



HARYANA POWER GENERATION CORPORATION LIMITED

**1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR, HARYANA**

EPC PACKAGE TENDER SPECIFICATION

**VOLUME - V
INSTRUMENTATION & CONTROL WORKS**

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VOLUME - V	INSTRUMENTATION & CONTROL WORKS
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VOLUME - V	Instrumentation & Control Works (Part - A)
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S No.	CHAPTER DESCRIPTION	No. of Sheets
1	Scope of Supply and Services	96

VOLUME - V	Instrumentation & Control Works (Part - B)
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Chapter No.	Titles	No. of Sheets
1	General Information and Design Criteria.	10
2	Field and Measuring Instruments	64
3	Distributed Digital Control, Monitoring & Information System	86
4	Main Equipment Related Control and Instrumentation System	19
5	Steam and Water Analysis System (SWAS)	12
6	Supervisory Control Panels, Supervisory Desks and Equipment Panels	26
7	UPS System & 24 V DC system	19
8	Process Connection & Piping	11
9	Instrumentation and Control Cables	36
10	Maintenance and calibration Equipments	55
11	Control Valves with Actuators	10
12	On line Plant Performance Analysis, Diagnosis & Optimization System (PADO)	6
13	Type Test Requirement	11
14	Plant Auxiliary System with Annexure	34
15	Environment Monitoring Systems	26
16	Plant Security and Surveillance System	18
17	Quality Assurance and Testing and Guarantee	32
18	Control Philosophy for BOP Packages	34
19	Operator Training Simulator	27
20	Documentation Management System	11
21	Video Conferencing System	11
22	Communication System	26
23	Material Supply, Ware Housing, Erection, Testing and Commissioning	20

1.0 CONTROL AND INSTRUMENTATION SYSTEM – SCOPE OF SUPPLY AND SERVICES**1.00.00 GENERAL**

1.01.00 The Bidder shall provide Control & Instrumentation system for control, monitoring and operation of entire plant including all the systems, equipment etc. covered under various sections of these specification (like Mechanical sections for SG/TG/Auxiliaries/Offsite/BOP etc, Electrical sections for Generator/MCC/SWGR/Transformer/Switchyard etc.) in all regimes of operation in safe and most efficient manner. The scope of work for the equipment, material and system to be furnished in accordance with this specification shall include design, engineering, manufacture, fabrication, assembly, pre-shipment testing at manufacturer's works, proper packing for transportation, delivery at plant site, unloading, storage, installation, interconnection with related plant and equipment, calibration, erection, testing, commissioning and putting the Control and Instrumentation System together with all accessories, auxiliaries and associated equipment as specified hereinafter in a fully operational condition and in the manner acceptable to the Owner as covered under this specification. The Bidder shall also provide all material, equipment and services which may not be specifically stated in the specifications but are required for completeness of the equipment/systems furnished by the Bidder and for meeting the intent and requirements of these specifications. The work shall be consistent with modern power plant practices and shall be in compliance with all applicable codes, standards, guidelines and safety requirements in force on the date of award of the contract. The requirements of statutory Authorities (e.g. MOEF, Inspector of Factories, IBR, TAC, CPCB/SPCB,CERC, CEA, BEE etc., with regard to various plant areas like main plant, Fuel Oil Plant/System, Chlorinating Plant, Firefighting system, Emission measurements, AAQMS etc.) shall be complied even if not actually spelt out.

Anything which is not specifically mentioned but is required for completeness of the systems and reliable operation of the Unit shall be provided by the bidder in its scope.

1.02.00

It shall be the responsibility of the EPC Bidder to coordinate with Owner and offer Control and Instrumentation System to meet the actual requirements of the plant and furnish a complete system as per clause 1.01.00 above, and all other related equipment and systems.

1.03.00

The brief scope of the above is described in following clauses. It is intended to provide the brief scope only, any other equipment/system required for ensuring the safe, reliable and trouble free operation of the plant under the present scope of the work shall be provided within the lump sum quoted price of the contract. The detailed technical specifications are stipulated under various Control and Instrumentation Sub-sections/chapters, Part - B, Vol. V of the specification as well as in various other Parts of the Technical Specifications including all annexure, appendixes & drawings etc.

1.04.00

In the event of conflict between requirements of any two clauses of specification documents, the more stringent requirements shall apply unless otherwise confirmed by the Owner in writing before the award of this contract, based on a written request from the Bidder for such clarification.



1.05.00 The contract quantity shall be as per Appendix-I to C&I section, part- A, Vol. V of Technical specification read in conjunction with detailed technical specification.

In addition, the Bidder shall also provide all system/equipment/instruments etc. described elsewhere in this specification.

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

2.00.00 **DISTRIBUTED DIGITAL CONTROL, MONITORING & INFORMATION SYSTEM (DMIS)**

2.01.00 Latest state of Art microprocessor based Distributed Digital Control, Monitoring & Information System (DDCMIS) shall be provided comprising of the following as a minimum and meeting all the requirements specified under Sub-section, Chapter 3, DDCMIS of Part -B, Vol. V of Technical Specification and the following contents of this chapter 3:

- i. Control systems for boiler, turbine & balance of plant (namely SG-C&I, TG-C&I & BOP-C&I including their respective measurement systems).
- ii. Man-Machine interface and Plant Information System (MMIPIS).
- iii. Sequence of events (SOE) recording system.
- iv. Annunciation system.
- v. Master & slave clock system.
- vi. HART System
- vii. Station LAN System
- viii. Special Requirements for system (refer details below)
 1. Software for determination of optimum Controller parameters
 2. Performance Calculations (Class I & II)
 3. Messaging System
 4. Trend Alarms
 5. Alarm Analysis
 7. Automatic Unit Startup & Shutdown
 8. Replay software for Trip/ Disturbance Analysis
 9. Other functions of Control system
- ix. Security Policies and Procedures
- x. Data Communication System
- xi. Annunciation System
- xii. System Programming, Maintenance & Documentation

The contract quantity of various subsystems of DDCMIS like I/O and drive quantities, signal exchange with other systems, hardware and peripherals of HMIPIS, programming station etc. shall be as per Appendix-I to Part- A, Vol. V of Technical specification read in conjunction with detailed technical specification.

For Messaging system, wireless link Remote Access Services, Broadband services and Remote Service Centre connectivity the fixed cost (e.g. service provider charges & its equipment etc.) and running cost till warranty period shall be included in the Quoted Price.



2.02.00 The DDCMIS systems to be provided for this project shall be as follows :-

a. DDCMIS consisting of following :

- (i) SG system.
- (ii) TG system
- (iii) BOP system.

b. Plant Water DDCMIS System

c. AHP DDCMIS System

d. CHP DDCMIS System

e. Flue Gas Desulphurization (FGD) DDCMIS System

f. Standalone DDCMIS Systems

g. Fuel Oil Pump House DDCMIS System

h. Waste Water RO DDCMIS System

The primary control locations for above systems shall be as follows.

a. Unit DDCMIS : Unit CER/CR

b. Plant Water system DDCMIS: Plant Water system control room.

c. AHP DDCMIS: AHP control room.

d. CHP DDCMIS: CHP control room.

e. Flue Gas Desulphurization (FGD) DDCMIS –FGD control room

f. Standalone DDCMIS : Respective Control Rooms

g. Fuel Oil Pump House DDCMIS :FOPH Control Room

h. Waste Water RO DDCMIS : Respective Control Room

Remote IO's (RIOs) are envisaged for systems (a) to (e) above, which will be finalized during detailed engineering stage. Also refer Appendix III TO Part A.

Also refer clause no 9.00.00 of this sub-section for systems not covered above.

2.03.00 **The Control systems (Including its Measurement system) to be provided for this project shall be as follows:**

2.03.01 The control system shall broadly consist of the following system(s):-

a. Unit System :-

i. SG System :

The SG C&I system comprising of Burner Management system (BMS), Secondary Air Damper Control (SADC), Soot Blowers Controls, Aux. PRDS control, Atomising Steam/Air Pressure Control, Mill Reject system, Fuel oil header pressure/flow control, Mill fire control, mill lube oil system control , SCAPH drain tank controls, Start Up System Controls, Start Up Drain and vents controls etc. and control of common systems like FOPH , FO unloading, Air Compressors etc. The BMS shall comply with NFPA 85. The Master Fuel Trip (MFT) Sub Group of BMS shall comply with EN50156-1:2015, clause 10 and latest standard.

ii. TG System

1. Steam Turbine and Generator (TG) C&I system comprising of Turbine Protection System Function (TPS) including generator mechanical protection system, Turbine Electro-hydraulic Governing system, Turbine Stress Evaluation / Control System (TSCS) and turbine supervisory system, Gland steam pressure control, turbine oil temperature control for Main and BFP Turbine, Automatic online Turbine Testing (ATT), Automatic Turbine Run up/Shut down System (ATRS), HP/LP Bypass Control System, Turbine - Generator control system for Seal oil, primary water, Generator gas temperature control, Turbine Extraction NRV control ,complete BFP turbine and its auxiliaries OLCS and CLCS controls. Miscellaneous turbine related start Up Drain and vents control etc. Please also refer FG guidelines specified in Annexure-III to contract quantities of DDCMIS of Appendix-I to part-A.

2. Other Miscellaneous TG system controls:-

- (1.) Condenser on load tube cleaning & SCS controls
- (2.) Turbine lube oil purification control
- (3.) Central lube oil purification control

iii. BOP System

The balance of plant (BOP) C&I system shall be provided comprising of modulating control functions pertaining to the other plant areas like coordinated master control, combustion control, furnace draft control, FW flow control etc. and binary control functions pertaining to other plant auxiliaries like FD/ ID/ PA fans/ APH/ MDBFP/ CEP/ DMCWP/ various other pumps, valves & dampers , electrical breakers, control & monitoring of offsite system plants like CW & ACW system, CPU (service vessel), Cooling Tower, Air Conditioning & ventilation system of Main plant control building area , ESP control building area etc.,SCR Aux system including Ammonia dosing, unloading & storage system and for some station level controls/supervisory functions, Water Control System comprising of binary & modulating controls of Make Up Water Pumps etc.



The BOP control system shall comply with the requirement of combustion control implosion protection as stipulated in NFPA-85. Automatic unit startup and shutdown controls under various regimes of operation shall also be implemented. Also refer FG guidelines specified in Annexure-III to contract quantities of DDCMIS of Appendix-I to part-A.

b. Water System.

Water System Control System comprising of binary and modulating controls of PT plant, PT & CW chlorination system, CW Treatment System, Make-up water pumps, DM plant, Ash Water recirculation, Effluent treatment plant (CMB sump & Pumps system), CSSP, CW Chlorination System, CW Treatment plant etc. However, the control of sewage pumps in various plant areas (as applicable) shall be through self-standing local control panel.

c. AHP System.

Ash Handling Control System comprising of binary and modulating controls of dry and wet ash handling system, bottom ash handling system, ash slurry pumps, air compressors etc.

d. CHP System.

Coal Handling System Control System comprising of binary and modulating controls of crushers, conveyers, dust suppression systems etc.

e. FGD System

FGD system control system comprising of binary and modulating controls of Absorber System, Lime Handling System including Lime Sampling System, Dust Extraction System, Dust Suppression System, Service Water System, Potable Water System, Gypsum Dewatering System, Gypsum Handling and evacuation System, Waste Water Treatment system and for some other FGD system controls/supervisory functions etc.

f. Stand-alone System

A stand- alone common system shall be provided for control and monitoring of some common system plant like FOPH, FO unloading, Plant Air Compressors, Ammonia Handling System, Cooling Tower, Air Conditioning and ventilation system of Main plant control building area, Make Up Water Control System and CPU (regeneration) and for some station level controls/supervisory functions.

- 2.03.02 It is preferable to provide control systems of same make for SG, TG & BOP systems of Unit system defined above. However, control systems for BOP part of unit DDCMIS & Off-site DDCMIS shall be of same make & model and PLC systems as applicable for balance plant packages shall also preferably be of same make & model.

Further, it shall be ensured that all instruments/devices are preferably of the same make, series and family of hardware, so as to ensure smooth and optimal maintenance, easy interchangeability and efficient spare parts management of various C&I instruments/equipment. For example, all 4-20mA electronic transmitters/ transducers, control hardware, control valves, actuators and other instruments/ local devices etc. for steam generator, turbine generator and other auxiliaries shall preferably be of the same make and series for similar applications, except for the instrument integral to TG, boiler and BFP which may be manufacturer specific. The complete control systems equipment and instruments/ devices etc. shall employ latest state of the art technology to guard against obsolescence.



- 2.03.03 The functional grouping of the above systems shall be as per the guidelines given in annexure – III of contract quantities for DDCMIS, Appendix I to part A.
- 2.03.04 The control system of each of the sub systems shall consist of controllers, communication controllers and other hardware as elaborated in Sub-section – chapter 3, DDCMIS, Part-B, Vol. V of Technical Specification.
The above system(s) shall include their respective measurement system for signal acquisition, conditioning and signal distribution of various types of inputs/outputs, meeting specification requirements including respective Hardware requirements as stipulated in Sub- section – chapter 3, DDCMIS, Part-B, Vol. V of Technical Specification.
- 2.03.05 The Bidder shall provide HART based control systems only with suitable interface for unit DDCMIS for centralized configuration, maintenance, diagnosis & record-keeping for all electronic transmitters, control valves & analyzers with HART protocol.
- 2.03.06 In addition to above, Bidder shall comply and follow the guidelines notified by Ministry of power and CEA, time to time for Cyber security of power plants.
- 2.04.00 Human - Machine Interface & Plant Information System (HMIPIS)**
- 2.04.01 HMIPIS configured around latest state-of-the art servers/Workstations with open architecture supporting OPC/TCP/IP protocols, etc. shall be provided.
- 2.04.02 Unified HMI is to be provided for complete Unit DDCMIS (i.e. SG, TG, BOP systems) even if separate control systems shall be envisaged for critical STG Protection systems. The detailed functional requirements for the Unified HMIPIS are indicated at Part-B, subsection chapter 3, DDCMIS and its associated contents. In order to fulfill the above functional requirement, the requisite interfacing hardware and software has to be considered by the Bidder without any cost implication to the Owner. All the performance requirement of Unit DDCMIS including command response time shall be demonstrated with Unified HMI. The solution offered for Unified HMI will be tested as part of Major Design Feature Testing. Unified system needs to be maintained for the subject project.
Bidder is required to provide configuration and write-up for implementation of Unified HMI in the Bid.
- 2.04.03 Cross HMI operation shall be applicable through which drives in one HMI (DDCMIS) can be controlled from a different HMI (DDCMIS) through authorized access. Refer Part-B, subsection chapter 3, DDCMIS for details.
- 2.04.04 It shall be possible to control interfacing systems like FOPH, FO loading/unloading, Air Compressors etc from plant DDCMIS.
- 2.04.05 The HMIPIS will include the following as a minimum:
- 2.04.06 Operator Work Station (OWS) in Unit Control Room (UCR).
- 2.04.07 Processing Stations (Servers/Workstations) in redundant configuration including RAM, dual bulk memory etc. Optical Drive or equivalent as per DDCMIS Supplier's standard practice shall be used for historical storage and retrieval and long term storage and retrieval of data.

Servers/ workstations which are located in programmer's room will be multiplexed with the help of matrix KVM switcher for six users (Refer drg. No. 114-01-100 sheet 2 of 2).

- 2.04.08 Network ready Heavy duty line impact Dot Matrix Printers and laser printers for taking printout of logs/reports, color hardcopy and for printing curves/graphs.
- 2.04.09 Minimum amount of conventional mosaic compatible hardwired devices mounted on draw out portion of Control Desks.
- 2.04.10 OWS based monitoring Stations located at various plant areas.
- 2.04.11 Redundant LAN for communication between various OWS, between OWS and processing stations and OWS/PC. A redundant station-wide LAN for connecting the unit and other sub systems of DDCMIS, PLCs, as applicable OWS, stations & DMS etc. as well for connecting to the other off-line services of the Station LAN This shall include all cables, hardware, software and accessories required for connecting Bidder's system upto the remote terminals at Headquarters. Complete system interfacing & successful implementation is in Bidder's scope.
- 2.04.12 Large Video Screens (LVS) with its work station (independent of OWS) and graphic processors to dynamically display plant data / mimics / alarms and any other process information. The Large Video screens shall have additional features to work in association with multiple numbers of plant cameras also to be supplied under this package.
- 2.04.13 Wireless Link:-For the following system identified below, Bidder shall consider wireless link or hardwired link for remote operation of the systems:
1. AAQMS system as described in Vol. V, Sub Sec chapter 15, Part B.
 2. Between CHP stacker reclaim PLC and station LAN switch/CHP DDCMIS as described in Vol. V, Sub Sec chapter 14, Part B.
- Also Bidder to include the following:
- i. Bidder shall include all necessary equipment including towers on both sides.
 - ii. All licenses, statutory clearances for equipment in his scope.
 - iii. The fixed charge and the running cost till warranty period shall be included in the quoted price.
 - iv. All the Coordination, obtaining clearances and payment of applicable fees required for obtaining license in owner's scope shall be in Bidder scope.
- 2.04.14

Adequate measures shall be provided for the security of the DDCMIS including the Station LAN as detailed at Part-B, subsection chapter 3, DDCMIS. This includes Redundancy in firewall, IPS module in the firewall, Connection to Bidder remote service center through VPN technology, Network based IDS with Station LAN switch, NMS, additional server for NMS/firewall logging, Test Server, creation of DMZ zone in the firewall. etc.



2.05.00 Data Communication System

2.05.01 System Bus connecting Control System and HMIPIS. Other bus systems for connecting various systems/subsystems of DDCMIS like Cubicle Bus, Local Bus, I/O Bus (Including Remote I/O Bus) soft links (including those from Field Bus based temperature transmitter) as well as within systems/sub-systems of DDCMIS. All the bus systems shall be redundant except for backplane buses which can be non-redundant.

2.06.00 Remote Input/ Output Modules

2.06.01 Remote input / output modules and cubicles for specified locations in the plant for the signals, which are used for information and Control / Interlock purpose, are to be provided. Actual locations shall be finalised during detailed engineering.

2.07.00 SER & Annunciation Function

2.07.01 Sequence of events recording function (in-built with BOP / Unit DDCMIS) for all inputs connected to it with a resolution of one millisecond with facility of historical storage.

The annunciation system shall be built as a part of the control system of the DDCMIS, for which HW annunciation system shall also be provided by Bidder.

2.08.00 System programming, diagnostics & documentation facility.

2.08.01 The programmer station shall be provided for configuration /tuning/structuring of control system and program development /modification of HMIPIS. A Workstation based system documentation facility for automatic generation of system documentation shall be provided to achieve paperless documentation for the project. The diagnostic system shall have elaborate diagnostics facility giving details of fault in I/O modules, other modules and cabinets on OWS/ LVS in form of display and text messages.

2.08.02 For each of the DDCMIS/ DDCMIS based controls being provided for any system, 1 set of programming tool/laptop for each such system shall be provided to view & change logic/program/settings. The Bidder shall furnish a comprehensive list of such systems within 6 months of NOA.

2.08.03 Software for determining optimum controller settings for control loops shall be supplied as per subsection DDCMIS, Part-B, Chapter- 3.

2.09.00 Master & Slave Clock System

2.09.01 One Geo-positionary satellite (GPS) based Master Clock in redundant configuration and slave clocks for the unit and common areas shall be provided with suitable equipment including antenna, receiver and associated electronics to receive synchronization signals from GPS. The master clock shall synchronize DDCMIS of the unit and other DDCMIS subsystems, PLC and microprocessor based control system at suitable intervals to maintain uniform time throughout the power station. The clock system shall be date insensitive.



2.10.00 Power Supplies

2.10.01 Hot parallel Redundant power packs/ supplies for powering the systems described above in system cabinets with necessary auctioneering and distribution.

Cabinets**2.11.00**

- (a.) System cabinets housing electronic modules and power pack supplies of system described above.
- (b.) Marshalling cabinets separate from system cabinets for terminating inputs from field, MCC/SWGR etc., for further wiring to control system and for terminating outputs from control system to MCC/SWGR etc.

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.

- (c.) Relay cabinet-housing relays for providing contact outputs by control system to other system wherever contacts are used in circuit/scheme of Control supply/power supply of more than 24 V and in cases where the VA burden is more than the VA burden the Output module can drive. Alternatively, these relays can also be mounted in termination/marshalling cabinets also. It may be noted that relays cannot be mounted in system cabinets. Make of relays and relay board shall be from same OEM.
- (d.) Electrical hardware cabinet for items required for synchronization (like auxiliary. PTs and synchronizing check relay and guard relay as well as auxiliary relays on as required basis etc.).
- (e.) In case different control system is provided for TG system (refer clause 2.03.02) & it is Bidder's standard and proven practice not to provide separate marshalling cabinets, then the system cabinet can be suitably partitioned to create separate marshalling area on the rear side of the system cabinet to ensure segregation of the electronic module area from the marshalling area.

2.12.00 Warranty

2.12.01 Warranty for all DDCMIS systems, Simulator, PLC system, all types of C&I instruments/system and other critical components shall be as per Sub-section chapter 3-DDCMIS, chapter 17-Part -B, Vol. V of Technical Specification and as per warranty clauses included elsewhere specified in the specification.

2.13.00 Representative of OEM shall be required to be present during Factory acceptance testing of respective DDCMIS/DCS/PLC/any other micro-processor based control system etc. for testing of finally implemented control system. Logic/HMI implementation for various DDCMIS/DCS/PLC system/microprocessor based control system etc. shall be done in Uniform way and documents of these shall be furnished in uniform format, as approved by Owner.



3.00.00 MAIN EQUIPMENT RELATED CONTROL & INSTRUMENTATION SYSTEM

Other special C&I systems shall be provided by Bidder including but not limited to the following as a minimum as per the requirement of Sub-section, Chapter 4, Main Equipment Inst. Sys., Part -B, Vol. V of Technical Specification.

- a) Flame Monitoring System and flame detector testing kit.
- b) Coal-Feeder Control & Instrumentation.
- c) Coal Bunker Level Monitoring System
- d) Electromatic safety valves.
- e) Furnace temperature probes.
- f) Acoustic Steam Leak Detection System
- g) Furnace and Flame Viewing System.
- h) Level switches Drip legs employing conductivity type probes.
- i) Mill & Air heater Fire Detection System.
- j) On Line Carbon in Ash Analyzers System
- k) Turbine supervisory system (TSS) including vibration analysers, vibration monitoring system, axial shift, eccentricity measurement system etc. for Main Turbine and BFP Turbine etc. Hardware and software provisions for diagnosis and analysis of plant auxiliaries vibration as indicated under Appendix-I to Part-A, Vol. V, "Contract Quantities other than DDCMIS item".
- l) Complete hardware and software system for turbine stress computation, fatigue analysis for all affected critical components of the turbine, computation of Residual Life Analysis and long term storage of the relevant monitoring of turbine critical components.
- m) Auto synchronizer for Turbo-Generator.including Test kit for Auto synchronizer for Turbo-Generator. 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.
- n) Load Transducers, Hardware & Software based Load shedding Relays (if applicable)
- o) Acoustic Pyrometers.
- p) Coal Mass Flow & Velocity Measurement System.
- q) Coal Bunker Level Monitoring System (For each coal bunker of coal feeder using 3D type acoustic wave level transmitter – 1 No. and strain gauge method system – 1set.).
- r) Viscosity Meter for HFO.
- s) Effluent Quality Monitoring system (EQMS)
- t) Seal Oil Pressure, H2 Pressure and Instruments Air Pressure Measuring devices
- u) Analyzers for NOx Control System & FGD system

4.00.00 MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)

The Following shall be provided as minimum meeting the Specification requirements Of Sub-Section – Chapter 2, Measuring Instrument and chapter 18, BOP control philosophy Of Part-B, Vol. V and other volume Of Technical Specification.

- (a) All the primary Instruments like Microprocessor based transmitters including temperature transmitters employing HART protocol, thermocouples & RTDs, Ultrasonic flow Transmitter / Impact Head type flow elements for CW flow, transducers, Ultrasonic / Guided Radar type level transmitters, Pressure/Diff. Pressure/Temperature/Flow/Level transmitters & Gauges, Flow Sensing Elements (Orifice Plates, Flow Nozzles, Impact Head Type Elements, Coriolis Type Flow Measuring System etc.) , Ultrasonic Flow Transmitters , positive displacement type flow transmitters , Magnetic Flow meter, Vibration sensor, key phasor, CEMS, O2 analyser, Mercury analyzer, AAQMS etc. shall be provided on as required basis meeting functional redundancy, available and reliability requirements of the specification subject to minimum quantities as indicated in enclosed tender drawings/ BOQ, corresponding Mechanical / Electrical sections.



- (b) All the instruments which are required to implement the control philosophy as specified in corresponding Mechanical sections or as finalised during detailed engineering shall be provided by the Bidder within his quoted lumpsum price.
- (c) All Instruments which are Integral to equipment like pumps, motors etc. / skid mounted instruments and are not indicated in enclosed drawings (as applicable) or in BOQ etc. included in relevant sub-sections, but are required for control, monitoring and operation of the equipment/plant/ Systems are to be provided by the Bidder to meet actual system requirements. Specification / type of instruments shall be subject to owner's approval during detailed engineering. However, for temperature elements including bearing/ winding temp of motors / pumps temperature transmitters shall be provided, with philosophy as defined at e (i).
- (d) All instruments which are required for implementation of specified monitoring, diagnostics and analysis system such as on-line Plant Performance Analysis, Diagnosis & Optimization system (PADO) for the station , vibration analysis system, various online Performance Monitoring calculations etc, in main plant area are also to be provided by the Bidder.
- (e) Temperature transmitters :-
Rail mounted/ Rack mounted (Dual input Field mounted temperature transmitters)/ Field Bus Compatible temperature transmitters for temperature elements (for all the temperature elements being procured by the Bidder) are to be provided by the Bidder as per the followings :-
- i Bidder shall provide at least one dual input transmitter for temperature measurements being used in trip/protection/major interlock of Major auxiliaries. eg. when three/two temperature measurement points are being used to for monitoring one bearing temperature, both elements of one duplex temperature element is to be connected to one dual input temperature transmitter.
 - ii For monitoring of Boiler SH/RH metal temperature Profibus / Foundation Field Bus Compatible temperature transmitters are also acceptable.
 - iii Remaining temperature transmitters in main plant area are to be Single Input DIN rail mounting type, mounted in JB's.
 - iv DIN rail mounted in JB's, as finalized during detailed engineering stage, can be provided for Auxiliary plants like Water System, Cooling Tower, Ash Handling Plants etc.

(f) **Type of Instruments :-**

For sequence, protection, control and alarm circuits, electronic transmitters, temperature elements with temperature transmitters etc. are to be provided. Process actuated switches may be accepted only in very few cases if the same is as per standard and proven practice of equipment supplier subject to owner's approval. Wherever process actuated switches are being provided for sequence, protection and alarm purposes, adequate number of blind type switches separate for each application (i.e. sequence, protection, alarm) with separate necessary indicating gauges are to be provided meeting adequate redundancy requirements. Contacts of indicating type switches, gauges and receiver instruments shall not be acceptable.



Wherever redundant transmitters, temperature elements are being provided for sequence, alarm and protection circuits, transmitters/temperature elements separate for each applications are not required to be provided.

(g) Redundancy requirements/Criteria for Sensors & Signals from MCC/SWGR

Redundancy of components and systems shall be dictated by availability criteria described under DDCMIS/DCS/PLC to ensure the system availability target as well as safety considerations in critical applications are fully met.

Bidder shall also introduce redundant control equipments or instruments, wherever it is felt by owner that the introduction of the same shall lead to reduction of downtime of plant and equipments, in addition to the case/criteria clearly defined/identified in the specification.

Triple redundancy or dual redundancy for signals from MCC/SWGR, field instruments/sensors and transmitters will be used for critical control /Protection application, critical monitoring applications & all other control/interlock applications. Where correction/ compensation for the measured signal are involved, the computed signal shall be the one transferred for control purposes. The measured value indicated shall be the duly corrected/ compensated signal.

Sensor/signals/measurements redundancy required (2 out of 3 or 1 out of 2) requirement have been specified in respective control system specifications and as specified elsewhere in the technical specification. However, sensor/signals/measurements utilization will be decided during detailed engineering. It is mandatory to use sensors/signals/measurements with 2 out of 3 logic for critical control & protection (Analog & Binary) application/service and sensors/signals/measurements with 1 out of 2 logic for all other control & interlock (Analog & Binary) application/service as explained below:

i. Triple measurement scheme

Triple measurement scheme for analog inputs employing three independent transmitters connected to separate tapping points shall be employed for the most critical measurements. The same shall be used in analog control functions including, the following but not limited to:-

Main Steam Pressure, HRH Steam Pressure, CRH Steam Pressure, Furnace draft, feed water flow, Feed Water Temperature, feed water pressure before Economiser, Discharge Flow of each BFP, BFP discharge Temperature, BFP suction & discharge pressure, TDBFP suction Flow, MDBFP Suction Flow, Economiser flow, Boiler recirculation pump suction temperature, Differential pressure across the Boiler recirculation pump, Boiler Separator level control, Steam Pressure, Main steam & RH steam temp. control, SH spray Flow, RH spray Flow, throttle pressure, soot blower steam pressure control, PA/SA Air Flow, PA/SA Air Temperature, PA header pressure, Mill Air Flow, Mill outlet Temperature, Feeder Speed Control, Spray water flow, SH, RH & Aux. Steam Desuperheater inlet & outlet Temp at each stage, SH Platen Steam Temperature before Desuper heater, SH Platen Steam Temperature after all super heaters, RH steam Temperature at Turbine end, Main steam Temperature at turbine end, Aux steam Pressure & Temperature controls, turbine first stage pressure, deaerator level, Deaerator Pressure, Deaerator Flow after Last LPH, Hotwell level, GS steam Pressure, Condenser pressure, condensate flow before recirculation line, turbine speed, , Power measuring device, HP and LP Heater level, PA header pressure, SCAPH temp. Control, HP Bypass controls, LP Bypass controls, HP Bypass flow, Light Oil Pressure, Heavy Oil Pressure, Atomising Steam Pressure, Heavy Oil Temperature, Hydrogen gas pressure of generator, TDBFP steam Pressure, TDBFP steam Temperature, TDBFP controls, BFP Speed control, Turbine lube oil temperature control and all other trip & protection logics etc. All corresponding temperature and pressure compensation instruments shall also be triple redundant only.

For MFT/ FSSS/ BMS/ Turbine protection/ Generator /Unit tripping, triple signals/ measurements/ sensors shall be provided.

For Binary and analog inputs required in major equipment (Furnace, Turbine, trinning/protection of any HT drive etc.) protection triple-sensing devices shall be provided.



Binary and analog inputs, which are, required for protection of more than one equipment as well as protection signals for HT Drives (fed by a supply feeder of ratings 3.3 kV onwards)/MDBFP/TDBFP etc., triple sensing devices/signals shall be provided.

Separate Triple sensors shall be provided for Instruments required for auto starting of HT driven pumps or HT driven pump tripping due to very low level of water & discharge pressure very low and Trip of any auxiliary which will lead to substantial (50%) loss of unit availability.

For lube oil protection of all the HT drives, 2 out of 3 logics shall be provided and necessary pressure and level transmitters for lube oil shall be provided by bidder accordingly.

Left and right side shall be treated as individual path / individual parameter, and each side/path shall have own triple redundancy accordingly.

ii. Dual measurement scheme

For binary and analog inputs required for all other modulating control, protection and interlock conditions purpose of other equipments and other critical monitoring applications etc., min. dual instruments/sensors shall be provided.

Dual instruments/sensors shall be provided for Instruments required for auto starting of LT driven pumps or LT driven pump tripping due to very low level of water/discharge pressure very low.

Dual position transmitters shall be provided for Steam Admission Valves i.e. (Main steam Stop & Control Valves, Reheat Stop Valves & Control valves and TDBFP steam stop valves & control valves), Extraction steam QCNRV, CRH NRV.

Dual sensors shall be provided for instruments required for Heat rate measurements & PADO calculations. Redundant duplex Temperature Elements shall be provided before and after of each LP Heater and HP Heater on water lines for TTD in PADO.

Dual analysers shall be provided for chemical dosing controls and O2 dosing controls.

Dual duplex RTD shall be provided for each bearing of HT drives covering Motor & driven equipment.

- iii. For binary and analog inputs used for alarm and monitoring only, single sensor criteria shall be applicable.
- iv. All the instruments/ sensors/ transmitters/ switches meant for redundant applications shall have completely separate and independent impulse pipes/ root valves etc. No redundant instrument shall share a single process tapping. There will be separate and independent tapping for every individual instrument.
- (h) CEMS instruments including SO_x, NO_x, CO, CO₂, Mercury Analyser, dust emission monitoring systems for chimney and ESP, O₂ and Ambient Air Quality Monitoring Stations (AAQMS). For Quantities, refer to Appendix-I to Part-A, Vol. V, "Contract Quantities Flue Gas Analysers & CEMS Analysers".
- (i) Wall mounted/panel mounted Digital Display unit /Indicator shall be provided for Main steam pressure, temperature, Fuel flow, Generator load, MW export, MVAR, frequency, Turbine speed, Condenser vacuum for unit control room, off-site control rooms and service building.
- (j) Refer to Appendix-I to Part-A, Vol. V, "Contract Quantities for the following:
 - (i) Microprocessor based vibration monitoring system for monitoring of vibration of major equipments.



Notes :-

- 1 For measuring instruments type, specification, redundancy and quantities that are connected to STG integral systems Skid Mounted systems, integral to Equipments, Bidder's standard and proven practice can be accepted subject to owner's approval.
- 2 For various auxiliary systems like DM/CPU/PT/CW chemical treatment/AWRS/ETP/LWTP/PT plant/Chlorination /CW/ACW/ / Cooling Tower/ Ash Handling etc systems, the required quantity of instruments including the analysers shall be provided to facilitate the remote operation of these plants through DDCMIS based control system.
- 3 For measurement of Condenser / Hotwell level, LP Heaters level Guided Radar type level transmitters shall be provided.
- 4 The instruments for CHP shall be provided as per standard and proven practice of CHP supplier. However for temp elements, DIN rail type temp transmitters mounted in JB's shall be provided.
- 5 Required number of Electronic flow meters shall be provided to measure the on line water consumption of individual plant areas as indicated in the water balance diagram / flow schemes. For measurement of water flow in open channel, parshall flume is to be provided.
- 6 For measurement of level of tanks/vessels/sumps containing oil, chemicals or water, Ultrasonic type level transmitters shall be provided. However, other type of level transmitters, if any, shall be acceptable only if there are constraints on account of process/equipment/device for having an effective measurement using the above. The acceptability of the same shall be subject to Owner's approval.
7. Level switches / pressure switches / flow switches/any other process switch etc. for OLCS / Alarms / Interlocks / Protection. Pressure switches at inlet, outlet of individual pumps and discharge header of pumps for protection and auto start / stop & alarms shall be provided.
8. Level switches for sump/tank/vessel/container/heaters level high/normal/low/very low interlocks shall be provided.
9. Pressure gauges and temp. Gauges at inlet and outlet of each heat exchanger and cooler shall be provided.
10. DPG, DPT & DPS across the filters/strainers shall be provided.
11. All primary Instruments, hardware & JB's etc used for measurement for HFO, LDO & Turbine Lube Oil system shall be flame proof (IEC-79.1, Part I).
12. All Thermocouples & RTDs shall be Duplex. Thermocouples shall be provided for Mill outlet temperature and for Services with Temperature ≥ 200 deg C.
13. Flow elements with flow transmitter & Flow meter for flow measurement of process medium like Steam, Water, Air, Flue Gas, Fuel oil, lube oil, open channel liquid, solid fuel, ash flow, ash slurry, DM water, Raw water, Instrument and Service air etc. shall be provided as decided by owner.



14. For Turbine oil, HFO/LDO applications & H2 gas applications, zener diode protection on power supplies shall be included.
15. Transmitters (all type) for monitoring & controls purpose shall be provided.
16. Gauges (all type) for local monitoring in field shall be provided.
17. All instruments should be supplied with valid calibration and test certificates provided by OEM.
18. Process switches like pressure switch, level switch etc. shall be provided with triple redundancy for all the applications required for Trip & protection of HT drives, boiler, Turbine & Generator and the applications, whose non-availability may lead to loss of generation. In addition, Transmitters & gauges shall also be provided for monitoring purpose. Further usage of switches for any other application based on functional/process requirement shall be decided by owner during detailed engineering.
19. Bidder to also refer Appendix V to Part A for further details of Field Instruments.
20. CEMS, EQMS and AAQMS instruments shall be provided with redundant bidirectional connectivity over Modbus/RS-232/RS-485 for real time data monitoring, remote diagnostics & remote calibration checks, etc., complying with CPCB IT Division document
21. "Protocol for real time (Emission & Effluent) data management from industries version 1.2 (10.6.2015) or the latest regulatory requirement prevailing at the time of execution of the contract.
22. All necessary hardware and software required at instrument end shall be provided by the Contractor.
23. Necessary details like scheme, registered addresses of analyzer, etc. shall also be provided by the Contractor for implementation of above.
24. For CEMS and EQMS - In addition to above requirement, 4-20 mA connectivity to DDCMIS shall be provided by the Contractor.
25. For AAQMS - In addition to above requirement, analysers shall be connected to respective local data logger and central data logger by the Contractor as stipulated in other part of specification.

5.00.00 ELECTRICAL POWER SUPPLY SYSTEM

- 5.01.00 The DC Power Supply system shall be used for powering the control systems including the network devices and UPS AC Power supply system for powering HMIPIS and other critical loads.
- 5.02.00 Bidder shall provide power supply distribution panels/cabinets/boxes for sub-distribution of DC/Main UPS//utility feeders on as required basis. The power supply distribution box shall included change over circuitry, lamps, switch fuse units, MCB's, terminal blocks etc suitable for application.



5.03.00 For the exact number of 24 V DC power supply system, 230 V AC Un-interruptible power supply (UPS) system, Battery Health Monitoring System (BHMS) and other type of industry standard power supply system, refer Appendix-I to Part-A, Vol. V, "Contract Quantities UPS and 24V DC Power Supply Systems" and chapter 7, part B, vol. V.

6.00.00 PROCESS CONNECTION & PIPING

6.01.00 Process connection & piping including all impulse piping, sample piping, pneumatic piping/tubing, valves, valve manifolds, fittings and all other accessories required for proper installation & completeness of impulse piping system, sampling piping system and air supply system shall be SS material, and as per the details stipulated under Sub-section PCP, chapter 8, Part-B, Vol. V of Technical Specification shall be provided by the Bidder on as required basis.

6.02.00 All transmitters, switches etc. in Boiler Turbine Generator measurements (except for all fuel oil applications) shall be suitably grouped together and mounted inside (i) Local Instruments Enclosures (LIEs) in case of open areas of the plant like boiler area, etc. and (ii) In Local Instrument Racks (LIRs) in case of covered areas like Turbine/Generator area.

6.03.00 Local Instrument Enclosures (LIEs) and Local Instrument Racks (LIRs) complete with all fittings, mountings & accessories etc. are to be provided by Bidder on as required basis.

6.04.00 For skid mounted instruments and instruments integral to equipment, process connection and piping can be in line with Bidder's standard and proven practice.

7.00.00 INSTRUMENTATION CABLES, CONTROL & POWER SUPPLY CABLES & CABLES SUB-TRAYS

7.01.01 All instrumentation cables twisted & shielded, PVC insulated & sheathed with FRLS properties, including thermocouple extension cables (PVC / extruded FEP insulated & sheathed) and prefabricated cables (with plug-in connectors), Power Supply distribution cables, optical fiber cables, all cables related to fire detection and protection system (including short term fire proof cables) as applicable for interconnection of all equipment/system/devices DDCMIS/PLC/MCC/LT SWGR/HT SWGR/ Etc. shall be supplied, terminated and laid by the Bidder on as required basis.

7.02.00 For all the cables mentioned above at 7.01.01, all necessary laying & termination accessories, hardware, sub trays , main trays etc. for meeting requirements specified under Sub-section INST CABLE, chapter 9, Part -B, Vol. V of Technical Specification shall be supplied by the Bidder on as required basis.

7.03.00 Separate cables are to be provided for dual / triple redundant instruments used for protection of Unit and HT drives. These cables are also to be laid in separate routes to the extent feasible.



- 7.04.00 Complete Instrumentation cables shall be armored. Outer insulation color of the instruments cables shall be Pink/ Orange for identification.
- 7.05.00 Heat resistant instrumentation cable shall be provided for all instruments / equipment/ drives / devices located in hot areas such as Burner tilt, Hot air gates etc. This cable shall be laid from instruments / equipment / drives / devices from hot area application to a field JB / panel located in areas where ambient temperature is around 50 Deg. C. Heat resistant instrumentation cable shall have same specification as of instrumentation cable specified under Sub-Section chapter 9, Instrumentation and control Cables, Part-B of Technical specification, except that insulation and outer sheath material shall be Teflon. This cable shall be suitable for continuous operation at 205 Deg C.
- 7.06.00 Fire Survival cables shall also be provided by bidder as per requirements for Fire alarm, detection & protection system, Trip Push Buttons, emergency trip system, safe shut down circuitry and as specified elsewhere in the specification etc.

8.00.00 CONTROL VALVES & ACTUATORS

- 8.01.00 Pneumatically operated Control valves, actuators and accessories, shall be provided meeting requirements specified under Sub-section chapter 11, CONTROL VALVE, Part-B, Vol. V of Technical Specification. Specially designed valves/trims to prevent cavitation and limit noise and control outlet velocity, shall be provided.

- 8.02.00 Microprocessor based electronic positioner is to be provided with all the pneumatic operated control valves and all control dampers being provided by the Bidder. However, pneumatic positioners are also acceptable for high temperature and dust prone applications like SADC dampers and Burner Tilt.

9.00.00 CONTROL AND INSTRUMENTATION FOR MAIN PLANT AUXILIARY SYSTEMS

- 9.01.00 For Air conditioning and Ventilation system for Service building ,Fire Detection & protection system, Stacker & Reclaimer, In Motion Weigh Bridge system and Wagon Tippler of Off-site package of Coal handling Plant, complete microprocessor based PLC and GIU based control and instrumentation system along with all required power supplies, instrumentation cables, measuring instruments, process connection and piping, HMI system etc. with all accessories, auxiliaries and associated equipment and cables to be provided for the safe, efficient, trouble-free and reliable operation.
- 9.02.00 Instrumentation and Control System with interlocks, protection and annunciation of the mechanical common auxiliary systems shall be provided. Instrumentation for this system shall meet the requirement stipulated under Sub- section/chapter Aux. Plant. Ctrl, chapter 14, Part -B, Vol. V of Technical Specification.
- All necessary equipments / system for control, monitoring and operations of the plants as well as the incomers and bus couplers shall be provided.
- 9.03.00 For certain auxiliary plants, control system shall be provided as indicated in Sub-Section/chapter Aux. Plant. Ctrl, chapter 14, Annexure A, Part-A of Technical Specification.

10.00.00 TYPE TEST REQUIREMENT

10.01.00 The type tests to be conducted for C&I systems & equipments shall be as detailed out in Sub-Section/chapter C&I TYPE TEST, chapter 13, Part-B, Vol. V of Technical Specification.

11.00.00 PLANT PERFORMANCE ANALYSIS, DIAGNOSIS & OPTIMIZATION SOFTWARE

11.01.00 The Bidder shall provide a OWS & server based On-line Plant Performance Analysis, Diagnosis & Optimization system (PADO) for the station, which will provide proper guidance to the plant operator.

11.02.00 The PADO system shall provide the following functions in a modular and seamlessly integrated environment, using a common plant model and a dynamically shared database.

- (i) Performance analysis and monitoring of systems and components.
- (ii) Emission Analysis and monitoring.
- (iii) System and performance diagnosis.
- (iv) System and performance optimization.
- (v) Boiler performance optimization including optimized operation of soot Blowing system.
- (vi) Boiler stress condition analysers.
- (vii) Interactive water and gas chemistry management system.
- (viii) Regenerative cycle performance optimization system.
- (ix) Thermal Performance analysis including heat rate and efficiency of generation.

11.03.00 All the software, hardware, instruments etc. which will be required to implement the above at Bidder's end shall be in the scope of Bidder, even if the same is not indicated in the tender drawings & other sections of the specification.

11.04.00 Details regarding software, hardware, instruments etc. are elaborated in Subsection PADO, chapter 12, Part B, Vol. V of technical specifications.

12.00.00 CONTROL DESK, PANELS & FURNITURES

12.01.00 The contract quantity shall be as per Appendix-I to C&I section Part-A, Vol. V of Technical Specification and as approved by Owner.

12.02.00 Minimum amount of back up instrumentation to be mounted on draw out portion of UCD shall be provided as per Appendix-I to C&I section, Part-A, Vol. V of technical specification.

13.00.00 STEAM & WATER ANALYSIS SYSTEM (SWAS)

13.01.00 The following shall be provided as a minimum meeting specification requirements stipulated under Sub- section SWAS, chapter 5, Part-B and item water system related analyzer system of Sub-section Measuring Instruments (primary and secondary), chapter 2, Part B, of Vol. V of Technical Specification.



- 13.02.00 Sample piping, primary & secondary coolers, chiller etc., complete with sampling pumps, gauges, switches, valves etc.
- 13.03.00 Analyzers with 4-20mA output & HART compatible for measuring conductivity (Specific & Cation), pH, Hydrazine, Silica, Sodium ion, Dissolved Oxygen, Chloride, Turbidity, Fe and for any other process parameter etc. For sodium, silica, iron and Chloride analyzers, Vendor may provide the Modbus RS 485/Profibus connectivity in addition to 4-20mA signals with DDCMIS/PLC without daisy link for all diagnostic facility in case same are not available with HART protocol.
- 13.04.00 SWAS panels viz. Sample conditioning panel and analyzer panel complete with valves, fittings, wiring etc.
- 13.05.00 OWS based stations for display of information and alarm to operator to be located at SWAS room (through station LAN).
- 13.06.00 All the chemical, reagents required for 12 months operation is to be supplied in phased manner depending on shelf life in addition to that indicated under mandatory spares.
- 13.07.00 All analyzers etc. are to be supplied on as required basis to make the system complete in line with the intent of this specification.
- 14.00.00 **COMMUNICATION SYSTEM**
- 14.01.00 Complete Communication system including telephone system, Modems, EPBAX, wireless system, Public Address system, OWS, UPS, including Handset stations, loudspeaker, cables, junction boxes, Industrial Grade communication Hardware, Surge protection devices, Fire walls etc. shall be provided covering the total plant area as detailed out in Chapter 22, COMMUNICATION SYSTEM, of Part-B, Vol. V of Technical Specification. For Quantities, refer to Appendix-I to Part-A, Vol. V "Contract Quantities PA System and Chapter 22, COMMUNICATION SYSTEM, of Part-B, Vol. V of Technical Specification.
- 15.00.00 **Operator Training Simulator System**
- 15.01.00 The Operator Training process plant simulator system shall be provided based on the design of the super critical power plant projects. The Simulator Design shall include equipment, Instrumentation and controls that will enable operator to function in all modes of the specified coal fired power plant operation including normal, abnormal or emergency operating conditions as specifically noted in Vol. V, Part B, Chapter no.19.
- 16.00.00 **Documentation Management System**
- 16.01.00 Bidder shall supply high standard State-of-the-art Documentation Management system as per Vol. V, Part B, and Chapter no.20. Minimally DMS shall facilitate Seamless integration with leading SAP,ERP and CRM solutions, Smart search function to make retrieval of information convenient, Consistent Workflows, Reliable data security irrespective of volume and capacity. DMS shall store documents, as to share them online with team members for convenient editing, and track changes in the document. Necessary permissions and restrictions shall be attributed for each document type as per the Owner's prior approved sensitivity rules and documentation policies to be finalized by Owner during implementation stage.
- 17.00.00 **VIDEO CONFERENCING SYSTEM**
- 17.01.00 Video Conferencing System shall be provided at the conference rooms in TG building and Service building. Video conferencing system facility with dedicated internet connection shall be provided as per in Vol. V, Part B, Chapter no.21, so as to talk to other thermal power stations, load dispatch center, HPGCL Headquarters etc. Supplier shall have AVIXA/Infocomm, USA's Certified Technology Specialists (CTS, CTS I & CTS D). However, the CTS holder should be associated with a manufacturing organisation, not an individual like consultant. Documentary proof of CTS holder being a part of supplier shall also be submitted.

18.00.00 PLANT SECURITY AND SURVEILLANCE SYSTEM

18.01.00 Plant security and surveillance system consist of Perimeter Intruder Detection System and Closed Circuit Television System (CCTV) and Plant cameras along with video switcher/control system, keyboards, monitors, interconnecting cables & interface to the LVS of HMIPIS shall be provided as detailed out in Sub-section chapter 16, CCTV, Part-B, Vol. V of Technical Specification for surveillance, safety and security of the various plant areas. For Quantities, refer to Appendix- I to Part-A, Vol. V, "Contract Quantities CCTV & Plant Intruder detection system".

19.00.00 M&C EQUIPMENT

19.01.00 One set of M&C Equipments as listed under chapter 10, C&I Section, Part-B, Vol. V "Bill of Material - M&C" shall be supplied by the Bidder. In addition to above, Bidder shall also provide any other equipment deemed necessary for maintenance and calibration of C&I devices/systems being provided under this contract. The Bidder shall erect and commission all M&C equipments and set up the electronic & pneumatic M&C laboratory.

19.02.00 All M&C items shall meet requirements stipulated under Sub Section-MCE, chapter 10, Part-B, Vol. V of Technical Specifications.

20.00.00 TOOLS & TACKLES

20.01.00 The Bidder shall furnish a complete new set of all special tools and tackles of reputed make and model which are required for erection, ease in maintenance to have minimum down time, testing and calibration of all the equipments and systems to be provided by the Bidder under this specification for C&I systems.

The Bidder shall hand over all the tools (Mechanical, Electrical and Electronic) in working condition to Owner, used by him during erection, commissioning and trouble shooting of the system. For further details refer to General Technical Requirements, Vol. II, Chapter 5. For Quantities, refer to Appendix-I to Part-A, Vol. V, "Contract Quantities TOOLS & TACKLES"

21.00.00 The Bidder shall furnish all OEM software & software licenses with life time validity. As and when such software is updated / upgraded, same shall be supplied & installed by bidder free of cost for a period of three (3) years after warranty period.

22.00.00 SCOPE OF SERVICES

The Bidder or his sub-vendor(s) / associate(s) / engineering firm(s) shall have established engineering setup including skilled & experienced manpower, engineering software(s) and other required resources for carrying out basic and detailed engineering of control and instrumentation systems of respective plant areas including main plant and offsite plants viz. Ash handling plant, Coal handling plant, Water systems plant etc. The Control and Instrumentation engineering shall include the following as a minimum.

Preparation of basic logic / loop diagrams (not just the implementation), I/O list, Drive list, instrument list etc for each of the plant areas of the complete plant including offsite systems based upon the flow schemes / write ups by the OEM's.

The block logics shall be in the format as approved by Owner during detailed engineering stage.

Engineering of power supply system for DDCMIS & PLC, Process connection and piping, SWAS, Control valves, field Instruments, Flow Elements etc.



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



- a. Instrumentation cable engineering including preparation of interconnection cable diagram, cable schedule etc.
- b. Erection, laying & commissioning of Erection Hardware & cables.
- c. Quality Assurance, Testing and Guarantees.
- d. Material ware-housing, erection, testing & commissioning.
- e. Training of Owner's personnel.

h. Erection, Testing and Commissioning

Bidder's scope for erection, installation and commissioning work under this specification shall include:

Installation, interconnection, testing and commissioning of all field instruments, equipment, cables and systems furnished by the Bidder as per this specification. This will include all required erection, testing and commissioning work for ensuring satisfactory operation of control and instrumentation equipment as per intent and requirements of this specification.

- i. Supply of all necessary tools, tackles, test instruments and experienced personnel for completion of the above erection, testing and commissioning works. Services of collaborators specialist if necessary or felt necessary by owner for successful commissioning of the system(s) shall be provided by Bidder within overall Package price.

ii. Other Services

The Bidder shall provide all other services necessary for meeting the intent and requirements of this specification. These shall include, but shall not be limited to, the following services for all equipment/ systems furnished as per this specification:

1. System engineering and design for all equipment/systems specified on system basis to ensure that the intent and requirements of this specification are fully met.
2. Preparation and furnishing of all drawings, data sheets, cable schedules, information as stated hereinafter in multiple copies to the Owner and other equipment Bidders. This will include all drawings/documents, technical literature identified under this specification and shall be adequate for:-
 - a) Ensuring proper review by Owner to ensure full compliance with specification requirements and proper interface with other related system.
 - b) Quality assurance checks during various stages of design, manufacture, installation, testing, system integration and commissioning; performance guarantee tests.
 - c) Post commissioning operation and maintenance of the equipment and systems.
 - d) The above drawings/documents shall be prepared by the Bidder and furnished to the Owner generally as per Distribution Schedule.
 - e) As commissioned/built drawings and documents.



3. Participation of Bidder's senior personnel and experts in discussions with Owners during various stages of contract implementation as required by the Owner.
4. Facilities for detailed engineering, system integration, inspection and witnessing of shop and site tests by representative of Owner and carry out performance guarantee test.

The Bidder shall conduct all shop and site tests as per the requirements of this specification and Owner approved 'Quality Assurance Programme'. All approval/Inspection are to be carried out by Owner or owner appointed agency only.

5. Training/Familiarisation / Acquaintance of Owner's engineers in all aspects including system design, engineering, installation, system integration, testing, commissioning, operation and maintenance at Bidder's manufacturing works either in India or abroad.
6. Recommendations and proposal covering spare parts required for 3 years trouble-free operation.
7. Guarantee for all equipment and system furnished under this specification.
8. Provision of post commissioning support on as required basis beyond Guarantee period on terms to be discussed and finalised later.
9. Provision of spare parts for at least 15 (Fifteen) years after commissioning of the plant.

2.0**APPENDIX - I TO PART - A****CONTRACT QUANTITIES OF GENERAL REQUIREMENTS****2.1****GENERAL REQUIREMENTS OF CONTRACT QUANTITIES**

The general scope of C&I systems under this specification is covered in Part-A of this specification and technical details given in Part-B. The purpose of this appendix is to supplement the same. The Contract quantities of many subsystems covered under Part-A and Part-B of technical specification are generally not reproduced here to avoid duplication. However, in case of any conflict or repetition, the more stringent requirements among them are to be complied with.

2.2**CONTRACT QUANTITIES FOR DDCMIS**

1.00.00 The Bidder shall provide DDCMIS complying with requirements specified in Subsection chapter 3, Part-B, other sub sections and enclosed drawings. Bidder should note that he has to supply system complete in all respects with all software, hardware, accessories, interfacing equipment required, etc., whether specifically stated herein or not, to make the system operational and fully meeting the functional, parametric, hardware, software, interfacing, quality assurance & testing requirements within the quoted lumpsum price.

1.01.00 The Bidder shall provide functional groups as per guidelines defined in Annexure-III. For each of the functional groups, separate sets of redundant controllers, I/O modules, communication controllers, power packs/modules, etc. shall be provided.

No. of Inputs/Outputs/Cabinets/Equipment

The quantity of I/Os, drives and other equipment related to Control system, HMIPIS are indicated as below:-

Annexure-I – Quantity of Drives and Inputs/Outputs, Cabinets, other equipment for Control System:

Table IA/IB - Quantity of Process Inputs/Outputs

Table IIA/IIB - Quantity of Drives

Table III - Quantities of HART signals

Table-IV - Quantities of equipment for control system

Annexure-II – Quantities of HMIPIS/ other equipment

The Bidder shall provide all hardware/software to meet the specification requirements and quantities defined in various Tables & Annexures will in no way limit Bidder's responsibility. Further, this list should be read in conjunction with the following and various notes:

- a) Typical MCC/switchgear in connection scheme Drg. No. 114-15-0101 to 0115 (For I/O count per drive, the quantity in the Table shall be applicable).



- (b) Guidelines for functional grouping of controllers (Annexure-III)
- (c) Table-“Drive I/Os” giving drive related inputs/outputs specified for each type of drive.

1.02.00 The requirement of loop reaction time (from change of input & the input module to the corresponding control command output) shall be as follows. The loop reaction time shall be within 250 milliseconds for close loop control system (CLCS). However, for faster loops such as feed water, furnace draft, PA header pressure control loop etc the same shall be based on actual process requirement but shall not be more than 100 milliseconds. For Open loop control system (OLCS), for some specific application like synchronization related breakers and Tie/ trip selection faster and deterministic loop reaction time (approximately 100 m sec) shall be provided if required to meet synchronization requirement. For other applications it will be suitable to match actual process requirement.

Notes for Table – “Drive I/O’s”, I, II, III & IV:

1. SOE is to be provided in UNIT DDCMIS for critical condition like each of the protection condition of HT drives, MFT, TG protection, trip of HT & critical drive, critical process parameters and status of some important electrical breakers.
2. Redundancy in binary outputs for OLCS drives:
 - (i) **UNIT DDCMIS**
 - a) SG System: For all drives of following systems: ERV, Oil System, coal/mill system, scanner air & seal air system, SADC system
 - b) TG System: As per the standard practice of TG supplier
 - c) BOP System: For 10% of drives distributed in various functional groups (Exact application shall be finalized during detailed engineering.)
 - (ii) For Other DDCMIS: HT, HTCHP type of drives.
3. Redundancy in analog outputs for CLCS drives:
 - (i) **UNIT DDCMIS**
 - a) SG System: For control valves of FOPH, CBD, Oil system, SADC
 - b) TG System: As per the standard practice of TG supplier
 - c) BOP System: For 10% of drives distributed in various functional groups (Exact application shall be finalized during detailed engineering.)
 - (ii) **For Other DDCMIS:** Not applicable



4. Additional note for Table "Drive I/Os"

(*) The on/off status of HT drives of Unit DDCMIS will be wired to DI modules in parallel. The open/ close status of sync type electrical breakers of Unit DDCMIS will be connected in parallel to DI and DISOE modules. For these types of drives in other DDCMIS systems the status will be connected to only one DI module.

(**)The 2 signals of HT drives & sync type electrical breakers of Unit DDCMIS are to be connected to DISOE module; for HT drives & sync type electrical breakers in other DDCMIS these will be connected to DI module.

5. Spare I/O channels and spare relays shall be provided as specified in Sub Section- chapter 3, Vol. V, Part-B over and above specified quantity.**6.** (i) Contact type output through relay is specified for few types of drives in the DRIVE I/Os table. These relays shall be driven by 24V DC command outputs through DO modules. In case of redundancy in outputs for drives, redundancy shall be provided only in DO modules, but not for the relays.

(ii) Power supply for energizing such drives in the field shall be routed through contacts of the above mentioned relays. The monitoring of power supply extended to field shall be done in DDCMIS for such drives. In case Unit system- there shall be separate monitoring for each drive. However, in case of other systems /offsite systems monitoring can be done for group of drives as finalized during detailed engineering.

7. For SOE signals generated within control system, item " SOE (Calculated) of Table in case the Bidder's system cannot use the internally calculated points for SOE monitoring, additional one no. Digital Output and one no. SOE input per SOE point, shall be provided within quoted price.**8.** The changeover type contacts (i.e. 'NC' + 'NO' together) shall be wired to the control system for all the binary inputs required for control purposes, and inputs as indicated in table for Drive I/O list except for other inputs from MCC/Switchgear, actuators and inputs related to hardwired signal exchange among various functional groups for which non-changeover type contacts ('NC' or 'NO') shall be wired to the control system. The binary inputs required for information/monitoring purpose only shall be wired to control system in the form of non-changeover type contacts.

Annexure-I

TABLE IA/IB:

PROCESS IOs FOR ALL DDCMIS/PLC: - On as required basis

General I/O requirements

- (i) I/O requirements for process shall be hardwired as per approved and as commissioned PIDs, as per interrelated control sub system requirements and as per redundancy criteria. Similarly I/O requirements for drives shall be hardwired as per Drive Control Philosophy, and as per redundancy criteria . Hardwired I/Os shall also be included by Bidder for electrical system, UPS, 24 V DC Charger system, 220 V DC Charger system etc. in respective package I/O list.
- (ii) The DDCMIS & PLC shall be provided with the capacity and capability to handle either 30% additional modules for each type of modules or 30% over and above the specified number of modules connected to the system bus without any additional hardware or software requirements. These additions shall not result in decrease in system response time (i.e. control response time, display response time, SOE resolutions etc.).
- (iii) Separate DI, DO, AI & AO shall be considered by Bidder for HW Annunciation windows, Mimic, ILPB, PBs, lamps, Indicators, recorders, A/M stations & other HW etc mounted on back up control desk/panel & UCP. Similarly control system related Hard wired Signals like Cooling Fan fail alarm, 230 V AC/24 V DC convertor Fail alarm, 24 V DC under voltage alarm, 24 V DC over voltage alarm, loss of UPS power supply feeder alarm and Flame & Smoke detector alarm etc shall also be included by Bidder in the respective package I/O list.
- (iv) Electrical I/Os required as per Energy Distribution Management System (EDMS), Energy Management System (EMS), Station Electrical system and any other electrical system shall also be considered/included by Bidder in respective package I/O list.
- (v) The control system shall be functionally distributed, (For Boiler, TG and BOP and similarly the control for 2 similar equipments like ID Fan A, B and C should be in different controllers & I/O cards) highly modular and arranged to reflect the functional grouping plant equipment and systems to be controlled. This functional group control strategy shall also form the basis for the partitioning of the controller to enhance the system reliability and flexibility. In case of redundant Analogue and Binary Signals, these will be connected to different input modules as specified in wiring scheme. Similarly whenever inputs are more than one and needs temperature and pressure correction/compensation, the same shall be carried out in different CPU.

In case of redundant/standby/multi Pumps/Drives are provided for same service, all related Inputs & outputs of main pump/drive shall be in separate I/O cards and similarly all related Inputs & outputs of respective standby pump/drive shall be in separate I/O cards. Inputs/outputs of any same services pumps/drives shall not be mixed in one common I/O card.

- (vi) Wherever redundant I/O modules/cards are used as per specification requirement, both (1:1 redundant) input or output modules shall execute the designated functions parallelly. The offered system shall have facility to enable final output from any of redundant input/output module, in case both modules are healthy. In case one of redundant card/module is unhealthy, the system shall detect the same and the output to and from system shall be given from the healthier card. I/O card redundancy shall not be achieved



through relays, diodes or any other additional hardware or software, Engineered solution for redundancy in I/O cards are not acceptable.

- (vii) Current Transducer with dual output (for Drives \geq 30 KW rating) shall be provided for interfacing with DDCMIS/DCS/PLC. The some critical application motors like barring gear motor, air heater motor, lube oil pump, jacking oil pump etc. irrespective of their kW rating, same shall be provided with a CT, ammeter and a current transducer with remote metering in DDCMIS/DCS.
- (viii) Local stop push button status (latched or unlatched) for HT/LT pumps/HT/LT fans/unidirectional Drives shall be connected to DDCMIS/DCS/PLC in addition to local stop push button command connected directly to HT/LT switch gear.
- (ix) Interposing relay shall be mounted in respective SWGR/MCC/integral starter required for commands signals of HT/LT unidirectional drives and bidirectional drives from DDCMIS/DCS/PLC or any control system.
- (x) Start & stop command from DDCMIS/DCS/PLC shall be latched at SWGR/MCC end and integral starter end respectively.
- (xi) Signal / Data exchange between any control systems (i.e between two different DDCMIS/DCS, DDCMIS/DCS to / from PLC etc.) for SOE, annunciation, control, interlock & protection and critical information shall be through hardwired input/output in the form of galvanically isolated 4 - 20 mA signal and potential free contact input, output. Hardwired signals shall be dual redundant or triple redundant depending upon the requirements i.e. control, interlock & protection. Quantum of such requirements shall be finalized during detailed engineering.

TABLE IIA/IIB:**DRIVE IOs FOR ALL DDCMIS/PLC: - On as required basis****TABLE III:**

HART Signals: On as required basis

TABLE IV:

- (i) Various types of cabinets/equipment: On as required basis
- (ii) ECP: On as required basis, to mount synchronizing relays, aux PTs, other relays, etc.
- (iii) 5 nos. hand-held calibrator for HART compatible devices total for unit.

Table V:

Field Instruments: On as required basis.



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



Table - " Drive I/O's "												
No. of I/Os required for various type of drives shall be as follows												
Type of Control	Type of drive	No. of inputs (changeover)	No. of inputs (Non-changeover)	No. of SOE inputs	Total no. of binary inputs per drive	No. of Binary outputs (24 VDC)	No. of Binary outputs (Contact type) (through relay)	Total no. of analog inputs per drive (4-20 mA)	Total no. of analog inputs per drive (4-20mA, Galvanic)	Total no. of Analog outputs per drive (4-20mA)	Total no. of Analog outputs per drive (4-20mA, Galvanic)	Remarks
OLCS	HT	1X2*		2	4+ 2** (SOE)	2		2				* & ** Refer Note-4 above.
	LT	1	1		4	2		2				
	VFD-O		10		10	2						
	MOD/MOV	1	1		4	2						
	MOVI/MODI	1	1		4	2		1				
	AC-MOV1				2	1						
	AC-MOV2				2	2						
	DSOV		3		3		2					
	SSOV, SOV/O, SOV/C/L			3		3		1				
	SOV (1)			3		3		1				
	SOV (2)			1		1		1				
	SOV (3)			8		8		3				
	HTCHP			10		10	1					
	LTCHP (1)			4		4	1					
	LTCHP (2)			3		3	1					
	ACT			10		10	2					
	CSU			10		10	2					
	RDOL			4		4	3					
Elect Breakers (Non-Synch)	1	1			3	2		2				
Elect Breakers (Synch)	1X2*		2		4+ 2** (SOE)	2		2			* & ** Refer Note-4 above.	
CLCS	CLCS-1								1	1		
	CLCS-2								1		1	
	CLCS-3, CLCS							1		1		
	CLCS-4							1			1	
	CLCS-M				1				1		1	
CLCS-5 (VFD)								2		1		



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



APPENDIX-A
LIST OF OWS STATION

SL.NO.	OWS STATION FOR	QUANTITY	LOCATION	PURPOSE
1	PROGRAMMER	1	PROGRAMMER'S ROOM	Total Plant data for general purpose. Software development on plant database, calculations, reports etc.
2	HART SYSTEM	1	C&I MAINTENANCE AREA IN CER	To meet functionality of HART communication system
3	C&I SHIFT MAINTENANCE ENGINEER	1	C&I MAINTENANCE AREA IN CER	Total Plant data maintenance records, C&I fault and drive operation during commissioning stage (Password protected)
4	SWAS	1	SWAS ROOM	Plant data, SWAS related Displays & annunciation
5	OPERATION AND EFFICIENCY GROUP	1	SERVICE BUILDING	Merit order rating calculation and related functions
6	HEAD OF STATION	2	TO BE DECIDED DURING DETAILED ENGINEERING.	Plant overview, parameters, efficiency and performance monitoring.
7	Shift In Charge	1	Shift Supervisor Room	Total Plant data
8	C&I Lab	1	C&I Lab Room	As per Vol-V , chapter-10 - Maintenance and calibration equipment.

Note1 :- In addition to above OWS, OWS & printers specified elsewhere in the specification shall also be provided by Bidder.

APPENDIX B

SIGNALS FROM OTHER SYSTEMS TO BE CONNECTED TO HMIPIS/STATION LAN

S.NO.	SYSTEM	TOTAL DATA		PERIODICALLY TRANSMITTED	
		BASE		ANALOG	BINARY
		ANALOG	BINARY	ANALOG	BINARY
1	ESP	ON AS REQUIRED BASIS			
2	FIRE PROTECTION Control System				
3	FIRE WATER PUMP HOUSE PLC				
4	Air Conditioning & Ventilation system PLC				
5	STACKER RECLAIMER PLC				
6	SWGR				
7	Wagon Tippler PLC				
8.	Motion in weigh bridge system PLC				
9.	Hydrogen Generation Plant				
10.	Any other system as decided during detailed engineering by Owner.				

- Note:
1. # Ten (10) binary signals are considered per HT drive / Elect. Breaker.
 2. For Signals from HMIPIS to Station LAN, the total database size is to be estimated by Bidder to meet the spec. requirements. The requirement of periodic transmission shall be as finalized during detailed engineering stage.
 3. All the subsystems of respective DDCMIS shall be connected to each other through Station LAN or as indicated in Vol. V, Chapter 14, Annexure A to be finalized during detailed engineering by owner.



APPENDIX C

LIST OF AREAS FROM WHICH SOFT SIGNALS IS TO BE CONNECTED TO DDCMIS/PLC (OTHER THAN REMOTE I/O) through redundant interfacing.

S.NO	AREA	CONNECTE D TO THE DDCMIS SYSTEM	MINIMUM QTY. OF LINKS/LOCATIO N	TYPE	QTY. OF SIGNALS
1	BOP C&I, SG C&I, TG C&I AND OTHER 24 V DC charger SYSTEM	UNIT DDCMIS & RESPECTIV E DDCMIS SYSTEM and respective PLC system	ON AS REQUIRED BASIS	AS PER BIDDER'S STANDARD PRACTICE	ON AS REQUIRE D BASIS
2	UNIT AND OTHER UPS SYSTEM	UNIT DDCMIS & RESPECTIV E DDCMIS SYSTEM and respective PLC system			
3	SWITCHYARD/ GENERATOR RELAY PANEL/ Numerical Relays of HT & LT Switchgear/CONTRO L SYSTEM	UNIT DDCMIS & RESPECTIV E DDCMIS SYSTEM and respective PLC system			
4	AHP COMPRESSORS	AHP DDCMIS			
5	AIR COMPRESSORS (IAC, PAC, MILL REJECT SYSTEM, Fire water Pump system PLC, Fire Protection & detection control system, AC & Ventilation plant PLC, FGD SCR)	UNIT DDCMIS			
6.	M&C lab system	UNIT DDCMIS			
7.	CHP's offsite PLC system	CHP DDCMIS			

Notes-

- For further details regarding the Systems to be connected to respective DDCMIS, refer Tender drawings and Vol. V, Chapter 14, Annexure A.

2.3 CONTRACT QUANTITIES OTHER THAN DDCMIS ITEM

A. CONTRACT QUANTITIES FOR UCD & PANELS

1.00.00 CONTROL DESKS AND PANELS

1.01.00 The following are the contract quantities of control desks:

1. Arc shaped Control Desks & other furniture shall be provided as mentioned below.

Sl no	Area	Control Desk length	Qty	Item description for furniture/ other items	Qty
1.	UNIT Control Room/ other adjacent Rooms	7m	1	a. Chair	8
				b. Key pad	1
				c. Locker set	2
				d. Almirahs	3
				e. Unit In charge Desk (3 meter)	1
				f. OWS/PC rack	1 Set
2.	Programmer Room	-	-	a. Chair	12
				b. Key pad	1
				c. Server Rack	1
3.	C&I Maintenance Room	-	-	a. Chair	2
				b. Computer Table	2
4.	Water system, AHP, CHP Control Room	4m	1 set per system	a. Chair	4
				b. Key pad	1
				c. Locker set	1
				d. OWS/PC rack	1
				e. Workstation furniture	1 set
5.	PLC system control room	2 m	1 set per system	a. Chair	2
				b. Key pad	1
				c. Locker set	1
6.	For each Workstation (located at areas not covered above) and for each Common PC Station (As per Contract quantities)	-	-	a. Chair	1 for each
				b. Computer Table	1 for each
7.	For Printer in area where workstation furniture is not available.	-	-	Printer Table	1 for each Printer

8.	For each Control Room (Other than those mentioned above)	-	-	a. Key pad	1
				b. Locker set	1
9	Ac Plant Control Room	2m	1	a. Chair b. Key pad c. Locker set d. Printer Table	3 1 1 1 no
	For OWS mentioned at Appendix A.	-	1	Computer table, printer table & Chair	1 no. each.

Note1 :- The quantity of various items indicated above are minimum. Same shall be as on required basis.

Note 2:- The UCD in Unit Control Room shall have mechanism for concealing the LED monitors (6 nos.) and synchroscope (1 no.). The exact details shall be finalized during detailed engineering stage.

Note 3:- Provision for no. of Monitors, mouse, keyboards on each CD: (i) As per OWS/LVS count and HMI specification for various control areas (ii) For UCD: As per OWS/LVS count and HMI specification for Unit AND one no. synchroscope plaque.

Note 4: Provision for no. of Monitors, mice, keyboards in each Unit in-charge desk (UID): 2 nos.

Note-5: Draw-out section/plaque shall be provided in UCD and CD for CHP as follows:

(A) UCD:

- (i) One no. draw out section for process side - 16(h) X10(w) mosaic tiles, each of size 48 mm x 24 mm or 50 mm x 25 mm.
- (ii) One no. draw out section for electrical side - 20(h) X13(w) mosaic tiles, each of size 48 mm x 24 mm or 50 mm x 25 mm.
- (iii) One no. synchronization plaque - mosaic tiles, of adequate nos. so that synchroscope, 2 nos. voltmeters, 2 nos. frequency meters and two indicators are accommodated in the size of one LED monitor, so that size of concealing arrangement for this plaque is same as that of LED monitor.
- (iv) Emergency / Trip Push Button stations mosaic tiles compatible.

(B) CD of CHP:

One no. Draw out section for process side - 10(h) X10(w) mosaic tiles, each of size 48 mm x 24 mm or 50 mm x 25 mm.

Further, blank tiles shall be provided on as required basis.

Note-6: Computer table should be designed such that OWS, UPS (with external batteries, if any) and printer, if any shall get



accommodated.

Note-7: One set Conference Table & 15 no's industrial grade executive class Chairs shall be provided in main conference room. Conference table shall be made of teak wood top quality only with industry standard glass top.

Note – 8: For exact requirements of Almirahs, chairs & tables, also refer Vol. V, Part B, Chapter 6.

Note – 9: One locker set shall consist of minimum 8 individual locker with own lock & key.

1.02.00

The following contract quantities of instruments shall be to be mounted on the draw out section of Unit Control Desk .

Item Description	QTY (NOS.)
3 PB+ 4 LEDs	15
3 PB+ 3 LEDs	5
2 PB+ 4 LEDs for Electrical Breaker	25
2 PB+ 3 LEDs for Electrical breakers	15
2 PB+ 3 LEDs	48
2 PB+ 2 LEDs	17
2 LED	4
3 LED	5
6 LED	10
1 LED	10
1 PB+4 LED	3
4 PB+4 LED	2
Digital Indicators	5
Analog Indicators	1
Trip PB	10
Raise Lower PB	6
Release PBs	3
Acknowledge PBs	3
Test PBs	3
Single PB	5
Hand Switches	8
Mimic Tiles	150



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



Voltmeters	2
Frequency meters	2
Synchroscope	1

(b) The following instruments shall be furnished for Coal Handling Plant to be mounted on the draw out section of Control Desk of Coal Handling Control Room.

1. Stop PB: 45 nos.
2. Release PB: 1 no.
3. Emergency stop PB: 1 no. (With red flap cover)

1.03.00 Arc-shaped LVS panel shall be provided in the Control Room wherever LVSs are envisaged.

Pl. refer quantity of LVS & location in HMIPIS quantity of DDCMIS. The length of the panel shall be suitable to mount specified no. and tiers of LVS. The no. of tiers of LVS in various areas will be as follows:

Unit Control Room: 1 tiers
Other Control Rooms: 1 tier

1.04.00 50 nos. wall mounted/panel mounted digital indicators shall be considered by Bidder to be mounted at various place i.e TG floor, unit control room, BOP control room etc. Exact details shall be finalized by owner during detailed engineering.

B CONTRACT QUANTITIES FOR UPS AND 24 V DC POWER SUPPLY SYSTEM

1.00.00 UNINTERRUPTED POWER SUPPLY (UPS) AND 24 V DC POWER SUPPLY SYSTEM

The following clauses shall be read in conjunction with sub-section/chapter 7 "Uninterruptable Power supply system & 24 V DC systems", Vol. V, part-B of technical specification and drawing no. 114-17-0100/0200 to arrive at the detailed quantity.

2.00.00 UNINTERRUPTED POWER SUPPLY SYSTEM

Uninterrupted Power Supply (UPS) system of continuous duty shall supply regulated, filtered and uninterruptible 230V, 50 Hz single phase power within the specified tolerances shall be provided on as required basis for AC loads of HMIPIS, Analyzers, Vibration monitoring system, TSS, Simulator, PSSS, CCTV, PA system, communication system, Simulator, C&I Lab, LVS, CEMS, SWAS Analyzers, HART system, Master- Slave clock, microprocessor based control system, PLC based control system and any other critical load/system/sub system etc, meeting the specification requirements and taking care of the approved configurations and layouts.

2.00.01 a) Bidder to note that the UPS rating shall take care of all Bidder's Load as required taking care of all the requirements as indicated in the Part B of the Technical specifications within the quoted lumpsum price.

b) Bidder may specifically note that the KVA rating of UPS system as indicated



above shall be guaranteed at 50 deg. C ambient temperature and load power factor of 0.8 lagging.

In case the Bidder's standard UPS KVA ratings are applicable at a lower ambient temperature (say 40 deg. C) than specified 50 deg. C temperature, the Bidder shall consider derating factor of at least 1.5%/deg. C for arriving at the specified UPS capacity at 50 deg. C ambient temperature so that required capacity is ensured at 50°C. The Bidder shall demonstrate the above stated capacity at 50°C during shop testing.

- c) For the main plant, the UPS system has to be supplied. The UPS configuration for main plant shall be as per clause 7.01.05 (A), Part-B, Vol. V, chapter 7 of the specification. For other offsite/BOP packages as indicated at Annexure-II to contract quantities for DDCMIS and in chapter 14, Vol. V, Part B, configuration as per clause 7.01.05(A), Vol. V, Part-B, chapter 7 can be provided. For all other operator locations as indicated at Assignment of Operation Location Appendix-III, Part-A, the configuration as per clause 7.01.05 (C), Vol. V, Part-B, chapter 7 can also be provided .

2.01.00 The Bidder may note that for UPS of capacity above 25 KVA, the following should be followed:-

- (a) Both the inverters shall not be housed in single cubicle.
(b) Both the chargers shall not be housed in single cubicle.

One inverter and one charger can be housed in one common cubicle i.e. there will be two such cubicles per UPS system if the same is standard and proven practice of the Bidder.

2.02.00 One set of manual discharge resistance bank of adequate capacity shall be provided for the following:

- (a) Main Plant UPS System : 1 Set
(b) UPS System of Max rating at offsite/BOP package DDCMIS based :1 Set
(c) UPS System of Max rating at offsite/BOP package PLC based: 1 Set

2.03.00 Bidder may note that in case the calculated UPS rating is not same as one of the standard KVA rating of the single UPS system, the next higher standard rating of the manufacturer shall be selected and provided. Bidder may specifically note that UPS of manufacturer's non- standard rating shall not be acceptable. Furthermore, it may be noted that to attain the calculated UPS rating, paralleling of multiple UPS systems of lower ratings will not be accepted.

3.00.00 **24 V DC POWER SUPPLY SYSTEM**

24 V DC Power Supply system shall be of continuous duty as mentioned in Subsection "Uninterruptable Power Supply System & 24 V DC systems", chapter 7, Part-B, Vol. V shall be provided on as required basis meeting the specification requirements and taking care of the approved configurations and layouts.



- 3.00.01
- a) Control system as well as remote I/O system in this context would cover as a minimum, controllers, I/Os, associated modules etc. as well as, data communication system & Network devices (like LAN Switches), related to control system associated relays and solenoid valves driven by 24 V DC system, etc;. Any other loads of Bidder requiring 24 V DC supply shall also be included in this calculation.
 - b) Bidder to note that the Charger rating shall take care of all Bidder's Load as required, taking care of all the requirements as indicated in the Part B of the Technical specifications within the quoted lumpsum price.
 - c) For the main plant SG, TG, FGD and BOP systems, the 24 VDC power supply system has to be supplied. The 24 VDC configuration for main plant SG, TG and BOP Systems shall be as per clause 7.01.03(A),Part-B, chapter 7 of the specification. Bidder may note that separate unitized 24 V DC Charger system has to be supplied for each Main Plant BOP systems. However, for main plant SG and TG systems common or separate unitized 24 V DC Charger systems can be offered meeting the technical requirements of the system. For other offsite DDCMIS packages systems configuration as per clause 7.01.03(A), Part-B, chapter 7 shall be provided.
 - d) For off-site PLC systems, configuration as per clause 7.01.03(A), Part-B, chapter 7 and chapter 14, Part-B, Vol. V shall be provided.
 - e) For remote locations, separate 24 V DC system shall be provided as per clause 7.01.03(A),Part-B, chapter 7 of the specification.
- 3.00.02
- One set of manual discharge resistance bank of adequate capacity shall be provided for the following:
- (a) Main Plant BOP(C&I) 24 V DC Charger System : 1 Set
 - (b) Water System DDCMIS : 1 Set
 - (c) AHP DDCMIS : 1 Set
 - (d) CHP DDCMIS : 1 Set
 - (e) FGD DDCMIS : 1 set
 - (f) RIO system of Max rating : 1 Set
 - (g) Off site PLC system max rating : 1 set

- 4.00.00
- a) Bidder to note that, 7 number of loose PDBs for the plant with redundant 230 V input AC supply with Auto Change Over and 7 number of output feeders with LED, MCB and Fuse ratings of 4A/6A are to be provided.
 - b) Furthermore, minimum 1no. number of PDB with 230 V input AC utility supply for distribution of utility power supply to the cabinets being procured under this package and located in CER is to be provided.

C CONTRACT QUANTITIES FOR INSTRUMENTATION CABLES

- 1.00.00
- The Bidder shall supply, erect, lay, terminate and test the following cables ensuring functional completeness of the control system on as required basis.
1. All instrumentation, control & power supply cables.



2. Co-axial cables, network cables including Optical fibre/shielded twisted pair Cat-5e cables for system for connection of peripherals, data highway, network etc. The routing of these cables shall be separate from other Instrumentation.
3. All types of cables related to fire detection and protection system (including short term fire proof cables & fire survival cables) etc. on as required basis. All the cables to be employed for Plant communication system package & Coal Handling Plant shall be armoured only.
4. All cable trays/ sub trays, rigid and flexible conduits, GI/HDPE Conduits, conduit fittings, cable glands, junction boxes including temperature transmitter JBs(both DIN rail mounted and dual temp type), lugs, pull boxes accessories and all supports between the cable trays (trunk route) and equipments as required for installation of all cables, on as required basis.
5. All grounding cables for control systems, cabinets, equipments etc on as required basis.
6. All special tools required for wiring terminations as recommended by Bidder.

D CONTRACT QUANTITIES OF PA SYSTEM

1.01.00 The quantities mentioned below are minimum required

No	Item Description	Unit Area	CHP	Common
1.	Handset Stations			
	(i) Outdoor wall/column mounting type - (nos.)	40	70	30
	(ii) Indoor desk top mounting type (nos.)	10	5	10
	(iii) Indoor control desk mounting type (nos.)	5	2	-
2	(i) Outdoor Industrial Horn Loud speakers -	40	70	30
	(ii) Indoor wall mounted Cone Loud speakers-	9	5	10
3.	Portable handset stations with multi-pin plug and sockets			
	(i) Sockets-(nos.)	15		
	(ii) Portable handset stations with plug	4		
4.	Armoured cables like Mains, signal, telephone and loudspeaker cable - (km)	On as required basis		
5.	Acoustic hood (nos.)	12		
6.	Master Control Unit	1	1	2
7.	Junction boxes	On as required basis		
8.	GI earthing wire (KM)	On as required basis		
9.	GI rigid conduit for main cables, signal cables, LS	On as required basis		

1.02.00

Following are the indicative PA system handsets location details. These will be updated at the time of detailed engineering.

S.no.	Description	Total Qty.	Type
A.	Unit Area		
1	ESP CONTROL ROOM	1	B
2	ID FAN-A	1	A
3	ID FAN-B	1	A
4	BOILER ELEVATIONS	9	A
5	FD/PA FAN A	1	A
6	FD/PA FAN B	1	A
7	NEAR ESP STRUCTURE	1	A
8	NEAR DEAERATOR	1	A
9	NEAR TDBFP/HP HEATER	1	A
10	TG HALL	4	A
11	NEAR TG MAIN OIL TANK	1	A
12	NEAR MDBFP/LPH	1	A
13	CHARGER/ UPS ROOM	1	S
14	NEAR GAS CYLINDER ROOM	1	A
15	NEAR TG SEAL OIL UNIT	1	A
16	NEAR HOTWELL	1	A
17	NEAR CLEAN OIL/DIRTY OIL TANK	1	A
18	CONTROL FLUID ROOM	1	A
19	BOILER MCC ROOM	1	B
20	LT SWITCHGEAR ROOM	1	B
21	MV SWITCHGEAR ROOM	1	B
22	CCR (ON UCD)	2	C
23	CER	1	B
24	SHIFT INCHARGE ROOM	111	S

25	C&I SHIFT ENGINEER ROOM	1	S
26	PROGRAMMER ROOM	1	S
27	OTHER LOCATION (TO BE DECIDED DDE)	6	A
28	OTHER LOCATION (TO BE DECIDED DDE)	4	B
29	OTHER LOCATION (TO BE DECIDED DDE)	4	C
30	OTHER LOCATION (TO BE DECIDED DDE)	15	S
B.	CHP AREA		
1	BUNKER FLOOR	8	A
2	CHP CR	1	C
3	MACHINERY WELLS	6	A
4	MCC ROOM	6	B
5	PENT HOUSES	8	A
6	PUMP HOUSES	1	A
7	TPs	18	A
8	WAGON TIPLERS	8	A
9	CRUSHER HOUSES	8	A
10	TRACK HOPPER (AT DIFFERENT LOCATIONS)	4	A
11	RECLAIMER HOPPER	4	A
12	OTHER LOCATION (TO BE DECIDED DDE)	15	A
C.	COMMON PLANT AREA		
1	AIR COMPRESSOR HOUSE	1	A
2	DM PLANT AREA	1	A
3	PT PLANT AREA	1	A
4	CHLORINATION PLANT	1	A
5	FIRE WATER PUMP HOUSE (FWPH)	1	A

6	ASH SILO CONTROL ROOM	1	B
7	SWITCHYARD CR	1	B
8	COOLING TOWER AREA	1	A
9	CHIMNEY	1	A
10	CPU REGENERATION BUILDING	1	A
11	TRANSFORMER YARD	1	A
12	FO PUMP HOUSE	1	A
13	RAW WATER PH CONTROL ROOM	1	B
14	MILL REJECT COMPRESSOR HOUSE	1	A
15	CW CHEMICAL TREATMENT / SW PH AREA	1	A
16	Void	-	-
17	CW PUMP HOUSE CONTROL ROOM	1	B
18	WATER SYSTEM CONTROL ROOM	1	B
19	DG ROOM	1	B
20	AHP CONTROL ROOM	1	B
21	ASH WATER PUMP HOUSE	1	B
22	TRANSPORT AIR COMPRESSOR HOUSE	1	A
23	ASH SLURRY PUMP HOUSE	1	A
24	OTHER LOCATION (TO BE DECIDED DDE)	8	A
NOTES			
1.	THE LOCATION ARE INDICATIVE ONLY. THE EXACT LOCATION OF HANDSET SHALL BE DDE BASED ON ACCESSABILITY AND INSTALLATION EASE AS PER SITE REQUIREMENT.		
2.	TYPE-A - OUTDOOR WALL/COLOUMN MOUNTING TYPE HANDSETS.		
3.	TYPE-B - INDOOR DESK TOP MOUNTING TYPE HANDSET		

4.	TYPE-C - INDOOR CONTROL DESK FLUSH MOUNTING TYPE HANDSETS.
5.	TYPE-S- SOCKET FOR PORTABLE HANDSETS.

1.03.00 Walki Talki System.

- a. Sixty (60 Nos.) hand held two way transmitter receiver sets.
- b. Battery charger for hand-set batteries-60 Nos. Rapid Charger (which can charge 10 handset batteries at a time) shall be provided in PHB main plant control room.
- c. Base Stations as per requirements detailing in Vol. V, Part B, Chapter 22.

E Contract quantities for CCTV SYSTEM

The quantities and locations mentioned below are minimum required and will be updated at the time of detailed engineering.

1.00.00 PTZ DOME TYPE CAMERAS ALONG WITH HOUSINGS.

1.01.00 Unit Areas

SN	Locations	No. of Cameras
a	TG hall Elevation (Turbine floor)	05
b	TG hall Elevation (Intermediate floor)	08
c	TG hall Elevation 0 Meter	05
d	MOT room	02
e	Raw Coal Feeders	08
f	Air Heater	08
g	ESP Field area	06
h	CER	04
i	Cable Gallery (at different areas)	08
j	Switch Gear Room	05
k	Transformer Bay	03
l	Boiler Firing floor	08
m	Other areas to be decided during detailed Eng. Stage	10

1.02.00 Common Plant Areas -Other than Coal Handling plant

SN	Locations	No. of Cameras
a	Ash slurry Pump House Area	03
b	Ash water Pump House	02
c	Chimney	02
d	CW Pump House	03



e	FOPH (Including LDO)	08(Refer Note-1)
f	PT Plant Area	03
g	DM Plant Area	03
h	Switch yard	04
i	Air Compressor	04
j	Condensate Polishing Unit- Regeneration Plant area	03
k	Train entry and Exit point near plant boundary	03
l	Raw Water Pump House	03
m	Make Up Water Pump House	02
n	H2 generation Plant	02 (refer Note 1.* (i))
o	FGD	20
p	ETP	02
q	Ammonia handling and unloading area	10
r	AAQMS	02 per shelter
s	Seepage Water pump House	02
t	Center of Ash Dyke	02
u	At periphery of Ash Dyke	04
n	Other areas to be decided during detailed Eng. Stage	07

1.03.00

Common Plant Areas - Coal Handling Plant (refer Note 1.* (ii))

SN	Locations	No. of Cameras
1.	Track Hopper	02
2.	Wagon Tripler (each)	02
3.	Pent House (each)	02
4.	Crusher house (each)	05
5.	At each Transfer Point	01 (per floor)
6.	At each Conveyer Gallery	02 (length 250 m) 03 (length 550 m) 04 (length > 550m)



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



7.	Reclaim Hopper	02 per each S/R machine area
8.	CHP Control Room	01
9.	T/U Tower	02
10.	Train Wagon Entry/Exit Gate	02
11.	Other areas to be decided during detailed Eng. Stage	04

1.04.00

Distant plants

SN	Locations	No. of Cameras
a	Raw Water Intake Pump House	02

2.00.00

FIXED CAMERAS ALONG WITH HOUSINGS:

2.01.00

Common Plant Areas -Other than Coal Handling plant

SN	Locations	No. of Cameras
a	Main Entry Gate	02
b	Colony Entry Gate	02
c	Stores Entry/Exit Gate	02
d	(Entry/Exit Gate to Township)	02
e	ADM Building Entry/Exit Gate	322332

Note:

- 1.* (i) Cameras & its accessories for FOPH, H2 Generation, Ammonia handling & unloading area, O2 dosing area has to be Explosion proof (As per NEC code)
(ii) Flame/Explosion proof cameras shall be provided.
2. Quantities of cameras are minimum and the same shall be finalized during detailed Engineering.

3.00.00

PERIMETER INTRUDER DETECTION SYSTEM

SN	Locations	No. of Cameras
----	-----------	----------------

a	Along the entire length of fence/ boundary of the power plant and all entry & exit gates on the boundary.	60 no. minimum with the condition that camera shall be provided at every 70 meter distance. (Quantities shall be more than 60 nos. to achieve above condition). In case camera's coverage area is less than 70 meters, quantities shall be increased accordingly.
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4.00.00

The following items shall also be provided

S NO	ITEM	QUANTITY
1	Hot Redundant Database Video Management Server	On as required basis. Minimum Two (2) sets. One set for CCTV package and one set for Plant Intruder detection system.
2	Camera Server	On as required basis subject to Two no. minimum for main plant security control room and minimum seven nos. for common areas*
3	Operating Stations	Eleven (11) nos. with 32" LED monitors.
4	PTZ controllers and Inter Connecting Cables	On as required basis without any cost implication to owner.
5	≥ 55" diagonal sized full HD LED TV of latest version with advanced features.	Four (4) nos.
6	<u>Network controllers, Layer III switch/Router & Network managed type industrial grade Ethernet switches with 30% spare ports.</u>	On as required basis without any cost implication to owner.
7	Hardware and Software for interfacing with Large Video Screens (LVS).	On as required basis considering minimum one set each for Unit LVS, CHP LVS, AHP, FGD LVS & water system LVS.
8.	Mini- smart redundant UPS	On required basis.
9.	Printers	Two numbers laser jet colour printer (A4 size) shall be provided with each Work Station/ Server.

- * Common areas shall include service building, Central Fire Station building, Water system Control Room, Ash handling system control room, Main Gate of the Plant, coal handling plant and any other location to be decided during detailed engineering.
- * Hardware like network switches, camera/database servers, Layer-3 switches/routers, trunk cables (i.e. cables between network switches), mini UPS, PDB & software, Wireless Equipment etc. along with necessary licenses for each zone shall be capable of handling 30% additional cameras over and above the number of camera specified in each zone.

Notes:

1. Cameras & its accessories shall be Explosion proof for explosion proof cameras. Explosion proof camera shall also be provided for other area, which shall be decided during detailed engineering.



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



2. For make-up water plant the functionalities of client work station can be implemented on the camera/database servers.
3. For CHP area, camera shall be flame proof type Only as per zone system i.e. Zone 20-22, alternatively Explosion proof cameras can also be provided.
4. 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.
5. Access points for wireless cameras shall be mounted on lighting mast. Wireless equipment and type of wireless connectivity shall be decided during detail Engineering. Wireless communication for the above should be subscribing the latest Cyber-security standards including encryption and shall be industrial grade only. The wireless modem should support dynamic encryption techniques.
6. Any other equipment, accessories and facilities required for completeness of this system shall be furnished by the Contractor within the quoted price.
7. The location are indicative only. The exact location of CCTV shall be DDE based on accessibility and installation ease as per site requirement.

F CONTRACT QUANTITIES FOR SWAS

LIST OF ANALYSERS:

Sample	Measurements
Makeup DM water	Specific Conductivity, Cation Conductivity, Silica, Sodium, Dissolved Oxygen
CEP discharge	Specific Conductivity, Cation Conductivity, Silica, Sodium, pH, Dissolved Oxygen
CPU outlet	Specific Conductivity, Cation Conductivity, Silica, Sodium, pH
Deaerator	Silica, pH, Dissolved Oxygen
FW at Eco inlet	Specific Conductivity, Cation Conductivity, Silica, Sodium, pH, Hydrazine, Dissolved Oxygen
Separator outlet	Specific Conductivity, Cation Conductivity, Sodium
Separator O/L - LTSH I/L	Specific Conductivity, Cation Conductivity, Silica, Sodium, Hydrazine
Main Steam - HTSH O/L	Specific Conductivity, Cation Conductivity, Silica, Sodium, pH
Reheated steam	Specific Conductivity, Cation Conductivity, Silica, Sodium, pH
Closed circuit CW (TG & SG)	pH, Specific Conductivity (Separate each type of analyser for TG and SG circuit).
Hotwell	Specific Conductivity (on each side)
Condenser CW	Specific Conductivity, pH
Condenser Tube Leak detection at each inlet & outlet CW line.	Cation Conductivity (Insertion /Retractable Type)
Note	(i) Multi channel/stream for Silica & sodium Analysers shall be acceptable. Multi channel/stream analysers shall have at least one stream as spare without external sequencer. Multi channel/stream analysers shall have at least 50% streams as spare with external sequencer.

	<p>Any other analyser except Silica and Sodium shall be single channel only.</p> <p>(ii) Quantities & Type of Analysers for OTHER BOP/Offsite packages shall be as specified elsewhere in the specification.</p> <p>(iii) The above indicated quantity are minimum and if the process requirement calls for any other services for measurement and performance of the plant the same shall be included in addition to the above services.</p> <p>(iv) The system shall be designed to provide 20% more than the maximum sample flow requirement.</p> <p>(v) Triple and Dual analysers shall be provided for DM Plant Controls and chemical/O₂ dosing controls.</p>
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G1 LIST OF FLUE GAS ANALYSERS

SnO	KKS CODE	DESCRIPTION	RANGE	ZONE	REMARK
1	HBK10CQ101	O ₂ ANALYSER AT PLATTEN SH OUTLET	0-10%	SH ZONE, BOILER	
2	HBK20CQ101	O ₂ ANALYSER AT PLATTEN SH OUTLET	0-10%	SH ZONE, BOILER	
3	HNA10CQ101	O ₂ ANALYSER AT ECO OUTLET (L)	0-10%	ECO-3 O/L	
4	HNA10CQ102	O ₂ ANALYSER AT ECO OUTLET (L)	0-10%	ECO-3 O/L	
5	HNA20CQ101	O ₂ ANALYSER AT ECO OUTLET (R)	0-10%	ECO-3 O/L	
6	HNA20CQ102	O ₂ ANALYSER AT ECO OUTLET (R)	0-10%	ECO-3 O/L	
7	HNA10CQ103	CO ANALYSER AT ECO OUTLET (L)	0-10%	ECO-3 O/L	
8	HNA20CQ103	CO ANALYSER AT ECO OUTLET (R)	0-10%	ECO-3 O/L	
9 *	HNA11CQ101	PAH-A GAS O/L O ₂	0-10%	PAH-A O/L	
10 *	HNA11CQ102	PAH-A GAS O/L O ₂	0-10%	PAH-A O/L	
11 *	HNA12CQ101	SAH-A GAS O/L O ₂	0-10%	SAH-A O/L	
12 *	HNA12CQ102	SAH-A GAS O/L O ₂	0-10%	SAH-A O/L	
13 *	HNA21CQ101	PAH-B GAS O/L O ₂	0-10%	PAH-B O/L	
14 *	HNA21CQ102	PAH-B GAS O/L O ₂	0-10%	PAH-B O/L	
15 *	HNA22CQ101	SAH-B GAS O/L O ₂	0-10%	SAH-B O/L	
16 *	HNA22CQ102	SAH-B GAS O/L O ₂	0-10%	SAH-B O/L	
17	HNA50CQ101	IDF-A I/L O ₂	0-10%	IDF-A I/L	

18	HNA60CQ101	IDF-B I/L O2	0-10%	IDF-B I/L	
19		**Dust Emission Analyser	0-200 mg/Nm3	ESP Outlet	

NOTES:

- * These O2 Analyzer quantities are w.r.to Bi-sector RAPH, However, for total quantity of O2 Analyzers for Tri-sector type RAPH outlet refer tender drawing.
- ** Dust Emission Analyser shall be provided in each ESP path.

G2 LIST OF CEMS ANALYSERS

SnO	KKS CODE	DESCRIPTION	RANGE	ZONE	REMARK
1	HNE10CQ001	NOX ANALYSER AT CHIMNEY	0-300/0-1000PPM (SELECTABLE)	CHIMNEY	
2	HNE10CQ002	CO2 ANALYSER AT CHIMNEY	0-40%	CHIMNEY	
3	HNE10CQ003	OPACITY ANALYSER AT CHIMNEY	0-999 mg/m3 (PROGRAMMABLE)	CHIMNEY	
4	HNE10CQ004	CO ANALYSER AT CHIMNEY	0-1000 (SELECTABLE IN 0-100/0-200,0-500,0-999 PPM)	CHIMNEY	
5	HNE10CQ005	SOX ANALYSER AT CHIMNEY	0-300/0-1000PPM (SELECTABLE)	CHIMNEY	
6	HBK10CT101	Flue Gas Temp. Measurement	0-200 Deg C	CHIMNEY	
7	HNE10CQ006	Hg Analyzer	0 - 100 microgram/Nm3	CHIMNEY	
8	HNE10CQ007	Flowmeter (Ultrasonic Time of Transit Type)		CHIMNEY	

NOTES:

- SOX NOX analyser are shown separately for the purpose of input only otherwise SOX and NOX monitor may be supplied as a single unit as per specifications.
- OWS station with Application software & redundant UPS shall be provided for CEMS Analysers/Monitors.

H CONTRACT QUANTITIES OF TOOLS AND TACKLES

The list of minimum Tools and Tackles to be supplied as part of this package is as follows:-

Sl. no	Item Description	Qty
1.	Ring spanners set	3 sets
2.	Combination spanner set	3 sets
3.	Adjustable spanner set	3 sets
4.	Pliers set consisting of nose pliers, combination pliers	1 set



5.	Cable termination kit (including crimping & wrapping tools for various types of termination blocks)	1 set
6.	Pipe wrench set, slide wrench set, Torque wrench set of various sizes and also adjustable type	1 set
7.	Cable stripper	1 set
8.	Allen key set (General and special purpose)	2 sets
9.	Insulated screw gripping screw driver set	2 sets
10.	Adjustable Position Hacksaw	1 set
11.	Cable splicer and cutter set	1 set
12.	Precision tweezer	1 set
13.	Copper /SS tube cutter and bender	1 set
14.	Fold up Hex key set	1 set
15.	Rubber Mallet	1 set
16.	Needle file set	1 set
17.	Marking punches	1 set
18.	IC inserter and Extractors	1 set
19.	Portable Testing and Commissioning tool-	2 nos.

I**OTHER INSTRUMENTS**

SI. No.	Instruments	Quantity
1	Vibration Sensors (Also refer note 1 & 2)	:- Bidder shall furnish microprocessor based vibration monitoring system for all HT motors and its associated pumps, fans, drives etc. for X, Y & Key Phasor directions, in BTG & BOP /offsite packages.
(a)	ID (Fan + Motor)	
(b)	FD (Fan + Motor)	
(c)	PA (Fan + Motor)	
(d)	CEP (Motor + driven drive)	
(e)	BFP (Motor + driven drive)	
(f)	DMCW PUMP and ACW pump (Motor + driven drive)	
(g)	CW Pumps (Motor + driven drive)	
(h)	Air Compressor (Motor + Driven Drive)	

(i)	Mill motors (Motor + driven drive)		
(j)	Coal Crushers & conveyors (Motor + Driven Motor)		
(k)	For any other HT motors & driven drive envisaged for plant.		
2	Vibration Monitors		On as required basis based on the type of monitors. One set of monitors are to be provided for each of the following:- Main plant Control Equipment Room per unit, CW Pump House per unit, CHP control room, AHP control room, Air Compressor Room, FGD Control room and Raw Water Pump House.
<p>Note: 1. The system shall interface with the main plant vibration analysis & diagnostic system via suitable redundant communication network link like modbus / Ethernet to provide analysis, diagnostic & recording facility for the acquired data. Two (2) nos. Buffer outputs shall be provided by Bidder for each measurement required for Vibration analysis & diagnostic system. All the hardware required for condition monitoring, analysis & diagnostic shall be mounted in VMS panel, in case distance between VMS panel and Vibration analysis & diagnostic system is more than the distance covered by buffer outputs.</p> <p>2. Bidder shall provide 2 vibration sensors per measurement location - Driven end & non driven end (one for horizontal & one for vertical measurement).</p> <p>3. BOP/offsite System shall have separate vibration analysis & diagnostic system. VMS system and VMAS system for complete plant shall be from single make and model only. VMS panels location indicated are minimum in the plant and same shall be finalised during detailed engineering. Bidder shall provide separate vibration monitoring, analysis and diagnostic system for Unit and BTG auxiliaries. Similarly vibration monitoring, analysis and diagnostic system shall be separate for plant BOP package / system like CHP, AHP, FGD and plant water system.</p> <p>4. In case, Vibration monitoring system is not provided for compressor's bearing due to system/equipment's limitation/space constraints, then bidder shall provide casing vibration monitoring system and one no. additional portable type Vibration meter cum analyser as per details mentioned in Vol. V, Chapter 10.</p>			
3	Impact Head type flow element with flow transmitters		Two nos.
	(As on alternate DUAL PATH TRASIT TIME CLAMP-ON ULTRASONIC FLOW METER can be supplied for this application).		
4	Transducers		
	Incoming voltage		1 no
	Incoming Frequency		1 no



	Running voltage		1 no
	Running Frequency		1 no
	Grid frequency		2 nos.
5	Synchronising relays		
	Check relays		2 nos.
	Guard relays		2 nos.
	Auxiliary relay		1 no.
	Auxiliary Potential Transformer 110V/110V		2 nos.
	Auxiliary Potential Transformer 63.5 V/110V		2 nos.
6	Bunker Level Monitoring System		One set per Bunker
7	Ambient air quality monitoring system(AAQMS)		4 sets.
a	SOX, NOX, CO, CO2, O3 ANALYSER , Multi gas Calibration system, OWS based Data logger for e a c h A AQMS stations, UPS		4 each
b	Mercury Analyser		2
c	Suspended Particulate Monitors		8
d	Sampling Inlet Heads		4 (PM 10, PM 2.5 AND TSP)
e	PC/OWS Based Data Logger For Central Station With A4 Laser Printer Along With Ups		1
f	Meteorological sensors		1 LOT
g	Meteorological Mast		1
	Meteorological Data Logger		1
h	Sample Handling System Including Compressed Air For Purging		1 LOT
i	Connectivity From Central AAQMS Station To Individual Stations thru either wire less link or station wide LAN		1 LOT
j	Window A/C For Individual AAQMS Stations (1.5 Tons minimum Each)	2no. (one working & one hot standby) in each AAQMS station.	
8.	Effluent Quality Monitoring System (EQMS)		
a	pH Analyser		1 no
b	Conductivity Analyser		1 no
c	Chemical Oxygen Demand *(COD) Analyser		1 no
d	Biological Oxygen Demand *(BOD) Analyser		1 no
e	Total Suspended Solids (TSS) Analyser		1 no

f	Oil In Water (OIW) Analyser		1 no
g	Temperature Element (RTD)		1 no
h	Temperature Transmitter		1 no
i	Flow transmitters		1 no
J	UPS Power Supply Distribution Board (UPS PDB) with redundant		1 no
	* BOD & COD analysers are shown separately for the purpose of input		
	Above quantities shall also be finalised as per redundancy		

Annexure-II to contract quantities for DDCMIS

A Operating Devices & their locations							
Unit HMI							
	Units	Qty	-	Location	Areas for which Primary Operating Point	Areas for which Secondary Operating Point	
OWS	No	8		UCD in Unit Control Room	SG,TG & other unitised main equipment, Electrical system of main plant, DMCW/ECW system, CW pumps, ACW pumps, COLTCS, Air Conditioning system, AHUs for ESP building, Main Plant Building area, Ventilation system LP dosing system, MRHS, Condensate Storage Tank, Air compressor drives, cooling tower, makeup water system, FOPH		
OWS	No	1		UID in Unit Control Room	Do		
LVS along with its	No	5		Unit Control room	Do		
LVS to be connected to other systems (See Note-	No	1			NA		
GIU	No.	1		AC Plant equipment room.		Air conditioning system for main TG building & ESP building, Ventilation system.	



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



	GIU	No.	1		ESP Building Area		AHU of ESP building.
	GIU (Refer Note-6	No	1			For mill reject system	
Standalone System HMI (2 NOS. SERVER WS/1 NO. PROGRAMMER CUM DOC. STN & LASER JET							
	OWS	No		2	UCD in Unit Control Room between both units UCD.	Electrical system of common system in main plant, Air Conditioning system, AHUs for Main Plant Building area, Ventilation system for Main Plant Building, Plant Air compressor System, cooling tower, makeup water system, FOPH, CPU (Regeneration area).	
	LVS along with its workstation	No		2	Unit Control room	Do	
	GIU	No.		1	AC Plant equipment room.		Air conditioning system
	GIU (Refer	No		1	Near Cooling Tower		Cooling Tower
	OWS	Nos		1	IA/SA Area	IA/SA System	
	GIU (Refer	Nos		1	FOU Area	Fuel Oil Unloading System	
	GIU	No		2	Near Pumps	Makeup Water system	



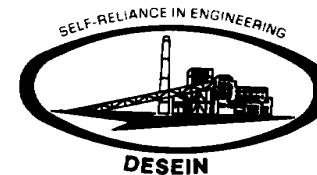
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DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



	OWS	No		1	CPU REGN		CPU regeneration
	GIU	No		1	CPU Regn, Alkali Dosing Area		CPU regeneration
	GIU	No		1	CPU Regn, Acid Dosing Area		
	GIU	No.		2			Location & function to be decided during detailed engineering
		Water system HMI					



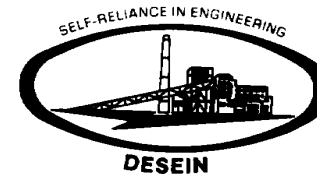
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DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



	OWS	No	3		Water System Control room	Plant Water System consist of Raw water system, AHP pumps, Pre-Treatment plant, clarified Plant includes control of APH/ESP wash water pumps, Service water pumps, AHP seal water make-up pumps, DM feed pumps, RGF backwash pumps and DM plant including DM storage tanks, DM Neutralization pit, DM regeneration System, degasser system, Acid/alkali storage system, DM transfer pumps, DM regeneration pumps up to condensate storage tank, Air conditioning & ventilation of water system control room, CPU, CW Chlorination System and CW treatment Plant , ETP CMB sump & pump system etc. To be checked.	
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"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



LVS with its workstation	No	3	Water System Control room	Plant Water System consist of Raw water system, AHP pumps, Pre-Treatment plant, clarified Plant includes control of APH/ESP wash water pumps, Service water pumps, AHP seal water make-up pumps, DM feed pumps, RGF backwash pumps and DM plant including DM storage tanks, DM Neutralization pit, DM regeneration System, degasser system, Acid/alkali storage system, DM transfer pumps, DM regeneration pumps up to condensate storage tank, Air conditioning & ventilation system of water system control room, CPU, CW Chlorination System and CW treatment Plant , ETP CMB sump & pump system etc.
OWS	No	1	Clarified water Pump House Building	CW chemical treatment, CW chlorination, Service Water Pumps. Acid & Alkali Unloading pumps of CW Chemical Treatment system, Service water pumps, Misc pumps near service water pumps, CW chlorination
GIU	No	3	Near the pumps	Acid & Alkali handing pumps & agitators, dosing pumps



GIU	No	3		Chemical House		PT chemical house agitators
GIU	No	1		Near the pumps		Filter & filter backwash water pumps
GIU	No	1		Near equipment		CW Chemical Treatment
GIU	No	1		Raw Water pump house		Raw Water pump house (sec)
GIU	No	1		AT Raw water intake pumps		Raw water intake pump house.
OWS	No	1		CPU REGN		CPU regeneration
GIU	No	1		CPU Regn, Alkali Dosing Area		CPU regeneration
GIU	No	1		CPU Regn, Acid Dosing Area		
GIU	No	1		Near CPU Service Vessel		Respective CPU service vessel
				Ash Handling System HMI		
OWS	No	2		Ash handling Control room	Ash slurry system & Ash Water system, Dry ash, Air conditioning & Ventilation of ash handling system,	Bottom ash, Ash silo



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



LVS with workstation	its No	2		Ash handling Control room	Ash slurry system & Ash Water system, Dry ash, Air conditioning & Ventilation of ash handling system,	Bottom ash, Ash silo
OWS	No	1		Ash Silo Area	Ash Silo	
GIU	No	1		Near equip.	Bottom ash	
GIU	No	1		Near equip.	Fly / Coarse ash	
Coal handling system HMI						
OWS	No	2		CHP Control room	Coal conveyors, track hopper, Belt weighers, Metal detectors, Inline Magnetic separators, Coal sampling Units, Hydraulic Scoop Coupling	Mobile tippers over bunkers
LVS with workstation	its No	2		CHP Control room	Coal conveyors, track hopper, Belt weighers, Metal detectors, Inline Magnetic separators, Coal sampling Units, Hydraulic Scoop Coupling.	Mobile tippers over bunkers
Unit DDCMIS						
	Units	Qty		Location	Remarks	
Redundant Servers / Information Workstations	No	2		Programmer's room	Redundancy required.	



Programmer cum Documentation Station (Refer note-2)	No	3		Programmer's room		
Monitor, keyboard, mouse	sets	6		Programmer's room	For hardware multiplexed using matrix KVM switch	
Laptops	No	2			These Laptops as shall be supplied to function as portable programming devices for all the DDCMIS systems	
Laser jet colour printer (A4 size)	No	2		Programmer's room		
Colour laser printer (A3 size)	No	1		Programmer's room		
Line impact dot matrix printer, Heavy duty	No	1		Programmer's room	These are for SOE	
Standalone DDCMIS						
	Units	Qty	-	Location	Remarks	
Redundant Servers / Information	No	2		Programmer's room	Redundancy required.	
Programmer cum Documentation	No	1		Programmer's room	Can be clubbed with Server/ Information workstations.	



Laser jet colour printer (A4 size)	No	1		Programmer's room		
Water system HMI						
	Units	Qty		Location	Remarks	
Redundant Servers / Information Workstations	No	2		Water system control room	Redundancy required.	
Programmer cum Documentation Station (Refer note-2)	No	1		Water system control room	Can be clubbed with Server/ Information workstations.	
Laser jet colour printer (A4 size)	No	1		Water system control room		
FGD system HMI						
	Units	Qty		Location	Remarks	
Redundant Servers / Information	No	2		FGD control room	Redundancy required.	
Programmer cum Documentation	No	1		FGD control room	Can be clubbed with Server/ Information workstations.	



Laser jet colour printer (A4 size)	No	1		FGD control room		
Ash handling system HMI						
	Units	Qty		Location	Remarks	
Redundant Servers / Information Workstations	No	2		Ash handling control room	Redundancy required.	
Programmer cum Documentation Station (Refer note-2)	No	1		Ash handling control room	Can be clubbed with Server/ Information workstations.	
Laser jet colour printer (A4 size)	No	1		Ash handling control room		
Coal handling system HMI						
	Units	Qty per unit	Qty - Com	Location	Remarks	
Redundant Servers / Information Workstations	No	2		CHP Control room	Redundancy required.	
Programmer cum Documentation Station (Refer note-2)	No	1		CHP Control room	Can be clubbed with Server/ Information workstations.	



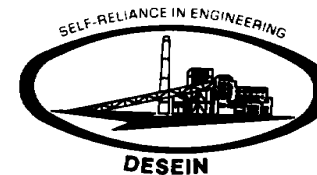
Laser jet colour printer (A4 size)	No	1		CHP Control room		
Colour laser printer (A3 size)	No	1		CHP Control room		
Line impact dot matrix printer, Heavy duty	No	1		CHP Control room	For logs	
	FOPH					
	Units	Qty		Location	Remarks	
Laser jet colour printer (A4 size)	No	1		FOPH Area		
	CW/ACW system					
	Units	Qty per unit		Location	Remarks	
Laser jet colour printer (A4 size)	No	1		CW/ACW house		
	Plant Air system					
	Units	Qty per unit		Location	Remarks	



Laser jet colour printer (A4 size)	No	1		Plant Air room		
	Station LAN			(See Note-7)		
Station wide redundant LAN	sets	1				
Redundant Station wide LAN switch with IDS	Sets	1				
Hardware Firewall in failover mode with IPS & VPN termination	Nos.	2				
Redundant Servers for MIS/Station wide LAN in DMZ zone	sets	1				
KVM Matrix Switch	No	2				
KVM Switch (for operator keyboard multiplexing)	No	5				



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



Network Management Software	set	1				
<p>OWS stations (For quantities & locations, please refer Appendix-A, Part A and Chapter 3, & Chapter 14, Part B). One number laser jet colour printer (A4 size) shall be provided with each OWS.</p>						
<p>1.The assignment of ' LVS to be connected to other systems' for this project is Flame cameras, PSSS/CCTV system in this package.</p>						
<p>2. (i) In case, separate control system programming device is required, same shall be provided for each DDCMIS system.</p>						
<p>(ii) For each of the DDCMIS based controls being provided for any system, 1 set of programming tool for each such system shall be provided to view & change logic/program/settings as mentioned in Vol. V, Part B, Chapter 14.</p>						
<p>3. Redundant master clock as per chapter 3 of Part B of Vol. V shall be located in CER. Interconnecting cables shall be on as required basis.</p>						
<p>4. Software for DDCMIS meeting requirements specified under item "SYSTEM SOFTWARE REQUIREMENTS" sub-section DDCMIS, Part-B, Vol. V of technical specification shall be on as required basis for all the DDCMIS.</p>						
<p>5. Data communication system shall be on as required basis. One set of suitable interfaces and links for connectivity between station wide LAN and DDCMIS sub-systems, unit/station PLCs, PC stations, CCTV etc shall be provided per DDCMIS , as applicable. Cubicles for mounting networking components and power supply distribution equipment shall be provided on as required basis.</p>						



“1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR”



	6. GIU is included in this Annexure as an operating device and same shall be industrial grade. Interfacing with DDCMIS shall be as per other requirements defined in Part-B of this specifications. Local control panels are also included as an operating device. Interfacing with DDCMIS & PLC shall be as per other requirements defined in Part-B of this specifications.
	7. For detailed requirements of Station LAN, please refer Part-B, Chapter 3, Vol. V.
	8. For signals from different systems to HMI/Station. LAN, refer Appendix-B.
	9. List of areas from which soft signals are to be connected to DDCMIS is given at Appendix-C
	10. The GIU is applicable only in case of IDCT.
	11. Client server architecture shall not be acceptable in any case for all DDCMIS control systems i.e. only Open architecture shall be accepted for DDCMIS. Client Server Architecture is a computing model in which the servers host, deliver and manage most of the resources and services to be consumed by the clients, hence limitation of the client-server approach is that if too many clients request data from particular server at the same time, the server may get overloaded. In addition to generating network congestion, too many requests only result in a denial of services.
	12. In case any bidder offers separate DCS based control system for TG integral control likes EHC, Turbine Protection, Generator protection, ATRS, TSC and ATT, then following requirements shall apply: (i) Separate DCS based control system shall be provided with Two no. operating work stations, one no. operating cum engineering cum programming work station, hot redundant OPC server, one no. A3 sized heavy duty line impact DMP and one no. A4 sized coloured LJP in addition to TSC integral OWS & printer.



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DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
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- (ii) DCS based turbine controls system shall be connected to Unit DDCMIS through OPC hot redundant bidirectional communication link for continuous monitoring. Hardwired signal interfacing shall be provided for any signal required for command, time critical, SOE, interlock, control & protection from any other control system. Hard wired Signals shall be dual redundant or triple redundant required for control & protection.
- (iii) Drawout backup desk shall also be provided by bidder for safe shut down and emergency trip push buttons with the control system as per technical specification.
- (iv) Remote service center shall be provided with the control system as per specification, Vol. V, Part B, chapter 3, Cl. No. 3.41.00 & 3.47.00.
- (v) The OPC system interface (OPC UA) shall comply with the following requirement as a minimum (a) OPC Data Access (OPC DA) (b) OPC Historical Data Access (OPC HAD) (c) OPC Alarm and events (OPC A&E) (d) Supervisory Control: - Transmission of operating commands (start/stop or On /off).
- (vi) Unified HMI shall also be achieved irrespective of separate control systems (DCS) offered for Turbine integral controls (GSPC, EHC, Turbine protection, TSC & ATT etc.). Unified system shall be achieved through with hardwired signal exchange and OPC interface between DCS based TG control system and Unit DDCMIS.
- (vii) Quantities of programming cum Engg& Diagnostic work stations, servers, work stations, laptops & printer shall remain same with Main plant DDCMIS as specified in technical specification and specified elsewhere irrespective of separate control systems (DCS) offered for Turbine integral controls

13. In case, any bidder offers separate DCS based control system for Boiler protection system (BPS – MFT), then following requirements shall apply: :

- (i) Separate DCS based control system shall be provided with one no. operating work stations, one no. operating cum engineering cum programming work station, hot redundant OPC server, and one no. A4 sized coloured LJP.
- (ii) DCS based BPS MFT controls system shall be connected to Unit DDCMIS through OPC hot Redundant bidirectional communication link for continuous monitoring. Hardwired signal interfacing shall be provided for any signal required for command, time Critical, SOE, interlock, control & protection from any other control system. Hard wired Signals shall be dual redundant or triple redundant required for control & Protection.
- (iii) Drawout backup desk shall also be provided by bidder for safe shut down and emergency trip push buttons with the control system as per technical specification.
- (iv) Remote service center shall be provided with the control system as per specification, Vol. V, Part B, chapter 3, Cl. No. 3.41.00 & 3.47.00.



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



- (v) The OPC system interface (OPC UA) shall comply with the following requirement as a minimum (a) OPC Data Access (OPC DA) (b) OPC Historical Data Access (OPC HAD) (c) OPC Alarm and events (OPC A&E) (d) Supervisory Control: - Transmission of operating commands (start/stop or On /off).
- (vi) Unified HMI shall also be achieved irrespective of separate control systems (DCS) offered for Boiler protection system (BPS – MFT). Unified system shall be achieved through with hardwired signal exchange and OPC interface between DCS based Boiler protection control system and Main Plant DDCMIS.

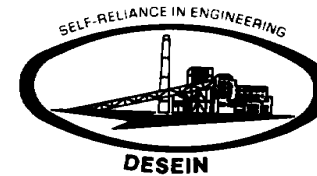


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Annexure-III to contract quantities for DDCMIS**Guidelines for Functional Grouping of Controllers**

- 1.00.00** The guidelines for the functional grouping in Control System of various DDCMIS shall be as follows.
- a) Keeping in view the functions of various systems/ sub-systems/ equipment of various process, systems (main plant, off sites etc.) are divided in to various sub-systems. Each sub- system is divided in to different process blocks. In some of the process systems, the process blocks and sub-systems will be same.
 - b) Separate sets of FG(s) are to be provided for each of the process blocks defined below. The functions of two different process blocks cannot be mixed.
 - c) The information signals of respective process areas will be generally kept along with respective main equipment.
 - d) For some of the process blocks, remote I/Os for some applications is envisaged, which is indicated in the Annexure-I to Contract Quantities for DDCMIS.
 - e) Electrical system of Unit DDCMIS will be a separate process block. However, electrical breakers of other DDCMIS shall be distributed along with respective process areas.
 - f) The exact allocation of areas to different FGs shall be subject to Owner's approval during detailed Engg. Stage.
- 2.00.00** The process blocks of Control System of various DDCMIS are defined below. It may be noted that in each of the process blocks, the process areas, equipment, logic, loops given below cover major areas of control. The exact areas/ control shall be finalized by Owner during detailed engineering stage.
- 3.00.00** **UNIT DDCMIS**
- 3.01.00** **SG SYSTEM**
- a. The stream wise process redundancy is to be maintained in SG C&I DDCMIS. That is, if there are more than one main equipment (e.g., A/B/C streams) in a process block, these are to be allocated to different FGs, unless allowed explicitly. In the FGs, thus obtained, main equipments of similar streams are to be allocated. For example, if one FG caters to stream-A main equipment, all main equipments of stream A of the same block shall be put together, e.g., Seal air fan-A and Scanner air fan-A should be put together. Further, the auxiliaries of main equipment will be allocated in the same FG where corresponding main equipment is allocated, for example, LOP of Mill-A will be allocated with Mill-A.
 - b. For different streams of process blocks defined below, separate sets of FG(s) are to be provided. Where different streams of process blocks are not defined, separate sets of FG(s) are to be provided for the process blocks. The functions of two different process blocks/ streams cannot be mixed unless explicitly allowed.

- c. The information signals of respective process areas will be generally kept along with respective main equipment.
- d. The exact allocation of areas to different FGs shall be subject to Owner's approval during detailed engineering stage.

3.01.01 Burner Management System:

- (a) **MFT block:** This block will consist of MFT protection system employing 2V3 controllers. The configuration of this block shall be generally as per Drg.No. 114-01-100/103.
- (b) **Boiler common functions block:**
 - (i) **Common stream-1:** This block will consist of Seal air fan-A control, Scanner air fan-A control, boiler common functions like Furnace purge, HOTV, LOTV, HORV, Scanner air emergency damper control, etc.
 - (ii) **Common stream-2:** This block will consist of Seal air fan-B control, Scanner air fan-B control, Atomizing steam/ air press. control, LDO press. /flow control, SADC, Aux PRDS controls, Boiler Drain tank level control, etc.
- (c) **Firing system blocks:** Maximum two mills and respective oil elevation can be assigned to one FG, e.g., Mill-A, Mill-B & Oil elevation-AB can be kept in one FG. Number of FGs in this block shall depend on actual no. of coal and oil elevations.
- (d) **Other SG system block:** This block will consists of Soot blower control including press & drain temp control, Boiler drains/vents including start up drains/vents, Mill reject system, FTP, ERV, MTM, Mill fire protection, SCAPH, Start up controls including control of Boiler Recirculation Pump, Separator, Flash tank, Minimum Economizer flow etc.

3.01.02 FOPH Control System (including control of Fuel oil unloading system):

This system shall have one block - Fuel oil pump house block consisting of Light oil discharge pr. control, Controls related to Fuel oil unloading etc. This control block shall be located in the FOPH control room.

3.01.03 Air Compressor System:

This system shall have one block- Air Compressor block including Air compressor for Mill reject system. If the controller is integral to compressor then Microprocessor / PLC based control system along with suitable operator interface as per vendors practice for individual air compressor shall be provided. If the controller for individual compressor is not integral to compressor then control shall be through SG-C&I. For both the cases, overall control shall be through SG-C&I. For compressors with integral controllers, redundant connectivity to SG-C&I to be provided for information and overall control.

3.01.04 MDBFP Control system:

This block will consist of MDBFP OLCS and CLCS controls, including auxiliaries of



MDBFP. If more than one MDBFP is being provided in the scope of the package, then separate FG shall be provided for each of the MDBFP.

3.02.00 **TG SYSTEM**

The Bidder shall provide functional groups as per the following guidelines.

- (i) STG integral controls (i.e. Close loop control (CLC), Open loop Control (OLC) and protection pertaining to steam turbine and generator) block:
 - The Bidder shall provide Turbine protection and Turbine EHTC, Automatic Turbine Testing, TSE's, Gland steam system controls, Turbine and Generator Auxiliaries including ATRS, Oil System, Vacuum system, seal oil system, stator water system, Turbine Extraction NRV system etc. functionalities in this block. The STG Integral control process block shall consist of set(s) of controllers, I/O modules, communication controllers, power packs/modules. The configuration of this block shall be generally as per Drg. No. 114-01-100/102.
- (ii) Over and above the STG integral controls block envisaged above, the Bidder shall also provide functional groups as per the following guidelines. The TG control system is divided into different process blocks. For different process blocks, separate sets of FG(s) are to be provided. The process blocks of the TG control system are defined below. It may be noted that the process areas, equipment, logic, loops given below cover major areas of control. The exact areas/control shall be subject to owner's approval during detailed engineering stage.
 - a. **BFP Drive Turbine-A block:** This block will consist of BFP Drive Turbine-A OLCS and CLCS controls, including EHTC/protection of Drive Turbine-A and **auxiliaries of Drive Turbine-A. To be includedde .**
 - b. **BFP Drive Turbine-B block:** This block will consist of BFP Drive Turbine-B OLCS and CLCS controls, including EHTC/protection of Drive Turbine-B and **auxiliaries of Drive Turbine-B.**
 - c. **Balance control implementation:** - The remaining controls envisaged in the scope of the work such as HP/LP bypass system, condenser on load tube cleaning system, SCS, Turbine lube oil purification control, central lub oil purification control etc. can be implemented in any of the above process blocks or separately as per the Bidder's standard and proven practice. The exact implementation methodology, how-ever shall be strictly as approved by Owner during detailed engineering.

3.03.00 **BOP SYSTEM**

The stream-wise process redundancy is to be maintained in Unit DDCMIS. That is, if there are more than one main equipment (e.g. in A/B/C/D streams) in a process block, these are to be allocated to different FGs (unless allowed explicitly). For example, ID fans-A & B will be allocated to two different FGs: BFP-A, B & C will be allocated to three different FGs, etc. In the FGs thus obtained, main equipment of similar streams is to be allocated. For example, if one FG caters to stream-A main equipment, all main equipment of stream-A of the same block should be put together, e.g. ID fan-A, FD fan-A should be put together. Further, the auxiliaries of main equipment will be allocated in the same FG where corresponding main equipment is allocated, for example, LOP-A & LOP-B of FD fan-A will be allocated with FD fan-A.



3.03.01 The Control System of **BOP DDCMIS** is divided in following major sub-systems:

- (i) **BOP-SG**
- (ii) **BOP-TG**
- (iii) **Electrical system**
- (iv) **BOP- offsite system**

For each of the above major sub-systems, the process blocks, along with major equipment/ control loops in each block are as follows:

(i) **BOP-SG**

- (a) **Secondary air block:** ID fans A&B, FD fans A&B, Secondary Air Heaters-A&B along with flue gas temp control/ fire detection, Secondary SCAPH-A&B; Stack Path; furnace draft control, air flow control etc.
- (b) **Steam & Water block:** Main Steam/SH/RH valves along with temp control, DMCW pump-SG- A&B along with DP control, Dosing; FW valves, SG misc drives; Coordinated Master Control (CMC), feed water control, Group controls, RH protection, SWAS etc.
- (c) **Primary air block:** PA fans-A&B, Mills/feeders-controls for outlet temp, PA flow & feeder speed (alternate mills/feeders are to be kept in separate FGs), PA header pressure control, Primary SCAPH-A & B, Primary air heaters A&B along with temperature control/fire detection, etc.

(ii) **BOP-TG**

BOP-TG block:

The BOP-TG consists of following major equipment/ control loops: BFP Motor driven BFP; CEP-A, B & C along with recirculation controls; Gland seal pressure control for condensate;; HP heaters-valves & level control (all HP heaters are to be kept in one FG), LP heaters valves & level control (all LP heaters are to be kept in one FG), hot-well level control, Spill over control, Deaerator level & pressure control, DMCW pump-TG-A, B & C along with DP control, TG misc valves/ controls, etc.

(iii) **Electrical system**

Electrical block: Electrical breakers – synchronization (sync) and non-synchronization (non- sync) type electrical breakers are covered in this system. The hardwired monitoring signals of power supply (UPS & DC system) will also be connected here.

(iv) **BOP – Offsite System**

The Control System of Unit DDCMIS has following process blocks. The major equipment/control loops in each block are indicated below.

- a) **CW/ACW block: CW and ACW pumps, CW makeup system-**



(not more than 2 nos. CW and ACW pumps are to be kept in one FG; and alternate ACW pumps are to be assigned to different FGs)

- b) **Cooling Tower Block:** Cooling tower system
- c) Makeup water system block. - (DM) Hotwell Make-up Pumps, Hotwell makeup Valve control and CST onwards monitoring and Boiler Fill Pumps, Deaerator & Boiler initial filling lines etc.
- d) Air Conditioning & Ventilation system for main TG building & ESP building.

4.00.00 Water System DDCMIS

The Control System of Water System DDCMIS has following process blocks. The major equipment/ control loops in each block are indicated below.

- (i) **DM plant block:** DM plant streams, DM storage tanks, DM neutralization pit, DM regeneration system up to condensate storage tank, degasser system, acid/ alkali storage system, Ash water recirculation pumps, CW chemical treatment, misc pumps, air conditioning & ventilation of water system control room & local control rooms etc.
- (ii) **PT plant block:** Raw water Intake pump system, Raw water pumps system, Pre-Treatment plant, Pressure filters, chemical house, CW chlorination system, PT chlorination system, , Clarifier water pumps system includes control of APH/ESP wash water pumps, Service water pumps, AHP seal water make-up pumps, DM feed pumps, FGD makeup water pumps (if provided) etc., CL water tank, Sludge pit, Treated water tank, potable water system, service water system, condition monitoring basin, CW blow down system, , effluent treatment plant – CMB sump, etc.
- iii) **CPU Block:** CPU regeneration system, CPU service vessel.
- (iv) **Electrical system for water system.**

5.00.00 Ash handling System (AHP) DDCMIS

The Control System of AHP DDCMIS has following process blocks.

- (i) **Bottom ash and fly ash block**
- (ii) **AHP common system block:** ash slurry pumps, ash slurry disposal system, ash water pumps, ash silo, air compressors for AHP, Air Conditioning & ventilation system of AHP building & local control rooms etc.
- (iii) **Electrical system for Ash Handling system.**

6.00.00 Coal handling System (CHP) DDCMIS

The Control System of CHP DDCMIS has following process blocks:

- i. All belt conveyors.
- ii. Track Hopper
- ii. Vibrating Grizzly feeders.
- iii. Belt Feeders



- iv. Crushers
- v. Flap Gates.
- vi. Dry Fog Dust Suppression System
- vii. Apron Feeder with dribble conveyor
- viii. Belt Weigher
- ix. Metal Detector
- x. In Line Magnetic Separator
- xi. Hydraulic Scoop Coupling.
- xii. Coal Sampling unit.
- xiii. Air Conditioning & Ventilation system for CHP
- xiv. Electrical system for CHP.
- xv. Service water system, Cooling water system and Potable water system.
- xvi. Compressed Air System for CHP.

7.00.00 Stand-Alone Systems.

The Control System of Stand-Alone DDCMIS has following process blocks. The major equipment/control loops in each block are indicated below.

- i) **Main Plant AC Common Block:** Common Air conditioning & ventilation system of various areas like TG building, CER, SWAS Room, UPS Room, Charger Room etc.
- ii) **Cooling Tower Block:** Cooling tower system
- iii) **CPU Block:** CPU regeneration system.
- iv) **Makeup water system block.** - (DM) Hotwell Make-up Pumps, Hotwell makeup Valve control and CST onwards monitoring and Boiler Fill Pumps, Deaerator & Boiler initial filling lines etc.
- v) **FOPH Control System (including control of Fuel oil unloading system):**

This system shall have two blocks - one for Fuel oil pump house block consisting of Light oil discharge pr. Control & other FOPH controls, other block for Controls related to Fuel oil unloading etc. This control block shall be located in the FOPH control room.

vi) Air Compressor System:

This system shall have one block- Air Compressor block per one no. IA compressor, one no. SA compressor and one no. Dryer. If the controller is integral to compressor then Microprocessor / PLC based control system along with suitable operator interface as per vendors practice for individual air compressor shall be provided. For compressors with integral controllers, redundant connectivity to standalone DDCMIS to be provided for information and monitoring. Hardwired interfacing shall be provided for overall operation and control.

vii) Electrical System.

Electrical block: Electrical breakers – synchronization (sync) and non-synchronization (non- sync) type electrical breakers are covered in this system. The hardwired monitoring signals of power supply (UPS & DC system) will also be connected here.

viii) FGD Control System

The Control, monitoring & operation of FGD Block shall be from FGD DDCMIS. Hard wired interfacing shall be provided with Main Plant DDCMIS for time critical, interlock, control & protection signals. DCS based control system shall be provided with 2 sets of Redundant Hot Standby Processors (1 set for FGD system and 1 set for common system like Lime stone handing system and water system) .

SCR Auxiliaries System

Main Plant DDCMIS shall be used for control of SCR & Auxiliaries Block. Instrumentation and Control System for monitoring, interlocks, control, operation, protection and annunciation of SCR systems shall be provided in Main Plant DDCMIS with Software and hardware as required to provide a complete functioning of the system.

8.00.00

The Bidder shall provide requisite number of function groups for each Control System considering the guidelines defined above for functional grouping, and considering all specification requirements defined in the specification. The major aspects to be considered shall be as follows.

- (i) Hardware capacity, including spare capacity
- (ii) Software capacity, including spare capacity
- (iii) Response time/ signal acquisition time requirement for Control System
- (iv) Parametric requirements of DDCMIS
- (v) Functional grouping and associated requirements specified under Vol. V, Part B, chapter 3 and notes for Contract Quantities of DDCMIS.

The Bidder shall furnish functional grouping diagram for Control System of each DDCMIS, in the bid supported by back-up calculations and reasons for proposed functional grouping, and exact functional grouping shall be finalized during detailed engineering stage, as approved by the Owner.

8.00.01

1 set of hot redundant Controller means physically two no. separate Controller. All the 100% hot back up Controllers shall be identical in hardware and software to their corresponding main Controllers. Further, each of the 100% hot back up Controller shall be able to perform all the tasks of their corresponding main Controller. The 100% hot back up Controller shall continuously track/update its data corresponding to its main Controller. There shall be an automatic and bump less switchover from the main Controller to its corresponding back-up Controller in case of main Controller failure and vice versa. The changeover shall take place within 50 msec. Engineered solution for redundancy in CPU are not acceptable. Dual redundant Controllers shall be placed separately and shall not share the same motherboard or shall not have any other common sharing point.

Any switchover from main Controller to 100% hot back up Controller and vice versa, whether automatic or manual shall not result in any process upset or any change in control status. The transfer from main Controller to the back-up & vice-versa shall be indicated as alarm on all operator station OSs.

In case of switchover from main Controller to back up Controller, the back-up Controller shall be designated as the main Controller.



APPENDIX-II TO PART-A

TECHNICAL INFORMATION AND DATA TO BE SUBMITTED AFTER THE AWARD OF CONTRACT

1.00.00 GENERAL

The minimum requirements of data, drawings and instruction manuals for this package are indicated in this Part-II, in addition to the requirements of various clauses of Technical Specification, Vol. V and other applicable Sections (to be submitted in multiple copies to the Owner as per General Technical Requirements, Part-C, Vol. V).

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

2.00.00 DISTRIBUTED DIGITAL CONTROL, MONITORING & INFORMATION SYSTEM (DDCMIS):

(Refer Subsection DDCMIS, Part-B, Vol. V and other applicable Sections)

Phase I, Phase II, Phase III documentation shall be submitted in Two hard copies and three soft copies in CD-ROMs. Phase IV and Phase V documentation shall be submitted as per Annexure 1 to GTR, Part C of Technical Specifications. The CD-ROM based documentation shall be provided which shall be compatible with on-line documentation facility specified in item System Documentation Facility, Subsection DDCMIS, Part B, section and item SYSTEM DOCUMENTATION Subsection DDCMIS, Part B of Vol. V, other applicable Clauses/Sections.

2.01.00 PHASE- I (Standard Documentation)

2.01.01 Detailed standard technical literature for all types of modules, peripherals of DDCMIS.

2.01.02 User guide/details of following:

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

2.01.03 List of all types of software used in HMIPIS, Control system, Programming & Documentation Stations, etc. (Software BOM).

2.01.04 Details of all types of functional software blocks (or macros) available in the system



2.01.05 for developing control loops/logics including methods of developing customized block/macro, either fresh or as modification of standard ones.
Details of standard & customized applications in HMIPIS, covering all HMIPIS functionalized.

2.01.06 Details of symbols used in graphic displays/mimics in HMIPIS.

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

2.02.00 PHASE-II (Preliminary Design Documents)

2.02.01 Overall configuration diagram of DDCMIS showing all components/modules.

2.02.02 Detailed functional grouping diagram of Control System showing distribution of drives, calculations showing capabilities (including spare capacity) of each group.

2.02.03 Detailed configuration diagram of HMIPIS showing all peripherals and network connections.

2.02.04 Preliminary Bill of Material (BOM) of DDCMIS indicating no. of all types of modules, controls (system cabinets, marshalling cabinets, relay cabinets, etc.) like servers, workstations, LVS, peripherals like Monitors, printers etc. network components, cables, peripherals etc. with weight, heat load, degree of protection of each item.

2.02.05 Outline & mounting drawings for all types of cabinets, peripherals in DDCMIS, next mesh with done.

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

2.03.00 PHASE-III (Detail Design Documents)

2.03.01 Functional Design Specification for DDCMIS containing:

- (i) Design philosophy for DDCMIS indicating how the specification requirements are translated in Bidder's system, implementation philosophy, redundancy features, etc.
- (ii) Write up on the system offered and as configured & customized for this project.
- (iii) Write up on HMIPIS elaborating
 - (a) System/operator functionalities for displays, logs, calculations, historical storage, long term storage, Unit/Station LAN.
 - (b) Various application engineering details.
 - (c) System security
 - (d) Redundancy features
 - (e) Parametric requirements
 - (f) Programming requirements
 - (g) Diagnostic facilities
 - (h) Connectivity with LAN and other owner's system as applicable. (i) Interfaces for other systems like PLCs, PADO, off-line LAN etc.



- (j) Alarm system (LVS based & other features)
 - (iv) Write-up on SOE collection & reporting
 - (v) Write-up on time synchronizing scheme for master clock system & details of Slave Clock.
- 2.03.02 Single line diagram for power supply requirements and distribution scheme of DDCMIS (both 24V DC and UPS).
- 2.03.03 Grounding Scheme for DDCMIS.
- 2.03.04 Standard O&M manuals & programming guides e.g. for data base, mimics, logs, HSR, etc. in HMIPIS.
- 2.03.05 Calculations to show how system spare capacity & expandability requirements as specified is being met in Bidder's system.
- 2.03.06 Calculations to show how system parametric requirements as specified is being met in Bidder's system.
- 2.03.07 Detailed BOM of DDCMIS with main & mandatory spares quantities for each of the subsystems of DDCMIS. The detailed BOM shall be furnished for each cabinet & peripheral indicating quantity, make, model, part no., ordering code for each part/component so that based on this information Owner can procure these parts/components.
- 2.03.08 Detailed I/O list giving complete connectivity of input & outputs. This shall include tag no., TB no., cable no., marshalling rack/pin no., functional group, system cabinet no., I/O module location, channel no., related loop/logic drawing no., process range, alarm limits, set points, use of signal for interlock/protection/sequence/control loop/SOE/annunciation/information only etc., destination details for output signals including system cabinet no., I/O module no., channel no., Cable no., etc. The exact no. of fields in the list shall be as approved by Owner during detailed engg. stage.
- 2.03.09 Implemented control loop & logic diagrams for control system, write up for CLCS loops.
- 2.03.10 Implemented displays, mimics, logs, reports, etc. for HMIPIS.
- 2.03.11 Total HMIPIS data base consisting of following:
- (a) Field I/O (as per 2.03.08 above),
 - (b) Computed points in Control System,
 - (c) Computed points in HMIPIS,
 - (d) Point received from SG/TG System & other systems through LAN etc.
- 2.03.12 General Arrangement, Internal Arrangement of all cabinets and other equipment and devices.
- 2.03.13 Interfacing details indicating interfacing arrangement of Bidder's system with other systems not in Bidder's scope.
- 2.03.14 Interconnection schedule (ICS) for connecting all equipment/cabinets in Bidder's scope.
- 2.03.15 Schematic/wiring drawings for all cabinets/systems.
- 2.03.16 Safety requirements for grounding, interlocks, safety control circuits, etc.

(Standard plus project specific as applicable)

- 2.03.17 Site handling, storage requirement/recommendations. (Standard plus project specific as applicable)
- 2.03.18 Fuse/MCB characteristics of all types of fuses/MCBS used in the system, fuse coordination, make/model nos. of all fuses/MCBS.
- 2.03.19 Detailed listing showing complete system connectivity right from field instruments/devices/MCC/SWGR/actuators to individual channels of input modules and system outputs from individual output channels to relay cabinets / MCC / SWGR/actuators, etc. irrespective of scope of supply of instruments / devices /actuators & cables.
- 2.03.20 ATS test documents including:
- (a) ATST plan / FAT procedures for tests to be conducted at works.
 - (b) Type Test results / report / certificate as applicable.
- 2.03.21 Any other design data, drawings and documents prepared for this project but not specifically listed above.

2.04.00 PHASE-IV (Along with Equipment Dispatch)

- 2.04.01 Operation and maintenance manuals and diagnostics/trouble shooting guides for all equipment/devices of DDCMIS. The manuals shall include all information required for trouble-shooting and maintenance information (for both Hardware & Software) regarding all the equipment furnished for the completeness of the system. Sufficient documentation including general description, block diagrams, manual controls, detailed wiring and external connection drawings, etc. shall be provided to carry out trouble-shooting for all equipment.
- 2.04.02 Installation & Commissioning manuals.
- 2.04.03 Detailed instruction manuals for all systems/modules of DDCMIS which shall include all standard technical literature and drawings/documents approved by Owner.
- 2.04.04 Authenticated software listings including back up media on CD-ROMs for all software as listed at cl. 1.02.06 of Sub Sec III E-01 and also any other document not listed specifically here but required to understand, trouble-shoot, repair, maintain the offered system.
- 2.04.05 Consolidated detailed BOM of all devices/equipment as approved, approved datasheets on soft copies.

2.05.00 Phase-V

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

Also refer item SYSTEM DOCUMENTATION Subsection DDCMIS, Part B of Vol. V, and other applicable Clauses/Sections.

3.00.00 MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



(Refer Subsection, chapter 2, MEAS INST, Part-B, Vol. V and other applicable clauses)

3.01.00 Supplementary Data

1. Complete Bill of material for all instruments including all necessary accessories etc.
2. Detail description of each category of items covered under this contract.
3. Data sheets for all instruments and other equipment like CJC Boxes, E/P converters, electrical transducers/meters/relays etc. including transducers.
4. Instruction manual covering instructions for installation, calibration, commissioning, normal operation, trouble shooting and maintenance for all instruments furnished by the Bidder.
5. Test certificates of all instruments, wherever applicable.
6. Design certificate for thermo wells and test wells furnished in accordance with the specification requirements.

3.02.00 Contract Drawing Requirements

3.02.01 Typical measurement schematic diagram, hook-up diagram detailing hardware included for each category of measurements, e.g., pressure measurement, flow measurement, etc.

3.02.02 Outline and mounting drawings, detailing all necessary dimensions for each category of instrument, thermo well etc,

3.02.03 Installation drawings for instruments and measurement systems furnished along with details of erection material furnished.

3.02.04 Applicable internal wiring diagram, external connection and interconnection diagram for each type of instrument furnished.

3.02.05 Name-plate design and engraving. (Only typical for approval)

3.02.06 Vibration monitoring system drawings shall include the following:

- a) Vibration monitoring equipment details showing general arrangement/layout etc.
- b) Vibration monitor rack mounting drawing showing dimensional details
- c) Transducer mounting pad drawing, showing mounting hole and other mounting details.
- d) Vibration monitoring system cabinets mounting drawing showing details of mounting, floor opening (if any).
- e) Wiring diagrams for vibration monitoring system.

3.02.07 Recommended Installation drawings for Flue Gas Oxygen Analyzer Probe Flue Gas CO Analyzer probe and Stack Opacity Monitor.



3.02.08 Write-up, data sheet, BOM wiring / instrumentation etc. of Coal Bunker Monitoring System.

3.03.00 TG RELATED MEASURING INSTRUMENTS

(Refer Sub-section- chapter 4, TG related Measuring instruments, Part-B of Vol. V and other applicable clauses)

3.03.01 Turbine Supervisory System

3.03.01.01 Data Sheets of various Supervisory Instruments and their accessories.

3.03.01.02 Consolidated BOM.

3.03.01.03 Installation and mounting drawing for each sensor and other accessories.

3.03.01.04 Technical Write-up explaining the operating principle for each Supervisory Instrument.

3.03.01.05 Total Schematic giving interconnection between various system components, power supply etc.

3.03.01.06 Interconnection scheme and cable schedule.

3.03.01.07 Technical details and User manual for the On-line Spectrum and Harmonic Analysis system

3.03.01.08 Detailed Technical Literature giving system description, all technical parameters, installation procedure & precautions, trouble-shooting and maintenance procedure etc.

3.03.02 BFP Turbine Supervisory System

Same as Turbine Supervisory System above.

3.04.00 SG RELATED CONTROL AND INSTRUMENTATION SYSTEM (Refer Sub-Section- chapter 4, Main EQPT INST SYST., Part-B, Vol. V and other applicable clauses)

3.04.01 Flame Monitoring System

3.04.01.01 Data Sheets of flame Scanners and accessories.

3.04.01.02 Consolidated BOM for Flame Monitoring System

3.04.01.03 Arrangement drawings of the flame scanners along with justification for location of flame scanners.

3.04.01.04 Installation and mounting drawing for the flame Scanners and accessories along with cooling connection.

3.04.01.05 Interconnection scheme and cable schedule.

3.04.01.06 Detailed Technical Literature giving principle of operation, all technical parameters, installation procedure & precautions, trouble-shooting and maintenance procedure etc.



3.04.01.07 Details of the flame detector testing kit along with its user manual.

3.04.02 Coal Feeders Control & Instrumentation

3.04.02.01 Data Sheets of load cell, speed sensors and other associated local devices.

3.04.02.02 Total Schematic drawing for feeder control cabinet and local feeder electronics giving interconnection between various system components, power supply etc.

3.04.02.03 Consolidated BOM.

3.04.02.04 Interconnection scheme and cable schedule.

3.04.02.05 Detailed Technical Literature giving system description, all technical parameters, installation procedure & precautions, trouble-shooting and maintenance procedure etc.

3.04.03 Electromotive Safety (Relief) Valves

3.04.03.01 Data Sheets of ERVs.

3.04.03.02 Total Schematic drawing for ERVs, associated field instruments giving interconnection between various system components, power supply etc.

3.04.03.03 Consolidated BOM.

3.04.03.04 Interconnection scheme and cable schedule.

3.04.03.05 Detailed Technical Literature giving system description, all technical parameters, installation procedure & precautions, trouble-shooting and maintenance procedure etc.

3.04.04 Furnace Temperature Probes

3.04.04.01 Data Sheets of Furnace Temperature Probes along with accessories.

3.04.04.02 Installation and mounting drawing for the Furnace Temperature Probes and its accessories.

3.04.04.03 Consolidated BOM.

3.04.04.04 Total Schematic drawing giving interconnection between various system components, power supply etc.

3.04.04.05 Interconnection scheme and cable schedule.

3.04.04.06 Detailed Technical Literature giving system description, all technical parameters, installation procedure & precautions, trouble-shooting and maintenance procedure etc.

3.04.05 Acoustic Pyrometers

3.04.05.01 Data Sheets of Acoustic Pyrometers along with accessories.



- 3.04.05.02 Technical write-up giving principle of operation.
- 3.04.05.03 Configuration diagrams of the PC-based system and total Schematic drawing giving interconnection between various system components, power supply etc.
- 3.04.05.04 Consolidated BOM.
- 3.04.05.05 Installation and mounting drawing for the Acoustic Pyrometers and its accessories.
- 3.04.05.06 Interconnection scheme and cable schedule.
- 3.04.05.07 Detailed Technical Literature giving system description, all technical parameters, installation procedure & precautions, trouble-shooting and maintenance procedure etc.
- 3.04.05.08 User Manual for use of the PC-based software.

3.04.06 Furnace and Flame Viewing System

- 3.04.06.01 Data Sheets of Furnace Flame Cameras along with accessories.
- 3.04.06.02 Technical write-up giving principle of operation of the cameras, flame image processor and the PC-based Management system.
- 3.04.06.03 Consolidated BOM.
- 3.04.06.04 Configuration diagrams of the PC-based system and total Schematic drawing giving interconnection between various system components, power supply etc.
- 3.04.06.05 Installation and mounting drawing for the Furnace Flame Cameras and its accessories.
- 3.04.06.06 Interconnection scheme and cable schedule.
- 3.04.06.07 Detailed Technical Literature giving system description, all technical parameters, installation procedure & precautions, trouble-shooting and maintenance procedure etc.
- 3.04.06.08 User Manual for use of the PC-based software.

3.04.07.01 Separator Drain Level Control and Monitoring System (For Boilers Provided with Separator)

- 3.04.07.02 Data Sheets of level switches, metal temperature and other local instruments and other accessories.
- 3.04.07.03 Installation and mounting drawing for all instruments.
- 3.04.07.04 Consolidated BOM.
- 3.04.07.05 Technical write-up and control loop/logic for the system operation.
- 3.04.07.06 Total Schematic giving interconnection between various system components, power supply etc.
- 3.04.07.07 Interconnection scheme and cable schedule.



3.04.07.08 Detailed Technical Literature giving system description, all technical parameters, installation procedure & precautions, trouble-shooting and maintenance procedure etc.

3.04.07.09 Detailed technical Write-up, calculations/algorithms for stress evaluation (if applicable)

3.04.08 Conductivity Type Level Switching System

3.04.08.01 Data Sheets of Electrodes, Electronic Units and other accessories.

3.04.08.02 Installation and mounting drawing for the electrodes, vessels and other accessories.

3.04.08.03 Consolidated BOM.

3.04.08.04 Total Schematic giving interconnection between various system components, power supply etc.

3.04.08.05 Interconnection scheme and cable schedule.

3.04.08.06 Detailed Technical Literature giving system description, all technical parameters, installation procedure & precautions, trouble-shooting and maintenance procedure etc.

3.04.09 Mill Fire Detection System

3.04.09.01 Data Sheets of the temperature elements and other accessories.

3.04.09.02 Consolidated BOM.

3.04.09.03 Installation and mounting drawing for the temperature sensors and other accessories.

3.04.09.04 Write-up for the logic/ algorithms to be used for fire detection and protection.

3.04.09.05 Total Schematic giving interconnection between various system components, power supply etc.

3.04.09.06 Interconnection scheme and cable schedule.

3.04.09.07 Detailed Technical Literature giving system description, all technical parameters, installation procedure & precautions, trouble-shooting and maintenance procedure etc.

3.04.10 Detailed drawings/documents/data sheets/GA drawings for Carbon in Ash Analyser system.

4.00.00 ELECTRIC POWER SUPPLY

(Refer Subsection, chapter 7, Power Supply, Part-B, Vol. V and other applicable sections.)

4.01.00 Supplementary Data



- 4.01.01 Complete Bill of Materials for all Uninterruptible Power Supplies (UPS) & DC power supply system equipment and system components including associated accessories.
- 4.01.02 Detailed description of each type of device/instrument furnished for UPS system & DC supply system, cooling system arrangement, power supply requirement.
- 4.01.03 Design specification sheet for each type of system hardware/instrument.
- 4.01.04 Write up on uninterruptible power supply system including descriptions for start-up/shut down procedures, normal operation etc.
- 4.01.05 Calculations for sizing of inverters, batteries, battery charger, transformer etc.
- 4.01.06 Specifications, ratings etc., of various components/devices including international code numbers which will enable the Owner to procure these components/devices from sources other than the original system supplier.
- 4.01.07 Instruction manual covering instructions for installation, testing, commissioning, normal operation, trouble shooting and maintenance for each type of UPS system & DC power supply system hardware furnished and for the system as a whole.

4.02.00 Contract Drawing Requirements

- 4.02.01 Outline and mounting drawing showing dimensional details for all cabinets/enclosures.
- 4.02.02 General arrangement, layout drawings for all cabinets/enclosures.
- 4.02.03 AC & DC distribution board general arrangement, layout assembly and mounting drawings.
- 4.02.04 Wiring diagrams showing connections between terminal board and the devices/instruments, for all cabinets.
- 4.02.05 Wiring diagrams for AC & DC distribution boards.
- 4.02.06 Wiring diagrams for the uninterruptible power supply system electrical devices, logic and associated battery.
- 4.02.07 Schematic diagrams and power distribution single line diagram giving feeder ratings and External Connection / TB diagram, ICS & Cable Schedule.

5.00.00 PROCESS CONNECTIONS AND PIPING

(Refer Sub-Section, chapter 8, PCP, Part-B, Vol. V and other applicable Sections)

5.01.00 Supplementary Data

- 5.01.01 Bill of Materials for impulse piping, sample piping, pneumatic tubing, fittings, instrument valves, valve manifolds, tubing trays and all other accessories required for erection.
- 5.01.02 Detail technical specification including material specification, dimensional details of each type of impulse piping, sample piping, pneumatic piping/tubing, fittings, flexible hoses, instrument valve, Air line valves, valve manifolds Cond. pot. and all



other required accessories.

5.01.03 Instruction for inspection and erection of process connection, fittings, hydraulic and leakage test methods and procedures.

5.02.00 Contract Drawing Requirements

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

5.02.02 Drawings indicating complete tray system, supports, etc., giving construction and design features.

5.02.03 Overall installation scheme for installation and commissioning of all instruments and systems furnished under this specification as per intent and requirements of this specification.

5.04.00 Local Instrument Enclosures/Racks

Following data/drawings shall be submitted for the transmitter enclosures/racks:

- a) Typical G.A. drawing for all LIE/LIRs. (One for each type of LIE/LIR).
- b) Outline and mounting drawings for transmitter enclosure/racks.
- c) Drawing showing construction details for transmitter enclosures/racks.
- d) Piping, Tubing and electrical wiring layout drawings for transmitter enclosures/racks.
- e) Power supply wiring diagram.
- f) Instrument installation detail drawing showing instrument location, mounting within enclosure/rack, floor opening (if any).

6.00.00 INSTRUMENTATION AND POWER SUPPLY CABLE

(Refer Subsection, chapter 9, INSTRUMENTATION AND POWER SUPPLY CABLE, Part-B, Vol. V and other applicable Sections)

6.01.00 Supplementary Data

6.01.01 Complete Bill of Materials for all types of instrumentation cable and electrical field construction material and accessories.

6.01.02 Detail technical data sheet for cables, and wiring conduit and fittings, junction boxes; terminal blocks and other electrical installation materials furnished by the Bidder.

6.01.03 Instruction for laying, pulling, inspection tests and termination procedures for cables and erection of electrical field construction materials, instruction of continuity, identification, circuit checking and testing of cables.

6.02.00 Contact Drawing Requirements

6.02.01 Cable cross sectional details and sizes.

6.02.02 Detail boxes showing arrangement of terminal blocks.

6.02.03 Detail drawings for conduit and fittings.



- 6.02.04 Detail dimensional drawings for other electrical construction materials.
- 6.02.05 Cable interconnection diagrams and cable lists for all cables furnished by the Bidder.

7.00.00 CONTROL DESK & PANEL

(Refer Subsection, chapter 6, Control Desk & Panel, Part-B, Vol. V and other applicable Sections)

7.01.00 Supplementary Data

- 7.01.01 Complete Bill of Material for all control desk, panels, desk mounted items and LVS panel.
The Bill of Material shall include the accessories associated with panel mounted items. The format of the Bill of Material shall be finalised during detailed engg. & as approved by Owner.
- 7.01.02 Design specification sheet of all panel/desk mounted items detailing contact rating, no. of contacts etc. as applicable. Also, specification sheet of all LVS panel mounting accessories.
- 7.01.03 Power supply requirements for all equipment.
- 7.01.04 Physical data necessary to coordinate structural design requirements for all control desk, unit control panels & LVS panel installed in central control room and elsewhere.

7.02.00 Contract Drawing Requirement

- 7.02.01 Outline and dimensional drawings for control desk, unit in-charge desk, LVS panel etc.
- 7.02.02 General arrangement drawings showing location of all items mounted on the control/in-charge desk & LVS panel with proper identification and full dimensional details.
- 7.02.03 Panel/desk rear view & side view (profile) drawings showing location of terminal blocks and all other equipment mounted within the panels. Similar drawings for LVS panel.
- 7.02.04 Panel, Control Desk, Unit In-charge/desk manufacturing drawings describing location of wire ways, floor openings, mounting of base frame on floor opening bracing etc. necessary to install wiring entering and leaving panels.
- 7.02.05 Control desk, Unit In-charge Desk, panels internal wiring diagrams applicable to all electrical devices mounted on the panels/desk, between the devices and from the devices to terminal blocks.
- 7.02.06 Connection and interconnection wiring diagrams.
- 7.02.07 Interconnection diagrams for all cables required for interconnection of equipment.
- 7.02.08 Terminal block/wire way/conduit arrangement drawings.



- 7.02.09 Name plate design (Tagging Information) and engraving for each item mounted on panel & desk.
- 7.02.10 Set of isometric drawings of the LVS & unit control/incharge desk at various angles so as to give a feel of these equipments in control room.

7.03.00 Lighting /Receptacle Power Distribution Board

Following data/drawings shall be submitted for the lighting and receptacle power distribution board:

- 7.03.01 Single line diagram indicating incoming and outgoing feeders with rating of each component.
- 7.03.02 Drawing showing construction details of the distribution board and its mounting arrangements.
- 7.03.03 Wiring diagram for the distribution board.

7.04.00 Furniture

Following data/drawings shall be submitted for the furniture.

- (i) Profile & dimensional drawing
- (ii) Data sheet/Catalog for each of the above items.

8.00.00 STEAM AND WATER ANALYSIS SYSTEM (SWAS)

(Refer Subsection, chapter 5, SWAS, Part-B, Vol. V and other applicable Sections)

8.01.00 Supplementary Data

- 8.01.01 Technical Data Sheet for all analyzers, instruments & other devices like valves, fittings. Etc.
- 8.01.02 Complete bill of material for all steam and water quality sampling and analysis system and chiller unit components including a detailed description for each item.
- 8.01.03 Power supply requirements of all electrical equipment, chiller units furnished in the SWAS system.
- 8.01.04 Cooling water system requirements for primary coolers and secondary coolers of each unit.
- 8.01.05 Test certificates of all instruments & devices furnished under this system including chiller units.
- 8.01.06 Instructions for installation, testing, commissioning, normal operation, trouble shooting and maintenance of the Steam and Water Analysis System including all analyzers, chiller unit and associated devices & accessories.

8.02.00 Contract Drawing Requirements

- 8.02.01 Layout & dimensional drawings with cross sectional details, floor opening & mounting details for sample conditioning panel, analyzer panel and recorder panel.



- 8.02.02 Sample flow diagrams covering all proposed equipment for SWAS.
- 8.02.03 Chiller unit – layout, dimensional & mounting drawings.
- 8.02.04 Sample conditioning panel piping and tubing diagrams showing interconnection and external connection configuration.
- 8.02.05 Analyzer panel wiring diagrams applicable to all electrical transducers/receivers incorporated in the steam and water analysis system and installed on the panel.
- 8.02.06 Panel manufacturing drawings describing location of piping/tubing entrance to sample conditioning panel, location of wire ways, floor openings, panel bracing, etc., necessary to install entering sample lines, drains, cooling system supply and return, etc.

9.00.00 COMMUNICATION SYSTEM

(Refer Sub Section /chapter 22, Communication system, Part-B, Vol. V and other applicable Sections)

9.01.00 Supplementary Data

- 9.01.01 Complete Bill of Materials for all items furnished including all the accessories provided.
- 9.01.02 Descriptive and illustrative literature of the various devices and accessories. The literature furnished should also contain performance data of devices and accessories, method of assembly of the devices and accessories and general compliance of the devices and accessories with requirements of this specification.
- 9.01.03 Test Reports for various equipment.
- 9.01.04 Instruction manuals for all equipment which shall contain detailed step by step instructions for all installation, operations and maintenance requirements.

9.02.00 Contract Drawing Requirements

- 9.02.01 General arrangement drawing of devices and accessories showing dimensions, fixing details, cable entry location and earthing terminal location and dimensions.
- 9.02.02 Schematic wiring & interconnections diagram.
- 9.02.03 Outline dimension drawings showing junction box.
- 9.02.04 Outline dimension drawings of the acoustic hood provided in noisy areas.

10.00.00 CLOSE CIRCUIT TELEVISION SYSTEM & Plant Intruder detection System.

(Refer Sub Section chapter 16, PSSS, Part-B, Vol. V and other applicable Sections)

10.01.00 Supplementary Data

- 10.01.01 Complete Bill of Materials for all items furnished including all the accessories



provided.

- 10.01.02 Descriptive and illustrative literature of the various devices and accessories. The literature furnished should also contain performance data of devices and accessories, method of assembly of the devices and accessories and general compliance of the devices and accessories with requirements of this specification.
- 10.01.03 Test reports of various equipment
- 10.01.04 Instruction manuals for all equipment which shall contain detailed step by step instructions for all installation operations and maintenance requirements.

10.02.00 Contract Drawing Requirements

- 10.02.01 General arrangement drawing of devices and accessories showing dimensions, fixing details, cable entry location and earthing terminal location and dimensions.

11.00.00 MAINTENANCE AND CALIBRATION EQUIPMENT

(Refer Sub-Section, chapter 10, MCE, Part-B, Vol. V and other applicable sections.)

11.01.00 Supplementary Data

- 11.01.01 Complete Bill of Material for all items furnished including all the accessories provided.
- 11.01.02 Design specification sheet of each type of equipment furnished.
- 11.01.03 Instruction manual covering mounting, operation, calibration, trouble shooting and maintenance, etc., as applicable for each type of equipment furnished.
- 11.01.04 Test certificate for each of the maintenance and calibration equipment furnished.
- 11.01.05 Certified temperature curve and other calibration curves/data as applicable to different maintenance and calibration equipment furnished.
- 11.01.06 List of spare parts furnished.
- 11.01.07 Guarantee for availability of spare parts.

11.02.00 Contract Drawing Requirement

- 11.02.01 Outline and dimension drawings for the maintenance and calibration equipment and equipment accessories furnished.
- 11.02.02 Physical dimensional, installation and general arrangement drawings for electronic and pneumatic test benches.
- 11.02.03 Electrical schematic and wiring drawings applicable to each kind of equipment furnished.
- 11.02.04 Electrical wiring/pneumatic tubing diagram as applicable for test benches showing



utility (Power supply/air supply) connection details.

12.00.00 CONTROL VALVES AND ACTUATORS

(Refer Sub-section- chapter 11, Control Valve, Part-B, Vol. V and other applicable clauses)

12.01.00 Data sheets/specification sheet of each control valve & its accessories.

12.02.00 Sizing calculation of each control valve.

12.03.00 General arrangement, dimensional and edge preparation drawings.

12.04.00 Complete bill of material of control valves & accessories.

12.05.00 Technical details of control valves.

12.06.00 Interconnection schemes & wiring details

12.07.00 Piping & tubing diagrams.

12.08.00 Instructions for installation, settings & maintenance.

13.00.00 PADO

(Refer Sub-section- chapter 12, PADO, Part-B, Vol. V and other applicable clauses)

13.01.00 Hardware configuration diagram.

13.02.00 Detailed technical write-up of each sub-system/module of PADO clearly explaining the algorithm of various routines & their input-output relationship.

13.03.00 List of data & curves from the main equipment supplier being used, sub-system/module wise.

13.04.00 Source listing of each application software.

13.05.00 User manual of system installation, setting & trouble shooting of the system.

14.00.00 CONTROL & INSTRUMENTATION FOR AUX. PLANT

(Refer Sub-section- chapter 14, Aux. Plant Control, Part-B of Vol. V and other applicable clauses)

14.01.00 Technical data sheets for all measuring instruments & accessories.

14.02.00 Complete bill of material of main and mandatory spare quantities.

14.03.00 Other applicable details as referred in clause 4.00.00 above.

14.04.00 Configuration drawings for PLC system (including its MMI).

14.05.00 Bill of material for PLC system (including MMI) and its accessories.

14.06.00 General arrangement drawing of PLC panels with complete BOM of panel mounted items.

14.07.00 Control schemes and functional write-up of control system including hardware



- and software details.
- 14.08.00 Wiring and termination details.
- 14.09.00 Interconnection cable schedules and diagrams.
- 14.10.00 Powers supply single line diagram.
- 14.11.00 Interfacing details & diagrams of control systems with station wide LAN and signal exchange.
- 14.12.00 Detailed I/O list including tag nos, process range, alarm limits, set points, cable no. TB no. etc.
- 14.13.00 Details of software used in PLCs, symbols in graphic displays etc.
- 15.00.00 TYPE TESTS**
(Refer Sub-section-C&I Type Test, Part-B of Vol. V and other applicable clauses)
- 15.01.00 Type test procedures for items for which tests are to be conducted.
- 15.02.00 Type test certificates / results for all identified items.
- 16.00.00 Detailed documents, drawings, data sheets, GA drawings for DMS, Simulator system, Video Conferencing System shall be provided by Bidder for approval.
- 17.00.00 Detailed QAP (Quality Assurance Plan), FAT procedure & FQP (Field Quality Plan).

APPENDIX - III TO PART – A, ASSIGNMENT OF OPERATION LOCATION**1.00.00 CONTROL & MONITORING PHILOSOPHY**

This clause explains the Control & Monitoring philosophy to be adopted for this project irrespective of the scope of supply.

1.01.00 The Control & Monitoring philosophy envisages control from:

- (a.) Central Control Room (CCR)
- (b.) Coal Handling Plant Control Room
- (c.) Ash Handling Plant Control Room
- (d.) Water System Control Room
- (e.) Local PLC based system control Room
- (f.) FGD Control Room
- (g.) Standalone Systems Control Room
- (h.) FOPH control Room

In very few cases, local operation facilities has been provided to take care of very specific operators needs so as to provide assistance during commissioning, re-commissioning, maintenance activities etc.

1.02.00 Control and Monitoring from CCR

The Main Plant equipment (namely SG & Auxiliaries, TG & auxiliaries, power cycle/LP piping, DMCW system & Circulating Water system (CW), makeup water system etc.) for this project is envisaged to be controlled mainly from the Large Video Screens (LVS) in association with the operator workstation (OWS) mounted on the Unit Control Desk (UCD) located in the Central Control Room (CCR) under all regimes of operation i.e. start-up, shutdown, load maneuvering, load throw off & emergency handling. All the information required for safe and efficient operation of the plant shall be displayed on the LVS and the Monitor at high speed and accuracy in specially designed displays suitable for Power plant operation. In addition to above minimum amount of backup devices are mounted in a draw out console on UCD.

1.03.00 Control & Monitoring of the off-site & Auxiliary Plant

The control, monitoring & operation of the off-site and auxiliary Plants shall be carried out from above referred major control locations supported by secondary operation locations wherever required. The facility of operation shall be also LVS / OWS based similar to the CCR based facilities mentioned above.

2.00.00 LOCATION OF CONTROL EQUIPMENT

The equipment envisaged in the Control Rooms, Control Equipment Rooms, SWAS room, UPS / Charger Room and Battery rooms is as follows:

- 1 Unit control room is envisaged for subject unit. The control room is envisaged in control tower in Main plant building (TG Hall). Unit Control Desk, Large Video Screen (LVS), shall be located in Control Room. Control for common plant systems like Ash handling system, Coal handling system, Water treatment system, etc. shall be located in respective Control Rooms.



2 Control Equipment Room (CER) is envisaged in the same floor i.e. control tower in Main plant building (TG Hall). It shall have various system cabinets such as BOP DDCMIS cabinets, SG C&I system cabinets, TG C&I system cabinets, vibration monitoring system cabinets, Coal bunker level monitoring unit, marshalling cabinets, network panel etc. Control equipment room for common plant systems like Ash handling system, Coal handling system, Water treatment system, Makeup water system etc. shall be near respective control room. For other common plant areas, over and above control equipment rooms, remote I/O rooms shall be provided on as required basis. The exact RIO location shall be finalized during detailed engg stage.

3 Programmer Room

Programmer Room is envisaged to be located near the CER. This shall house the servers/ other workstations & Engineer station/Programmer's consoles for DDCMIS (SG, TG and BOP C&I systems), various PCs and PADO hardware and server/workstation for computer aided engineering based Documentation management system.

4 SWAS Room.

SWAS Room for unit shall be at '0.0' meters in Main Plant building. This room shall house the sample conditioning system panel, analyzer panel and PC Station etc. for steam and water quality monitoring.

5 UPS, Charger Room and Battery Room

UPS, charger & battery room shall be located below main control room & CER in control tower in Main plant building (TG Hall) and shall house UPS, 24 V DC chargers, DC distribution boards, AC distribution boards etc. Batteries for UPS & 24V DC systems shall be housed in battery room, adjacent to UPS/Charger room.

The 24 V DC Chargers and UPS system for common plant systems like Ash handling system, Coal handling system, Water treatment system, Makeup water system etc. shall be located in respective Control Equipment Rooms.

Batteries for power supply system (24 VDC/ UPS) as required for remote I/O rooms and CERs of common plant system shall be placed in a separate ventilated room within Remote I/O room.

6. Operator Training Simulator Room

The operator training simulator room shall be located in the service house building. The room shall be set with all the required hardware and software to meet the functional requirements.

3.00.00

ASSIGNMENT FOR OPERATION LOCATION

As per the design requirement, the operation of any particular plant sub-area (or in some cases some specific drive / equipment) should be possible from any LVS / OWS of any connected sub-system of DDCMIS, through their interconnection through station-wide LAN. However, for each such sub-area / equipment, a primary operating point shall be defined. In addition, secondary and further operating point shall also be defined for additional operating location based on the



process as well as administrative requirement. It should be possible to define the scope of operation in each such case, i.e. while the operation of upto individual drive level may be possible for a sub-area from one operating point, only sequence control may be allowed from the other operating point. Such allocation should be possible to any sub-area / drive or a combination of the same.

The primary and secondary operating points are defined in Annexure-II to contract quantities for DDCMIS. However, the same shall be modified during detailed engineering as per the finalised operating philosophy. In any case, it shall be possible to customize this function at any point of time at Site under System Administrator's rights. Such modifications will include, add/delete operating point, modify scope of operation, access to additional information etc.



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



CHAPTER – 1**GENERAL INFORMATION AND DESIGN CRITERIA****1.00.00 GENERAL REQUIREMENTS**

- 1.01.01 The Bidder shall provide Independent Control & Instrumentation system, Distributed Digital Control, Monitoring and Information System (DDCMIS), associated measuring & field instruments, PLC /Relay based control system, associated measuring & field instruments, Process Connection and Piping & LIE/LIRs, Electrical Power Supply System, Maintenance and calibration equipment, PADO, Public Address system (PAS), Steam and Water Analysis System (SWAS), Control Desk (CD), Plant security and surveillance system consist of Perimeter Intruder Detection System and Close Circuit Television System (CCTV), Communication system, Operator Training Simulator, Video Conferencing System, Documentation Management system, associated Instrumentation and Power Supply Cables, Control valves and actuators etc. as identified in the specification.
- 1.01.02 The Bidder shall provide all material, equipment and services so as to make a totally integrated Instrumentation and Control System together with all accessories, auxiliaries and associated equipment ensuring operability, maintainability and reliability. This work shall be consistent with modern power plant practices and shall be in compliance with all applicable codes, standards, guides, statutory regulations and safety requirements in force.
- 1.01.03 Further Bidder shall also include in his proposal and shall furnish all equipment, devices and services which may not be specifically stated in the specification but are needed for completeness of the equipment/systems furnished by the Bidder and for meeting the intent and requirements of the specification.
- 1.01.04 It is to be noted that wherever quantity has been specified as on as required basis, the same is to be supplied by the bidder on as required basis by the bidder within his quoted lump sum price.
- 1.01.05 Bidder shall include in his bid a detailed Bill of Material (BOM) for each of the systems.
- 1.01.06 In addition to requirements specified under this Volume V, Part-B, all C&I systems/ sub- systems/ equipment/ devices shall also meet other requirements stipulated under other chapters/ parts/ sections/Volumes of the specification.
- 1.01.07 Each communication Network shall be industrial grade and shall be provided with minimum 1Gbps speed or any other upper speed mentioned elsewhere in this NIT/Specification, industrial grade managed Ethernet switches, industrial grade media convertor, industrial grade communication hardware, external surge protection system/devices and industrial firewall etc. Industrial grade managed type Ethernet switches shall be provided with in built diagnostic features, minimum 20% spare ports & in built redundant 24 V DC power supply.

- 1.01.08 In Fire Protection & Detection system, Loop wiring & Panel networking shall be designed meeting the NFPA Style 10/latest requirements.
- 1.01.09 All the instruments/equipment/electrical items shall be provided & designed with maximum star rating as available in line with energy conservation policies notified by BEE, GOI (Govt. of India) at the time of supply.
- 1.01.10 All process parameters (i.e. pressure, temperature & flow) shall be indicated in the P&IDs on all important process lines.
- 1.01.11 Special attention shall be given in the design for inspection, removal, replacement, cleaning and protection of any of the component parts of any equipment/system/instrument etc supplied for project.
- 1.01.12 All approval/Inspection are to be carried out by Owner or owner appointed agency only.
- 1.01.13 Incomer/outgoing feeders for any Distribution Board's rated upto 63A shall be with fast acting semi-conductor fuse & MCB controlled, and above 63 A to 400A shall be MCCB Controlled. Above 400A it shall be breaker controlled. Each feeder shall be provided redundant in configuration with LED indication.
- 1.01.14 Bidder to note that all type of hardware & electronic modules like controllers, I/O cards, communication modules, power supply modules, and interface modules etc used in PLC shall be of same family and sourced/supplied from their Principal's works.
- 1.01.15 All tag nos. shall follow KKS numbering. For 1 x 800 MW, tag nos shall have prefix 10.
- 1.01.16 All OEM software & software licenses shall be supplied with life time validity. . As and when such software is updated/upgraded, same shall be supplied & installed by bidder free of cost for a period of three (3) years after warranty period.
- 1.01.17 All the WORK STATIONS, OWS, EWS, PC, Printers, Laptop, Servers, LVS as mentioned anywhere in this NIT/Specification shall meet the minimum technical requirements specified in chapter 3, Part B, Vol. V.
- 1.01.18 Instrument should be in easy reach of maintenance person, there should be separate platform for unreachable instruments. Easy access should be provided to all the tapping points of instruments used for measurement & control.
- 1.01.19 Material described in the specification are the minimum requirements, which shall be complied by bidder. Any other better material may also be considered to suit the process and environmental conditions at site subject to owner's approval.
- 1.01.20 Valve end position (Open & Close) shall be monitored for the manual critical valves, wherever provided.
- 1.01.21 Any system/package connected to cyber world or connected to internet shall be provided with cyber security as per IEC 62443/latest standard.

- 1.01.22 Minimum 2 SPDT or DPDT type contacts shall be provided with relays and switches.
- 1.01.23 Wherever 2x100% Air conditioners are provided, working of same shall be based on temperature based (in case required temperature is not mentioned, standby Air conditioner shall start automatically with adjustable time delay), timer based (Standby Air conditioner shall start working automatically after a time duration of 12 hours and main Air conditioner shall be in standby mode for that duration) and auto changeover based (In case main air conditioner failed or tripped, standby Air conditioner with takeover automatically).
- 1.01.24 All electrical devices like switches/ transmitters/ controller/ analyzer/ solenoid valves which are located in the in hazardous areas like hydrogen gas area, seal oil area etc. shall be made intrinsically safe by providing suitable type of transformer isolated barrier/ Zener barrier of standard make in case it is a standard and proven practice of the bidder. Otherwise such instruments shall be provided with explosion proof enclosure suitable for hazardous areas described in National Electric Code (USA), Article 500, Class-I, Division-I or EN60079-14 or shall comply with the essential requirements of ATEX directives. All fittings, cable glands etc. shall be provided complying to above safety requirements.
- 1.02.00 **PROVENNESS CRITERIA**
- 1.02.01 Bidder shall provide DDCMIS for SG-C&I, TG-C&I and Balance of Plant- C&I Station C&I) from Owner's approved Vendors/sub-vendors meeting all provenness, parametric, technical and other requirement specified under various chapters of this specification.
- 1.02.02 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 coal fired utility power stations as specified in Vol. II and/or Volume V. 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 elsewhere. Whenever a material or article is specified or described by the name of a particular brand, manufacturer or vendor, the specified item mentioned shall be understood as establishing type, function and quality desired. When the phrase "or, acceptable equal" is used, other manufacturers' products will be considered, provided they meet the experience requirements as specified in Vol. II and/or Volume V and sufficient information is furnished by the Bidder to allow the Owner to determine that the products proposed are equivalent to those named. When this phrase is not used, it shall be understood that no alternative equipment offered will be considered.
- 1.02.03 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 sub-vendors as a part of his proposal. However the make and model of all bought out items supplied by the Bidder shall be as approved by Owner during detailed engineering stage. Bidder to note that all the C&I system equipment system i.e. Annunciation System, Communication System etc. of shall be of indigenous make.

1.03.00 RELIABILITY AND AVAILABILITY

1.03.01 Each component and system offered by the Bidder shall be of established reliability. The minimum target reliability of each piece of equipment like each electronic module/card, Power supply, Peripheral etc. shall be established by the Bidder, considering its failure rate/mean time between failures (MTBF), meantime to repair (MTTR), such that the availability of the complete C&I system is assured for 99.7%.

1.03.02 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 **600 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.

1.03.03 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 HP LP Bypass system, sensing device as per Bidder standard and proven practice in same rating plant shall be provided. Continuous self-checking features shall be incorporated in system design with automatic transfer to healthy/redundant circuits to enhance the reliability of the complete system.

1.03.04 In general, failure of equipment used for alarm purpose will cause switching to the alarm state.

1.03.05 Mean Time between Failure (MTBF) of the instruments shall be considerably higher than the equipments/system, they shall cater to in order to avoid shutdown on account of instrumentation failure.

1.03.06 All instruments and control equipments shall ensure high reliability, low down time and ease of maintenance to the satisfaction of owner.

1.04.00 STANDARDISATION AND UNIFORMITY OF HARDWARE

1.04.01 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 so as to ensure smooth and optimal maintenance, easy interchangeability and efficient spare parts management.

1.04.02 Bidder to ensure that the width of all the cabinets (both DDCMIS and Non-DDCMIS) shall be minimum 800 mm.

1.04.03 During detail engineering of the project or at the time of procurement, if the offered / approved model becomes or is likely to become obsolete, then the latest product launched or introduced shall be supplied without any price implication subjected to purchaser's approval.

Technical specifications specified for all types of hardware, field instruments, equipment's & software are the minimum requirements to be met and confirmed by bidder. All the hardware and software shall be latest, with advanced features and field proven at the time of supply / dispatch as available in the market without any price implication.

Bidder shall offer latest system available at the time of detail engineering & shall also confirm that DDCMIS/PLC based control system, hardware / software shall be upgraded free of cost (for hardware up to completion of detail engineering and software up to handing over of the project), whenever after the offer such up-gradation takes place for his system offered by him or by his collaborator. " During detail engineering of the project or at the time of procurement, if the offered / approved model becomes or is likely to become obsolete, then the latest product launched or introduced shall be supplied without any price implication subjected to purchaser's approval "

1.05.00 OPERABILITY & MAINTAINABILITY

1.05.01 The design of the each 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 / minimised.

1.05.02 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.

1.05.03 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.

1.05.04 The equipment shall employ latest state of the art technology to guard against obsolescence. In any case, Bidder shall be required to ensure supply of spare parts in 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 Owner in case of obsolesce so that Owner can take appropriate actions as necessary (both during the tenure and outside the tenure of the contract).

1.06.00 **CONTROL & MONITORING PHILOSOPHY**

1.06.01 Control & Monitoring philosophy to be adopted for this project irrespective of the scope of supply is explained in Appendix-III, Volume V, Part-A and Part B.

1.06.02 **Back-Up Instrumentation**

Certain back-up instrumentation and Secondary instruments are to be provided by bidder. The minimum quantities is indicated in Part A, Volume V, however the exact quantity of the back-up instrumentation or any further improvement shall be as finalized by owner during detailed engineering in consultation with the Bidder.

1.07.00 **ENVIRONMENTAL CONDITIONS**

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

Ambient Temperature Outside cabinets	Pressure	Relative Humidity	Atmosphere	Required Protection class of panels/cabinets/desks to be provided by bidder
Outdoor Location				
55 degree C max	Atmosphere	100 % Max	Dusty area \$	IP 65***
55 degree C max	Atmosphere	100 % Max	Air (dirty)	IP55
4 degree C min	Atmosphere	5 % min	Air (dirty)	IP55
Indoor Location				
55 degree C max	Atmosphere	95 % Max	Air	IP54**
4 degree C min	Atmosphere	5 % min	Air	IP54**
Air Conditioned Areas				
24 +/-5 degreeC normal	Atmosphere	95 % Max	Air	IP32/42***
50 degree C max.*	Atmosphere	5 % min	Air	IP32/42***

* During air conditioning failure.

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

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

\$ Dusty area like Conveyor galleries, Transfer points, bunker area, Track hopper area, Crusher house, ash silo, bottom ash area etc.

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

LVS, PCs, OWS, EWS, Servers, Network Switches, Printers, mini intelligent UPS and other peripherals, maximum temperature limit shall be 35 Deg. C.

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

Refer Measuring Instruments and subsections for specific requirements due to corrosive applications and corrosive environment project.

1.07.02 All equipment/systems for air conditioned areas shall also be designed and constructed to operate indefinitely without loss of function, departure from specifications or damage during periods of air conditioning failure in summers even if such temperature may rise up to 55 deg. C.

1.07.03 The period for which the equipment/system can function satisfactorily without A/C (Air Conditioning) shall be mentioned by the bidder.

1.07.04 Distribution boxes, junction boxes, cold junction compensation boxes, terminal boxes and all other field mounted equipment to be furnished as per this specification shall have weather protection conforming to IP 65.

1.07.05 IK-09 Enclosure Protection class as per NEC-370 Article 18, 19 & 20 against external mechanical stresses as per EN 50102/IEC 62262 shall be provided for all type of panels mounted at indoor or outdoor locations and IK-08 Enclosure Protection class as per NEC-370 Article 18, 19 & 20 against external mechanical stresses as per EN 50102/IEC 62262 shall be provided for all type of junction Boxes, Distribution Boxes, Terminal Boxes and Cold junction compensation boxes mounted at indoor or outdoor locations. Same shall be stainless-steel SS-304 with 1.5mm thickness, IP66 rating, RoHS compliant, UL / TÜV Rheinland certified and manufactured in accordance with IEC 62208, ensuring the highest quality.

1.08.00 **GROUNDING SYSTEM**

All panels, desks, cabinets shall be provided with a continuous bare copper ground bus. This Scheme is applicable for all type of control panels, DCS, DDCMIS, PLC based control panels, Microprocessor based control system and any other electronic system installed anywhere in the plants in addition to CCR, LCR & CER. 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 50mm x 6mm min., length as applicable).

Shield on instrumentation cables shall be grounded on panel side. When shielding termination is required in cabinets furnished under this specification, suitable terminals shall be furnished on copper flat forming system ground.

Bidder shall submit the Earth Mat design calculation to ensure that the electrical Earthing resistance is less than One (1) Ohm and electronic Earthing resistance is less than 0.5 ohm. Redundant Earthing pits with earthing electrode shall be provided by bidder. Cables used for Earthing shall be multi strand and with Cu conductor. Complete plant Earthing shall be as per IS3043 and IEEE 1050 standard (IEEE guide for Instrumentation & control system grounding in generating station).

As per IEEE-80 recommendation, the length of ground conductor below earth will be sufficient to ensure a ground resistance as per requirements.

The Bidder shall submit with the offer recommended grounding scheme required for his system. The exact grounding scheme shall be finalised during detailed engineering as approved by owner.

1.09.00 STATION BLACKOUT

Availability of all equipment, drives, emergency power supplies, controls, logics required for the protection/safe operation/shutdown of the boiler/turbine and auxiliaries during emergency blackout shall be ensured by bidder. All the related drives, controls shall operate automatically on the occurrence of blackout. All such drives, controls required during emergency and black out shall be provided with continuous power supply source (each type of power supply depending upon requirements, sizing shall be done considering this requirements) to ensure availability and shall be designed for fail safe mode. All the required controls shall be available as the system to be powered from DG set/plant UPS/DC Power supply system. All the continuous power supply source like DG set/ UPS/DC Power supply system shall be designed to remain operational in case of emergency and station black out (total power failure) for safe shut down of plant.

1.10.00 SURGE-PROTECTION DESIGN CRITERIA FOR SOLID STATE/MICRO PROCESSOR BASED EQUIPMENTS/DCS/DDCMIS/PLC/UPS/DC power supply system etc. anywhere provided for subject plant

- i. All solid-state equipment shall be able to withstand the noise and surges inherent in a powerhouse. The equipment shall be designed to successfully withstand without damage to components and/or wiring, application of surge withstand capability (SWC) wave whose shape and characteristics are defined in ANSI publication C37.90a - 1974 entitled "Guide for surge withstand capability (SWC) Tests". External Surge Protection devices (SPD) shall be provided by bidder as per recommendation specified in "IEEE 1100-2005, IEEE recommended practice for Powering and Grounding Electronic Equipment".
- ii. All solid state equipment, power supply to electronic cards, power supply to controllers, PLC panels, DDCMIS/DCS panels, control panels, SMPS power supply, UPS, battery chargers, Master clock system, Plant Communication system, PSSS, HMS, any other

microprocessor/electronic control system, Relay based control panels, etc shall have external surge protection device with Plug ability and life indication as per IEC 61643- 1:1998-02 and E DIN VDE 0675 part 6: Latest Edition, to withstand max. 40 kA, 8/20 u Sec of Surge. The connection of the devices should be made as per TT configuration wherever applicable.

- iii. Signal lines shall have surge protection devices with pluggability and testability as per IEC 61643-21: Latest Edition and E VDE 0845 part 3-1: Latest Edition, to withstand max. 20 kA, 8/20 u Sec of surges.
- iv. For data lines, communication lines, Ethernet/Can networks/LAN, Coaxial lines, plant communication system, modular surge protection device should be used as per IEC 61643- 21: Latest Edition to withstand a min of 2.5 kA, 8/20 u Sec of surges. The surge protection device should be used with the corresponding connector as being used for the lines i.e. RJ45, D Sub, BNC, N-Type etc.

"The Bus systems (like Profibus/ Modbus etc) or the Serial Port Systems (like RS-232/ RS-485 etc) shall be protected with suitable surge protection devices, confirming to the latest IEC-61643-21 guidelines. The surge handling capacity of device shall at least be 10 KA, 8/20 μSec between core-core and 20 KA, 8/20 μSec between core-ground. The device shall be pluggable & on-site testable".
- v. All electronic cards/modules shall also be protected from failure against accidental/inadvertent application of high voltage upto 500V DC (common mode) even though these modules may be designed to operate at lower voltage levels such as 24V/48V.
- vi. In the case of DC powered system/subsystem/instrument, the design shall ensure protection against reverse polarity.
- vii. The Bidder shall provide details of production tests being carried out to fully satisfy the Owner that the proposed equipment meets the above requirements and to assure that the products furnished shall be of the desired grade.

1.11.00 General Tools and Tackles, Special Calibration Instruments:

Bidder must offer general tools & tackles and special calibration instruments required during start-up, trial run, operation and maintenance of the plant.

1.12.00 PG TEST POINTS

- 1.12.01 Pressure, temperature and flow test points shall be provided in line with latest performance test code requirements.
- 1.12.02 In addition, pressure and temperature test points shall be provided for the following services:
 - (a) At the discharge of all pumps and fans
 - (b) At the inlet and outlet of the heat exchangers for the fluid media involved

- (c) Adequate number at the different zones of combustor, boiler & its auxiliaries.
- (d) At the inlet and outlet of each control valve
- (e) Adequate number at the different zones of Turbine & its auxiliaries.

1.12.03 Pressure test points shall be complete with root valves and shall terminate with a nipple.

1.12.04 Temperature test points shall be provided with thermowell with a cap and chain.

1.13.00 **General Tools and Tackles, Special Calibration Instruments:**

The Bidder shall provide the all type of general tools & tackles and special calibration instruments required during start-up, trial run, operation and maintenance of the plant.

The Bidder shall furnish a complete new set of all special tools and tackles of reputed make and model which are required for erection, ease in maintenance to have minimum down time, testing and calibration of all the equipment and systems to be provided by the Bidder under this specification for C&I systems.

The Bidder shall hand over all the tools (Mechanical, Electrical and Electronic) in working condition to Owner, used by him during erection, commissioning and trouble shooting of the system.

CHAPTER – 2**FIELD AND MEASURING INSTRUMENTS****2.00.00 MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)**

- 2.00.01 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/chapter 1, Vol. V, 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 Owner's approval.
- 2.00.02 Every panel-mounted instrument requiring power supply shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.
- 2.00.03 All transmitters, sensors, and switches, Gauges for parameters like pressure, temperature, level, flow etc. as required for the safe and efficient operation and maintenance as well as for operator and management information (including all computation) of equipment in the system under the scope of specification shall be provided on as required basis with in quoted lump sum price. The Bidder shall furnish all Instrumentation / Control equipment & accessories under this specification as per technical specification, ranges, makes & model as approved by the Owner during detailed engineering.
- 2.00.04 The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifolds and all the other accessories required for mounting/erection of these local instruments shall be furnished, even if not specifically asked for, on as required basis. The contacts of equipment mounted instruments, sensors, switches etc. for external connection including spare contacts shall be wired out in flexible/rigid conduits, independently to suitably located common junction boxes. The proposal shall include the necessary cables, flexible conduits, junction boxes and accessories for the above purpose. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg./sq.cm.
- 2.00.05 For corrosive applications, all instruments applications, they shall be provided with wetted parts made of Monel/ Hastelloy C or any other material (if proven ness experience of the proposed material for such applications is established by bidder).
- All instruments shall be provided with durable epoxy coating for housings and all exposed surfaces of the instruments.
- 2.00.06 All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. The enclosures of all electronic instruments shall conform to IP-65 unless otherwise specified (Explosion proof for NEC article 500, class 1/2, Division 1 area & Flame proof area) and an anti corrosive paint shall be applied to the

field mounted enclosures / instruments. In general, double cable entry shall be provided, wherever available, unused cable entry shall be provided with blind metal plug. All the field instruments shall also be provided with SS tag nameplate. Counter and mating flange (SS316 material), fastener, gaskets, Nuts, bolts etc. shall also be included wherever required with the field instruments.

- 2.00.07 In general, front draw out type instruments with plug-in facility at the rear for connecting cables for power supply and signal shall be provided unless otherwise specified like for Explosion proof area, Flame proof area and high vibration prone area. Separate plugs & socket connection shall be provided for connecting power supply cables and signal cables.

The plug & sockets shall be polarized to prevent wrong connections and have facility for secure coupling in plug-in position to prevent loose connections.

Signal and Electrical connection shall be screwed connection with double compression type Nickel-plated brass/SS316 cable glands (Material as decided by owner) for Explosion proof area, Flame proof area and high vibration prone area.

- 2.00.08 The minimum quantity of secondary instruments etc. to be provided by Bidder is listed in Appendix- I to Vol. V, Part A of Technical Specifications. Any other additional quantity of secondary instruments shall be envisaged by bidder as per system and process requirements without any cost implication.

2.01.00 SPECIFICATION FOR ELECTRONIC TRANSMITTERS

2.01.01 SPECIFICATION FOR ELECTRONIC TRANSMITTER FOR PRESSURE, DIFF. PRESSURE AND DP BASED FLOW, LEVEL MEASUREMENTS

S. No.	Features	Essential/Minimum Requirements
1	Type of Transmitter	Sealed capacitance/Inductance/Silicon resonance type microprocessor based 2 wire type, Hart protocol (latest) compatible
2	Accuracy	± 0.1% of calibrated span (minimum) (upto turn down ratio of 10:1).
3	Output signal range	4-20 mA DC (Analog) along with superimposed digital signal (based on HART protocol)
4	Turn down ratio	10:1 for vacuum/very low pressure applications. 5:1 for very high pressure application. 100:1 for other applications.
5	Stability	± 0.15% of URL for 10 years.
6	Zero and span drift	+/- 0.015% per deg.C at max span. +/- 0.011% per deg.C at min. span.
7	Load impedance	500 ohm (min.)
8	Housing	Weather proof as per IP-65 with durable corrosion resistant coating.
9	Over Pressure	150% of max. Operating pressure.

S. No.	Features	Essential/Minimum Requirements
10	Connection (Electrical)	Plug and socket type
11	Process connection	1/2 inch NPT (F)
12	Span and Zero	Continuous, tamper proof, Remote as well as adjustability manual from instrument with zero suppression and elevation facility
13	Material	Die cast Aluminum with epoxy coating/SS316 for body. SS316 for Diaphragm.
14	Accessories	<ul style="list-style-type: none"> • Diaphragm seal, pulsation dampeners, syphon etc. as required by service and operating condition. • LCD/TFT digital integral Indicators with scale of Engg. Units. • 2 valve SS316 manifold for absolute & Gauge pressure transmitters, 3-valve SS316 manifold for vacuum pressure transmitters & where DP transmitters are being used for pressure measurement and 5 valve SS316 manifold for DP/Level/Flow applicable. <p>Transmitters should not be mounted directly on the manifold; Manifold shall be non integral type only.</p> <ul style="list-style-type: none"> • Snubbers/Pulsation dampners shall be used where the process media is unstable for measurement such as the discharge of a pump. • For hazardous area, explosions proof enclosure as described in NEC article 500.
15	Diagnostics	Self Indicating feature
16	Power supply	24V DC \pm 10%.
17	Adjustment/calibration From hand held calibrator/centralized OWS based system/ maintenance (as applicable).	From hand held calibrator/centralized OWS based system

Notes:

For primary air/ secondary air/flue gas applications, DP type transmitters shall be provided for pressure measurement.

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.

For Hydrogen gas pressure/differential pressure transmitters, the suitable material and coating shall be chosen as per the suggestion of transmitter manufacturer.

2.02.00 Specification for Pressure Gauge, D.P Gauge, Temperature Gauge and Level Gauge

S. No.	Features	Essential minimum requirements		
		Pr. Gauge/DP Gauge/Draught gauges	Temperature gauge	Level Gauge
1	Sensing Element and Material	Bourdon for high pressure, Diaphragm/ Bellow for Low pr. Of SS 316	Mercury in Steel for below 450°C and inert gas actuated for above 450°C of SS bulb and capillary	Tempered * toughened Borosilicate gauge glass steel armoured reflex or transparent type.
2	Body Material	Die Cast Aluminum with stoved enamel black finish /SS316	Die Cast Aluminum with stoved enamel black finish /SS316	Forged carbon steel/SS 304
3	Dial Size	150 mm with toughened shatter proof glass	150 mm with toughened shatter proof glass	Tubular covering entire range
4	End Connection	½ inch NPT (M)	¾" NPT (M)	Process connection as per ASME PTC and drain/vent 15 NB
5	Accuracy	+/- 1% span	+/- 1% span	+/- 2%
6	Scale	Linear, 270° arc graduated in metric units	Linear, 270° arc graduated in °C	Linear vertical
7	Range Selection	Cover 125% of max. of scale	Cover 125% of max. of scale	Cover 125% of max. of scale
8	Over range test	Test pr. For the assembly shall be 1.5 to the max. Design pr. At 38°C		
9	Housing	Weather and dust proof as per IP-65	Weather and dust proof as per IP-65	CS/304 SS leak proof.

S. No.	Features	Essential minimum requirements		
		Pr. Gauge/DP Gauge/Draught gauges	Temperature gauge	Level Gauge
10	Zero/span Adjustment	Provided	Provided	-
11	Identification	Engraved with service legend or laminated phenolic name plate		
12	Accessories	Blow out Disc, siphon, snubber, pulsation dampener, chemical seal (if required by process) gauge isolation valve	SS316 Thermowell	Gasket for all KEL-F shield for transparent type vent and drain valves of CS/ alloy steel/SS as per process requirement.
13	Material of Bourdon/ movement	SS 316	SS 316	

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

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

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 inert liquid suitable for the application.

For condensate storage tank and DM water storage tanks, the pressure gauge in terms of 0-10000 mm wc or suitable range having **dial size of 300mm or bigger size** shall be provided.

2.03.00 GUIDED WAVE RADAR TYPE LEVEL TRANSMITTER

Guided wave radar type level transmitters shall be provided for level measurements of the vessel under vacuum or low pressure applications as specified in Part-A.	
Type	Guided wave Radar
Principle	TDR (Time domain reflectometry)
Probe Type & Material	Coaxial, SS316/316L. If required, probe shall be suitable for overflow prevention.
Connection type and material	Flanged and SS316/316L.
Signal o/p	4-20mA with HART signal suitable for overflow prevention.
Display	Integral
Power supply	24 VDC

Accuracy	5mm
Electromagnetic compatibility	Shall meet EN 61326-1 (1997) and AmdtA1, class A equipment/EN 50081-2 & EN 50082-2
Housing material	Die cast Aluminum/SS316.
Vent & Drain Plug material	SS 316
Local Display	LCD digital type, configured in engg. Units.
Accessories	Integral cable between sensor and transmitter unit with connectors on both side, gasket and cable gland, digital panel meter, name plate and metal tag. All material of accessories will be SS 316.
Mounting	External cage mounting
<p>The transmitters shall be provided with IP-65 protection class with durable corrosion resistant coating.</p> <p>The transmitters shall be able to provide digital signals super imposed on 4-20 mA signal as per HART protocol.</p> <p>Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications. Same to be decided by owner during detailed engineering.</p>	

2.04.00 Ultrasonic Type level Transmitter

S. No.	Features	Essential/Minimum requirement
1.	Type of Transmitter	Non-contact Microprocessor based 2 wire type, HART protocol compatible Ultrasonic transmitter. Also refer note-3.
2.	Output signal	4-20mA DC (Analog) along with superimposed digital signal (based on HART protocol)
3.	Sensor Accuracy	+/- 0.5% of calibrated span.
4.	Sensor Repeatability	3mm or better
5.	Power supply	24 V DC +/-10%
6.	Temperature compensation	To be provided within transducer
7.	Housing	Weather proof as per IP-65 with durable corrosion resistant coating.
8.	Adjustment/Calibration / maintenance	From hand held calibrators/ centralized OWS HART based system (as applicable)
9.	Zero and Span adjustment	Continuous, tamper proof, remote as well as manual adjustability from instrument. It shall be possible to calibrate the instrument without any level in the tank/sump etc.

S. No.	Features	Essential/Minimum requirement
10.	Sensor Material	Corrosion resistant material to suit individual application requirement.
11.	False signal tolerance	Transmitter shall be capable of ignoring false echoes from internal tank/sumps obstructions such as pipes, heating coils or agitator blades. Also transmitter shall have adjustable damping circuitry
12.	Range	Range of transmitter shall be capable of covering the complete level span of tank taking care of blocking distance, frequency attenuation due to surface, obstructions, vapors etc.
13.	Display	LCD display with integral keypad to be provided.
14.	Diagnostics	Loss of echo alarm etc.
15.	Load Impedance	500 ohms minimum.
16.	Electrical Connection	Plug and socket.
17.	Accessories	<ul style="list-style-type: none"> • All weather canopy for protection from direct sunlight and direct rain. • All mounting hardware and accessories required for erection and commissioning mounting fittings materials shall be SS 316. • For hazardous area, explosion proof enclosure as described in NEC
18.	<p>1) Bidder can also provide Radar type transmitter in place of ultrasonic transmitters subject to approval by Owner during detailed Engineer.</p> <p>2) The frequency used for Ultrasonic /sonic measurements shall be suitable for envisaged applications and this shall be supported by the standard product catalogue of the instrument manufacture.</p> <p>3) Four wire type transmitters can also be provided subject to Owner's approval during detailed engineering stage. However, in such cases isolated 4-20mA DC (analog) output shall be provided. Power supply required for such transmitters shall be 24V DC for main plant and CW system applications. Power supply can be 240V AC (UPS) / 24V DC for other application.</p> <p>4) Additional separate local display unit with large alphanumeric back light LCD/LED & to be provided for the applications which will be decided by owner during detailed engineering.</p> <p>Separate Sensor unit & electronics unit with LCD display to be provided for the applications, which will be decided during detailed engineering by owner.</p>	

2.05.00 Electronic Water Level Indicator

Application - HP heaters & Boiler Separator Storage tank and Aux. Boiler Drum.

This electronic level indicator shall be provided by bidder, **in addition to continuous level transmitter** used for modulating control of respective level.

Electronic Remote level Monitoring System working on principle of difference in electrical conductivity between steam and water. The Monitoring System shall meet the requirements as indicated below.

The sensing electrodes shall be placed in equal pitch. The maximum distance (gap) between two electrode shall be 50 mm and the electrodes shall be arranged in such a way that the last and the first electrode shall not be at any alarm or trip level.

Both indication and validation system shall be supplied with double isolation valves in water, steam, drain and vent lines.

Each electronics unit shall be provided with 2x100% redundant power supply pack converters to be fed from two feeders of 24V DC or 240V AC UPS system as per system requirement. These two power supplies shall be internally fused and failure of one power supply shall not affect the performance of the system. Self-monitoring facility to detect and alarm the loss of power supply shall be provided.

The detector unit, logic units, 2x100% redundant power supply units/packs shall be housed in separate and independent cubicles for pressure vessel on each side of the tank. The Electronic unit mounted locally should have detector units, logic units etc. & shall be independent for each pressure vessel. The min enclosure rating IP 65.

Indication shall be provided at field for both indication and validation system. Remote indication is to be provided for indication system at unit control panel in CCR. Local Indication should be inbuilt in local electronic unit.

Electrode assembly shall have blow out and leakage proof sealing arrangement. Field proven ceramic/zirconia probes with insulation suitable for design pressure and temperature are to be provided.

The system design shall be such that it shall ensure that failure of one probe circuit shall not affect another probe circuit and failure of any electrode will not hamper the system function and operation. Further the entire system shall be of proven fail-safe design.

The logic shall be such that the trip and alarm relay circuits shall be independent for each for Low, Low-Low, High and High-High levels of tank. Monitoring of set time for trip generation and provision of setting time delay shall be available in the system. Trip logic shall be independent and separate from faultfinding logic.

The system shall have fault diagnostic features such as process fault, system hardware fault, probe failure, circuit board failure, shorted wire etc. Further

the system shall be able to distinguish between a cable fault and an electrode fault.

The necessary relays and relay modules for the Output Contacts shall be of proven design and each contact shall be rated for 5A, 240V AC/0.25A 220V DC rating. All these contacts shall be 2SPDT type. The **vessel** holding electrodes **shall be IBR certified**.

The system shall be proven and approved by Factory mutual, USA of equivalent, IBR etc.

2.06.00 Temperature Elements and accessories

2.06.01 Thermocouples

S. 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 S/R) depending on operating temperature Range (ungrounded type).
2.	No. of element	Duplex
3.	Housing/Head	IP-65/Die cast Aluminum. Head of TE to be provided with sufficient space and arrangement to head mounted temperature transmitter (as applicable). Plug in connectors are to be provided for external signal cable connection.
4.	Sheathing of Thermocouple	Swaged type magnesium oxide insulation. Magnesium Oxide shall be provided with high purity of 99.4% minimum.
5.	Calibration and accuracy	As per IEC-751/ANSI-C-96.1(special class) for T/C
6.	Characteristic	Linear with respect to temp, within $\pm 1/2$ percent of top range value
7.	Accessories	Thermo well (as specified below) and shall be spring loaded for positive contacts with the well.
8.	Standard	ANSI C 96.1 for Thermocouple and ASME PTC-19.3 (latest edition) for Thermo-well.
9.	Sheath Material/ Insulation	316SS/Compacted Magnesium Oxide.
	Sheath O D	8 mm.
10.	Insulation Resistance	More than 1000 M Ohms at Ambient temperature
11.	Response Time	6-10 Sec bare & 30 Sec. With protective sheath/thermowell
12.	Instrument Connection	1/2 " NPT (F).

S. No.	Features	Essential/Minimum Requirements
13.	Electrical connection	Gold plated Plug in type. Double entry, one unused entry with blind plug.
14.	Enclosure Class	IP-65 or better.
15.	Process Connection	i) M33 x 2 ii) Flanged for Air & Gas systems with mating flanges, fastner, gasket etc.
16.	Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
17.	Extension neck length	Minimum 100 mm above Insulation of pipe and Minimum 160 mm when there is no insulation on pipe.

Notes

1. Extension cable exposed to atmosphere in the conventional method melts away due to high temperature at the top of mill or due to coal burning. Hence The terminals of temperature sensors shall not be at the top of mills itself. The temperature sensors wires are to be laid up to JB though SS tube of required diameter and the head shall be placed nearer to the JB.
2. Thermocouples provided for steam services like super heater / de super heater area, where the process pipe is inside the insulation of boiler penthouse, Thermowells are inaccessible and terminal head and connecting cable cannot withstand high temperature, for such services thermocouples shall be provided with flexible extension SS316 Sheath of 10-15 meters.
3. Bidder may also provide Triplex Thermocouples as per process requirements.
4. Metal plug with chain is to be provided with thermowell to avoid ingress of foreign material inside thermowell when TE is not fitted or during maintenance.

2.06.02 Resistance Temperature Detector (RTD)

S. No.	Features	Essential/Minimum Requirements
1.	Type of RTD	Three wire/Four wire, Pt-100 (100 Ohms resistance at zero degree Centigrade).
2.	No. of element	Duplex
3.	Housing/Head	IP-65/Diecast Aluminum. Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable). Plug in connectors are to be provided for external signal cable connection.

S. No.	Features	Essential/Minimum Requirements
4.	Sheathing of RTD	Metal sheathed, ceramic packed
5.	Calibration and accuracy	As per DIN-43760/IEC 60751 Class-A for RTD
6.	Characteristic	Linear with respect to temp, within $\pm 1/2$ percent of top range value.
7.	Accessories	Thermo well (as specified below) and shall be spring loaded for positive contacts with the well
8.	Standard	DIN-43760/IEC 60751 for RTD and ASME PTC-19.3 (latest edition) for Thermo-well.
9.	Sheath Material/ Insulation	316SS/Compacted Magnesium Oxide.
	Sheath O D	8 mm.
	Gauge	18 SWG
10.	Insulation Resistance	More than 1000 M Ohms at Ambient temperature
11.	Response Time	6-10 Sec bare & 30 Sec. With protective sheath/thermowell
12.	Instrument Connection	1/2 " NPT (F).
13.	Electrical connection	Gold plated Plug in type. Double entry, one unused entry with blind plug.
14.	Enclosure Class	IP-65 or better.
15.	Process Connection	i) M33 x 2 ii) Flanged for Air & Gas systems with mating flanges, fastner, gasket etc.
16.	Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
17.	Extension neck length	Minimum 100 mm above Insulation of pipe and Minimum 160 mm when there is no insulation on pipe.

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) Metal plug with chain is to be provided with thermowell to avoid ingress of foreign material inside thermowell when TE is not fitted or during maintenance.

2.06.03 Metal Temperature Thermocouples

S. No.	Features	Essential/Minimum Requirements
1.	Measuring Medium	Metal Temperature
2.	Material of Thermocouple	Chromel Alumel Type K
3.	Type of Thermocouple	Duplex with separate hot junctions, ungrounded Insulation Mineral Insulation Magnesium Oxide.
4.	Thermocouple wire gauge	16 AWG
5.	Protective sheath	SS 321
6.	Protective sheath dia	8 mm O.D
7.	Characteristics of Thermocouple	Special limits of error as in ANSI thermocouple MC 96.01, 1975
8.	Mounting accessories	1/2" BSP SS sliding end connector, weld pad, clamps of heat resistant steel SS310.
9.	Cold end sealing	SS pot weal with colour coded PTFE headed sleeve Insulated flexible tails. Sealing compound- Epoxy resin
10.	Minimum bending radius	30 mm
11.	Length of T/C	30 Mtr. (minimum)

Notes:

- 1) The specification for thermocouples of bearings metal temp measurements can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However type of thermocouples shall be K-type.
- 2) For boiler metal temperature applications considering the location of installation and response time, manufacturers standard and proven specification for metal temperature measurement can also be a accepted subject to OWNER approval. The manufactures shall submit adequate supporting documents for establishing their standard and proven practice.

2.06.04 Thermo well (for all process temp. elements) - (As per ASME PTC 19.3, latest edition)

- a) Shall be one piece solid bored type of 316 SS/F11/F22/F91 of step-less tapered design for water and steam Services depending upon process parameters.
- b) For Mill classifier outlet long life solid sintered tungsten carbide material of high abrasion resistance shall be provided.

- c) For Air & Flue gas 316 SS protecting tube with welded cap. (However bidder shall provide better material for Flue gas service if required based on the specified boiler design parameters).
- d) For furnace zone, impervious ceramic protecting tube of suitable material along with Incoloy supporting tubes and adjustable flanges.
- e) Bidder shall provide calculation for thermowell as per ASME – PTC-19.3 (latest edition).

“All Thermowells in high velocity steam service shall be checked for Strouhal’s frequency limit to arrive at a safer size and design of Thermowells”.

2.06.04 Cold Junction Compensation (CJC) Boxes

CJC Boxes are not required, Thermocouple cables shall be directly terminated at Thermocouple I/P cards only.

2.06.05 TEST THERMOWELLS (TW)

Applicable Standard	:	ASME PTC 19.3 TW - 2010
Type/Construction	:	Machined from Bar Stock
Material	:	316 SS/F11/F22/F91
Connection		
- Pipe	:	M33 x 2
- Test Instrument	:	To suit test instruments
Accessories	:	Plug with SS chain
IBR Certification	:	For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations
		Bidder shall provide calculation for thermowell as per ASME – PTC- 19.3 TW - 2010.

Test wells shall be provided on main steam, reheat steam, extraction steam, feed water, condensate, spray water lines and other piping as required to meet ASME test requirements.

2.07.00 TEMPERATURE TRANSMITTER

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

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

These shall be suitable for mounting in the head of temperature element itself. The protection class of head of thermo well along with its plug-in connector shall be min. IP65.

b. **Single Input DIN-rail mounted Temperature Transmitter**

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

Head mounted temperature transmitter with clamps to make it suitable for DIN-rail mounting shall not be acceptable under this category.

c. **Dual-input Temperature Transmitter with Indicator:**

These shall be suitable for mounting on pipes/ support. Indicator shall be provided with these transmitters. These transmitters shall have bump less change over facility to second sensor in case first sensor fails. This change-over is to be alarmed. Protection class shall be IP65 minimum.

The exact applications for which this type of transmitter is to be provided shall be finalized by owner during detailed engineering.

d. Common requirements for each of the above type of temperature transmitters.

Output	:	2-wire (power supply from input card of Control System) with 4-20mA output with superimposed HART protocol signal.
Input	:	Same transmitter shall be capable to handle Pt-100 RTD, Thermocouples –K&R types (input type to be selectable at site through HART terminal)
Isolation	:	Min. 500 V AC
EMC compatibility	:	as per EN 61326
Operating ambient temperature	:	0 to 85 deg C (without indicator) 0 to 70 deg C (with indicator)
Power supply	:	Compatible with input module of Control System
Accessories	:	Mounting arrangements including Clamps etc.
Composite Accuracy	:	a) For head mounted and DIN-rail mounted type Refer note-2 RTD = <0.4% of 0-250 degC span

T/C-K type = <0.4% of 0-600 deg C span

T/C-R type = <0.4% of 0-1000 deg C span

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

b) For dual-input type:

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

e. Field bus compatible temperature transmitters:-

Temperature transmitters of this category shall be field mounting type & shall be capable of withstanding operating ambient temperature upto 85 deg C. These modules shall be connected to DDCMIS through field bus such as Profibus, Foundation Field bus etc directly from the transmitter. Maximum Number of inputs per such temperature transmitter shall be eight. These shall be mounted in cabinets in non-AC areas.

As an alternate, these signals from temperature transmitters can be connected to DDCMIS through standard remote I/O modules of the DCS, in which case, the temperature transmitter signals will be acquired through 4-20mA input modules in the remote I/O cabinet for connecting to DDCMIS through remote I/O bus.

Notes (Common for a to e above):-

1. In case of failure (open or burn-out) of RTD/thermocouple, temp. Transmitter shall provide low temperature output.
2. Composite Accuracy is to be calculated as summation of all applicable accuracies of temp transmitter, for converting sensor input to output in 4-20 mA (e.g., basic accuracy, digital accuracy, D/A accuracy, etc.) and temperature effect on these accuracies at ambient temperature of 50 deg C, based on the figure/ formula given in the standard product catalogue for span as specified above for various types of Temperature Elements specified. All such accuracy/ temp effect figures in catalogue shall be first converted to deg C, and then percentage of this converted accuracy in specified span shall be calculated to compare with the specified composite accuracy figures.
3. For BFPs' differential temperature protection by 2 out of 3 logic, DTT shall be employed to deliver 4-20 mA output to DDCMIS using suction & discharge temperature measurements.

2.08.00 IMPACT HEAD TYPE FLOW ELEMENT

The impact head type element shall be tubular insert type with four impact ports facing upstream direction, located precisely for determination of average flow velocity and shall be of SS 316 L.

Accuracy shall be 1.0% of actual value or better. Repeatability shall be $\pm 0.1\%$ of actual value or better.

The elements shall be supplied complete with mounting hardware; end support plugs and SS316 valve manifold (1/2" NPT connection) for instrument connections. All pertinent data including Owner's instrument tag no. for the flow element shall be punched on a stainless steel plate and affixed to the element.

Flushing arrangement shall be provided.

Dual path transit time clamp-on Ultrasonic Flow meter may also be used for measurement of CW flow.

2.09.00 FLUE GAS ANALYSER

The following flue Gas analyzers are envisaged:-

- i) Flue Gas analyzers for control and monitoring – quantities as indicated in Vol. V, Appendix I, Sr. no. G1, Part A.
- ii) Flue Gas Dust Emission analyzer for each ESP (at each Path) – quantities as indicated in Vol. V, Appendix I, Sr. no. G1, Part A.

Each analyser shall be independent and shall not share power supply, processor etc. with other analyser except compressor for purging air.

The common requirements to be met for all types of analysers are as below. The specific requirements to be met by each type of analyser are detailed in the subsequent clauses.

2.09.01 Common Requirements for all Analysers:-

S. No.	Features	Essential/Minimum Requirements
1	Output signals	
	Analog	4-20 mA DC galvanically isolated. If analyser provides superimposed HART signal on 4-20 mA DC output, It shall also be connected to OWS/ PC based station.
	Binary	2 NO + 2 NC for high alarm
2	Zero & span Adjustment	To be provided with range selection facility.
3	Ambient temp.	50°C
4	Indication	Digital Alphanumeric Display. Display of reading in engineering units shall be provided.
5	Enclosure Type/Material	Weather & Dust proof (IP 65) Die cast Aluminium/SS.
6	Type of Electronics	Microprocessor based with self diagnostic.

S. No.	Features	Essential/Minimum Requirements
7	Digital Signal transmission	HART/RS 485 Port Modbus Protocol/Ethernet TCP/IP protocol.
8	Calibration	Auto & Manual (from Remote)
9	Power Supply	To be arranged by Bidder subject to Owner's approval.
10.	Others	I) All interconnection tubing and cabling between probe and analyser / analyser panel and cabling from analyser/ analyser panel to DDCMIS (in central control room) & OWS/PC station are to be provided by Bidder. 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	High temp O2 -SH zone Low temp O2:- ECO outlet, AH outlet and ID inlet. Dust emission analyser – In each ESP gas stream/path
12	Compliance to standards	USEPA, TUV, MCERTS or equivalent standards
13	Type of Technology	Dust emission analyser – Opacity In situ (Path)type/ Tribo Electric Induction method In situ type Low temp O2 & High temp O2-Insitu type

2.09.02 Low temp O2 and High temp O2 Analyser cum monitor:-

Specification Requirements system	Oxygen Analyser cum Monitor (High Temp.)	Low temperature O2 Analyser cum monitor
Type of instrument	Non-heated in-situ dry type	Heated type in-situ
Principle of Measurement	Partial-pressure using Zirconium Oxide Cell	Partial-pressure using zirconium oxide cell
Measurement Range	0.01% to 10% oxygen	0 to 25% oxygen programmable up to min 0.5% of O ₂
Accuracy	+/-1% of F.S. or 0.5 % O ₂ , whichever is	+/-1% of Full Scale

Specification Requirements system	Oxygen Analyser cum Monitor (High Temp.)	Low temperature O2 Analyser cum monitor
	more	
Linearity	$\pm 1\%$ of F.S.	$\pm 1\%$ of F.S.
Repeatability	$\leq 0.5\%$ of span	$\leq 0.5\%$ of span
Response time(up to 90% of full scale)	≤ 5 secs	≤ 5 secs
a) Temperature Drift	-	-
b) Zero Drift	-	$< 1\%$ span/week
c) Span Drift	Stability:- 1% deviation throughout life of sensor	$< 1\%$ measured value/week
Operating Temperature Range	600-1600 deg. C	0-450 deg. C
Filter	Cell shall be protected using ceramic boot	Suitable filter to be provided
Accessories purging system	Not applicable	Not applicable
Temperature	Yes With R/B type thermocouples (to be finalised during detailed Engineering) required.	Automatic temperature control of heating circuit through thermostat

Note: 01. For O2 Analyzer, the construction of the sensor shall be such that joints between dissimilar materials are avoided to prevent formation of cracks.

2.09.03 **Technical Specification of Flue Gas Dust Emission Monitor for ESP**

Optical Trans-receiver type or Tribo Electric Induction method type microprocessor based dust Monitor shall be provided by bidder in each of the ESP gas streams/paths on the ducting between ESP and the common duct at ID fan inlets, meeting the following requirements.

2.09.03.01 **The Optical Trans-receiver type microprocessor based flue gas opacity monitors shall meet the following specification:**

- (a) The transceiver shall contain a light source, the light from which shall be modulated and alternatively projected through the flue gas stream to reflector and a reference path within the sealed transceiver unit. Both the reference beam and the measurement beam reflected back from reflector unit shall be projected on a common photocell detector in the transceiver unit and the ratio of measurements signals to reference signal shall be used to determine the opacity and optical density of smoke in dust.

The instrument shall automatically and continuously correct the measurement of variations in temperature, line voltage, ambient

illumination, lamp aging detector drift and associated shift in component characteristics. The transceiver shall produce a 4-20 mA DC signal corresponding to the smoke density measurement.

- b) The transceiver and reflector units each shall be provided with separate air purging equipment including blowers, cartridge filters, junction boxes, mounting plates and associated accessories. Transceiver and reflector units shall also be provided with automatically operated shutters to protect the lenses and reflectors in the event of purge air or electric power failure.
- c) The transceivers shall be provided with automatic zero and span calibration capability with manual over-ride facility. The automatic calibration interval shall be selectable from the remote converter unit.
- d) Alignment indicator shall be provided in transceivers to permit visual observation of system alignment.
- e) The signal converter/remote control unit shall be suitable for panel mounting in the ESP control room and house all hardware to convert the transceiver output to a linear (4-20 mA) output corresponding to duct smoke density measurement.

The converter shall be provided with the following features:

- (i) Opacity/density indication with switch selection of ten measurement ranges and outputs.
 - (ii) Simultaneous 4-20 mA outputs corresponding to duct exit opacity and optical density for recording in analog recorder and data acquisition system.
 - (iii) Remote automatic transceiver calibration interval control.
 - (iv) Status indication of in-situ equipment such as lamp, air filters, shutters, optical surfaces (windows and reflectors) and over range operation etc.
 - (v) Two independent high level alarms with adjustable time delays.
- (f) The performance of the opacity monitors shall be as follows while operating continuously at flue gas temperature.

i)	Mean interval between maintenance cleaning	Not less than 90 days
ii)	Auto Calibration interval	1 to 24 hours (remote selectable)
iii)	Calibration drift in 24 hours	1.00%
iv)	Zero drift in 24 hours	1.00%
v)	Calibration error	2.00%
vi)	Power Supply (nominal)	240 VAC from UPS
vii)	Range	0-200 mg/Nm ³

- g) As recommended by the opacity monitor manufacturer, the location shall be upstream of the proposed point of location to ensure laminar flow of the flue gas.

2.09.03.02 The Tribo Electric Induction method type microprocessor based flue gas dust monitors shall meet the following specification:

Measurement principle	:	Inductive Electrification
Measurement objects	:	Solid particles in a flue gas flow
Measurement range	:	Approx. 0.1 mg/Nm ³ to 1 kg/Nm ³
Probe length	:	As per requirement
Probe dia	:	10 mm minimum.
Response Time	:	Less than 1 second
Accuracy	:	0.01 mg/Nm ³
Resolution	:	0.1% of measurement scale
Drift	:	No Drift
Linearity	:	≤2%
Repeatability	:	+/- .009 mg/Nm ³
Signal Averaging	:	Adjustable
Self Zero Span check	:	Yes
Output signals	:	Isolated 4–20 mA (2 nos.) Two SPDT relays: 5A, 24VAC/DC Serial communication RS-485

Material

Probe	:	SS 316L
Faraday cage	:	SS 316L (As per requirement)
Insulation of probe	:	Peek or better
Enclosure	:	Aluminum alloy
Process Connection	:	Flange SS 316L
Power Supply	:	230 VAC, from UPS
Protection	:	IP65 or better.
Remote Display	:	Yes, In ESP control room.
Compliance to standards	:	TUV or equivalent standards

- 2.09.03.03 The dust monitor shall be designed to operate with flue gas temperature between 100-200°C continuously. The temperature may exceed his value for a short time following failure of air heaters and the equipment shall not be damaged during such excursion.
- 2.09.03.04 Separate isolated 4-20 mA DC signals shall be provided for indication on unit control room and in ESP control room from each flue gas dust monitor. Dust emission in terms of mg/Nm³ shall be monitored. The system shall include all devices, software necessary for computing dust emission in mg/Nm³. The monitoring system shall meet the requirements stipulated by EPA/TUV regulations.
The location shall be finalised as per the suppliers recommendations, as far as possible.
- 2.09.03.05 All necessary approach, platform etc. for the dust monitors shall be provided for maintenance of each dust monitor by bidder.
- 2.09.03.06 The bidder shall, after installation at site, establish the correlations between the optical density output and participate grain loading for display and recording of particulate grain loading.
- 2.09.04 Connectivity with DDCMIS:-
1. 4-20mA signals from all the above analysers/flow meters/temperature transmitter to DDCMIS.
 2. All the accessories and cables required for connecting Analysers outputs to DDCMIS shall be provided by Bidder on as required basis.

2.10.00 VIBRATION MONITORING SYSTEM FOR HT DRIVES:

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, Vol. V.

The Vibration Monitoring System shall be furnished on a system basis including, vibration transducers, key phasor with low noise flexible cables in flexible conduit, terminated in local terminal boxes, necessary pre-amplifier/electronics mounted in local weather proof IP 65 boxes, vibration monitors, 19" mounting racks and cabinets etc. The vibration monitoring system shall include all redundant power supplies, interconnecting cabling, calibration equipments, indicators, integrating units, signal conditioning devices and all other accessories, erection hardware required for monitoring of Vibration at each point. The bidder shall provide the Anti-Corrosive vibration pads.

The vibration monitoring system shall meet the requirement of API-670-1994 (Latest edition) and BS: 4675, Part-2.

Bidder 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 Bidder, 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 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. The incremental scale factor of sensor (proximity probes) shall not be more than $\pm 5\%$ of 7.87 mV/micrometer within the testing range temperature. The sensitivity of sensor (accelerometer) shall not be more than 100 mV/g $\pm 5\%$ within the temperature testing range. Operating Temp. for sensors and extension cables shall be 0-125 deg. C.

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 Bidder.

Vibration Monitoring system shall interface with the main plant vibration analysis & diagnostic system via suitable redundant communication network link like modbus / Ethernet to provide analysis, diagnostic & recording facility for the acquired data. 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 key phasor. The signal shall be suitable for use as an input to DDCMIS as well as for analog recording & analysis, linear in proportion to vibration velocity as well as displacement. 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.

All the hardware required for condition monitoring, analysis & diagnostic shall be mounted in VMS panel, in case distance between VMS panel and condition monitoring, analysis & diagnostic system is more than the distance covered by buffer outputs.

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. Bidder shall feed the vibration monitoring cabinet from redundant 24 V DC feeders from the respective 24 VDC chargers in the bidder's scope.

If 240 V AC UPS power supply is required for panel PC/ desktop OWS, Mini UPS for the same shall be provided by the bidder. The power supply arrangement shall ensure that if external power supplies are used, 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. However, if any power supply modules internal to the monitors are envisaged, the failure of one such module should not affect more than one monitor.

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.

In case it is the proven standard practice of a Bidder to provide vibration monitoring LCD TFT monitor/GIU panel, instead of dedicated monitors with the signal conditioning equipment on VMS panels, the same shall also be acceptable. However, all relevant functional requirements detailed above shall be met and the system shall be subject to Owner's approval.

Test calibration instruments/jigs, shakers table etc., for site calibration of all sensors of VMS shall be provided by Bidder. This shall be in addition to provided with TSS/TSI system.

Complete VMS shall be time synchronized from Master clock system.

2.11.00 Instrument Air System

The instrument Air Supply System for various pneumatic Control & Instrumentation devices like pneumatic actuators, power cylinders, I/P converters, pneumatically operated valves etc. shall be complete in all respect with necessary Air Filter Regulators, valves, piping/tubing etc.. Each pneumatic instrument shall have an individual air shut off valve. The pressure-regulating valve shall be equipped with an internal filter, a 50 mm pressure gauge and a built in filter-housing blow down valve.

Filter shall be of minimum 5-micron size & sintered bronze material.

On collection of water in the drains of instrument air lines, mechanical automatic drains and periodically solenoid operated drains (with electronic timer - 15m, 30m, 60m and 2 Hours & Timing adjustable) are to be provided.

For mechanical type & Electrical type, the locations to be provided in the instrument air lines of boiler area, Chimney area, turbine area etc., shall be decided during detailed Engineering.

Individual moisture separator for O₂ analyzer or vital application shall be provided nearby the instrument so as to enhance the cell life or the performance of vital final control elements.

2.11.01 Air Filter Regulator (AFR)

Constant bleed type AFR with an accuracy of ± 0.1 % inlet pressure range of 5-8 kg/ cm² and suitable spring ranges (AFR) for use with positioners in control valves, control damper, E/P convertors and shut off valves with phosphor bronze sintered filter element; Filtering particles above five

microns. Weather and water proof enclosure. Built in blow down valve shall be provided. AFR shall have automatic drain feature. Material of accessories will be SS316. Body material of Air Filter regulator shall be Die Cast Aluminum or SS316. Degree of protection shall be IP 65.

Air filter regulators shall be provided in the :

- (a) Air supply line to valve positioners / power cylinders.
- (b) Air supply line to electric to pneumatic converters.
- (c) Air supply line to pneumatic interlocked block valves.
- (d) For each instrument rack, field instruments enclosure for purging.

2.11.02 E-P CONVERTER

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

Air supply: 1.5 kg/cm sq., Input signal: 4-20m A dc (as required by the design of control system), Output signal: 0.2 to 1.0 kg/cm sq., Linearity: 0.5% of span or better, Hysteresis:0.5% of span or better, Ambient Temperature Effect: less than 0.02% of span per deg C between -20 to +60 deg C. Mounting: Close to actuator (but not on the actuator), output capacity-to suit the actuator, protection class IP 65. On loss of control signal, the last set point pressure shall be maintained so that the associated control valve remains in stay put condition without any additional solenoid valve. The allowable drift rate will be +2% of set point/ hour maximum. Material of accessories will be SS. E/P convertors shall have fail freeze (stay put) feature also. Zero/span adjustment facility shall be provided.

2.12.00 SPECIFICATION FOR FLOW ELEMENTS & FLOW METERS

2.12.01 Orifice Plate

S. No.	Features	Essential/Minimum Requirements
1	Features	Essential/Minimum Requirements
2	Type	Concentric as per ASME PTC-19.5 (Part-II), ISA RP-3.2, 1960 or BS-1042, ISO 5167
3	Material	316 SS
4	Thickness	3.18 mm for main pipe diameter up to 300 mm, 6.35 mm for pipe diameter above 300 mm & less than 500 mm and 10 mm for main pipe diameter of & above 500 mm.
5	Material of branch pipe	Same as main pipe
6	Root valve type	Globe
7	Root valve material	316 SS
8	Root valve size	1 / 2 inch or 1 inch (as applicable)
9	Impulse pipe of same material up to root valve	Required

S. No.	Features	Essential/Minimum Requirements
10	Tapping	Flanged weld neck or D & D/2 with 3 pairs of tapping (as applicable). Root valves to be provided in all the tappings.
11	Beta Ratio	0.34 to 0.7
12	Beta Ratio calculation to be submitted	Yes
13	Assembly drg. and flow Vs DP Curves	Yes
14	Accessories	Root valves, flanges, Vent/drain hole (As required). The material of all type of accessories like root valves, gaskets, expanders/reducers, jack bolts, studs, bolts, nipples etc. will be SS316.

The accuracy of the each flow element shall be $\pm 0.5\%$ or better.

Bidder shall submit certified flow calculation and differential pressure vs. flow curves for each element for Owner's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Owner's approval. One Flow element of each type shall be calibrated in the test laboratory for validation of commutated flow calculations

Maximum pressure drop/loss shall be limited to 60% of DP for Orifice plate subject to beta ratio within the range as specified.

SS nameplate to flow elements shall include Tag no/ KKS No./Sl. No./ Body Material/Beta ratio/line size & thickness/ direction of flow.

2.12.02 Flow Nozzle

S. No.	Features	Essential/Minimum Requirements
1.	Type	Long radius, welded type as per ASME PTC- 19.5 (Part-III) or BS-1042
2	Material	316 SS and The material of Flow nozzle shall be A182F91, where pipe material is A335P91.
3	Thickness	Suitable for intended application.
4	Material of branch pipe	Same as main pipe
5	Root valve type	Globe
6	Root valve material	316 SS
7	Root valve size	1 inch
8	Impulse pipe of same material up to root valve	Required
9	Tappings	Flanged weld neck or D & D/2 with 3

S. No.	Features	Essential/Minimum Requirements
		pairs of tapping (as applicable).
10	Beta Ratio	Around 0.7
11	Beta Ratio calculation to be submitted	Yes
12	Assembly drg. and flow Vs DP Curves	Yes
13	Accessories	Root valves, vent and drain hole. The material of all type of accessories like root valves, gaskets, expanders/reducers, jack bolts, studs, bolts, nipples etc. will be SS316.

The accuracy of the each flow element shall be $\pm 0.5\%$ or better.

Bidder shall submit certified flow calculation and differential pressure vs. flow curves for each element for Owner's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Owner's approval. One Flow element of each type shall be calibrated in the test laboratory for validation of commutated flow calculations.

Flow nozzles shall be made with quarter, triple or dual sets of pressure taps installed in the pipe wall wherever required considering spare one set of pressure tap.

Maximum pressure drop/loss shall be limited to 30% of Differential Pressure for flow Nozzle subject to beta ratio within the range as specified.

SS nameplate to flow elements shall include Tag no/ KKS No./SI. No./ Body Material/Beta ratio/line size & thickness/ direction of flow.

2.12.03 ROTAMETERS

S. No.	Features	Essential/Minimum Requirements
1	Type	Variable Area Metal Tube
2	Fluid media	Water/oil
3	Tube body	SS316
4	Material of float	316 SS
5	Indicator	Linear scale
6	Accessories	Flange, orifice in case of bypass Rota meter (for line size above 100 mm)
7	Housing protection class	IP-65
8	Accuracy	$\pm 2\%$ of measured value

2.12.04 POSITIVE DISPLACEMENT TYPE FLOW TRANSMITTERS

The Bidder shall provide positive displacement type flow transmitters for fuel oil flow measurement, suitable for the fuel oil being used for the project, i.e., keeping in view the pressure, temperature and viscosity of the fuel oil in fuel oil unloading & handling package.

The meter shall be a volumetric meter type consisting of two meshing oval wheels driven by the fluid. Each revolution of the oval wheels shall displace a precisely known volume of the fluid from inlet to outlet. The housing/measuring chamber and oval wheels shall be of 316 SS. Air eliminators shall also be provided to ensure maximum accuracy.

The measurement accuracy of the transmitter shall be better than $\pm 0.2\%$.

The transmitter shall provide suitable 4-20mA dc output signal for control and indication/recording. Converters if necessary shall be provided to generate the 4-20mA signal.

A local indicator of fuel oil flow shall also be provided. The instrument shall be calibrated in Tons/hr. An electronic totalizer shall be provided for each flowmeter and the location of the totalizers shall be acceptable to the Owner.

Suitable strainer shall be provided before the transmitter for the protection of oval wheel meters against foreign matter contained in the fuel oil.

The exact model no. and type of material being used, etc., shall be subject to Owner's approval during detailed engineering without any price repercussion to Owner.

2.12.05 DUAL PATH TRANSIT TIME CLAMP-ON ULTRASONIC FLOW METER

The flow meters shall be of proven reliability, accuracy and repeatability requiring a minimum of maintenance. They shall comply with relevant international standards and shall be subject to owner's approval.

All accessories required for mounting/erection of this instrument shall be furnished, erected and installed as necessary for completeness of the system though not specifically asked for. Also the equipment shall include necessary cables, flexible conduits, junction boxes required for the purpose.

Flow meters shall be provided with suitable environment protection devices/structures such that they shall be suitable for continuous operation in the operating environment of a coal fired utility station without any loss of function or departure from the specification requirements.

TECHNICAL REQUIREMENTS

Items	Description
Type	Transit time Clamp On Ultrasonic meter
Mounting Style	Dual path with two sets of transducers on the same pipe
Flow measurement	Instantaneous Flow rate as well as totalized flow
Power supply	230 V AC from UPS.
Outputs: Analog Current Binary	Isolated 4-20mA linear outputs for each path Contact relay outputs, 2 NO + 2 NC for alarm

Items	Description
Communication ports	RS 232 C digital Hand held terminal port
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	Yes. Should be able to compute cumulative flow over intervals selectable by owner i.e., daily, weekly, monthly etc. The data shall be stored in the memory of flow computer for access in future
Software features	Compensation for any cross path errors. Programming, configuration, shall be possible from front panel.
Diagnostics	False signal tolerance , power supply failure etc.
Protection class	IP-65 'or better, Weather protection against direct sunlight, rain etc for Flow .' meter and suitable for Cooling water for Transducer
Accuracy	+/- 1%
Electrical connection	Plug and socket
Pipe location	Underground
Accessories	All mounting hardware required like clamping fixtures, mechanism to remove the transducers online, interconnecting cables etc. All weather canopy for protection from direct sunlight and direct rain. Material of all fittings shall be SS 316.

2.12.06 Mass Flow meter

Sensor

Measuring Principle	:	Coriolis Mass flow.
Primary Element	:	Flow Tube of 316SS or better
Heating Arrangement	:	Integral with Flow Meter.
Temperature Control	:	To be provided
For Heating		
Process Connection	:	ANSI RF Flanged and rating as per process requirement.

Drain	:	Self-draining facility
Accessories	:	Counter flanges, Mounting nuts, bolts, gaskets, liners etc.
Transmitter		
Measured quantities	:	Mass Flow rate, Total Mass Flow, Density, Temperature as minimum.
Input Signal Processing	:	Digital Processing.
Display	:	Digital Display (LCD).
Output	:	2 Nos. isolated output of 4-20mA DC HART selectable from four measured quantities.
Load	:	< 750 ohms.
Power supply	:	230V AC, 50 Hz. From UPS
Accuracy	:	$\pm 0.15\%$ of measured value for Liquid $\pm 0.5\%$ of measured value for Gas
Repeatability	:	$\pm 0.05\%$
Housing	:	IP 65/ (Explosion proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
Hazardous duty Version	:	FM Standards.
Nameplate	:	Tag number, service engraved in stainless steel tag plate
Accessories	:	a) As required for field mounting, Handheld configurator & complete Software, External zero adjustment facility b) Mounting U-bolts, nuts, bolts, prefab cable etc.
Application	:	Fuel Oil main lines, recirculation lines etc.

2.12.07 Turbine Flow meter

Sensor

Type	:	Turbine (in line full-bore, based on magnetic pick of pulses)
Output Signal	:	Pulse

Material of Construction	:	a) Body : AISI 316 b) Rotor: AISI 431 or 410 c) Bearings: Tungsten Carbide / Stellite Sleeve
Flow rate range	:	As required.
Linearity	:	±0.25% or better.
Repeatability	:	± 0.02% or better.
Ambient temperature	:	50 deg C
Mounting flanges of stainless steel.	:	On-Line mounting with ANSI RF
Enclosure	:	IP 65

Transmitter

Electronics	:	Microprocessor Based
Power Supply	:	230V AC, 50Hz. From UPS
Input	:	Input from Sensor
Display	:	4 1/2 digit LCD
Output	:	Isolated 4-20mA DC
Measuring Accuracy	:	± 0.5% of full scale range
Totalized Value	:	Required
Housing Class-1,	:	IP-65 (Explosion proof for NEC Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
Nameplate	:	Tag number, service engraved in stainless steel tag plate
Accessories cable	:	Clamping strip, bracket, prefab etc. Calibration or configurator kit.

2.12.08 Vortex Flow meter

Operating Principle	:	Karman Vortex Street
Applications	:	Liquid, Gases, Steam (as Decided by Owner).
Parameters	:	Volume & Mass Flow.

Sensor

Output Signal	:	Pulse
Material of Construction	:	AISI 316
Sensor Seal temperature	:	PTFE / higher based on
Flow range	:	As required.

Ambient temperature	:	50 deg C
Mounting	:	On-Line mounting with flanges of stainless steel.
Enclosure	:	IP-65 (Explosion proof for NEC Class-1/2, Division 1 area)/ flame proof (IEC- 79.1, Part I). As applicable).
Accessories	:	Nuts, bolts, gaskets etc.
Temperature Compensation	:	Yes, Integral.

Transmitter

Electronics	:	Microprocessor Based
Power Supply	:	230V AC, 50Hz. UPS
Input	:	Input from Sensor
Display	:	4 1/2 digit LCD
Output	:	Isolated 4-20mA DC HART
Measuring Accuracy	:	$\pm 0.75\%$ of reading for Liquid $\pm 1\%$ of reading for
Gases/Steam Repeatability	:	$\pm 0.25\%$ of reading.
Totalized Value	:	Required
Housing Class-1,	:	IP-65 (Explosion proof for NEC Division 1 area)/ flame proof (IEC- 79.1, Part I). As applicable).
Nameplate	:	Tag number, service engraved in stainless steel tag plate
Accessories prefab	:	a) Clamping strip, bracket, cable etc. b) Special tool kit for calibration/configuration.
Application	:	Instrument and Service air.

2.12.09 SIGHT FLOW GLASS INDICATORS

Type/Construction	:	Flapper type.
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Materials

Body	:	Carbon steel/SS316 as per process requirement
Glass	:	Toughened Borosilicate
Gaskets	:	Neoprene
Bolts & nuts	:	SS
Flappers / Rotating Wheel	:	316 SS
Flappers / Rotating Wheel holder	:	304 SS
Process Connection	:	SW
Accessories	:	Scale, Bolts, Nuts, Cover plates and Gaskets as required
Tests	:	Tested at two hundred (200) percent of the maximum process Pressure

2.12.10 SOLID FLOWMETER

Type	:	Online Impact type Microprocessor Based
Measuring Principle	:	The system measurement is basically pertains to the measurement of horizontal deflection using LVDT, created by the impact of solid flow upon online sensing plate. The horizontal deflection being proportional to the impact forces, LVDT convert this horizontal movement into electrical signal. The inbuilt integrator convert this signal into time based flow rate indication & provide totalized flow also.
Sensing plate	:	316 SS
Sensing head	:	Sensing mechanism shall be mounted outside the process flow line.
Enclosure	:	316 SS
Enclosure protection	:	IP 67)/ Explosion proof for NEC Class-1/2, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
Class		
Accuracy	:	+/-1% of measured valve.
Repeatability	:	+/- 0.1%
Drift	:	Both zero & span + 2% / month

Output	:	4-20mA DC isolated, load 600 ohm (min)
Digital communication (HART) facility	:	yes
Power supply	:	230 V AC, 50Hz. UPS
Ambient condition	:	Temperature -600 C, RH-95% Environment – Highly Dusty
Accessories	:	Shall be complete with all the accessories including digital display for flow rate, integral vents, baffles for air separation, etc. whichever required for satisfactory operation.

Note:-

1. The above on line flow meter shall not create any obstruction on flow.
2. User's list shall be submitted to support on proven satisfactory performance for similar process application.

2.12.11 Flow Transmitter (Ultrasonic) for Open channel flow measurement.

Type	:	ULTRA SONIC, 2-wired
Sensing element	:	Non-contact
Output	:	4-20mA with HART Protocol
Accuracy	:	± 0.25% FS
Supply	:	24 V DC
Enclosure class	:	IP-65

Transmitter

Mounting	:	On Nozzle
Mounting position	:	Top mounted
Housing	:	SS316/Die cast Aluminium
Display LCD	:	Head mounted LCD Display and remote Display indicator
Process connection	:	NPT/Flanged
Electrical connection	:	Plug & Socket.
Turn Down ratio	:	1:100
Measuring range	:	Adjustable (as per process requirement)
Totaliser	:	Required
Mounting fitting Material	:	SS316.
Canopy	:	Required
Accessories	:	As per process requirement Additional separate local display unit with large alphanumeric back light LCD/LED & to be provided for the applications which will be decided during detailed engineering.

2.12.12 ANNUBAR/Averaging Pitot tube

Type/Construction	:	Averaging Pitot tube with direct mounting type on pipe
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Materials

Body	:	SS316
Nipple	:	SS316

Gaskets	:	Teflon
Bolts & nuts	:	SS316
Flange	:	SS316
Beta ratio	:	0.4 to 0.7
Process Connection	:	1 1/2" Flanged
Instrument connection	:	1/2" NPT (F) through needle valve
Differential range	:	(To suit the accurate flow)
Accessories	:	SS316 Bolts, Nuts, Cover plates, Adapter and Gaskets, SS tag plate as required
Tests	:	Tested at two hundred (200) percent of the Maximum process Pressure. Material Test. Calibration Test.

2.12.13 Aerofoil

Materials	:	As per IS 2062 in line with Duct material
Accuracy	:	+/- 1to2%
Repeatability	:	+/- 0.1% to 0.2%
Type of tapping	:	Total 4 pairs of tapings (3 pairs of tapings with stubs & 1 spare pair plugged)
Tap size	:	1/2" SW
End connection	:	Flanged with mating flange
Beta ratio	:	0.4 to 0.7
Accessories	:	SS tag plate, SS316 nuts, bolts, packing & hardware, etc.
Standards	:	ASME PTC - 19.5 (Pt - II), or BS 1042/ISO 5167
Pressure Loss	:	<20% of DP

2.13.00 PROCESS ACTUATED SWITCHES

S. No.	Features	Essential/Minimum Requirements		
		Pressure/Draft Switches/ DP Switches	Temperature switches	Level switches
1	Sensing Element	Piston actuated for high pressure and diaphragm or bellows for low pr./vacuum	Vapor pressure sensing, liquid filled bellow type with SS bulb and capillary (10 m minimum)	Capacitance types for oil and dirty medium, water, condensate application. Float type for applications as decided by owner during detailed engineering. Capacitance/Conductivity/Ultrasonic type for acid and alkali application. RF/ Ultrasonic type for ash hopper, ash slurry

S. No.	Features	Essential/Minimum Requirements		
		Pressure/Draft Switches/ DP Switches	Temperature switches	Level switches
				application. Detailed spec are also included below.
2	Material of sensing element & movement.	316 SS	Bulb 316 SS/ capillary 304 SS	316 SS
3	End connection	½ inch NPT (F)	½ inch NPT (F)	Manufacturer standard
4	Over range proof pressure	150% of max. design pr	-	150% of max. design pressure
5	Repeatability	±_0.5% of full range		
6	No. of contacts	2 Nos. +2NC. SPDT snap action dry contact. Auto reset with internal Adjustable snap action micro switch. Differential shall be adjustable.		
7	Rating of contacts	60 V DC, 6 VA (or more if required by DDCMIS/PLC)		
8	Elect. Connection	Plug in socket		
9	Set point	Provided over full range. Differential shall be adjustable.		
10	Dead band adjustment	Adjustment upto 10% at set points.		
11	Enclosure	Die cast Aluminum with stoved enamel black finish/SS316, Weather and dust proof as per IP-65. Epoxy painting shall be provided for corrosive atmosphere.		
12	Accessories	Siphon, snubber, chemical, pulsation dampers as required by process.	Thermo well of 316 SS and packing glands	All mounting accessories
13	Mounting	Suitable for enclosure/rack mounting or direct mounting	Suitable for rack mounting or direct mounting	-
14	Power Supply (wherever Required)	24 V DC, to be arranged by Bidder except for Ash Level Switches, where the same shall be as per Bidder's Standard practice.		

Notes:-

- 1) 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) Pressure / Diff Pressure switches for very low pressure / DP measurements can have sensor material other than SS316 e.g. silicon etc., if the offered material is suitable for that application and the offered product is standard product of the manufacturer for very low pressure applications.
- 3) Repeatability can be upto +/-1% of full range in case of switches with diaphragm seals or very low pressure/DP range.
- 4) All the Pressure/ Diff. Pressure/ Temp./ Level switches etc. shall be with the provision of local digital display.

2.13.01 Conductivity Type Level Switch

Type	:	Conductivity discrimination.
Mounting	:	Flanged – on standpipe.
Probe MOC	:	Stainless steel with high purity ceramic.
Probe rating	:	> Maximum design pressure of vessel.
Input	:	Four independent channel with selectable switching threshold for water conductivity.
Relay Output	:	Four isolated output relays for Hi, Lo, Hi-Hi, Lo-Lo.
Contact type & rating	:	2SPDT or 1 DPDT @ 5A 30V DC.
Faults Detection	:	Power Fail/Electrode Connection Open circuit/short circuit to ground, Ground failure. In built Fail Safe Logic.
Indicator	:	One Red LED for steam/ one Green LED for water/ Two no. LED one each for Process & system fault.
Power supply	:	Dual 230V AC, 50 Hz, 1Ph from UPS.
Enclosure	:	Corrosion resistant & wall mounting type. IP-65 or better (Explosion proof For NEC Class-1/2, Division 1 area)/
flame	:	proof (IEC-79.1, Part I). As applicable).

Accessories	:	i.	PTFE cable from probe to electronics unit. Electronic unit shall be separate. Head mounted electronic unit is not preferred.
		ii.	Mounting accessories
		iii.	standpipe
		iv.	Washer & gasket
Test pressure	:		Two times rated pressure

2.13.02 Capacitance Type Level Switch

Type	:	Capacitance type
Probe	:	a) Rod or suspended electrode b) Rope type probes may be used only where required probe length is greater than 3 meters.
Probe Mounting	:	Stainless steel 1-1/2 ANSI RF Flange / 3/4" NPT (M)
Material of construction	:	316 SS
Insulation	:	PTFE Part/Full as per service.
Enclosure	:	Powder/Epoxy coated Die cast Aluminum. with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1/2, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
Ambient temperature	:	0-60 °C.
Mounting	:	On Top
Supply voltage	:	230V AC, 50Hz from UPS / 24V DC
Relay output	:	2SPDT
Contact rating	:	5A min. at 240V AC on resistive load
Response time	:	100 m sec or better
Cable connection	:	Plug in type
Accessories	:	Counter flange, Cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric.

2.13.03 RF TYPE LEVEL SWITCH

A. Electronic Controller

- | | | |
|-----------------|---|-----------------------|
| 1. Input Supply | : | 230 V AC from UPS |
| 2. Construction | : | Cast Aluminum Housing |

- | | | | |
|----|----------------------|---|---|
| 3. | Relay Output | : | 2 Nos. Relay Changeover Potential Free Contacts (2 SPDT) |
| 4. | Contact Rating | : | 5A at 240 V AC & 0.25 at 220V DC |
| 5. | Class of Protection | : | IP-66 |
| 6. | Ambient Temperature: | : | 55 Deg. C (Max) |
| 7. | Local Indication | : | Local LED Indications |
| | Green | : | Normal Level |
| | Red | : | Alarm Level |
| | Yellow | : | Probe Healthy |
| 8. | Cable Connection | : | 3/4" ET (2 Nos.) for Supply and Output 5/8" ET (1 No.) for Probe Connection |
| 9. | Repeatability | : | 100% |

B. Sensing Probe

- | | | | |
|----|--|---|------------------------|
| 1. | Type of Probe | : | Rigid |
| 2. | Material | : | Stainless steel SS 316 |
| 3. | Probe Head Housing | : | Cast Aluminum |
| 4. | Insulation (B/W Active & Shield And Shield & Ground) | : | PTFE |
| 5. | Probe Head Protection | : | IP-66 |
| 6. | Mounting | : | Side Mounted |
| 7. | Cable Connection | : | 5/8" ET (1No.) |
| 8. | Process Connection | : | 40 NB BSP
THREADED |

- | | | | |
|----|--------------|---|---|
| C. | Signal Cable | : | Coaxial cable for Connection Between Sensing probe and electronic Controller (@ 10 Mtrs. Per Level Probe) |
|----|--------------|---|---|

- | | | | |
|----|-------------|---|-------|
| D. | Application | : | Silos |
|----|-------------|---|-------|

2.13.04 FLOW SWITCHES (FS)

- | | | | |
|----|-------------------------|---|--|
| 1. | Type | : | Differential pressure type / vane actuator type, as per application. |
| 2. | Materials | | |
| | Body & Sensing Elements | : | SS316 |
| | Case | : | Die-cast aluminum |
| | Wetted Part | : | SS316 |
| 3. | Accuracy | : | ± one (1) percent Repeatability |
| 4. | Set point | : | Adjustable through range |
| 5. | Contacts | | |
| | No. of contacts | : | DPDT or 2 sets of SPDT |

	Type	:	Snap action micro switch
	Rating	:	5 Amp 240V AC 0.2 Amp 220V Dc
6.	Connection Instrument	:	1-1/2 or 1 inch NPT Male or Flanged or with SS316 Tee as per requirements.
	Electrical	:	Suitable for gland 3/4 inch & Plug in type.
7.	Protection Class	:	IP-65/ (Explosion proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
8.	Accessories	:	As required

2.14.00 SOLENOID VALVES

Solenoid valves shall be provided as per NAMUR standard with control valves / pneumatic control valves hooked up with process interlock requirements and where direct tripping is involved. The number of ways for solenoid valve shall be provided as indicated below:

- a. Type 2/3/4 way with body material of SS 316/Forged Brass and epoxy painting (depending on the application subject to Owner's approval during detailed Engg.). Material of Wetted parts shall be SS316.
- b. Power supply 24 V DC + 10%.
- c. Plug and socket electrical connection.
- d. Insulation: Class 'H'.
- e. All solenoid shall be with, LED indication, surge suppression diode circuits.
- f. For operation of the fuel oil corner nozzle valves, fuel oil trip valves etc., **double coil solenoid valve** (latch coil & relatch coil) shall be adopted.
Single coil usage requires always power and loss of power leads to closure of above valves resulting the unit trip or loss of generation.
- g. Two (2) way solenoid valves shall be provided, where process line of less than 50 mm with low pressure and temperature application.
- h. Three (3) way solenoid valve shall be provided commonly, where the pressure is admitted or exhausted from a diaphragm valve or single acting cylinder, e.g, Pneumatic operated spray water block valve.
- i. Four (4) way solenoid valve shall be provided for operating double acting cylinders, e.g, Pneumatically operated on-off type dampers.
- j. Solenoid valve shall operate on 24 V DC, UPS 230 V AC or 220 V DC as per system requirements.

2.15.00 Power Cylinders (Pneumatic)

Mounting Type	:	<ul style="list-style-type: none"> a) Fixed position mounting (End mounting). b) Trunnion mounting
Control Signal	:	0.2 to 1 Kg/Sq. cm. from I/P converter for modulating purposes. 24V/48VDC operated solenoid valve operating on pneumatic line. The Pilot solenoid will have separate coils for open closing purpose.
Supply Air	:	0-7 Kg / Cm ² .
Selection	:	Based upon thrust / torque, stroke length, angular movement, full-scale travel time, repeatability, space factor etc. Provision for air-to-open and air-to-close operation.
Casing	:	IP-65.
Accessories (as required)	:	<ul style="list-style-type: none"> a) Air lock relay b) Hand wheel. c) Air filter regulator with gauge. d) Volume Booster. e) Limit Switches. f) Positioner with Input, Output and supply pressure gauges. g) Pilot Solenoid Valve (Double Coil type) h) Position Transmitter (4-20 mA DC linear output, LVDT or non contact type).
Fail-safe operation	:	Stay put, open or close position on pneumatic / electrical power supply failure as per process safety criteria.
Repeatability	:	Better than 0.5% of full travel.
Hysteresis	:	Less than $\pm 1\%$ of full travel. Note :- Repeatability & Hysteresis are applicable for position transmitter & Positioner.

Note: In case of loss of mA signal. Manual adjustment shall be made through available manual knob and locked at required position for sufficient required process fluid flow.

2.16.00 WATER SYSTEM RELATED SPECIAL INSTRUMENTS (CW plant, D M PLANT, CPU PLANT, PT PLANT, AWRS, Service water, Potable water, etc.)

2.16.01 ANALYSER INSTRUMENTS:

For Technical specification of Cation/Specific Conductivity, pH, Sodium, Silica, Turbidity, Total Dissolved Solids (TDS) and Concentration analysers, and other requirements, please refer Specification of Analysers, Vol.-V, Part A and Part-B, chapter 5, SWAS chapter of this specification.

2.16.02 Residual Chlorine Analyser

- (a) An automatic chlorine residual analyser of amperometric type shall be provided alongwith the chlorinating plant for monitoring the residual chlorine content of cooling water. The analyser shall be suitable for accurate residual measurement in open/closed systems. The measurement accuracy shall not be affected by presence of treatment chemicals as chromates, phosphates, de-former highly polluted water, change in temperature etc.
- (b) The analyser shall comply with the following specification requirements, as a minimum
- | | | |
|--------|--------------------|---|
| (i) | Indicator | : Provision of LC display in the panel of analyser. |
| (ii) | Range | : 0 to 20.0 mg/L (ppm) |
| (iii) | Accuracy | : 2% or better |
| (iv) | Sensitivity | : 0.01 mg/1 |
| (v) | Output signal | : 4-20mA DC isolated output |
| (vi) | Alarm annunciation | : High and low alarms to be provided on panel and shall be field adjustable |
| (vii) | Calibration | :Zero and span adjustment facility to be provided. Final calibration adjustments of the analyser to be done at site and duly verified by titration. Temperature compensation range 0 to 50degC. |
| (viii) | Mounting | : The analyser shall be suitable for field mounting conform to protection class IP-65. |
| (ix) | Electrodes | : Platinum/Gold and copper electrodes shall be provided with cell cleaning system. |
| (x) | Power Supply | : 230 V AC, +/- 10%, 50 Hz. From UPS |
- (c) Circulating water as sample to residual chlorine analyser shall be taken from hot circulating water pipe work before entry to cooling towers. Exact location and layout of sampling arrangement shall be finalised during detailed engg. stage. Bidder shall provide necessary pumping system (with 100% standby) for meeting the analyser requirements, if needed. All the drains shall be terminated up to the nearest plant drainage system.

2.16.03 All the outdoor field instruments such as analysers/transmitters/meters etc. shall be provided with suitable Free standing cabinet(s)/panel/rack so that the equipments are protected against rain/ sunlight etc.

2.16.04 Parshall Flume

The Bidder shall provide all the control and Instrument devices including primary sensors, transmitters, flow indicator cum integrator / totaliser and shall include all required accessories for the flow measurement of raw water through the clarifier. The system shall be of reputed make and acceptable to the owner.

Level measurement shall be based on ultrasonic/radar technology. The flow compensation is to be implemented in the transmitter itself. The transmitter shall provide 4-20 mA DC in direct proportion to flow and shall be able to drive a load impedance of 500 ohms minimum

Accuracy shall be +/- 0.25 % or better.

All the mounting hardware and accessories required for erection and commissioning of the same are to be provided by the bidder. Mounting fittings material shall be SS316. All weather canopy is to be provided for electronics/sensor to protect the same from rain/ sunlight etc.

Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications which will be decided during detailed engineering.

The Type makes and models no. shall be subject to Owner's approval.

2.16.05 Electronic Flow-Meter

The electronic flow meter shall include flow sensor and flow indicator cum integrator / totaliser and shall include all required accessories for satisfactory operation. The flow meter shall be based on full bore ultrasonic / electromagnetic principle and shall be electronic type of proven design, make and model acceptable to the owner.

The Bidder shall submit all necessary technical literature and details of selection criteria of the instrument offered to substantiate the model selected. The Bidder shall also furnish list of similar installation along with feed back on satisfactory performance of the instruments.

The flow meter shall meet or exceed the following requirement:

(a)	Output	4-20 mA DC Isolated output HART compatible
(b)	Accuracy	± 0.5% of calibrated span or better *
(c)	Repeatability	± 0.2% of calibrated span or better
(d)	Ambient Temp. & Humidity	4 deg.C to 55 deg.C. 5% to 100% RH
(e)	Power Supply	UPS 240V AC ± 10%, 50 HZ ± 5%/ 24 V DC, to be arranged by the bidder.
(f)	Protection class	IP-65
(g)	flange material, Measuring tube & electrode material	SS 316

(h)	Liner material.	Teflon.
(i)	Features	zero stability, zero and span field adjustable, suitable for process medium with ≥ 5 micron Siemens conductivity.

The flow meter shall provide local indication for instantaneous flow. It should also be possible to get local display for daily and monthly discharge. The flow meter shall indicate totaliser / integrator to get the daily and monthly discharge as stated above.

2.16.06 REVERSE ROTATION INDICATOR (RRI)

For each of CW pumps & ACW pumps, a reverse rotation indicator comprising of proximity sensors, processing electronics with output of 4-20mA (corresponding to speed) interconnecting cables, speed display in rpm, normal, reverse indication and required channel alarm contact shall be provided. The contact rating shall be 60 VDC, 6VA (or more if required by Control system).

Reverse rotation monitor system with LCD display including sensors/transducers for zero speed, forward rotation & reverse rotation shall be provided from VMS supplier for CW pumps & ACW pumps and any other HT drive, wherever required. Sensors/transducers shall be proximity type. The incremental scale factor of sensors/Transducers (proximity probes) shall not be more than $\pm 5\%$ of 7.87 mV/micrometer within the testing range temperature.

The exact details of the RRI shall be strictly as approved by Owner during detailed engineering. The power supply of RRI is to be arranged by the Bidder from UPS.

2.16.07 Non - Nucleonic (Vibration) Type Density Meter (For CPU, DM & AHP Plant):-

Application : Liquid Density measurement

Detector

- | | | | |
|----|----------------------|---|-------------------------------|
| 1. | Orientation | : | As per requirement. |
| 2. | Case Material | : | SS 316L/ Cast Aluminum alloy |
| 3. | Wetted part material | : | SS 316L |
| 4. | Operating Principle | : | Vibration Density measurement |

Converter

- | | | | |
|----|-----------------------|---|---|
| 1. | Output | : | 4-20 mA DC isolated. |
| 2. | Electrical Connection | : | 1/2" NPT |
| 3. | Enclosure Class | : | IP 65 |
| 4. | Local Display | : | Digital 5 digit, density display with temp. Compensation. |
| 5. | Accuracy | : | +/- 1% |
| 6. | Response time | : | < 1 minute. |
| 7. | Power Supply | : | 230 V AC, +/- 10%, 50 Hz. From UPS |

2.16.08 FLOAT & BOARD TYPE LEVEL GAUGE

Type of Instrument	:	Mechanical Type (Float Operated)
Service/ Application	:	As per service requirement
Measuring Range	:	As per requirement
Material Specification		
a) Float Material	:	SS316 having 2 nos. Guide wires
b) Float Wire Pulley	:	Shall comprise of 2 nos. Cast Aluminum Pulley housing Assembly with SS 304 pulley and pulley shaft. Steel ball bearings shall be provided in pulley housing for easier float movement. Float wire material shall be SS316L. Between 2 pulleys, 1" NB G.I. short pipe.
c) Guide wire Assembly	:	CS chamber with spring and adjuster having 1" Class 150 ANSI RF MS flange. Guide wire rope shall be SS316L.
d) Counter Weight	:	MS counter - weight with Aluminum Pointer and Brass assembly Pull Chain.
e) Scale details	:	Aluminum/SS316 scale Graduated in mm with 1% accuracy of full scale range with arrow.
Nozzle Details	:	For float wire pulley assembly, one tapping and for guide wire assembly two tapping at the top of the tank; Size 1" NB (Top Mounting Type).
Process Connection	:	Flanged as per ANSI B 16.5 to suit 1" NB nozzle
		(Nozzle length - 150 mm for float wire, 100 mm for guide wire)
Accessories (to be supplied with the instrument)		
a) Counter flange	:	All mating Flanges, Nozzle
b) Mounting Accessories	:	All mounting accessories
c) Tag Plate	:	To be provided (material SS316)
Location	:	Field (Direct Mounting)

2.17.00 AC PLANT AND COMPRESSOR RELATED SPECIAL INSTRUMENTS

2.17.01 (HUMIDITY SENSOR)

Sensor	:	Capacitance type
Accuracy	:	+/-3% R.H
Range	:	0-100%
R.H Output	:	4-20 ma
Time constant	:	2 mins.

Output from the sensor is to be connected to respective control system. Bidder can also provide combined instrument for measurement of humidity and temperature subject to Owner's approval during detailed engineering. In all such cases, 4-20 ma outputs, each for temperature and humidity measurements are to be provided.

2.17.02 TEMPERATURE/ HUMIDITY INDICATOR

Sensor	:	RTD for (Pt 100) for temperature
	:	Capacitance Type for Humidity (specs for humidity and temperature shall be as mentioned above)
Display	:	Combined enclosure with two three digit seven segments LED display with decimal point after two digits. LED height shall be 4 inches, clearly legible from a distance of at least 10 meters.
Range	:	0-60 Deg C for temperature.
	:	0-95.0 % for Relative Humidity.
Accuracy	:	Better than +/-0.5 % for Temperature
	:	Better than +/-2.5 % for Relative Humidity
Mounting	:	Table Top/ wall mounting.
Power supply	:	240 V AC, 50 Hz.
Output	:	4-20 mA signal each for temperature.
Qty.	:	15 nos. each of temperature & Humidity indicators (combined indicators for Humidity and temperature is also applicable).

One Set of output signal is to be connected to respective control system. Apart from displaying the temperature/humidity values on indicator.

2.17.03 DEW POINT METER

Type	:	2 Wire Loop Powered Dew point
Transmitter	:	
Overall Range	:	-60°C to +20°C Dew point
Accuracy	:	± 2°C Dew point
Material	:	SS316 (wetted parts)
Features	:	a) AUTOMATIC CALIBRATION

- (b) Can be Configured for Linear 4-20mA signal in °C & °F Dewpoint, ppm(v), ppb(v), g/m³
- (c) Temperature Compensation
- (d) Failure Diagnostics
- (e) Long Term Stability
- (f) Fast Response
- (g) IP 66 / NEMA4X Protection
- (h) Supplied with Calibration Certificate Traceable to National & International Humidity Standards
- (i) Sensor protection with sintered filter
- (j) Local LCD Display for Dew Point

2.18.00 Limit switches

For offsite plant application Limit switches shall be gold plated with high conductivity and non corrosive type. Contact rating shall be sufficient to meet the requirement of DDCMIS subject to a minimum of 60 V, 6 VA rating. Protection class shall be IP 65. Contact shall be either 1 no, DPDT or 2 nos. SPDT minimum.

For main plant application, limit switches are to be provided as per bidder standard and proven practice.

All limit switch shall be conform to IEC-60947-5-1.

2.19.00 MATERIAL AND ASH HANDLING SYSTEM RELATED SPECIAL INSTRUMENTS

2.19.01 PULL CORD SWITCH

Type	:	Addressable Type
Body	:	Cast Iron
Contact rating	:	Continuous 10 Amp, Breaking 2 Amp. (240 V AC)
No. of contact	:	2 NO + 2 NC
Reset facility	:	Manual Reset
Type of enclosure	:	Die Cast Aluminum
Degree of protection	:	Flame proof/Explosion proof for NEC class 2, Division 1 area
Local trip indication	:	Required
Accessories switch.	:	<ol style="list-style-type: none"> 1. Canopy over lever of pull Cord 2. Linking of switches through a single cable for each section. 3. Each pull cord switch shall be provided with red LED indication lamp for prominent visible indication of tripping. 4. "One number Trip indicator panel per conveyor, which shall display the exact number of

safety switches (pull cord or belt sway switches) operated in a loop of conveyor considering 10% spare switches. It shall also monitor the condition of field cable connecting the switches in series & generate signal, if field cable is found broken or short. The trip indicator panel shall display the operated switch number. The same indication shall also be available in CHP DDCMIS operator station/SR PLC. Panel shall have Modbus TCP/IP/OPC redundant interfacing with concerned DDCMIS/PLC for monitoring & diagnostic purpose only. Trip Indicator panel shall be separate for PCS & BSS respectively. Complete software shall also be provided by bidder. Redundant Power supply shall be provided for each trip indicator. LCD display shall be provided with each trip indicator for details like fault location, fault indication, etc. Trip indicator shall be provided with dual digital outputs and Analog outputs, which shall be used in control system. Each event/trip shall be recorded in the trip indicator and DDCMIS/PLC.

2.19.02 BELT SWAY SWITCH

Type	:	Addressable Type
Body	:	Cast Iron
Contact rating	:	Continuous 10 Amp, Breaking 2 Amp. (240V AC)
No. of contact	:	2 NO + 2 NC
Reset facility	:	Auto Reset
Type of enclosure	:	Die Cast Aluminum
Degree of protection	:	Flame proof/Explosion proof for NEC class 2, Division 1 area
Accessories	:	<ol style="list-style-type: none"> 1. Canopy 2. The belt sway switches shall be provided with a common bridging push button which may be kept pressed to bypass the limit switch before restarting the conveyor. 3. Same as above 2.19.01 (4).

2.19.03 ZERO SPEED SWITCH

Type	:	Microprocessor Based
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Body	:	Cast Iron
Contact rating	:	Continuous 10 Amp. (240 V AC)
No. of contact	:	2 NO + 2 NC
Reset facility	:	Manual Reset
Type of enclosure	:	Die Cast Aluminum
Degree of protection	:	Flame proof/Explosion proof for NEC class 2,
		Division 1 area
Accuracy	:	+/- 5%
Repeatability	:	+/- 1%
Differential	:	+/- 5%
Accessories	:	Canopy, Neoprene Gasket and Stud Bolt, SS Tag plate, flame proof Nickel plated brass double Compression type cable gland, Terminal Boxes etc.
Temp. Rating	:	90 deg. C. minimum.

2.19.04 CHUTE BLOCK SWITCH

Type	:	RF Based
Sensor Material	:	SS 316
Mounting	:	Flanged
Insulation Material	:	PTFE
Contacts	:	2 NO + 2 NC
Type of enclosure	:	Die Cast Aluminum
Degree of protection	:	IP 66
Electrical Connection	:	¾ " ET
Repeatability	:	0.05%
Local Indication	:	To be provided
Accessories	:	a) Neoprene Gasket and Stud Bolt b) SS Tag plate, Nickel plated brass Double Compression type cable gland

2.19.05 Load Sensing Cell

(a) Type	Strain Gauge/Compression Type
(b) Enclosure Protection	Fully temperature compensated, with high accuracy, IP 67 protection class, SS316 enclosure.
(c) Load	
(i) Nominal Load	Bidder to specify in tabular form.
(ii) (ii) Rated Load	Bidder to specify in tabular form.
(iii) (iii) Destructive Load	Bidder to specify in tabular form.
(d) Supply Voltage	24V DC thru parallel redundant UPS 240 V AC to 24 V DC convertor. Redundnat UPS feeders shall be provided.
(e) Sensing	Resistance bridge
(f) Temp. Effect on Zero & span	+/- 0.015%/10K
(g) Basic Resistance	Manufacture's Standard

(h) No. Of Load Sensors	As per requirement.
(i) Mounting Type	Four idler
(j) Accessories	Mounting plate kit, cable etc.
(k) Accuracy	+/- 0.015% FSD
(l) Speed Sensor	Tacho/encoder
(m) Speed Output	Pulse train to be distributed (i)Local control panel for own use (ii)4-20 mA DC signal to PLC
(n) Load Sensor Output	4-20 mA DC isolated signal for PLC along with provision for serial communication link standard protocol
(o) Computed Flow rate	
(i) Hardware	4-20 mA DC isolated 2 numbers
(ii) (ii)Serial Link	In Compliance with standard protocol
(p) Protection class for measuring cell	NEMA 4X (IP 66)
(q) Accessories	Special cables, electronics, cabinets, Remote Display panel etc. As required to make the system complete, with bar/chain.
(r) Range	Application dependent
(s) Range increment	0.1% of this selected range
(t) Operating Temperature	0-90 deg C
(u) Accuracy	+/-0.25 % of FS range

2.19.06**3 D TYPE ACOUSTIC WAVE LEVEL TRANSMITTER**

Type	:	Acoustic Wave Level Transmitter (3 D type)
Application	:	Level, Volume, quantity & Mass of each Fly Ash storage silo/Bunker, each coal bunker and each ESP Hopper (First Field),FGD Silos
Temperature compensation	:	Required for high temp applications
Operating Principle	:	Non - Intrusive acoustic wave transmission & Reflection
Frequency Range	:	3 – 10 KHz
Accuracy	:	+/- 0.25 % for even surface +/- 0.5 % for un even surface
Resolution	:	1 mm
Output	:	4-20mA DC with HART
Display Unit:		

Type	:	Head Mounted LCD Display with Engg. Units
Location	:	Suitable location at bunker / Silo operating floor area
Protection Class	:	IP 65/ Explosion proof for NEC Class-1/2, Division 1 area)/ flame proof (IEC-79.1, Part I) As applicable).
Material Of construction:		
Housing	:	Polypropylene/Aluminum/SS
Flange	:	Polypropylene/Aluminum/SS
Sizes:		
Flange Size	:	2" ANSI 300 # RF SS
Electrical connection size	:	1/2" NPT (F)
Accessories	:	i. Double compression type SS316/Nickel Plated Cable glands (Material as decided by owner).
		ii. Suitable Mating Flange, necessary gaskets,
		iii. Local digital display unit at ground level with Suitable mounting brackets, necessary mounting hardware for Local display unit.
		iv. Complete software as required to have 3 D view on monitors.
		v. One number each Integral Operating Work station separate for ESP control room, for ash Handling system control room, FGD control room and at CHP control room for coal bunkers. Specification of OWS shall be same as specified in Vol. V, chapter 4. Above OWSs shall display Average level, Maximum level, Minimum level, Volume, Mass and real time complete 3D profile of each ESP Hopper (First Field), AHP hoppers and coal bunkers. In addition to the information available in above OWS, the bidder shall provide all required hardware and software to display the respective information on OWS provided with control system located at respective control room. 1 No. lap top with all necessary digital connectivity cable, hardware/software for configuration, calibration, maintenance, analysis for 3 D images for ESP, coal bunker application and for ash handling application.

2.19.07 Moisture Monitoring System

1.	Type	:	Microwave non-contact Type
2.	Measuring Range	:	0-85% (Residual moisture)
3.	Housing Material	:	SS316
4.	Ambient Temperature	:	0-80 Deg C
5.	Accuracy	:	0.1% of calibrated measuring range.
6.	Response Time	:	1 second
7.	Protection Class	:	IP 67
8.	Output	:	a. 4-20mA b. Two relay change over contacts
9.	Data Protection	:	In built Flash Memory
10.	Interface	:	RS 232, 485
11.	Application	:	Coal Handling Plant

2.19.08 Void

2.19.09 Coal Stock Pile Level & Volume and Inventory Measurement & Monitoring System

For measuring coal stock pile's level & volume, 3D type level & Volume monitoring system with local digital indicators and own work station & complete software shall be provided and indication/display shall be available on stacker-reclaimer PLC & main CHP DDCMIS. Quantities of 3 D sensors in one system shall be finalized during detailed engineering considering $\pm 1\%$ accuracy and depending upon sensor capability and stock pile volumetric area (Length x width & height) with 20% extra margin.

3D Scanner software element should calculate volume, publish reports in excel and provide a graphic interface.

Scan results should be immediately available on completion of a scan cycle and no additional calibrations or calculations should be necessary post scan as all 'spikes' or irregular points should be eliminated automatically by the software.

The software should also enable bulk densities to be applied to the calculated volumes, enabling reporting of bulk in tonnages. The software also allow for comprehensive 'contents bounds' to be built into the system for each individual storage vessel/area on the network. Flooring, walling, discharge points and structures should be configured into the system, enabling accurate volumetric calculations for each of these stockpiles with SPIKE FILTERS.

For accurate measurement for the stockpile, the 3D Scanner should be fixed mounted on the Lighting Poles or any fixed structure with rain & Sun guard canopy.

The 3D Scanner should a complete scan of the Stockpile and communicate with hard wired 4-20 mA signals and redundant wireless system to the CHP control room and Stacker reclaimer control system to generate the output in terms of Volume, Mass and Real Time 3D Profile of the Stockpile.

Confirmation of Readings: Devices Self Diagnostic feature which tells the confidence interval of the readings on the OWS Screen for the operator to confirm, if the device readings are reliable. This is done as during heavy rain and heavy dust storm some readings may be hampered and the device should tell automatically the confidence it has on its readings through the green and red marks on the measured topography.

2.20.00 RECORDERS (CHARTLESS)

Type	:	Micro-processor based, Digital TFT display type
- No. of Channels	:	Six (6) Points & Forty Eight (48) point). (Simultaneous parameter display preferred)
Input Signal	:	Fully configurable multi range (Programmable) universal (input)
Recording method	:	Continuous with different colour, for each channel
Display colour	:	Selectable from 30 Colours
Bar graph facility	:	To be provided
Digital indication	:	To be provided
Accuracy	:	+/- 0.1 % for reading for DCV Input And 0.1 Deg for TC/RTD input
Programmability	:	Front key board
Data Storage	:	hard disk/ Flash Memory
Data Retrieval	:	Compact 4 GB flash Memory card and USB port with 8 GB USB drive.
Scan rate	:	< 250 m second for individual channel. Selection of scan time for individual channel is required.
Power Supply	:	230 VAC 1 Phase UPS
Ambient Temperature	:	0-50 Degrees
Accessories	:	to be provided
Mounting	:	Front panel mounted weather & Dust proof IP 65
Application software	:	Yes, To be provided
Internal Memory	:	400 MB or more
Screen	:	5.5" colour LCD TFT for 6 Points Recorders and 10.5" LCD TFT for 48 points recorders.
Resolution	:	320 X 240 Pixels for 6 Points recorders and 640 X 480 Pixels for 48 points recorders.
Type of Display	:	i) Trends ii) Bar Graph iii) Digital display/ values

Event Sampling	:	1/2/5/10/30/60/120 sec.
Zoom & Scroll Facility	:	Required
WORK STATIONS and printer connectivity port	:	Required
	:	Necessary software shall be supplied for uploading the data.

2.21.00 DIGITAL INDICATOR

Type	:	Programmable electronic digital Indicator with floating point decimal.
Input	:	4-20 mA DC/1-5V DC/RTD/T/C/Universal/ RS 485 Port Modbus Protocol/Ethernet
TCP/IP	:	Protocol depending upon location of Digital Indicator.
Number of inputs	:	One
Range	:	As per requirement/adjustable by end user through key pad available on the indicator.
Number of digits	:	Four plus sign
Digit height	:	50 mm or larger
Display	:	Fluorescent red (LED, seven segment or dot matrix).
Input over range/open sensor (T/C)	:	All digits to flash
Input hold time	:	0.7 seconds max.
Accuracy	:	$\pm 0.25\%$ of reading.
Power supply	:	230V AC, 50Hz UPS
Mounting	:	Flush panel, compatible for Mounting on mosaic grid panel
Size	:	288 (w) x144 (h) mm
Other Particular	:	Indicator receiving thermocouple Signal shall have automatic cold junction compensation.
	:	Retransmission Output 4-20 mA isolated required.
	:	24 V DC inbuilt power supply
	:	Alarm contact with 2 NO/NC contact (rating 5A/230 V AC)

2.22.00 Wall Mounted Digital INDICATOR/Digital Display Unit

Type	:	Programmable electronic digital Indicator with floating point decimal.
Input	:	4-20 mA DC/1-5V DC/RTD/T/C/Universal/ RS 485 Port Modbus Protocol/Ethernet
TCP/IP	:	

	:	Protocol depending upon location of DDU.
Number of inputs	:	One
Range	:	As per requirement/adjustable by end user through key pad available on the indicator.
Number of digits	:	Four plus sign
Digit height	:	150 mm or larger as per location.
Display	:	Fluorescent red (LED or seven segment or dot matrix).
Input over range/open sensor (T/C)	:	All digits to flash
Input hold time	:	0.7 seconds max.
Accuracy	:	$\pm 0.25\%$ of span
Power supply	:	230V AC, 50Hz UPS
Mounting	:	Wall mounting.
Enclosure	:	IP 32 or better.
Size	:	290 (H) x675 (W) mm or as per bidder standard.
Other Particular	:	Indicator receiving thermocouple Signal shall have automatic cold junction compensation.
	:	Retransmission Output 4-20 mA isolated required.
	:	24 V DC inbuilt power supply
	:	Alarm contact with 2 NO/NC contact (rating 5A/230 V AC)

2.23.00 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 Vol. V, part-A. Application standard for electrical metering instruments shall be as per IS: 1248-2003(Revised). and conditions as specified elsewhere in the specification. The size of each instrument shall be as approved by Owner during detailed engg. All metering instruments shall be flush panel mounting type.

2.23.01 Electric System Meters:

Specification for electrical system meters shall be same as that of mosaic type Miniaturised Digital Indicators except the following instruments.

- a) Frequency meters for Synchronisation purposes: Scale: radial (arc of approx. 240 degrees), range - 45 Hz to 55 Hz, Input: Frequency signal for Synchronisation purpose, Type: taut band/pivot jewel system, Accuracy: $\pm 1.5\%$ of full scale. (For meter with 110 V AC frequency signal – magnetic shielding is to be provided). For other frequency meters, the specs. Of frequency meter shall be same as digital frequency meter as specified below.
- b) Synchroscope: Scale: Radial (slow fast), 360 degree, Input: 110V, 45-55 Hz. (To be provided with magnetic shielding).

- c) Semaphore Indicators:
Input: 24VDC, Indicator actuation
Two coil, spring return to normal.

(d) Voltmeters:

For Synchronization Scale: radial (arc of approx 240 degree), Input: 110V AC for voltmeters provided for synchronization (these shall be provided with magnetic shielding), Type: taut band/pivot jewel system, Accuracy: $\pm 2.0\%$ of full scale or better. Specification of other voltmeters shall be same as that of Miniaturised Digital volt Indicators as specified below.

2.23.02 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 100 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.

2.23.03 Auxiliary PTs for Measurement & Synchronization

S. No.	Features	Essential/Minimum Requirements
1.	Applicable Standard	IS : 3156
2.	Rated Voltage	110V
3.	Insulation Level	660V grade
4.	Frequency	50 Hz
5.	Mounting	Panel Mounting
6.	Test Voltage (Power frequency)	2.5 KV for 1 min
7.	Operating temperature	(-) 400C to(+) 850C
8.	Primary Voltage	63.5 V to 115V
9.	Secondary Voltage	63.5 V to 115V
10.	Class of accuracy	1
11.	Burden	25 kA
12.	Class of Insulation	E or better

2.23.04 AMMETERS (AMM)

Input	:	4-20 mA DC
Mounting	:	Flush panel, compatible for mounting on mosaic grid panel
Face Dimensions	:	96 x 96 mm
Scale/Type	:	Moving coil, circular, FSD 240 deg. With six times suppression scale
Zero adjustment	:	Screw on meter face
Accuracy	:	± 1 percent (class 1)
Indication	:	Pointer with scale
Magnetic Shield	:	Shielded Case
Quantities	:	For all HT Motors & LT motor with rating > 30 KW and other critical application motors/drives.

2.23.05 VOLTMETER:

Input	:	4 - 20 mA DC
Mounting	:	Flush Panel, compatible formounting on mosaic grid panel
Face Dimension	:	96x96 mm
Range	:	As per requirement
Accuracy	:	± < 1 %
Indication	:	Digital type 4 1/2 digit, Float decimal
Magnetic Shield	:	Shielded Case
Connection	:	Plug in type
Quantities	:	For 230 V AC input power supply, UPS power supply, 24 V DC interrogation voltage & 220 V DC.

2.23.06 FREQUENCY METER (DIGITAL)

Type	:	Electronic digital 7- segment with fluorescent display
Input	:	4 - 20 mA DC
Mounting	:	Flush Panel compatible for mounting On mosaic grid panel
Number of digits	:	4 1/2 digit, Float decimal.
Face Dimension	:	192X192 mm
Digit size	:	Approximately 40 mm
Range	:	As per requirements
Accuracy	:	± 0.2 Hz
Display	:	Red LED display
Connection	:	Plug in type
Magnetic Shield	:	Shielded Case

2.23.07 AC CURRENT TRANSDUCERS

Input	:	0 - 1 A CT current
Output	:	Dual 4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	± 0.25%

2.23.08 DC CURRENT TRANSDUCERS

Input	:	0 - 75 mV
Output	:	Dual 4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

2.23.09 AC VOLTAGE TRANSDUCERS

Input	:	0 - 110 V PT, Volts
Output	:	Dual 4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

2.23.10 DC VOLT TRANSDUCERS

Input	:	0-220 V DC/System Voltage
Output	:	Dual 4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

2.23.11 TRANSDUCERS FOR POWER

Input	:	CT and PT (1A) (110V)
Output	:	Dual 4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

2.23.12 TRANSDUCERS FOR FREQUENCY

Input	:	110 V PT Volts, 50 Hz
Output	:	Dual 4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

2.23.13 TRANSDUCERS FOR POWER FACTOR

Input	:	PT (110V)
Output	:	Dual 4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

2.23.14 TRANSDUCERS FOR MVAR

Input	:	CT & PT (110V/1A)
Output	:	Dual 4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

**2.23.15 DIFFERENTIAL FREQUENCY TRANSDUCERS
(FOR SYNCHRONIZATION)**

Input	:	110 V PT
Output	:	Dual 4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

2.23.16 DIFFERENTIAL VOLT TRANSDUCERS (FOR SYNCHRONIZATION)

Input	:	System voltage
Output	:	Dual 4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

2.23.17 DIFFERENTIAL FREQUENCY & DIFFERENTIAL VOLT INDICATORS

Input	:	4 - 20 mA DC
Mounting	:	Flush Panel, compatible for mounting on mosaic grid panel
Face dimension	:	96x96 mm
Scale	:	Horizontal with zero at center - 10%, 0, $\pm 10\%$
Range	:	- 10% - 0 - + 10% (for both)
Accuracy	:	$\pm 1.0\%$
Magnetic Shield	:	Shielded Case

2.23.18 TRIVECTOR METER (DIGITAL) (FOR GENERATOR)

Type	:	Electronic digital 7- segment with Fluorescent display
Input	:	4 - 20 mA DC
MOUNTING	:	Flush Panel, compatible for mounting on mosaic grid panel
Face Dimension	:	96 x 96 mm
Scale	:	Horizontal
Range	:	As per Schedule
Accuracy	:	$\pm 0.25\%$
Display	:	Red LED display
Connection	:	Plug in type
Magnetic Shield	:	Shielded Case

Trivector meter shall also be capable to display data even in case of emergency i.e. failure of Gen PT. For this purpose separate DC Auxiliary supply with auto changeover shall be provided by the supplier .If power supply requirement is 24 VDC / 220 VDC the same shall be extended by the bidder.

2.23.19 MW METER (DIGITAL)

Type	:	Electronic digital 7- segment with fluorescent display
Input	:	4 - 20 mA DC
Mounting	:	Flush Panel compatible for mounting on mosaic grid panel
Number of digits	:	4 1/2 digit
Face Dimension	:	192X192 mm
Digit size	:	Approximately 40 mm
Range	:	As per requirements
Accuracy	:	$\pm 0.25 \%$
Display	:	Red LED display
Connection	:	Plug in type
Magnetic Shield	:	Shielded Case

2.23.20 MVAR METER (DIGITAL)

Type	:	Electronic digital 7- segment with fluorescent display
Input	:	4 - 20 mA DC
Mounting	:	Flush Panel compatible for mounting On mosaic grid panel
Number of digits	:	4 1/2 digit
Face Dimension	:	192X192 mm
Digit size	:	Approximately 40 mm
Range	:	As per requirements
Accuracy	:	± 0.25 %
Display	:	Red LED display
Connection	:	Plug in type
Magnetic Shield	:	Shielded Case

2.23.21 POWER FACTOR METER (DIGITAL)

Type	:	Electronic digital 7- segment with fluorescent display
Input	:	4 - 20 mA DC
Mounting	:	Flush Panel, compatible for mounting on mosaic grid panel
Number of digits	:	4 1/2 digit
Face Dimension	:	192X192 mm
Digit size	:	Approximately 40 mm
Range	:	- 1 - 0 - + 1
Accuracy	:	± 0.25 %
Display	:	Red LED display
Connection	:	Plug in type
Magnetic Shield	:	Shielded Case

2.23.22 SYNCHROSCOPE

Synchroscope shall be designed to provide an illuminate and indication of phase and frequency difference between bus voltages and generator voltage. It shall denote the actual frequency difference corresponding to the inverse of time taken for one rotation of the illuminated vector spot. Synchroscope shall be designed as per IEC/DIN/BS standard.

Input	:	Differential frequency & Differential Voltage
Mounting	:	Flush Panel, compatible for mounting on mosaic grid panel
Face Dimension	:	96 x 96 mm
Accuracy	:	± 0.5%
Magnetic Shield	:	Shielded Case

2.24.00 CONTROL DESK/PANEL PUSH BUTTONS AND INDICATORS**2.24.01 PB/ ILPBs FOR ON/OFF, OPEN/CLOSE**

Type	:	Momentary/Miniaturized Suitable for mosaic grid 24x48 Mm with 2 PB and 3 coloured LED.
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Contact Configuration	:	2 NO + 2 NC
Contact Material	:	Hard Silver Alloy
Contact Rating	:	500V / 10 A
Insulation Voltage earth	:	2 KV for 1 minute between terminals and earth
Lamp Rating :-		
a) Voltage	:	240 V AC
b) Watt	:	2 Watt (approx.)
Colour		
Red	:	ON/Start/Open ILPB
Green	:	OFF/Stop/Close ILPB
Red	:	energized, running, Start, valve open LED/Lamp
Green	:	de-energized, stopped, valve closed LED/Lamp
Light yellow	:	abnormal, discrepancy LED/Lamp
Red	:	OFF/Stop/Close PB
Green	:	ON/Start/Open PB
Red	:	Emergency trip push buttons with red flap / Hinged Transparent acrylic cover.

2.24.02 PUSH BUTTON FOR Control DESK

Type	:	Momentary mosaic grid mounted 24x48 mm size, single PB 18x40 mm
Colours		
DESK RELEASE PB		- Yellow
Desk Lamp test PB		- Blue
Desk Acknowledge PB		- Green

2.24.03 PUSH BUTTON FOR SEQUENCE START/RELEASE

Momentary (Miniaturised) suitable for mosaic grid 24x48 mm, 3 PB + 5 LED.

2.24.04 PUSH BUTTON FOR ANNUNCIATION

Contacts		
- Number & Type	:	As per requirement
- Breaking capacity	:	1 Amp, 220V DC 10 Amp, 600V AC
		Different colours for Accept/Acknowledge
		- Green, reset Grey, test - Yellow & Audio Acknowledge - Black.

2.24.05 Digital Indicators for Control Desk Draw out section.

Type	:	Electronic digital 7- segment with fluorescent display
Input	:	4 - 20 mA DC
Mounting	:	Flush Panel

Number of digits	:	3 1/2 digit, Float decimal.
Size	:	48 mm (W) x 24 mm (h)/50 mm x 25 mm
Accuracy	:	2.5% of final value
Display	:	Red LED display
Temp. coefficient	:	0.15%/deg C of measured value

2.25.00 HART Hand Held calibrator

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

HART hand held calibrator shall be provided with following minimum accessories per set:-

- i. Soft carrying case with adjustable shoulder straps & lead compartments.
- ii. HART lead set.
- iii. Rechargeable batteries.
- iv. Battery charger.
- v. Power adaptor.
- vi. Universal plug kit for power adaptor.
- vii. Load resistor.
- viii. Interfacing cables of each type as per requirements.
- ix. Protective boot.
- x. Standard banana jack.
- xi. Operation manual & software CD.
- xii. Analysis & Diagnostic Software.

The quantities of HART hand held calibrators to be provided by Bidder are listed in Appendix- I to Part A, Annexure – I, Table IV, Vol. V of Technical Specifications.

2.26.00	Hydrogen Gas System Instruments/Analysers	
2.26.00.01	Hydrogen Gas Hygrometer	
A	Performance	
1	Measuring Range	-80 deg C to 20 deg C
2	Response Time for 63% Step Change	<5 sec.
3	Output Resolution	0.01 mA
4	Storage Temp: Max	70°C
5	Operating Ambient Relative Humidity	<95%
6	Sensitivity	< 5 seconds for 63% step change in moisture content
B	Construction	
7	Measuring Principal	Thin Film Alum Oxide
8	Enclosure Protection class	Intrinsically safe and explosion proof as per NEC article 500, class 1, Division 1 area I.
9	Display	3-1/2" Digit LCD

10	Mounting	In Explosion Proof Box
11	Location (Hazardous)	Hydrogen delivery after compressors.
12	Service	Measures Moisture content in the Hydrogen Delivery
13	Code & Standard	EMC directive 89/336/EEC and PED 97/23/EC for DN<25 - FM Standard 6320
14	Analog Output	4-20 mA, HART.
15	Type of Transmitter	4 to 20 mA loop powered 24 VDC
16	Certification	CE
17	Calibration	Required every 12 months, Calibrator shall be supplied by bidder.
2.26.00.02	TRACE OXYGEN (O₂) in Hydrogen gas Analyser	
A	Performance	
1	Nature of Fluid	Oxygen in Hydrogen
2	Response Time for 90% step change	< 10 sec.
3	Relative Humidity	0-99 %
4	Measuring Range	0-100 ppm
5	Accuracy	± 2%
6	Repeatability	± 0.1 ppm
7	Sensitivity	0 - 10 ppm < 45 seconds
B.	Construction	
8	Measuring Principle	Electrochemical Fuel Cell
9	Display	3-1/2" Digit LCD
10	Enclosure Protection class	intrinsically safe and explosion proof as per NEC article 500, class 1, Division 1 area I.
11	Mounting	On Panel with Sample System Calibration gas cylinder & accessories, reference air set, rotameters Ownership certificate, pressure test certificate, explosion proof certificate for standard gas cylinders shall be given and these will be used for next filling up of standard gases. To validate the measurement, for mid range value standard gas cylinder to be supplied for each analyzer.(% O ₂ shall be decided depending & method of calibration during detailed engineering.)
12	Service	Measure trace oxygen in the product hydrogen
13	Location (Hazardous)	Hydrogen delivery after compressors.
14	Code & Standard	ATEX Approved. II 1/2 G Ex ia II c T4
15	Output Current	4-20 mA, HART
16	Type of Transmitter	4 to 20 mA Loop powered 24 VDC
17	Calibration	Every 12 months with calibration gas, Calibrator shall be supplied by bidder.
18	Calibration Gas	5ppm O ₂ in N ₂ , shall be provided by bidder for one year after commissioning of plant.
2.26.00.03	Combined Gas Sensor and Hydrogen Leak Detector for Hydrogen Gas System	
	Application: 1. At various TG Floors of TG Building. (where the Hydrogen Flanges/possible leakage locations which shall be decided during detailed	

	<p>Engineering). Minimum 6 set of redundant Hydrogen leakage sensors along with 4-20 mA transmitters shall be supplied and installed for early detection of hydrogen gas leakages.</p> <p>2. At various locations, where the Hydrogen Flanges/possible leakage locations (like H2 gas generation room, H2 gas compressor room, H2 gas storage room, exact locations shall be decided during detailed Engineering). Minimum 4 sets of redundant Hydrogen leakage sensors along with 4-20 mA transmitters shall be supplied and installed for early detection of hydrogen gas leakages.</p>					
	<p>The detector electronics regulate the operating parameter (heating voltage) of the sensor. The sensor consists of an active and an inactive element. The inactive sensor element is connected to the active element in a wheatstone bridge and compensates for ambient influences, such as temperature variations. As soon as a combustible gas reaches the active sensor, combustion of the gas to be measured takes place. The heat of reaction changes the electrical resistance and thus the signal from the bridge circuit. These small voltage signals are processed and converted to 4-20 mA signal.</p>					
	<p>Integral alarm evaluation is switched on. Two alarm stages with cut-off hysteresis can be programmed. Alarm stage1 is intended as a pre alarm and does not incorporate normally-closed contacts with memory effect. Alarm stage-2 (main alarm) switches a pair of normally closed contacts with memory effect. When the signal falls below the alarm threshold, the alarm remains on and must be acknowledged via the reset input. An error-message contact signals malfunctions and exceeding the measurement range. In addition, the reading is transmitted as a 4-20 mA signal for further processing.</p>					
A	Performance					
1	Nature of Fluid	Hydrogen /Air				
2	Measuring Range	0 to 100% LEL				
3	Response 50%	<10 sec.				
4	Recovery to 10%	<30 sec.				
5	Accuracy	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">0-50%LEL range</td> <td style="width: 50%;">51-100% LEL range</td> </tr> <tr> <td style="text-align: center;">± 1%</td> <td style="text-align: center;">± 2%</td> </tr> </table>	0-50%LEL range	51-100% LEL range	± 1%	± 2%
0-50%LEL range	51-100% LEL range					
± 1%	± 2%					
6	Repeatability	± 1%				
7	Calibration frequency	180 days				
8	Output Range: 0-100 LEL	4-20 mA, HART				
9	Humidity RH	<99%				
10	Sensitivity	<12 seconds to 60% full scale				
B.	Construction					
11	Measuring Principle	Catalytically bead				
12	Enclosure Protection class	intrinsically safe and explosion proof as per NEC article 500, class 1, Division 1 area I.				
13	Display	3-1/2" Digit LCD				
14	Mounting	4 mtrs above respective instruments supporting Conduit				
15	Service	Monitor combustible mixture in the atmosphere of each room where hydrogen may be present.				
16	Code & Standard	FM Standard 6320 FM Standard 3600				
17	Type of Transmitter	4 to 20 mA Loop powered 24 VDC				
18	Calibration Gas	2% H2 in N2, shall be provided by bidder for one year after commissioning of plant.				

19	Calibration	Every 6 months with calibration gas, Calibrator shall be supplied by bidder.
20		Calibration gas cylinder & accessories, reference air set, rotameters Ownership certificate, pressure test certificate, explosion proof certificate for standard gas cylinders shall be given and these will be used for next filling up of standard gases. To validate the measurement, for mid range value standard gas cylinder to be supplied for each analyzer.(% O ₂ shall be decided depending & method of calibration during detailed engineering.)
2.26.00.04 Hydrogen Gas Purity measurement Analyser		
A Performance		
1	Range	80% to 100 % H ₂ in air 0 to 100 % H ₂ in pure gas * 0 to 100 % air in pure gas *
2	Accuracy/Lineraity	± 1 % of FSD
3	Resolution/Repeatability	± 0.5 %
4	Response Time for 90% step change	< 5 sec.
5	Stability/Drift	< ± 1 % of FSD/month
B. Construction		
6	Measuring Principle	Thermal Conductivity or Multi mode Oscillation type
7	Enclosure Protection class	Intrinsically safe and explosion proof as per NEC article 500, class 1, Division 1 area I.
8	Display	3-1/2" Digit LCD
9	Safety & EMC Standards	Safety Standards EN 61010-1 EMC Standard EN 61326
10	Output	2 nos. 4 – 20 mA DC, isolated from input
11	H ₂ Purity	99.99% Calibration gas cylinder & accessories, reference air set, rotameters Ownership certificate, pressure test certificate, explosion proof certificate for standard gas cylinders shall be given and these will be used for next filling up of standard gases. To validate the measurement, for mid range value standard gas cylinder to be supplied for each analyzer.(% O ₂ shall be decided depending & method of calibration during detailed engineering.)
12	Calibration Gas	shall be provided by bidder for one year after commissioning of plant.
13	Calibration	Every 6 months with calibration gas, Calibrator shall be supplied by bidder.
14	Note: * Pure Gas options: CO ₂ , N ₂ , Argon	

CHAPTER – 3

DISTRIBUTED DIGITAL CONTROL, MONITORING AND INFORMATION SYSTEM (DDCMIS) AND VARIOUS SUB-SYSTEMS.

- 3.00.00 **DISTRIBUTED DIGITAL CONTROL, MONITORING & INFORMATION SYSTEM (DDCMIS)**
- 3.01.00 **General Requirements**
- 3.01.01 The requirements for Distributed Digital Control Monitoring and Information System (DDCMIS) are indicated on functional basis in this specification. Bidder 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 Bidder has full responsibility for engineering and furnishing of a complete system.
- 3.01.02 Distributed Digital Control, Monitoring and Information System (DDCMIS) shall basically consist of:
- Control system of boiler, turbine & balance of plant (namely SG- C&I, TG- C&I & BOP- C&I including their respective measurement systems).
- Unified Distributed Digital Control, Monitoring and Information System (DDCMIS) shall be provided for Main Plant /BOP/Offsite/FGD /FOPH/Waste Water RO systems etc. Plant DDCMIS including Modulating / Regulating Controls, Interlocking and Protection, Sequential Controls, Operator Interface Units, Monitoring and Information data archiving, Historical data storage and retrieval, Sequence of Event (SOE) recording and alarms shall be provided for Station C&I Controls such as CMC Controls, SG / Boiler Auxiliaries, TG / Turbine auxiliaries, Condensate Polishing Unit (Service Area), HP & LP Dosing, Unit Electrical Systems, etc. including LVS, Work stations, SOE, printers, and other peripherals.
- 3.02.00 **System Configuration**
- DDCMIS shall basically consist of the following for each of the sub-system. Brief description shall be referred in Vol.-V, Part A of this specification also.
- 3.02.01 Control System (including the Measurement system).
- 3.02.02 Human-Machine Interface and Plant Information System (HMIPIS)
- 3.02.03 System Programming & Documentation Facility
- 3.02.04 Data Communication System
- 3.02.05 Integrated LVS based Annunciation functions
- 3.02.06 Time synchronization with Master clock
- 3.02.07 Annunciation System.

3.02.08 Sequence of Event Recording System

The basic configuration of DDCMIS shall be as indicated in the DDCMIS configuration drawing No. 114-01-0100, Rev 0.

Contract Quantities of the DDCMIS based C&I System shall be as per Vol. V, Part-A.

3.03.00 **System Expandability**

3.03.01 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.

3.04.00 **On-Line Maintenance**

3.04.01 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 the 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.

3.05.00 **Fault Diagnostics**

3.05.01 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/faults to be reported shall include:

- (a) Module level faults of control system.
- (b) Failure of HMIPIS bus/unit LAN, system bus, Local/Remote communication 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 colour 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.

3.06.00 **Fault Tolerance & Controllability**

3.06.01 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.

3.06.02 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.

3.06.03 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.

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

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

3.06.05 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.).

3.06.06 DDCMIS shall meet all requirements stipulated under other Sub-sections/sections of the specification including Part A, Chapter 8, Vol. II, (including the requirement Authorisation to shipment test ATST) Quality assurance (Vol, II, Chapter 11) & General Technical Requirements (Vol., II, Chapter-5).

3.07.00 **Signal Exchange**

All the signal exchange between various functional groups shall be implemented through redundant communication system control bus (the system control bus connecting various subsystems) and local redundant bus within a sub-system. It shall be ensured that any single failure in electronics involved for such communication e.g. communication controllers, bus interface modules, physical communication media, etc. does not result in loss of such signal exchange and there is no deterioration in specified system response and system parametric requirements. In case a controller utilizes some inputs generated/processed by any other controller/functional group and the requirement of controller response time is not met due to inadequate communication rate/procedure, then hardwired signal exchange shall be provided for such inputs.

Control & protection signal exchange between any functional groups controllers and sub systems shall be hardwired only.

3.08.00 **System Spare Capacity**

3.08.01 Over and above the equipment and accessories required meeting 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:

3.08.02 10 % spare channel shall be provided in each functional groups for each type of input / output fully wired upto the marshalling/ termination TBs.

3.08.03 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 Bidder for future use.

3.08.04 HMIPIS shall be provided with capacity to handle at least 1 no. of each type of peripherals/equipments, additionally, like OWS, LVS, printers, PCs etc., over and above already specified, without any additional hardware or software. HMIPIS data base (if applicable) shall have provision of at least 25% extra points of above mentioned signals.

3.08.05 Each controller shall have 30% spare functional capacity to implement additional function blocks, over and above implemented logic/ loops. Further, each controller shall have spare capacity to handle minimum 20% additional inputs/ outputs of each type mentioned in clause 3.08.02 & 3.08.03 above, over and above implemented capacity. Each of the corresponding



communication controllers shall also have same spare capacity as that of controller.

- 3.08.06 The Data communication system (including Main system Bus and other bus system) shall have the capacity to handle the additions mentioned above.
- 3.08.07 Twenty(20) percent spare relays wired 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.
- 3.08.08 Twenty (20) percent spare wired terminal blocks in each marshalling cabinets.
- 3.08.09 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.
- 3.08.10 DDCMIS shall meet system performance and parametric requirements as stipulated under Performance Guarantees under TABLE – 3.1 . of this section of the specification and general requirements indicated in Vol V Part A as well.

3.09.00 **SYSTEM DESCRIPTION**

- 3.09.01 The DDCMIS shall include following main constituents. (Also refer DDCMIS configuration drg. no. 114-01-0100). 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.

3.10.00 **Control System**

- 3.10.01 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.
- 3.10.02 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.
- 3.10.03 The control system shall also perform logic & computation for annunciation functions.
- 3.10.04 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 Vol.- V, Part-A) which shall be located in respective areas.

3.11.00 **Human-Machine Interface and Plant Information System (HMIPIS)**

3.11.01 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:

3.11.02 Operator interface for Control System

3.11.03 Plant Supervisory functions like displays, alarm monitoring & reporting, reports & logs, calculations, trend recording, historical and long term data storage & retrieval, etc.

3.12.00 **System Programming & Documentation Facility**

3.12.01 The programmer stations shall be provided for On-line configuration & tuning of Control System and On-line program development/modifications in HMIPIS.

3.12.02 In addition, latest state of the art work-station based system documentation facility shall be provided to generate, retrieve, store & all system documentation, logic, control loops, cable interconnection, etc. to achieve paperless documentation for the complete plant.

3.13.00 **Data Communication System (DCS)**

3.13.01 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.

3.14.00 **Annunciation System**

The annunciation logic will be implemented as a part of DDCMIS and annunciation shall be made available on all OWS/LVS except for some specific requirements as indicated for CHP DDCMIS. In CHP DDCMIS, Hardwired annunciation windows shall also be provided. Details of HW annunciation system shall be same as specified in cl. No. 3.27.00.

3.15.00 **Power supply:**

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) Each DCS/DDCMIS CPU rack & I/O rack shall be provided with redundant power supply modules required for CPU & I/O cards internal power supply.

3.16.00 **MEASUREMENT FUNCTIONS OF CONTROL SYSTEM**

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

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

3.17.00 **Analog signal conditioning & processing**

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

- a) Galvanic isolation of input and output signals for which power supply source is other than the measurement system of the control system.
- b) Transmitter power supply with per point fuse protection or current limiting and power supply monitoring.
- c) Pressure and temperature compensation
- d) Transducer/Transmitter signal output limit check
- e) Implementation of multiple schemes
- f) Square root extraction
- g) On-line ADC gain and drift monitoring and correction at periodic intervals
- h) LVM generation
- i) Linearisation of temperature signals (for thermocouple & RTD through temperature transmitters)
- j) Reasonably check for all analog inputs
- k) 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).
- l) For all thermocouples the Extension/Compensating cables shall be brought upto the T/C card.(only for data acquisition purpose)
- m) CMRR shall be ≥ 100 db @ 50 Hz.
- n) Fuse Protection and Fuse failure detection.
- o) Galvanic/optical channel to channel Isolation shall be built in Module. The current limitation shall not be considered as channel isolation.
- p) Failure of individual channel shall not disturb the other channels for AI/TC/RTD card.
- q) Cold junction compensation for thermocouples.
- r) Detection of open circuit for thermocouples.

3.17.02 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.

- 3.17.03 Analog Input & output cards shall be provided with diagnostic features.
- 3.17.04 The analog 4-20 mA input cards shall have input loop resistance ≥ 250 ohm 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.
- 3.17.05 Analog output card shall be provided with the following additional features:
- Channel wise isolated Analog outputs shall be 4-20 mA
 - Direct or reverse operation
 - Loop check back of output (wire break monitoring)
 - Default options upon failure.
- 3.18.00 **Binary signal conditioning & processing**
- 3.18.01 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.
- 3.18.02 The conditioning and processing functions to be performed as a minimum for the binary inputs coming for control and information purposes are:
- 24 VDC power supply for contact interrogation for all potential free contacts with as per point fuse protection or suitable current limit feature/ isolation through opto- coupler.
 - 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.
 - Facility for automatic pegging the binary signal to logic one/zero or last correct value in case of failure of binary input module.
 - All binary signals shall be acquired validated, processed, alarm checked and their data base updated within one second.
 - It shall be possible to manually disable any binary input either through deleting from scan or substitution from HMI.
 - The non-coincidence monitoring shall be provided for binary inputs for all changeover signals.
 - Binary signal distribution to different users shall be in such a way so as to ensure that a short/ground fault on one user is not reflected to the other user.

- h) Implementation of multiple measurement schemes for signals for control purpose.
- i) Checking for excessive number of status changes for all binary/contact inputs.
- 3.18.03 Binary Input card shall be provided with the following additional features:
- a. Channel wise signal isolation (optical)
 - b. Fuse protection
 - c. Field cable monitoring
 - d. Diagnostic features
 - e. Short circuit protection
- 3.18.04 Binary Output card shall be provided with the following additional features;
- a. Individually fused.
 - b. Individual contact suppression
 - c. Channel wise Signal isolation (optical)
 - d. Individually definable default state
 - e. Output read back verification.
 - f. Short circuit protection
- 3.19.00 **Multiple Measurement Scheme**
- 3.19.01 Triple / Dual measurement schemes shall be provided for triple / dual redundant sensors used in closed loop and open loop controls.
- 3.19.02 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.
- 3.19.03 The sensors for multiple measurement schemes for open loop controls shall always be in service (except when gone Bad) and operator shall not be able to select / deselect any of the sensors. Further, measurement scheme shall be implemented considering safety / availability aspects.
- 3.19.04 Individual transmitter signals, their status and selected value for control/ measurement and shall be available on LVS/OWS in the CLCS displays and the pop-ups.
- 3.20.00 **Wiring Scheme for inputs to control system**
- 3.20.01 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. Other channels of these modules can be used by other inputs of the same functional group.

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. Similarly, no single failure in any component of the control system shall lead to unavailability of more than one of dual/triple redundant Output signals from the control system.

3.20.02 The single (i.e. non-redundant) binary & analog signal required for control purposes shall be wired as follows:

- a. The on-off status of HT drives and synch type breakers shall be wired to two input modules in parallel.
- b. Triple/dual analog sensors are required both in CLCS and OLCS for control purpose, then all of these triple/dual sensors shall be wired to the controller where CLCS loop is configured. If based on the same set of sensors, any protection action is required in OLCS (e.g., protection stop of drive) in another controller(s), then CLCS Controller shall provide three digital outputs for each such controller from three separate output modules (at defined LVM-Limit Value Monitor blocks inside Controller). The three such digital outputs of CLCS controller shall be acquired in each of the OLCS controllers in three separate digital input modules. Similar philosophy will be used when triple/dual analog sensors are required in OLCS in multiple controllers for protection function.
- c. If triple/dual/single binary sensors are required in OLCS in multiple controllers for protection function in these controllers, each of these sensors shall be shared among these controllers. Each of these sensors shall be directly shared from marshalling TBs without any 'active' multiplying hardware ('active' defined as hardware which requires a separate power supply for its functioning). Further, removal/insertion of any of such multiple modules shall not affect availability of such signal(s) to other modules.
- d. The input sharing scheme shall be subject to Owner's approval during detailed engineering. The inputs/outputs for such sharing is already included in the Contract quantities in Part-A).

3.21.00 **Remote Input output modules and cubicles**

It is envisaged to use remote I/O modules in various plant areas. The remote I/O signals shall be connected to the respective functional groups through redundant extended I/O bus as indicated in the Contract quantities for DDCMIS. The hardware independence of functional groups mentioned elsewhere in specification shall be applicable for remote I/O as well.

It is mandatory to provide a small room or enclosure for above which will be properly air conditioned through window a/c so that environment similar to control equipment room is met. The remote input/output modules shall be located in cubicles in respective areas. Remote input/output modules may be located in harsh environment, the modules shall be designed in such a way to work continuously under the harsh environment expected to be encountered in these areas (high temp, dust level, humidity etc.). It shall be ensured that extending of I/O bus of functional group in field does not result in false signaling /noise pickups. Further, it shall in no way deteriorate the performance of that functional group and Control System.

3.21.00.01 Power supply arrangement for these cubicles shall be similar to DDCMIS system cabinets.

3.21.01 The maximum number of inputs/outputs to be connected to each type of module shall be as follows:

S.No.	Description	No of Channels
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.		
Channel density may also be reduced by bidder to meet the technical requirements.		
Further, Minimum 10% spare channels shall be kept in each of the input/output modules.		

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

3.21.02.01 Input filters to attenuate noise shall be provided.

3.21.02.02 All analog outputs shall be short circuit proof.

3.21.02.03 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.

3.22.00 **CONTROL SYSTEM REQUIREMENTS**

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

- 3.22.02
- (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 Vol. V, Part-A, and other Volumes of the specification.
 - (iv) Performing logic & computation for annunciation functions & other miscellaneous Controls, signal processing etc.



- 3.22.03 The number of Functional Groups (FGs) which are derived from the above mentioned guideline are the minimum required. For each of the FGs, separate sets of controllers, I/O modules, communication controllers, power packs/ modules etc. shall be provided. Mixing of hardware of two or more FGs shall not be acceptable. However, splitting of any functional group in more than one FGs due to any limitation in Bidder's system (e.g. limitation in handling number of inputs/outputs including spare capacity, limitation in implementation of number of functional blocks including spare blocks etc.) shall be acceptable, subject to Owner's approval. It may be noted that after splitting of the functional groups, each FG must have its own set of controllers, I/O modules, etc. It shall be ensured that failure of any set(s) of hardware of any FG does not affect other FG(s) and data communication between other FG(s) and HMIPIS. Each FG can have one or more set of controllers, if supported by standard design of the offered system.
- 3.22.04 The Bidder 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.
- 3.22.05 The Control System shall function reliably under the environmental conditions as specified in chapter 1 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.
- 3.22.06 The Control System shall have on-line simulation & testing facility.
- 3.22.07 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.
- 3.22.08 Power supply to individual functional group shall be from redundant 24V feeders with diode auctioneering and further sub-distribution.
- 3.22.09 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.
- 3.22.10 The application programs for the functional controllers shall be software based which shall be maintained even through power supply failure.
- 3.22.11 Independent and dedicated controllers (main and its 100% hot 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.

3.22.12 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.

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

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

3.23.02 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.

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

3.23.04 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.

3.23.05 **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
In this mode of operation, the sequence shall progress without involving any action from the operator. The sequence start/stop command shall be issued from the Operator Interface/KBDs.
 - ii) Semi-Automatic Mode
In this mode of operation, once the sequence is initiated, the step progressing shall be displayed on the LED. But the step execution command shall be prevented and shall be sent by the operator via the keyboards. It shall be possible to bypass and/or simulate one or more criteria to enable the program to proceed. This facility shall allow the program to be executed even if some criteria are not fulfilled because of defective switching device, etc., while the plant condition is satisfactory. All the criteria bypassed shall be logged and displayed. It shall be possible to put the system on the auto-mode after operating it on semi-automatic mode for some steps or vice-versa, without disturbance to the sequence operation.
 - iii) Operator Guide Mode/Test Mode
It shall be possible to use the sequential control in operator guide mode/ test mode i.e. the complete system runs and receives input from the plant and the individual push button stations (where provided)/ keyboards but its command output is blocked. The whole programme, in this case shall run in manual mode. This mode shall allow the operator to practice manual operation using step and criteria indications. The actual protection should remain valid during this mode of operation also.

3.23.06 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 drives, as quantified in vol. V, 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.

3.23.07 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.

- 3.23.08 For inching type of drives, position transmitter power supply and monitoring of position transmitter signal shall be provided.
- 3.23.09 The sequence interlock & protection requirements shall be finalised during detailed engineering and the same shall be subject to Owner's approval.
- 3.23.10 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).
- 3.24.00 **Modulating Controls/Closed Loop Control System (CLCS) Functions**
- 3.24.01 This Clause is applicable for all analog controls of DDCMIS.
- 3.24.02 The CLCS shall continuously act on valves, dampers or other mechanical 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 the load range of 50% to 100% MCR with variation or parameters within permissible limits.
- 3.24.03 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.
- 3.24.04 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. Refer 3.17.02 for the loop reaction time for CLCS .
- 3.24.05 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.
- 3.24.06 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.

- 3.24.07 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.
- 3.24.08 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.
- 3.24.09 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.
- 3.24.10 All controllers shall be freely configurable with respect to requisite control algorithms.
- 3.24.11 Time supervision facility shall be provided to monitor the final control element.
- 3.24.12 It shall be possible to block the controller output on a pre-programmed basis.
- 3.24.13 Whenever, alternate measurement is available for a control input the alternate measurement value will be automatically substituted in the control loop in case of loss of control input. All necessary software for switching and reconfiguration shall be provided. In addition, such substitution shall be balanceless and bumpless and shall be reported to the operator.
- 3.25.00 **HUMAN-MACHINE INTERFACE AND PLANT INFORMATION SYSTEM (HMIPIS) REQUIREMENTS**
- 3.25.01 **Operator interface to the Control System**
- 3.25.02 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.
- 3.25.03 Further, simultaneous availability of popup window/faceplate of multiple drives of control system shall be possible from a single display.
- 3.25.04 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 Owner 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.

3.25.05 Typically following user levels shall be available:

- a) Operator
- b) Supervisor
- c) Maintenance Engineer
- d) Programmer
- e) Shift Incharge/Station Incharge/other Monitoring Users.

3.25.06 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 Vol-V, 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.

3.25.07 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.

3.25.08 **Alarm monitoring and reporting**

The system shall display history of alarms in chronological order on any of the OWS. The HMIPIS shall have the capability to store a minimum of 1000 alarms each with paging features allowing the operator to view any page. The system shall have all alarm functions and related function keys like alarm acknowledge, reset, paging, summaries etc. Other design features like set point/dead band adjustments, provision of alarm priority, manual inhibition & automatic inhibition based on predefined logic, alarm filtering etc., shall be provided and shall be as finalised during detailed engineering. The alarm display/report format shall be as approved by the Owner.

Facility of audio annunciation including voice audio shall be provided in OWS upon the occurrence of OWS alarms irrespective of whether alarms are displayed or not. Facility to disable the audio annunciation per OWS shall be provided under the security level of Maintenance or Administrator.

All digital point should be categorized with severity/priority 1-5 level and all analog signals must be colour coded in such a way that during normal range its value will be green and after normal range up to certain level it should be yellow and in the dangerous zone it should change its colour to red to give alert signal to operator.

The following features shall be provided as a minimum:-

1. Process operating limits, viz. high limit, low limit or both high and low limits, high - high, low - low, and both high - high and low - low limits, rate of change limit etc. shall be assigned to specified analog inputs and calculated variables. The system shall check for violations of these limits to detect alarm conditions. Every limit shall have a dead band associated with it. Dead band shall be of absolute values or a percentage of range (maximum 8 dead bands).

2. Alarm reporting/actions:

The following sequence shall be followed for detection of alarms:-

- a) Display of alarm message on alarm OWS.
- b) Printing of alarm message on alarm printer.

3. Alarm/Fault Analysis Displays: In order to guide the operator in case of a process fault/alarm, a fault analysis display shall be provided so that the cause of the alarm, is presented to the operator. For each alarm, various reasons for the cause of the alarm shall be displayed.

Alarm annunciation sequence on OWS:

S.No	Condition	Visual	Audible
1.	Normal	OFF	OFF
2.	Alarm	Window Flash	ON (Sound-

1)

	3.	Alarm ACKED	Steady ON	OFF
2)	4.	Alarm return To Normal	Text Flash	ON (Sound-
	5.	Alarm return To Normal and Acknowledged	OFF	OFF

3.25.09

Displays

1. Various displays on the OWS/LVS shall as a minimum include P&ID displays or mimic, bar chart displays, X-Y & X-T plot (trend) displays, operator guidance message displays, group displays, plant start-up/shutdown message displays, system status displays etc. The resolution of mimics shall be at least equal to resolution of LVS, as specified in chapter 3, Vol. V. The minimum quantity of major types of displays of unit DDCMIS and each off-site DDCMIS shall be as follows:

A)	Control display(group/sub-group/sequence/ loop)	500
b)	P&ID/mimic display	200
c)	Bar Chart	100
d)	X-T Plot	100
e)	X-Y Plot (with superimposed operating curves + using user selectable stored data)	100
f)	Group displays	On as required basis
g)	Operator guidance message	100
h)	Start-up/ Shut down guidance message	100
i)	Other Misc. display	25
j)	System status & other diagnostic display	On as required basis
k)	Display covering all 3 D displays	On as required basis
l)	Alarm facia displays on OWS/ LVS	On as required basis

2. The assignment for the above will be done by the bidder as per the requirement of operation of bidder's system as well as for maintenance. The balance displays shall be left as spare for future modification/addition.

(a) **Mimic Displays:**

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

be generally carried out through the sub-area/ individual displays as finalized during detailed engineering.

Facility of adding a user specific symbol to the standard library shall be possible. It shall be possible to go to a predefined trend display on selecting a field on any analog point on the displays.

- i) Following Important Parameters shall be displayed on each Graphic/mimic Page :-

S. No.	Parameters
1.	Generator Load MW
2.	Generator Voltage KV
3.	Generator Frequency Hz
4.	Turbine Speed RPM
5.	Main Steam Pressure Kg/Cm2
6.	Main Steam Temperature deg C
7.	Main Steam Flow TPH
8.	Furnace Draught mmwc
9.	PA Header Pressure
10.	HRH steam Pressure
11.	HRH Steam Temperature
12.	Coal feed rate
13.	Condenser Vacuum.

- ii) Motor current shall be displayed near the respective motor in the graphic/mimic.

(b) Control Tile Display / Faceplates:

In this display the drives of a loop shall be displayed with related parameters such as process value, set point, deviation, for the loop, along with facility for any selections (like A/M selection, valve selector etc.) and the command output, disturbance status & the position feed back signals, for each drive. It shall be possible to call this display as a Pop-up window from the controlled drives in main mimics. The minimum Faceplate/ popup window of parameters to be opened simultaneously on OWS shall be 08 nos.

(c) Trend Display (X-T Plots):

These displays shall show the trend of analog points with respect to time. These displays shall be continuous curve plot & not point plots. Time spans of displays shall have operator selectable intervals of 5,10,15,30, 60 minutes, 8, 24 & 72 hours. In addition, zoom in/out, stretching facilities etc. shall be provided. Sufficient buffer space shall be provided to store data for minimum 500 points at HMIPIS scan rate for 72 hours.

(d) **X-Y Plots:**

At any instant of time, this page shall include up to 3 independent X-Y point plots (values of X and Y variables) of up to three equipments typically in the form of a cross 'X'. Operating curves shall be superimposed over the X-Y plot. Alphanumeric information shall be overlaid to indicate X and Y scales, point identification, current operating point value with engineering units, etc. Two or three pairs of X and Y variables having common operating curves shall be displayed on one display page only. In such cases distinct symbols shall be used to show operating point for each. The balance shall be programmable at site.

(e) **X-Y plot using stored data:**

This type of display will show the analog trend of X-axis variable with Y-axis variables. One example of such display is Turbine Bearing Vibration with respect to Turbine speed during turbine Start up Condition. The balance shall be as per operator's definition.

(f) **Sequence Displays:**

Sequence chain displays for each group & sub-group shall be used to trace the sequence of a control chain as well as to facilitate the operator interventions & enable mode changes/auto selection. Sequence chain display shall present complete sequence chain, in functional blocks, steps being carried out, criteria, running time, waiting time, monitoring time, operating mode, various parameters with associated engineering units for each step and criteria. It shall be possible to display a list of missing criteria for each sequence chain on operator's demand.

The sequence chain display shall automatically move forward when the auto sequence is in operation

(g) **Drive Level Displays:**

For each drive (both binary & modulating) a drive level display shall be provided which shall indicate the drive related inputs/outputs, permissive and protection the drive level logic and other drive related information including individual drive faults & disturbance criteria. It should be possible to call these displays as pop-up Windows. It shall also be possible to call these displays as first up displays from the control tile/faceplates.

(h) **CLCS Displays:**

The loop schematic for each loop shall be available in a display form which shall show the individual analog & binary values (input/output & intermediate).

(i) **Group Displays :**

The group display shall present point information including point ID, description, current value, range, function group, quality tag & engineering unit of a group of points.

(j) **Bar Graph Displays:**

Horizontal & Vertical bar charts shall be provided for the display of related points. The format & the point assignment shall be approved by owner during detailed engineering no. of bars in a display shall be limited only due to visibility & resolution & no restriction shall be there in the numbers otherwise.

(k) **Alarm/Fault Analysis Displays:**

In order to guide the operator in case of a process fault/alarm, a fault analysis display shall be provided so that the cause of the alarm, is presented to the operator. For each alarm, various reasons for the cause of the alarm shall be displayed.

(l) **Point Detail Display:**

From any display, i.e. mimic alarm or any other group display, facility shall be provided to select any point for point detail display. This display shall include all the database attributes of the point. For field I/Os, the termination and interconnection details up to field sensors shall additionally be available. In the point detail display of calculated point, by simple clicking of point or through soft key it shall be possible to display the calculation used and to get further details of any other calculated points used in the calculation.

(m) **Displays On large Video Screen**

In addition, top area of the LVS (around 20-25%), shall be reserved for display of soft replica of Conventional annunciation facia (for permanent viewing i.e., not operator changeable). The exact format shall be finalised during detailed engineering with the successful bidder. LVS based overview displays shall be provided, which shall be overlaid across all the LVS for viewing as video wall.

3.25.10. **Logs/Summaries/Reports**

The system shall generate three basic types of reports/logs i.e., Event activated, Time activated and on-demand log & summaries. The log format and point assignment for each logs/ report and other design features shall be as finalised during detailed engineering. The system shall have the facility for viewing of the logs/summaries on the OWS/LVS as well as for their copying in formats compatible to be used with MS-office or similar tools (eg.-MS-Excel etc.)

The system will be designed for automatic printing of all the reports/logs with a provision of inhibition of the print function for each log separately, with

selectable duration and selectable page/group of each log. Manual printing of time-actuated log shall also be possible.

Automatic switching of any log function from a pre selected primary printer to a pre selected secondary printer (defined) on a per log basis shall be possible. However, change in the assignment of the printers shall be possible from programmer station.

a. Event activated

Event activated logs shall as a minimum include alarm log, trip analysis log, startup log & operator action log. All operator actions, modification in data base etc. shall be logged (along with historical storage) along with the username responsible for that action.

The trip analysis log shall record 30 - 100 pre-trip and 30 - 100 post-trip readings, operator selectable at site for the pre-defined parameters (not less than 250 points), sub-divided in user defined groups. The data collection rate shall be HMI scan rate to 2 minutes (operator selectable at site). It shall be possible to assign 1- 4 initiating events. The exact details shall as finalised during detailed engineering.

The system shall be capable of generating and printing SG & TG start-up logs, the functionality of which will be similar to the trip analysis log. System error log shall report the diagnostics information from control system, data communication, nodes & network switches of HMIPIS.

Operator action log shall record all the operations carried out by the operator either through LVS/OWS or through hardwired push buttons.

C&I log shall record all the events in the control system like logs trip to manual, auto set point change, standby pumps start, drive start through sequence etc.

b. Time Activated Logs.

Time activated logs shall as a minimum includes shift log and daily log. Each of these shall provide hourly record of a minimum 250 points sub divided into user defined groups.

c. Operator demand logs

On demand logs shall include, as a minimum, digital trend log, maintenance data log, summary log, performance log and some special logs as decided during detailed engineering. The system shall be capable of generating and printing trend log for a minimum of 80 groups of 15 points each. Maintenance Data Log (MDL) shall provide schedule of preventive maintenance and routine equipments inspection for minimum 100 nos. of equipment of unit and for Auxiliary Plant. The data in MDL shall include current status, total running time, running time since last maintenance, running time in current financial year, loss due to downtime etc. Exact format shall be as approved by Owner during detailed engineering.

Performance log shall provide results of performance calculations.

d. Various summaries

Various summaries shall include off scan summary, constants summary, point quality summary, substituted values summary, peripheral status summary, alarm annunciation group summary, etc. This summaries shall also be available process area or sub-area wise, as well as based on any other data base criterion like functional group no, cabinet no, type of signal etc.

- e. Turbine Run up Log:** A log of up to 100 turbine and generator data points shall be collected and automatically printed at either 1, 2, 3 or 5 minutes intervals as selected by the operator. The log shall be initiated by turbine roll-off and shall remain in operation until stopped by the operator.
- f. Boiler Start-up Log:** A log of upto 100 boiler data points shall be collected and automatically printed at either 1, 3, 5 or 10 minutes intervals as selected by the operator. The log shall be initiated at the start of the boiler for purge sequence and stopped by the operator.
- g. Turbine and Generator Diagnostic Log:** The turbine diagnostic log shall contain upto 100 turbine and generator data points to be used in analyzing possible turbine and generator trouble. The data shall be printed out once every 24 hours at a time selected by the operator. Once the log printout is initiated, data shall be collected and printed out every minute until four sets of data have been recorded.
- h. Turbine Recall Log:** The turbine recall log shall be initiated by the occurrence of any one of several alarms and shall consist of all data defined for the turbine diagnostic log. The system shall store information whenever the turbine generator is on-line. The data shall be stored in the computer memory at one minute intervals. A total of 30 minutes of data shall be stored in the memory. Following the initial 30 minutes of operation, the oldest data in the memory shall be discarded and replaced with new data. The log printout shall be initiated by pre-selected alarm conditions and shall continue at 1 minute intervals after initiation of the log until the alarm conditions has disappeared or until stopped by the operator.
- i. Turbine Shutdown Analysis Log:** A log of upto 100 turbine data points shall be printed whenever the generator is taken off line. Data, except turbine speed, shall be collected at 1 minute intervals. Turbine speed shall be collected at 1 second intervals, for the first 5 seconds after the shutdown is initiated and at 2 minutes intervals thereafter. The log shall continue until terminated by the operator.
- j. Special Logs:** Several special logs shall be provided by the data distribution control system computer as follows:-
- i) Printing of data shall maintain assigned columns. The engineer's/ programmer's terminal shall include capability to edit logs to move all data columns currently in use to adjacent locations.

- ii) A log of all vibration inputs shall be made on demand.
 - iii) A summary log of all bad inputs shall be made on demand.
 - iv) A log of temperature devices including, but not limited to bearing temperatures of all 3300/11000 volt motors, stator hot spot temperatures of 3.3/11 KV motors and bearing temperature of all driven equipment equipped with temperature detectors shall be made hourly.
 - v) A log shall be made to provide a record and warning of 3.3/11 KV motor start limits.
 - vi) Provisions shall be made for a test log consisting of 50 parameters obtained in a very short time span through a priority interrupt. The program shall be repetitive at the selected standard sample rate until manually halted. The test log shall be printed on the programmer's printer only.
- k. **Performance Log:** Provision shall be made for logging upto 100 variables which can be used in unit performance calculations. This log shall be initiated and printed on demand by the operator. The log shall consist of averaged data which is accumulated over an adjustable period of time from 10 to 30 minutes. The log shall provide the result of performance calculations.
- l. **Other Reports:** The system shall store on bulk memory at suitable time intervals for further processing data to generate the following information:-
- i) Normalised values of data accumulated.
 - ii) List of all major equipment trips subsystem wise.
 - iii) Plant and major equipment availability.
 - iv) Fuel statement.
 - v) Long term performance deterioration trends.

3.25.11 Log Generation Utility

The Bidder shall offer a log generation utility to generate a log/report having following facilities as a minimum.

- a. Define format of the log like header information, time, date etc.
- b. Selection of any point (scanned and calculated) from the data base and assign it to a log group.
- c. Selection of log data collection process initiating event, collection intervals (1, 2, 3, 5, 10, 30, & 60 minutes) for each point of a particular log group. Facility shall also be provided for selection of 100 points at a collection intervals of 1, 2, 3, 5, 10, 20, 30 seconds.

- d. Assignment of log printout initiation on event or time including, selection of the printing interval for particular log group and time of printing. (For time initiated logs).
- e. Assignment of no. of samples to be collected for each point.
- f. Select points for which minimum, maximum accumulation over a selected period, average, etc., values can be printed. Also facility shall be provided to tag the time at which the parameter passed through maximum/minimum. It shall be possible to define 100 log groups of 15 points each. Any log group can have any point from the database. One log shall include at the maximum 10 such groups.

3.26.00 **LVS Annunciation and Display**

The LVS 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 implement the LVS annunciation functionality as described below as a minimum. There will be one alarm for each alarm window. Grouped alarms shall be provided only for pre-defined system / field faults like non-coincidence , monitoring etc. The alarm text is to be displayed only when that alarm is present. A "tool-tip" will be associated with each alarm window, which will show tag no. of alarm point when cursor is brought over alarm window.

Hooters/Speakers of different audio types shall be available forreporting new alarms and resetting of alarms (corresponding to slow flash) etc shall be available. All flashing windows shall flash together (synchronized) in any screen. Suitable means shall be provided to distinguish new alarms and return to normal messages.

Annunciation points shall be distributed on various stations based on process area. That is, each annunciation point will be assigned screen no.(s) and an alarm band no. A particular point can be assigned more than one station also.

No fixed space will be reserved for any alarm on any of the band. Once a particular alarm band is full, the new alarm in that band will be reported by automatic shifting of the older alarm(s) on left side of band one by one in FIFO fashion. Scroll buttons shall be provided on both the sides to view the alarms in a particular band after the particular band is full.

The scroll button will fast flash when scrolled alarms are fast flashing, will slow flash when alarms are slow flashing and will be steady when alarms are

steady. When scrolled alarms are of mixed type, the scroll bar will flash with highest flashing rate of scrolled alarms.

When operator right clicks on LVS alarm area, he will get a menu with following options (i) acknowledge all- to acknowledge all new alarm(s) (ii) reset all- to reset all alarm(s) returning to normal (iii) acknowledge point- to acknowledge the particular point in alarm (iv) reset- to reset the particular point in alarm (v) Root Cause – To link to Alarm Analysis result for that particular tag (vi) "configuration utility"- to view and edit alarm list, tag nos., etc of all points in all stations (vii) closing the annunciation display. This menu can be dragged & placed anywhere on station screen. The actions (i), (ii), (iii), (iv) and (v) can be done by operator but action (vi) & (vii) will be permitted only to Programmer. The acknowledge/reset facility shall be configurable to be specific to the station or to be global.

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 colour, text colour, flashing colour and frequency, font, etc.

3.26.01 **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.

3.26.02 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.

3.27.00 **Hard Wired Annunciation System for Coal Handling Plant Package:**

Visual Alarm Annunciation System for CHP DDCMIS shall consists of power supplies in completely redundant mode, panel mounted lamp box assemblies, set of operator interface devices such as push buttons, audible devices, prefabricated FRLS interconnecting cables with connectors for signal transmission from logic cards to lamp windows as per actual length as required.

Requirement of annunciation system are specified on a system basis. Bidder shall be fully responsible for engineering and furnishing a fully operational system complete in all respects meeting the intent and requirements of this specification. All equipment and accessories required for completeness of the system shall be furnished by the bidder within the quoted price, whether these are specifically mentioned herein or not.

Annunciation system offered shall be from reputed, experienced manufacturer of specified type and range of equipment whose trouble free performance has been proven at least for two years in not less than two pulverized coal fired utility power stations of reheat type. The evidence regarding experience shall be furnished.

Visual display of alarm messages in the VAS shall be through panel mounted annunciation windows. The annunciator components shall be designed for

50°C ambient temperature and 90 percent highest average monthly humidity.

The windows shall be in multiple groups as required. The arrangement on the panels will be decided and advised when panel layouts are finalised. Each window shall be 50 mm high and 75 mm wide and shall be provided with sixteen high intensity LEDs wired in parallel, and capable of replacement from the front. The life expectancy of these LEDs shall be minimum of 100,000 hours.

Each window or a group of windows shall be provided with Solid State CMOS Logic Cards, which shall be mounted separately in cabinets. Jumper switch shall be provided on each card so as to make it suitable for contacts that either open or close.

Sets of push buttons, namely, Silence 'Acknowledge', 'Reset', System Test and Lamp Test shall be provided for Annunciation system each on Annunciation panel & OWS control desk.

3.27.01 The sequence of annunciation for main control panels shall be as follows :-

Sl.No.	Condition	Visual	Audible
1	Normal	OFF	OFF
2	Alarm	Fast Flash	ON
3	Silence PB actuated	Fast Flash	OFF
4	Return to normal		
	a) before acknowledge	Slow Flash	ON(dif-ferent tone)
	b) after acknowledge	Slow Flash	ON(dif-ferent tone)
5	Alarm Acknowledge		
	i) before return to normal	Steady ON	OFF
	ii) after return to normal	Slow Flash	ON(dif-ferent tone)
6	Return to abnormal (alarm)	Fast Flash	ON
7	Reset	OFF	OFF
8	System test	Fast Full Operational sequence.	
9	Lamp test	ON	-

Note : Pitch and volume of the tone generators for the audible alarms shall be adjustable. Three sets of hooters buzzers, beacon lamps etc. shall also be provided above control panel

sections. Each audible device shall be driven by separate tone generator.

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

Complete HSRS functionality shall be implemented in server/Operator work station (Please refer Volume V, Part-A for redundancy requirements). The HSRS shall collect and store process and DDCMIS system generated Data 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. However, it shall not be less than the following:

(A) Periodic Data

1. Alternate-I (Based on exception recording)

*All analog points Dead band varying from 0 – 2.5% as defined by Owner during detailed engineering.

*All binary points On status change (with suitable protection against excessive status change)

2. Alternate-II (without using exception recording) Analog Points grouped in three different classes i.e 1 sec rate, 5 sec rate, 30 sec rate. The minimum quantity of points in each class, shall be as under:-

1000 Analog points 1sec rate
1000 Analog points 5sec rate
Balance analog points 30 sec rate.

Binary points On status change (with suitable protection against excessive status change)

(B) Logs & Reports

- All shift & daily logs
- All control related logs
- Post-trip & start-up logs
- Maintenance data log

3.28.01 The system shall provide user-friendly operator functions to retrieve the data from historical storage. It shall be possible to retrieve the selected data on OWS/LVS or printer in form of trend/report by specifying date, time & period

through point IDS/group of points. Further, suitable index files/directories shall also be provided to facilitate the same. The logs/reports for at least last sixty (60) days shall be available on the disk.

- 3.28.02 In addition to above, the system shall also have facility to store & retrieve important plant data for a very long duration (plant life) on portable storage device like DVD/HDD.

These data will include any data from the database as well as processed/computed data based on various calculations/transformation. The retrieved data from portable storage device should be possible to be presented in form of X-T display, X-Y display, logs, reports, etc.

3.28.03 **Quality Tag**

1. The system shall identify and tag the quality of all data (scanned and calculated points) in a way that makes all users (control, calculations, logs, displays, etc.) aware of its quality. Quality of data other than 'good' shall be clearly identified in all printouts and displays by appending quality character to the value/status of point. The quality tagging shall include good, bad, substitute.

2. Typically 'Good' will designate variable that satisfies all tests for quality, 'Substitute' designating a value that has been manually substituted, and 'bad' designating a open circuit, transducer limit violation on both upper & lower side, etc. for analog inputs & open fuses, excessive number of chattering etc.

Database

1. The database shall be organized in such a way that searching/querying & sorting on any field shall be possible. The same shall be as per bidder's standard practice.
2. All the points i.e. process I/Os, generated signals, complete signals of calculations, OPC tags shall be identified by a unique tag throughout the entire DDCMIS systems. The tagging shall be based on KKS CODE employing maximum 18 characters. Exact details shall be finalized during detailed Engineering.

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

- 3.29.01 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.

- 3.29.02 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.

- 3.29.03 Control system structuring/configuration/tuning facilities.

- 3.29.04 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.

- 3.29.05 It shall be possible to configure the system with ease without any special knowledge of programming or high level languages. The running logic should be capable of being viewed on-line with dynamic status of inputs, outputs of each logic/loop component on programmer station. Control strategy shall be implemented using familiar and conventional automation function blocks (software implemented). Whenever any change in configuration is done, it shall be recorded and modified configurations shall be available for printing and documentation and shall be stored in non-volatile memory. All the system configuration, tuning/fixed parameters shall be documented and printed in form of function diagrams and lists respectively.
- 3.29.06 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.
- 3.29.07 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.
- 3.29.08 **System Documentation Facility**
- 3.29.09 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.
- 3.29.10 **HMIPIS program development/modification and system maintenance facilities**
- Online system shall be provided for program development/modification to achieve various functions including development, modification and testing of software of HMIPIS, generation and modification of graphics, logs, HSRS functions in an interactive manner, HMIPIS Database modification/creations, down loading the software with associated data base from the console and other features necessary for system maintenance. All operator functions shall also be available on HMIPIS programmer station. Also facility shall be provided to print system fault as detected by the online self-diagnostic routine.
- 3.30.00 **DATA COMMUNICATION SYSTEM (DCS)**
- 3.30.01 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. UTP cables or coaxial cables or fibre optic cables shall be employed for system bus. In case of any distance or other limitation, provision of suitable repeaters, MODEMS, amplifiers, special type of cables like optical fibres etc., as required, shall be made to make the DCS fully operational. The system shall have the following minimum features:
- 3.30.02 Redundant communication controllers shall be provided to handle the

communication between each functional group of controllers of Control System and the System Bus.

3.30.03 Failure of one bus and changeover to the standby system bus shall be automatic and completely bumpless.

3.30.04 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.

3.30.05 The redundant buses shall be physically separate and shall be routed separately.

3.30.06 Data transmitting speed shall be sufficient to meet the responses of the system in terms of displays, control etc. plus 50% spare capacity shall be available for future expansion.

3.31.00 **POWER SUPPLY, GROUNDING, CABINET/PANELS, ETC.**

3.31.01 **Power Supply**

Bidder shall provide totally reliable & quality power supply for DDCMIS.

3.31.02 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.

3.32.00 **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. Each ground bus shall have provision at each end for connection of ground leads (6mm x 50mm GI Flats) by suitable bolting. All system cabinets shall be brought to a common system ground by the bidder. Electronic earthing resistance shall be <0.5 ohms.

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. The bidder shall furnish his recommendation regarding grounding requirements for all equipment/systems and shall specifically indicate the deviations if any from the above requirements as a part of his proposal.

3.33.00 **System Cabinets/Panels**

3.33.01 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 Bidder. All equipment and dedicated cabinets required for termination, marshalling and proper interface within Bidder's system and also with other systems shall also be provided by the Bidder. Bidder to also refer Vol. V, Part B, chapter 6 for details.



3.33.02 The cabinet mounted equipments shall be fully assembled, installed in mounting racks, wired and fully tested as per specification requirements and Owner approved drawings in the manufacturing works of a qualified manufacturer prior to shipment to the project site. The Bidder 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/UCP.

3.33.03 The DDCMIS cabinets shall be grouped into physically separate cabinets as follows:

- (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.

Bidder may make a special note that termination of field cables directly to control system cabinet is not acceptable.

3.33.04 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 Owner.

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

3.33.06 **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 Owner's approval. The Bidder 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 at all acceptable. 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. Bidder to also refer Vol. V, Part B, chapter 6 for details.

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

- 3.33.07 Bidder 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 Bidder shall indicate in his proposal his suggested procedure for cable entry and securing the cable at place.
- 3.33.08 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.
- 3.33.09 The protection class of cabinets and environmental rating shall be as defined in Basic Design Criteria, chapter 1. The Bidder 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.
- 3.33.10 The cabinets shall be totally enclosed, free standing type and shall be constructed with design criteria specified in Vol. V, Part B, Chapter 6, 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 Owner and shall be furnished by the Bidder during detailed engineering.
- 3.33.11 Front and rear doors shall be provided with locking arrangements with a master key for all cabinets. If width of a cabinet is 800 mm or above, double doors shall be provided.
- 3.33.12 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 colour 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 colours for exterior and interior surfaces shall be as mentioned in Vol V, Part B, Chapter 6.
- Paint films which show sags, checks or other imperfections shall not be acceptable.
- 3.33.13 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.
- 3.33.14 All alarm contacts located within cabinets as well as inputs/outputs from other related system shall be suitably terminated in the cabinets.

3.33.15 The Bidder may submit details of his standard wiring practice for similar application for consideration and approval of Owner.

3.34.00 **Relays**

3.34.01 All the relays provided by Bidder shall be suitable for control supply of 24V DC. Each relay shall have 2 set of silver plated 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. Self reset type status non-polarized LED indicator for the Coil (electronic) and a flag indicator for the Contacts (mechanical) shall be provided. Interposing relay & sockets for mounting the interposing relay shall be of same make only and sockets shall have the provision to plug in separate RC circuits/Varistors if required for EMI suppression.

3.34.02 The relays shall be mounted in relay cabinets except for cases where number of relays is very 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.

3.35.00 **SYSTEM SOFTWARE REQUIREMENTS**

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

3.35.02 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. That is, if any hardware/machine is upgraded or changed, the same license shall hold good and it shall not be necessary for Owner to seek a new license/renew license due to up gradation/change of hardware/machine in DDCMIS at site.

- i. Operating system for all OWS, PC & Servers
- ii. System related software's real time operating system for meeting the functionality of DCS and HMIPIS
- iii. System related software's real time operating system for meeting the functionality HMIPIS
- iv. Backup, History management and File management software for HSRS
- v. Programming and engineering software for HMIPIS functionality
- vi. On line diagnostics/debug software for control system
- vii. On line diagnostics/debug software for HMIPIS
- viii. Latest versions of MS-office.
- ix. High level programming support software's like Microsoft visual studio
- x. Software package for documentation system
- xi. Software drivers and other system interfacing
- xii. Anti virus software's for all the Machines
- xiii. Client server suite for OPC connectivity.

3.36.00 **SYSTEM DOCUMENTATION**

The Bidder 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, DVD/CD ROM based documentation system shall also be provided. The same should be compatible to the On-line document generation facility indicated above.

3.37.00 **Hardware documentation**

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.

3.37.01 **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. The operating manuals and maintenance instructions shall be in sufficient detail to enable the owner/end user to operate, maintain, dismantle, re-assemble, adjust or replace all equipment and components during the lifetime of the plant. The manuals shall be specifically prepared for the contracted plant. For details refer Chapter 5, Vol. II, General Technical Requirements.

3.37.02 **Software Documentation and Software Listings**

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 Owner's review and approval.

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

3.38.00 **TRAINING**

3.38.01 Bidder will be responsible for providing training to Owner's personnel on offered systems at Bidder's Works/Bidder's Associate's Works. It shall include training operators in the use of system, in the programming and hardware maintenance of the equipment to the extent that the Owner's personnel can make corrections and changes to the systems programs and maintains the system's hardware. For exact details and duration of training, refer to Chapter 5, Vol. II, General Technical Requirements. of specification.

3.38.02 The maintenance and operator training shall include lectures and hands on experience on a similar type of equipment/system at manufacturer's works and site. The details of hardware and software training shall be as finalised during detailed engineering and shall be subject to Owner's approval.



3.39.00 WARRANTY

3.39.01 The Bidder shall provide an unlimited warranty on all equipment and software during the Defect liability period. This warranty shall include repair, replacement or correction of identified software or hardware discrepancies at no cost to Owner.

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

3.39.03 The Bidder shall provide warranty spares and an exhaustive list of warranty spares including components for system hardware and instrumentation and peripherals based on (and keeping adequate margin over) normally experienced failure rate shall be submitted by the Bidder for Owner's review regarding adequacy of the same. The warranty spares as per the list mentioned above will be dispatched by the Bidder along with the main equipment consignment. The Bidder shall also provide expandable items for the warranty period. This shall include printer ribbon, ink/toner cartridge print head etc. Unused spare/consumable shall be bidder's property and taken back.

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

3.39.05 After six months of DDCMIS operation the Bidder shall provide the list of parts and expendables utilized for the period. The same information will be provided at the conclusion of the warranty.

3.39.06 In order to discharge the warranty responsibility, the bidder shall include in his proposal lumpsum price for the provisions of a team of service personnel at Site who will be fully qualified to perform the required duties throughout the warranty period of one year. The Bidder shall deploy at least one engineer, one supervisor and two technicians in the team. The Owner shall approve the exact nos. & composition of team members. In case, the team is unable to rectify hardware or software problems, the Bidder shall depute and/or station additional specialist to rectify the problem to ensure 99.7% availability of system. The availability of system shall be calculated as per Vol. II, Chapter 8.

3.40.00 **Not Used**

3.41.00 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. Refer Clause no. 3.47.00 for the method of connection. 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.

In Plant, complete hardware, telephone exchange, cables, UPS with battery, industrial grade Modem, industrial grade Ethernet switches, complete industrial grade networking components, Firewall, power sockets, Broadband connection, and software etc to make system complete in every aspect, shall be provided by bidder.

At other end, Bidder shall also provide the complete hardware & software to establish the link/connection with project DDCMIS/DCS.

Owner shall facilitate the bidder in obtaining the required clearance/license (if any) for establishing connectivity. However, bidder shall be responsible for obtaining all such clearances & permits at his own cost.

The fixed charges & running cost till warranty period shall be included in the Quoted Price.

3.42.00 **TESTING AND COMMISSIONING TOOL**

The testing and commissioning tool is intended to be used for test operation of any drive in absence of DDCMIS during initial commissioning (e.g. fan trial run, etc.) While the tool shall be used for all type of drives envisaged in the specification, it is designed to be operated for one drive at a time. Portable trolley mounted system completed with necessary hardware for operating the drives and monitoring its parameter shall be supplied.

3.43.00 **SG C&I CONTROL SYSTEM**

3.43.01 **REQUIREMENTS**

The protection, control and monitoring functions of the following systems shall be performed in SG-C&I DDCMIS. All specification requirements mentioned in DDCMIS sub-section of Technical specifications are also applicable.

3.43.02 **BURNER MANAGEMENT SYSTEM (BMS)**

3.43.02.01 Fully proven microprocessor based system, based on hardware and software specifically designed and proven for Burner Management application meeting the provenness criteria, specified elsewhere in Technical specifications, shall be provided to achieve the Boiler protection action e.g. Master Fuel Trip (MFT), control of mills & fuel oil systems etc.

3.43.02.02 The BMS shall be provided with automatic self-monitoring facility. All modules to be used in this system shall be of failsafe design. Any single fault in primary sensor, I/O modules, multifunction controllers, power supply, instrumentation cables etc. should not result in loss of safety function. All faults should be annunciated to the operator right at the time of its occurrence and on OWS/LVS

The BMS shall meet all applicable relevant safety requirements including



those stipulated in latest editions of VDE 0116, VDE 0160, NFPA 85 etc

The configuration of the MFT sub-group of BMS to be provided shall be as indicated in the drawing No. 114-01-0103, Rev 00. The exact implementation shall be subject to owner's approval detailed engineering.

BPS System shall be of True Triple modular redundant (TMR) configuration, SIL 3 complaint, IEC 61508 compliant and TUV Rheinland certified as to ensure 99.9% availability of system. The MFT functions shall be implemented in a fault tolerant 2 out of 3 triple modular redundant configuration. Each of the three independent channels shall have its own dedicated processors, multifunction controllers, communication controllers, I/O Modules interface etc. All safety related process inputs shall be fed to each of the 3 channels. All primary sensors for unit/boiler protection shall be triple redundant. Additional signal for each trip input shall be made available for 1ms resolution SERS (sequence of Event recording system) mentioned at Clause no. 3.46.01, Chapter-3, Vol. V at input level itself, without any processing so as to enable analysis in sequence of event, the exact cause of trip.

The Acquisition and conditioning of binary and analog protection criteria signals for MFT shall be carried out in each of the three triple redundant channels. Each channel shall compute the 2 out of 3 voting logic and issue a trip command. The trip signals of the three channels shall be fed to a failsafe 2 out of 3 relay tripping unit for each drive. The protection criteria for tripping shall be executed by a program which shall be identical in each of the triple redundant channel. The check back contact signals of each relay of the 2 out of 3 relay tripping unit shall be fed back to each of the triple redundant channels and shall be continuously monitored for equivalence in each of them.

In case one of the independent channels or any of the triple redundant sensors is faulty, the same shall be alarmed and the balance two channels/sensors shall operate in one out of two modes without loss of any safety function. Bidder shall certify compliance for already implemented MFT proposed for this contract to EN50156-1:2004 Clause 10. The functionality of operation of mill, oil etc shall be similar to that of OLCS as described later in this chapter.

3.43.02.03 The BMS shall be designed to:

- 1 Prevent any fuel firing unless a satisfactory purge has first been completed.
- 2 Prevent start-up of individual fuel firing equipment unless permissive interlocks have first been satisfied.
- 3 Monitor and control proper equipment sequencing during its start up and shutdown.
- 4 Provide equipment status feedback and annunciator indication to the unit operator.
- 5 Provide flame monitoring when fuel-firing equipment is in service and effect a burner trip or master fuel trip upon warranted firing conditions.
- 6 Continually monitor boiler conditions and accurate a master fuel trip during adverse operating conditions which could be hazardous to equipment and personnel.
- 7 Reliably operates and minimize the number of false trips.



- 8 Provide a master fuel trip relay independent of processors and I/O modules to provide a completely independent trip path.
- 9 Provide all logic and safety interlocks in accordance with National Fire Protection Association (NFPA).
- 10 Include a first out feature in all controllers to identify the cause of any burner trip or boiler trip.
- 11 Provide a complete BMS diagnostic system to immediately identify to the operator any system modules failure.
- 12 Allow burners and igniters to be started, stopped and tripped on a burner basis.
- 13 Allow the automatic start and stop of burners based on boiler load. The sequence on which burner will be started or stopped will be selected by the operator from an OWS/LVS display.

3.43.03 **SADC, AUX. PRDS, SBC SYSTEM**

3.43.03.01 **Secondary Air Damper Control System**

1. SADC system shall be provided to achieve the following function:
 - Control of fuel air flow
 - Control of auxiliary air flow at the oil elevation
 - Control of wind box/furnace differential pressure
 - Limit NOX content in the flue gas by modulating over fire dampers, if provided.
2. In case of tangentially fired boiler, SADC shall modulate fuel air dampers of each elevation based on the signal that is representative of the coal feed rate. Further, the auxiliary air dampers at the oil elevations shall be modulated on fuel oil pressure signal whereas the auxiliary dampers at all other elevations shall be modulated to maintain the wind box to furnace differential pressure.
3. In order to limit the NOX content in flue gas, SADC shall also include the control of over fire dampers (if provided). The secondary air dampers controls and necessary interlocks to modulate or to open/close shall be incorporated as per the requirements of the boiler design.
4. The secondary air damper control system shall also be provided even in case front and rear fired boiler is offered. All requirements indicated above shall be met by bidder. Further Bidder shall provide required secondary air flow devices for measurement of compartmental wind box air flow for each elevation etc.
5. Individual position transmitters are to be provided for each of the secondary air dampers and the same shall be connected to SADC Control System.

3.43.03.02 **Auxiliary pressure Reducing and Desuperheating Station (Aux. PRDS Control System)**



1. Auxiliary PRDS control system shall be provided to control the low capacity PRDS (with steam tapping off from CRH line) and the high capacity PRDS (with steam tapping off from MS line) and coordinate their operation under all regimes of unit/plant operation.
2. Each of the aux. PRDS units (i.e. Low capacity PRDS and high capacity PRDS) shall be provided with automatic control loops for steam pressure control, steam temperature control and spray water pressure control. However, facility for remote manual control shall also exist in case the automatic control fails. The signals for steam pressure and temperature control shall be taken from the down-streams of pressure reducing valve and de-superheating station respectively and their set points shall be adjustable. The spray water pressure control shall regulate the pressure up-streams to the temperature control valve and also based on feed forward signal from steam temperature control.

3.43.04 Soot Blower Control System

1. The soot blowing system shall be fully automatic & sequentially controlled through SG C&I control system. Alternately, a SMART soot blowing system based on heat flux sensors and flue gas exit temperature may be implemented with a fall back to sequential control, if required. Soot blower Control (SBC) system complete with provision for individual operation of any soot blower and facility to bypass any soot blower shall be provided with following:
 - i. Automatic starting of each soot blower in the system
 - ii. Cancelling the operation of any soot blower in the system when required.
 - iii. Indication of the soot blower selected to operate.
 - iv. Capability to monitor all the essentials of the soot blowing system.
 - v. Capability to prevent continued soot blower operation if the system is not functioning properly.
 - vi. The ability to operate two soot blowers located in opposite walls simultaneously.
 - vii. Manual Over riding of the automatic operations.
 - viii. To prevent automatic blowing when the parameters of soot blowing system are beyond permissible limits.
 - ix. Indications of soot blower which has multifunctioned.
 - x. Control circuit for retractable blower shall be so designed as to prevent insertion of the blowers into the combustion chamber unless the blowing medium is available.
 - xi. Limit switches and torque switches are to be connected to DDCMIS and command termination shall be done in DDCMIS only for each of the blowers.
2. Soot blower control system shall also provide control for:
 - (i) Pressure control of steam
 - (ii) Warm up control of the complete piping system which shall include flow control, drain temperature control etc.

(iii) Steam temperature control.

3.43.05 MISCELLANEOUS SYSTEMS

The functionality of Separator Drain Control System, Atomizing Steam/Air Pressure Control, Fuel oil header pressure/ flow control, SCAPH drain tank level control, Mill fire control, Mill lube oil control etc shall be similar to that of CLCS/OLCS as described in DDCMIS sub- section of Technical specifications.

3.43.06 COMMON SYSTEMS

The functionality of common SG related systems such as FOPH system, FO unloading control system, Air compressor system , Auxiliary Boiler, Mill Reject system etc. shall be similar to that of CLCS/ OLCS as described in DDCMIS sub-section of Technical specifications.

3.43.07 SPECIAL SG-C&I SYSTEMS

Special SG related C&I systems as mentioned in Vol-V, Part-A & part B of Technical specification shall be integrated with SG-C&I DDCMIS.

3.44.00 TG-C&I System

3.44.01 For the TG control systems, the specifications as defined in Clause No 3.09.00 (System Description), 3.16.00 (Measurement Function Of Control System) and 3.22.00 (Control system Requirement) of chapter 3, DDCMIS, Part-B of technical specification are indicative in nature. **Bidder's standard and proven practice shall also be acceptable. However, Bidder shall implement Unified HMIPIS requirement as stipulated under Vol.-V, Part-A, Cl. No. 2.04.00 of specification for control, operation and monitoring of TG integral and auxiliaries under the scope of work and refer section 4 – Main Equipment related Control .** In such case the acceptance of same shall be based on the documentary evidence of the reference project/plant indicated in the Bid document (with project/plant specific customization as necessary). Any other reference project, if proposed by the bidder during detailed engineering, shall be strictly as agreed by the owner during detailed engineering.

3.44.02 For DDCMIS general requirements further refer Vol V, part A, as indicated in various clauses within this section of the specification.

3.44.03 Where-ever in the specification ,Bidder is offering as per his "standard and proven practices" are identified to be acceptable, the bidder is required to provide the detailed explanation/concepts ,if required by owner, of such implementation along with the standard documentation. The list of such minimum documentation is as identified below

S.No.	Document
1	DDCMIS/DCS configuration schemes
2	DDCMIS System Fault Diagnostics features
3	H/W Signal exchange and Software signal exchange philosophy with-in bidders control system

S.No.	Document
4	H/W Signal exchange and Software signal exchange philosophy with external systems
5	Standard philosophy document for triple and dual measurement schemes
6	Standard open loop sequences schemes including ATRS
7	Standard Closed loop controls implementation schemes
8	Standard Turbine protection schemes
9	Standard Turbine Governing schemes
10	Standard ATT implementation scheme
11	HMIPIS Process Mimics implementation philosophy
12	HMIPIS OLCS and CLCS Control Display implementation philosophy
13	HMIPIS Logs/reports implementation philosophy
14	HMIPIS Trends implementation philosophy
15	HMIPIS Bars implementation philosophy
16	HMIPIS X-Y plots implementation philosophy
17	HMIPIS user authorisation and password implementation philosophy
18	HMIPIS Cyber security implementation
19	HMIPIS supported Software communication protocols for external systems
20	HMIPIS Navigation Display organisation and Philosophy
21	HMIPIS Alarm implementation Philosophy
22	HMIPIS Historical storage and retrieval system implementation philosophy.
23	DDCMIS programming and configuration tools for control system and HMIPIS
24	Quality Tag implementation Philosophy in DDCMIS for process/Calculated inputs
25	DDCMIS process point attributes philosophy
26	Specification recommendation for Server/Workstaion and other HMIPIS H/W for DDCMIS
27	Specification recommendation for Server/Workstaion for other PC based systems
28	Remote service access and implementation philosophy
29	DDCMIS System documentation features
30	DCMIS data communication philosophy
31	DDCMIS panels standard OGA,IGA layout ,including Panel

S.No.	Document
	Constructional, Painting details and internal wiring details
32	Standard Shielding and grounding philosophy of DDCMIS system
33	Standard Hook up and installation philosophy for STG integral equipment
34	Bidder's standard and optional Turbovisory instrumentation philosophy for Main Turbine
35	Bidder's standard and optional Turbovisory instrumentation philosophy for BFP Turbine
36	Bidder's standard Instruments Data sheets for Steam turbine and Generator
37	Bidder's standard Instruments Data sheets for Skid mounted instruments
38	Bidder's standard Control Valve Data sheets
39	Details on Turbine stress evaluation, Turbine Stress Controller and Residual Life computation

3.44.04 **Turbine Protection System (TPS)**

Fully proven microprocessor based system, based on hardware and software proven for turbine protection application for the same turbine as being offered, shall be provided to achieve the turbine protection action.

The turbine protection system shall be as per requirements indicated below or can be implemented as part of standard and proven practice of the turbine manufacturer:

- a) The Turbine Protection System shall meet all applicable safety standards/requirements including those stipulated in latest edition of IEC 61508 and IEC 61511 or VDE 0116 Section 8.7, VDE 0160 etc. The system design shall be such that safety function of the total system must not be jeopardized on occurrence of fault. Any single fault in either primary sensor, input/output modules, controller module etc. shall in no way jeopardise the safety of the turbine. All modules to be used in this system shall be of fail safe design.
- b) The Turbine Protection System shall be implemented in 2 out of 3 voting logic. Three independent trip channels each having its own dedicated processing modules, controllers, input/output modules etc. shall be provided to achieve 2 out of 3 voting logic. The outputs of the three channels will be used to implement 2 out of 3 voting logic in two relay units, the output of which will be fed to the two turbine trip relays.

As an alternative, two independent trip channels may be proposed, each having its dedicated and hot redundant processing modules, controllers and I/O modules. Two out of three voting logic will be implemented in each of the channels and the output of each channel to be fed to each of the two turbine trip relays. Turbine shall be

tripped when either of the above two trip relays operates. (Refer Drawing no. 114-01-0102).

- c) All trip signal inputs required for the safety of the turbine shall be based on 2 out of 3 logics. The system shall include turbine lock-out relays, redundant turbine trip solenoids and necessary hardware required for testing.
- d) The tripping devices shall be designed to operate on DC supply. The trip coils shall be monitored continuously for healthiness and failure shall be alarmed.
- e) Digital/Electronic Over speed protection & Monitoring system shall be provided with TMR configuration. This system shall comply the requirements of latest edition of IEC 61508, IEC 61508, SIL3, API 670 and API 612 requirements. System shall be SIL 3, TUV certified only.

3.44.05 Turbine Governing System

Fully proven microprocessor based system, based on hardware and software proven for turbine governing application for the same turbine as being offered, shall be provided to achieve the turbine governing action. The turbine governing system shall be as per requirements indicated below or can be implemented as part of standard and proven practice of the turbine manufacturer:

- a) The turbine generator unit shall be equipped with electro-hydraulic governing (EHG) system backed-up by mechanical-hydraulic control system. The system shall be designed such that the governing of the steam turbine shall be automatically and safely transferred to mechanical hydraulic control system during operation, in the event of a fault developing in electro-hydraulic control system. Alternatively, the EHG system shall be provided with 100% hot redundancy i.e. the system shall consist of two independent channels right from sensors, transmitters, other field mounted devices, input modules, controller modules, output devices etc. of the electro hydraulic converter. Further, each of these channels shall be fed from independent power Supplies (Refer Drawing no. 114-01-0102).
- b) The turbine governing system shall meet the following functional requirements:
 - 1. The controls covered in this system shall basically consist of speed controller, load controller, over speed protection controller, valve-lift controller, inlet steam pressure controller and output frequency droop characteristic controller. The speed controller shall ensure controlled acceleration of the turbine generator and shall prevent over speed without tripping of the unit under any operating condition or in the event of full load throw-off.
 - 2. The speed controller shall limit the over speed of the turbine on loss of full load to a value less than over speed protection set point value. The governing system shall be equipped with speed/load changer to control the speed or power output of the

steam turbine within the limits. The speed/load changer provided shall be capable of adjusting the speed of the turbo set to any value in the range of 94% to 106% of rated speed for manual/auto synchronisation of the generator with the bus. It shall be capable of varying the load on the machine from no load to full load.

- c) The governing system shall be capable of being operated remotely from unit control room for the purpose of limiting the amount of opening of the governor controlled valves to set the load at a predetermined limit, while the turbine is in operation.

The system shall be able to operate for isolated grid operation.

The operation of 800 MW Turbine shall based on FGMO mode for enhancing the safety of electrical/power grid due to frequency disturbances. **Necessary hardware and software for running the 800 MW Turbine on FGMO mode shall be supplied in Turbine Control System** based on the latest guidelines given by IEGC (Indian Electricity Grid Code) and available at the time of implementation of project.

3.44.06 **Turbine Stress Evaluation system (TSES)/Turbine stress Control System TSCS)**

A proven turbine stress control/ evaluation system shall be provided which will work in conjunction with turbine governing system and ATRS. The system shall be complete including measuring transducers for generator load, processing modules, microprocessor based controllers for stress calculations and turbine life calculations etc., colour LED monitor, recorders, etc. The TSCS shall meet the following functional requirements:

- a: Continuous on-line monitoring of thermal stress levels in all critical parts of the turbine such as main stop valves, control valves, HP casing, HP shaft and IP shaft etc.
- b: Continuous on line computation of stress margins available for the above- mentioned critical components of the turbine during various regimes of operation i.e. run-up, synchronisation, loading, load maneuvering, normal operation, run backs, unloading, shutdown etc.
- c: Computation of the limits of speed and load changes allowable at any particular instant before synchronisation and after synchronisation respectively. The system shall be designed to inhibit further operation like speed/steam temperature raising or lowering wherever upper and lower temperature margins are not available (during periods prior to synchronisation) and load/steam temperature raising or lowering whenever upper/lower load/temperature margins are not available (after synchronisation) within allowable limits.
- d: Carry out a fatigue analysis for all affected critical components of the turbine as per bidders standard and proven practice and also to compute the percentage service life consumption of the turbine.

- e Display the stress margins etc. on OWS for operator guidance and storage of necessary data such as percentage service life consumption etc. If the bidder's standard and proven practice require separate dedicated colour OWS and Printer for realising all the function enumerated in this clause , then the same shall also be acceptable.
- f Store long term data & carry out Residual Life Analysis.

The system shall be complete including measuring transducers for generator load and wall temperature, measured value processing modules, microprocessor based controllers for stress calculations and turbine life calculations etc., dedicated colour Operating station with 24" industrial type LED monitors & A4 colored LJP etc.

3.44.07 **HP/LP Bypass System**

- a) HP bypass control system: The system shall consist of steam pressure control loop & steam temperature control loop. HP bypass system shall be implemented through a set of redundant controller modules, I/O modules etc. The system shall be supplied with redundant primary sensor and suitable interface with other TG - C&I controls like LP bypass, EHG etc.
- b) LP bypass control system: The LP Bypass control system shall consist of steam pressure control loop and steam temperature/ steam enthalpy control loop. The LP bypass control shall be implemented through a set of redundant controller modules, I/O modules etc. The LP bypass control shall suitably interface with other TG control like HP bypass, EHG etc.

3.44.08 **Automatic On Line Turbine Testing (ATT) System**

The Bidder shall provide ATT system for on load testing of turbine protective equipment automatically in a sequential manner without disturbing normal operation and keeping all protective functions operative during the test. The ATT facility shall include but not be limited to the following:-

- 1) Opening and closing of Emergency stop and control valves, reheat stop and interceptor valve.
- 2) Over speed trips.
- 3) Low vacuum trip.
- 4) Electrical remote trip.

ATT mentioned at item (2), (3), & (4) above shall be possible to be carried out on 100% load.

The standard and proven practice of the OEM shall also be considered in respect of the above.

3.44.09 **Automatic Turbine Run-up 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 synchronization and loading up to 100% MCR.
- e) Unloading and shut down of the machine.

The features indicated for OLCS is also applicable for ATRS.

Two Set of Push buttons for Fire protection shall be provided near Main Oil tank – to isolate the Oil system in the event of fire or any emergency. These fire push buttons shall be wired directly to the Turbine shut down logic.

Emergency trip push buttons with front red cover/flap, for turbine shall be provided near the turbine.

3.44.10 **BFP Turbine Electro hydraulic Governing System**

- a) Electro hydraulic governor, stable and satisfactory speed control over full speed range from 0% to 100%, shall control the drive turbine speed. The electro – hydraulic governing system hardware shall be microprocessor based with hot backup. The exact implementation shall be as per standard and proven practice of the bidder.
- b) The governing system shall be able to receive speed demand signal in auto mode from FW control loop and in manual mode from OWS. The actual speed of the turbine shall be measured by three independent speed sensors and three independent speed measurement channels. The electro hydraulic controller shall be designed in such a manner that the transfer between different steam sources shall take place in a bumpless manner.

3.44.11 **Steam Turbine Water Induction Prevention (TWIP) System**

The turbine water induction prevention system detects the presence of potential water admission sources, disposes of accumulated water, and isolates the turbine from the water source as required. The turbine water induction prevention logic shall be designed in accordance with ASME Standard TDP-1. For detection of leakage of various drain valve, drain pipes and turbine, metal temperature thermocouple shall be provided to meet the ASME TDP-1 standard.

The TWIP system shall serve following major functions:-

- a) Prevents water accumulations by inhibiting the use of attemperating sprays at low loads.
- b) Prevents the carry-over of water from sources such as the boiler and deaerators.

- c) Disposes of accumulations of water in low point drains by forcing drain valves open during low load operations and prior to turbine startup.
- d) High level in heaters & Gland steam Condenser resulting water ingress.

Bidder to ensure that Motorized isolating valves shall be provided at extraction lines, condensate lines & extraction drain lines as per the protection criteria of ASME Standard TDP-1 "Recommended Practices for the Prevention of Water Damage to Steam Turbines used for Electric Power Generation".

3.45.00 **Requirements for HART System (Refer sub section Vol. V, Part A - Scope of supply & services for applicability of this clause)**

The Bidder shall provide a dedicated and standalone WORK STATIONS based HART system with suitable interface for main plant DDCMIS for centralised configuration, maintenance, diagnostics & record-keeping for all electronic transmitters, temperature transmitters, control valves position transmitters and analysers (as applicable) with HART protocol.

For this system, suitable HART interface modules, power supply modules etc. shall be provided, suitably mounted in cabinets for hooking up to the above dedicated OWS Station & a coloured A4 sized LaserJet printer to be provided by the Bidder.

This system shall meet following requirements as a minimum:

- i. Each of the transmitters shall be terminated in marshalling/termination cabinets to be provided by the Bidder. The signals from each of the transmitters shall be wired in parallel to Control System and to HART interface modules. The Control System will necessarily use 4-20 mA analog signals and superimposed digital signal shall be used in HART interface modules. In HART interface modules, provision for wired connecting at least 20% extra signals over and above the specified quantity shall be kept for future addition.
- ii. Industrial grade RS-485 to RS-232 converters shall be provided for interfacing HART data of transmitters to a HART OWS station. This converter shall also provide proper isolation to ensure data integrity.
- iii. The processor, Power supply, communication port shall be redundant. The configuration of HART OWS shall be fault tolerant. HART management system shall be time synchronized with station GPS based Master clock system.
- iv. Any failure/short/open-circuit and/or removal of any of the cards/devices/cables in this centralised configuration, maintenance, diagnostics and record keeping system, including failure/removal of HART interface modules, communication modules, converter, etc. shall in no way affect the 4-20mA analog signals being used in CLCS/OLCS/control system.
- v. The HART interface modules and communication modules (if applicable) shall be suitably mounted in cabinets. Suitable parallel

redundant 24V DC power supply packs/modules and redundant feeders shall be provided to feed all modules/ devices. These power supply packs/modules shall be fed from redundant feeders of plant UPS system.

- vi. All cables/links for connecting system described above shall be provided by the Bidder on as required basis within quoted price.

The Bidder shall provide following functionalities as a minimum through software:

- (a) Constant scanning to monitor faults or changes to instrument configuration.
- (b) Owner-defined and standard calibration and configuration procedures for all transmitters.
- (c) Constant signal data collection facilities to maintain continuously updated records.
- (d) Automatic tracking of configuration changes made in the field, such as may be introduced by hand-held communicator. All configuration function associated with hand-held communicators shall be available in the system.
- (e) Event and log reports on screen as well as on printer.
- (f) Any addition/deletion of transmitter will be reported on printer and logged in hard disk.

In case Bidder's DDCMIS has facility to acquire the HART signals through analog input (4-20 mA) cards and carry out the communication to the above OWS-based system through DDCMIS hardware (i.e. controllers, communication controllers, HMIPIS etc.), the same is also acceptable.

3.45.01 **Software package for Hart Maintenance system.**

Software licenses as applicable shall be provided for HART Maintenance system as provided for other software listed at, cl.no. 3.35.00 of this part of the Specification.

3.46.00 **Integrated SER (Sequence of events recording) Function**

3.46.01 Bidder to refer general guidelines for SOE in Vol V. Part A as well.

3.46.02 The system shall monitor SOE inputs with a resolution of one millisecond at all times for all inputs including spare inputs. That is, all SOE points shall be time tagged within 1 (one) millisecond of their occurrence. Input card shall be equipped with digital filters with filter delay of minimum 4ms (identical for all points) to eliminate contact bounce such that field contact which is changing state must remain in the new state for successive 4 ms to be reported as one event. The start of data collection for SOE report shall be reported to OWS within 2 sec of SOE data collection initiation. Time stamping of SOE inputs/points shall be performed in the



control system. Minimum 1024 pt. SOE shall be provided by bidder.

- 3.46.03 In addition to above, facility for adding a field adjustable software delay on a per point basis shall be provided.
- 3.46.04 The system shall also include provision for historical storage and retrieval of SOE reports for 3 months period.
- 3.46.05 The SOE report collection shall begin on occurrence of change of status of any SOE point and shall be printed after an operator selectable time interval of 1 to 3 min. or 100 status changes have taken place after the first event. Adequate numbers of buffers shall be provided to prevent loss of data before transferring to HSR.
- Adequate memory to accommodate 6 (six) SOE reports i.e., two buffers of 100 status changes each shall be provided. Seventh SOE report shall overlap the first SOE report memory and so on.
- 3.46.06 The SOE reports shall also include a list of major equipment trip in chronological order and include the points that initiated equipment trip / plant trip.
- The inputs for SOE shall include
- (a) Hardwired inputs in input cards and
 - (b) calculated points/generated points of Control System.
- In case the Bidder's system cannot use the internally calculated point (i.e. 'b' above) for SOE monitoring, all required I/O modules shall be provided within quoted price.
- 3.46.07 All the SOE inputs (Causes of Trip & Trip related inpts) shall also be available for interlock/protection functions.
- 3.46.08 The common requirements specified for all binary inputs including SOE signals shall be referred in this section of the specification.
- 3.46.09 The format of SOE report shall be as approved by Owner during detailed engineering. The quantities of SOE points shall be as approved by Owner during detailed engineering.
- 3.46.10 SOE in other subsystems of DDCMIS shall also be integrated into this system, as applicable.
- 3.46.11 SOE reports shall be stored in the HSRS like other logs/reports.
- 3.46.12 Software licenses as applicable shall be provided for SOE functionality as provided for other software listed at Vol-V, Part B, ch. 3 cl. no. 3.35.00.
- 3.47.00 **Requirements of Station LAN & MIS (Refer sub section, Vol. V, Part A - scope of supply & services for applicability of this clause)**
- 3.47.01 **Station-wide Local Area Network (LAN)**

- 1) The HMI of main plant DDCMIS and the off-site DDCMIS systems shall be connected to a station wide Ethernet Redundant LAN with fibre-optic cables, as per drawing no. 114-01-0121, Rev 0. Various main plant auxiliary system & off-site plant PLCs shall be connected to this station wide Ethernet LAN.

The station LAN shall be achieved through the MIS Servers in redundant configuration and High capacity Layer-III Ethernet switch (station LAN switch). Refer Vol-V, Part B, Chapter 3 for specifications of Station LAN switch.

- 2) The Station LAN shall connect following buildings:
 - i. TG Main building
 - ii. Service building
 - iii. Admin Building
 - iv. Buildings in BOP areas (off-site packages)
 - v. Any other plant area / building where STATION LAN need to be provided for the purpose of MIS.
- 3) The LAN network to be provided for all user's points in all the rooms in the buildings and within plant premises. Exact user points in each building and within plant premises will be decided during detailed engineering stage.
- 4) The various buildings shall be interconnected through the use of minimum 4 core single mode fibre and shall be connected to the main switch in the Service Building in a STAR topology.
- 5) Each building shall be provided with a 12.U high wall-mountable communications cabinet complete with glass door, 6 way power distribution unit, 6 shelves and force ventilation. All units are to be supplied with cage nuts and bolts to house LAN switches.
- 6) Industrial grade managed Switches provided shall be minimum 4x fibre (10000 Base-SX) 10 Gbps uplink ports or 6.x STP (10000Base-T) 10 Gbps uplink ports Ethernet switch, configurable via browser interface and have a 50% spare capacity for future addition of LAN points. These switches shall also be provided with in built diagnostic features, inbuilt redundant 24 V DC power supply modules features and Integrated Security features (IPS, ACL, Firewall).
- 7) The LAN shall be designed in a manner such that failure of an individual switch shall not hamper the failure of the entire system
- 8) Inter building wiring shall be a minimum of Category 5E/6 STP cable manufactured, tested and verified to ISO11801 EIA/TIA standard. Internal building wiring shall be of the structured cabling type and shall incorporate patch panels on every floor or as required. Communication cables shall be armoured and routed through GI conduit pipes or suitable grade permanently lubricated HDPE protection pipe as per IS 4984, IS 12235 & TEC.G/CDS-08/01 of suitable size @53% fill factor.

- 9) A minimum of two RJ-45 ports shall be provided for each specified location Category 5E shuttered modules shall be used in pre-assembled faceplates to save installation time. Modules shall include a slide label system.
- 10) Redundant Hardware firewalls in failover mode with Intrusion prevention system (IPS) features shall be provided to ensure the security of the network and prevent unauthorized access. Firewall will have minimum three zones. One inside (DDCMIS network), other outside LAN and the De-militarised zone (DMZ zone). MIS servers shall be placed in the DMZ zone. Data required for intranet (plant PC network) will be made available in these redundant MIS servers. No traffic shall pass directly between the Station LAN Enterprise network & the DDCMIS network, even through the firewall. All such traffic must be terminated or initiated at the DMZ. i.e. data required for all external applications including plant PC network shall be provided from the DMZ zone through the firewall & such data shall be populated in the DMZ servers from the different DDCMIS systems again through the firewall. (Refer drawing no. 114-01-0121, Rev0). Refer Vol V, Chapter 3 for detailed specifications of Firewall and IPS features. Internet access shall not be allowed from any machine in the inside zone of the firewall.

Firewalls shall be in redundant configuration. Both firewalls will be configured in "fail- safe" mode, i.e. in the event of failure, they will automatically block all traffic. When one firewall fails, other firewall shall carry the network traffic & keep the failure transparent to users. In normal conditions, traffic will be shared between the firewalls. Router will be configured accordingly. Both the firewall devices shall be of the same make & version along with similar options and service subscription so that there is no mismatch in the configuration.

Station LAN switch shall be provided with a Network based Intrusion Detection system (IDS) of a make different from that of the IPS provided with the firewall to achieve a multilayered defense mechanism against intrusions, as well as to guard against possible misuse/attacks from within the LAN. Refer Vol V, Chapter 3 of IDS.

The exact details shall be as finalized during detailed engineering and as approved by Owner.

3.47.02

Connection for Remote Service Centre:

Connection for Remote access to the DDCMIS for diagnostics as described at Vol-V, Part B, ch. 3, cl. No. 3.41.00 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 Owner's designated personnel. Also, it should be ensured that the hardware at the other end of the Remote access connection (i.e. at the bidder's works) shall be standalone/isolated (i.e. not connected to any network).

3.47.02A Provision for data transfer between Power Plant and ERLDC using IEC104 Gateway/ IEC 101 Gateway shall be provided by the bidder and shall be finalized during detailed engineering.

3.47.03 **Remote Access service (RAS) connection:**

In addition to above, facility shall be provided to connect 02 nos, remote OWS stations located at Owner's Headquarter through the telephone exchange to retrieve data as specified. The Bidder shall provide all necessary software & hardware including suitable modems for the connectivity. "ready to plug" ports shall be provided for future connectivity of 10 PC stations . Bidder shall arrange to test one such connection through telephone exchange at site

However to protect against unauthorized access to network, sufficient security arrangement in the form of firewall or any other suitable hardware / software keys etc., shall be provided by bidder. All hardware shall be of industrial grade only.

Complete hardware, UPS with battery (1 hour backup), complete furniture, Cables, LAN to install 15 nos. plug in type connection with 2 nos. OWS with A4 colored LaserJet printers, industrial grade Modem, industrial grade Ethernet switches, complete industrial grade networking components, Firewall, power sockets, Broadband connection, and software at HQ end for completeness of system shall be provided by Bidder.

In Plant, complete hardware, telephone exchange, cables, UPS with battery, industrial grade Modem, industrial grade Ethernet switches, complete industrial grade networking components, Firewall, power sockets, Broadband connection, and software etc to make system complete in every aspect, shall be provided by bidder.

Owner shall provide the raw power supply at one point and work space and storage space for remote OWS stations located at Owner's Headquarter, Except this complete scope of work & supply regarding remote OWS stations located at Owner's Headquarter hardware, software, furniture, civil work & electrical work at Owner HQ are in Bidder scope.

Complete system shall be commissioned & executed by bidder.

3.47.04 **Additional Tools:** Network management software (NMS) shall be provided in a server connected to Station LAN switch so that loading etc. on the station LAN can be ascertained. Refer Vol V, Chapter 3 for detailed specifications of NMS. The same server shall be listed for logging all firewall logs and also for the purpose of an administrative interface to firewall configuration etc. Refer Vol V, Chapter 3 for detailed specifications of this server.

3.47.05 **Time Synchronization:** Station LAN shall also be used for time synchronization of all the DDCMIS sub-systems as well as PLCs connected on the LAN in line with the Master & slave spec at Vol V, Part 5, Chapter 3.

3.47.06 **Expandability:** The Station LAN switch shall be suitably sized to provide, additional ports for connecting Servers/PC-stations etc. in future and fiber optic ports for connectivity and DDCMIS TCP/IP ports for interconnection to standard third party sub-systems of Owner.



In addition to PC stations indicated earlier, the station wide LAN shall have interface devices & other provisions to add 10 more PC stations on it. Further station wide LAN shall be connected with suitable interface with local telephone exchange.

3.47.07 Antivirus with IPS: All the workstation/servers shall be provided with antivirus software with IPS. Software licenses as applicable shall be provided for Station LAN functionality as provided for other software listed at Vol-V, Part B, ch. 3 cl.no. 3.35.00.

3.47.08 In order to test the Operating system patches/hot fixes & also other periodic software upgrades, a test server of the same configuration as the servers/workstations provided in HMI will be provided. All periodic upgrades/hot fixes/patches are intended to be checked on the test server before its installation in the main machines.

3.47.09 **Generated reports**

It shall be possible to generate certain reports in some of the PC's on the station LAN, which will constitute partly off-line data entered there-in and on-line information collected from the system. Owner will define ten (10) no such reports for implementation by Bidder during detail engineering, There shall be provision of generation of minimum ten (10) such reports per PC on the LAN.

3.47.10 Failure of station LAN shall be included in the failure/malfunctions to be reported in DDCMIS. Refer Vol V, Part B, Ch-3, cl 3.05.00, for a list of such failures/malfunctions.

3.47.11 The Station LAN network & the MIS servers shall also meet the redundancy requirements specified in Vol-V, Part B, ch-3, cl 3.06.04 , for servers etc.

3.47.12 20% spare ports in network switches and spare usable space shall be kept in network panels of Station LAN, for future use.

3.47.14 **Management Information system (MIS)**

3.47.14.01 **MIS-GENERAL**

An integrated management information system (MIS) shall be provided for the plant. System shall be able to provide information related to the following aspects to management personnel and pre-selected plant graphics & data can be viewed on real time data basis at selected nodes and from remote locations

- 1.00.00 Plant/Auxiliaries operation information.
- 2.00.00 Plant/Auxiliaries maintenance related information.
- 3.00.00 Environmental information
- 4.00.00 Plant process mimics/graphics.
- 5.00.00 Plant analysis, Diagnostics and optimization system (PADO) details. (Ref volume V , Section12.)

3.47.14.02 FUNCTIONAL REQUIREMENT

MIS will provide following plant information:

1. Environmental and hazard management.
2. Equipment/Auxiliaries maintenance history.
3. Fault cause analysis.
4. On-job information report.
5. Plant/Auxiliaries operation History.
6. Plant/Auxiliaries performance details.
7. Plant process mimics/graphics.
8. Mimics for Electrical schematics.
9. Plant analysis, Diagnostics and optimization system (PADO) details.
10. Any other plant operation data/details as suggested by the Owner During detailed Engineering stage.

3.47.14.03 DESIGN REQUIREMENTS

MIS system shall be based on client server and relational database environment. The system shall operate on a commonly used hardware platform and network operating system.

System shall be suitable for simultaneous use by multiple users. Presently, the system supplied shall be used by 20 nos. users and plant simulator package. However, the system shall be expandable in future to accommodate additional 05 nos. users through additional client workstations network nodes and user licenses.

The system shall be password protected. It shall be possible to organize system users into groups and each group shall have a separate security profile. It shall be possible to provide additional personal security settings for individuals within a group.

MIS processing shall be carried out in an independent MIS server interfaced with different plant control systems like main plant DDCMIS/DCS, all off-site plant DDCMIS, all PLC control systems, DG set control, Plant analysis, Diagnostics and optimization system (PADO), PSSS, Simulator, and other microprocessor based control system etc. Plant environmental data shall be obtained from AAQMS centralized station. The MIS system server will be connected with station LAN and all users WORK STATIONSs will be connected with the station LAN.

MIS users workstations will be located in different plant buildings and the same shall be connected to the MIS server through station redundant LAN network. The exact location shall be decided during detailed engineering. In addition the OWS stations for locations as identified at Vol-V, Part-A, Appendix-I, (Appendix A, List of OWS Stations for unit) shall also be connected to the Station LAN for monitoring data of main plant and off-site plants. It shall be possible to view all plant displays including trends as well as generate various plant reports from these OWS stations.

The system shall have facility to store bulk data for 5 years duration with facility for retrieval of the same. Memory size of servers shall be designed & provided by bidder accordingly. The system shall have facility to share all the

data in the hard disk/back up media and provide user-friendly utilities to retrieve and analyze stored data.

The system shall be provided with UPS power supply. The power supply provision shall be such that on failure of normal power supply the UPS power supply shall cater to the requirement of the equipment so as never to hinder the functioning of the system in any manner due to power supply failure.

3.47.14.04 MIS SYSTEM IMPLEMENTATION

Type of data & details and formats of data & details from MIS server to end users shall be user friendly and shall be finalised by owner during implementation stage.

It is preferred that bidder's implementation team will involve ultimate users personnel during system implementation.

System shall be delivered fully implemented and shall be user tested at site. It is the bidder's responsibility to demonstrate the proper functioning of the system to user personnel.

All the communication i.e. acquisition of data and dissemination of information shall be through OPC protocol. For this purpose OPC UA servers on MIS/station LAN server shall be available.

The OPC system interface shall also comply with the following requirement as a minimum

- (a) OPC Data Access (OPC DA)
- (b) OPC Historical Data Access (OPC HAD)
- (c) OPC Alarm and events (OPC A&E)

3.47.15 MIS HARDWARE/ SOFTWARE REQUIREMENT

3.47.15.1 MIS shall include all hardware and software as required for proper functioning of the system including but not limited to the following:

- i. Redundant MIS server with 1 no. MIS work Station and 1 LJP A4 B/W.
- ii. 50 nos. client workstations (40 Nos. each with WORK STATIONS, 24" LED display unit, keyboard/ mouse and 10 nos. shall be laptops of latest model.)
- iii. MIS software with multiple user's license.
- iv. Bulk Data storage and retrieval facility.
- v. Redundant communication link with all necessary hardware and software.
- vi. Server and User WORK STATIONSs with operating licenses.
- vii. Industrial Grade Hardware like System cables, interconnecting cables to station LAN switch etc. All hardware like routers, bridges, switches etc shall be managed type industrial grade only.
- viii. DDCMIS, PLC, PADO, CAAQMS and any other package software to be loaded on each MIS users work station for viewing the process mimics, trends, logs, data, details etc. Any other software required to achieve MIS functional requirements.
- ix. 10 nos. spare physical nodes for additional users with complete client workstations and user licenses.

- x. Intelligent UPS (on line) with 30 mins. Battery backup on machine load and 10% design margin at full load with all accessories and software for remote monitoring for each workstation and server.

3.47.15.2 All software user licenses shall be valid for entire life of power plant. User should not have to pay any recurring licenses fee during the usage period of the system.

3.48.00 Requirements for Master & Slave Clock System (Refer sub section- scope of supply & services for applicability of this Clause)

3.48.01 **MASTER AND 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 Vol. V, Part A, Scope of Supply and Services.

Master clock shall have separate signal conditioner facilities to transmit clock pulses of specific formats, (such as IRIG-B, pulse, NTP/SNTP etc.) for time synchronizing other equipment in the power plant such as, DDCMIS system, DCS, PLCs, SOE & for all microprocessor based system like TSI, TSC, VMS, HMS, Flame monitoring & detector system, Bolier tube leak detection system, Plant performance & Optimisation system (PADO), Numerical relays, EDMS, SAS, plant security and surveillance system etc. All the PLC & Microprocessor based system in entire plant shall be time synchronized from Master Clock System. Master Clock System shall be common for all the system in complete plant. Spare 2 nos. port of each type of signal shall also be provided for future use.

Redundant Time Synchronization signals shall be provided for DDCMIS, DCS, PLC and other control system, where redundant hardware configuration are envisaged, so that at failure of one signal, system shall not get affected. Separate signal conditioner cards shall be provided to generate redundant Time Synchronization signals.

The Bidder 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 synchronisation), lightning protection system, 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 Clock system shall be dual redundant microprocessor controlled and fully automatic. Clock system shall employ highly stable crystal oscillator to ensure accurate time indication. The stability shall be better than 0.5 sec. per day. Oscillator shall have redundant standby unit. Provision for manual setting of time shall be provided in the master clock. The master clock shall

incorporate alarms for fault conditions thru pot free contacts, which shall be displayed locally on the unit and also in DDCMIS.

All the Slave clocks shall derive impulse from the Master clock. Each Slave clock shall be connected to Master Clock by 2 pair copper wire with annealed, tinned, stranded Copper conductor, PVC insulated, PVC sheathed, GI round wire armoured, overall FRLS PVC sheathed. It shall be ensured that loss of any slave display unit does not affect the display of any other slave unit. Cable specification shall be as per NIT chapter 9. All slave clocks shall work in exact synchronism with Master Clock. They shall be weatherproof construction suitable for indoor or outdoor use. They shall be enclosed in a suitable heavy gauge sheet metal enclosure and fitted with protective antireflective glass face / cover.

Slave Clocks shall be digital type with updates at every second. The display shall be of six digits for hours, minutes and seconds. Display element shall be red LED and the digit size shall be 100 mm minimum for a viewing distance of 20 meter. Anti glare glass cover shall be provided. In control rooms wall / panel mounting type decorative slave clock shall be provided. The slave clock shall work on 230 V AC UPS supply.

Since the timing synchronization of many off-site facilities are being done through station 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

Ten no. for unit: Locations shall be at CER, HT Switchgear, Turbine Generator Area, Central Control room, other locations shall be decided during detailed engineering.

Fifteen no. for common: Locations shall be at Shift Incharge Room, CW Pump House, Water system Control room, Make up water control room, CHP plant building, Ash handling control room, Ash Silo Control room, Personal lift at Service Building, other locations shall be decided during detailed engineering,

All required hardware like signal conditioners, signal booster shall be provided as on required basis.

3.49.00 **Requirements for HMI Hardware (Refer sub section Vol. V, Part A-general requirements)**

3.49.01 **HMIPIS Hardware:**

The HMIPIS as specified shall be based on latest state of the art Workstations and Servers and technology suitable for industrial application & power plant environment.

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. The exact system

configuration and sizing shall be as approved by Owner. The Bidder to note that wherever memory (RAM or hard disk) capacities have been specified, it indicates actual "usable" Memory.

The Workstation/Servers employed for HMIPIS implementation shall be based on industry standard hardware and software which will ensure easy connectivity with other systems and portability of employed developed and third party software.

Redundant sets of communication controllers shall be provided to handle all the communication between the HMIPIS and redundant system bus and to ensure specified system response time and parametric requirements. Each communication controller shall have message checking facility.

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

All the peripherals shall conform to the following minimum requirement but the exact make & model shall be as approved by Owner during detailed engineering. The LAN to be provided under HMIPIS shall support TCP/IP protocol (Ethernet connectivity) with OPC RDI for interface with PLCs/other systems and shall have data communication speed of min. 100 MBPS. All network components of LAN and Servers/ Workstations shall be compatible to the LAN, without degrading its performance. The redundant LANs of all the units shall be connected through suitable network components. It shall be ensured that failure of this network component(s), shall in no way affect individual unit's operation monitoring & control in any way.

3.49.02 **The Servers/Workstations/PCs/Laptop to be provided by the Bidder should be latest available in the market at the time of supply to prevent early obsolescence and shall be subject to Owner's approval. The software packages to be included with the server/OWS/PCs shall also be the latest version available at the time of supply.**

3.49.03 However for Servers and Historians / Station LAN Server/ Programming station/NMS Server/operating work station/PC/Laptops, the hardware shall conform to the following minimum requirements:

S. No	Features	Servers/ Workstations for Information functions / Station LAN Server/ Programming station/NMS Server	Operator workstations/ Other workstations/ Documentation station (in case not part of prog. Stn.) and PC
1	Processor	Intel Xeon Sixteen (16) Core 64 bit Processor /36T capable 3.6 GHz with 24.75M cache, Dual independent 2666 MHz system bus (2 way SMF) or better.	Intel Xeon Six (6) Core 64 bit Processor capable 3.6 GHz with 16MB L3 cache memory per processor, Dual independent 1333 MHz system bus (2 way SMF) or better.
2	Memory	64GB ECC DDR – 4, 800 SDRAM.	16GB DDR4 RAM
3	Drives	HDD – RAID 5 (2000 GB) Ultra 320 SCSI adaptors with internal storage capacity 3.6 TB DVD/CDROM – 24X CDRW/DVD IDE combo USB – 4 ports DAT – 36 / 72 GB 2048 MB Graphic Accelerator	1 x 1000 GB IDE Hard Disc Drive of 7200 RPM or higher. 2048 MB Graphic Accelerator.
4	Monitor (colour)	LED based 29" sized Monitors. with non-interfaced refresh rate min. 75 Hz. Full HD resolution 1920 X 1080, 256 colors with MRPII compliant, viewing angle 178° vertical & Horizontal and fastest response time.	LED based 29" sized Monitors. with non-interfaced refresh rate min. 75 Hz. Full HD resolution 1920 X 1080, 256 colors with MRPII compliant, viewing angle 178° vertical & Horizontal and fastest response time.
5	RAID	SAS-channels, hardware RAID level 5 implemented	
6	Redundant hot swappable power-supply	2 nos.	
7	Removable bulk storage drive (DVD)	6GB (minimum)	

S. No	Features	Servers/ Workstations for Information functions / Station LAN Server/ Programming station/NMS Server	Operator workstations/ Other workstations/ Documentation station (in case not part of prog. Stn.) and PC
8	Removable Bulk Storage Media for above (with each server/work-station)	10 nos	
9	DVD R/W	16x or higher	16x or higher
10	Intelligent UPS (on line) with all accessories and software for remote monitoring for each workstation/server	1 no. each with 60 mins. Battery backup on machine load and 10% design margin at full load.	1 no. each with 30 mins. Battery backup on machine load and 10% design margin at full load.
11	Keyboard	ASCII	ASCII
12	Pointing Device	Optical Mouse	Optical Mouse
13	Accessories	Industrial grade furniture as approved during detailed engineering	Industrial grade furniture as approved during detailed engineering
14	Additional general purpose software (for using over network by servers/workstations/PCs)	Comprehensive disk maintenance utility for disk clean sweep/crash guard/antivirus, etc. (like "Norton System Work Latest edition")	
15	Software	Windows 10 /11 /Windows Server 2022 for servers or other latest edition server version standard /Enterprise Edition or latest & proven version of Windows Operating system. General MS Windows latest, MS-Office Professional, Adobe Acrobat, anti-virus software with IPS, etc. Application engineering & HMI software - to suit project Specific requirement.	Windows 10 /11 or other latest edition server version standard /Enterprise Edition or latest & proven version of Windows Operating system. proven with Multimedia. Third party operating system, graphical users interface and software, if required.

S. No	Features	Servers/ Workstations for Information functions / Station LAN Server/ Programming station/NMS Server	Operator workstations/ Other workstations/ Documentation station (in case not part of prog. Stn.) and PC
			General MS Windows latest, MS-Office Professional, Adobe-Acrobat, anti-virus software with IPS, AutoCAD etc. Application engineering & HMI software - to suit project Specific requirement.
16.	Misc. Requirements	<ul style="list-style-type: none"> i. 1 Parallel port ii. 4 nos. USB 3.0/2.0 ports. (2 nos. on front side). iii. 4 – 10/100/1000 MB/1GB network ports iv. Two non-boards and two added v. External SCSI port vi. Dual hot plug power supplies vii. Dual Hot plug fans viii. 2 PCI Express slots (1x4 lane and 1x8 lane) ix. 2 PCI X slots (64bit/100MHz) x. 2 PCI slots (one 32bit/33MHz, 5V & one 64bit/66Mz) xi. Hot Redundant Server shall be provided, wherever required. xii. Backup & Disaster Recovery software. xiii. 1 x 480GB SSD SATA Read Intensive 6Gbps 512 2.5in Hot-plug AG Drive, PERC H740P RAID Controller, 8GB NV Cache, Adapter, Full Height, Dual, Hot-plug, Redundant Power Supply (1+1), 1100W 	System chipset: Intel Express. 2 x RS – 232 ports. 1 x parallel port. 4 nos. USB 3.0/2.0 ports. (2 nos. on front side). 1 x 16 X or better DVD R/W Drive. 2 x Ethernet (10 / 100 / 1000MB) cards (Industrial Grade). 2 nos. graphic output cards minimum. Sound card & Internal speakers. Wireless internet & Blue tooth Interface. Redundant power supply (In built).

The supervisory function of HMIPIS like log, calculations, shall be implemented in redundant Server/Operator workstation, so that no functions are lost due to a signal failure.

The mouse/keyboard/monitor shall have extra length of cable depending on the location of CPU rack (normally placed behind LVS panel).

Individual Monitors shall be supplied for all stations (except LVS OWS) Bidder to ensure that the aspect ratio of these monitors is same as that of the LVS being supplied.

3.49.04 **Specification for Lap-Top (Note-Book) PC**

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).

The Laptop shall meet following minimum requirements:

- Intel Core i7-1165G7 Processor
- 2.8 GHz base clock, up to 4.7 GHz with Intel Turbo Boost Technology
- 4 cores and 12 MB L3 cache
- Intel Iris Xe Graphics
- 15" WXGA LED Screen with wide angle viewing.
- 1000 GB 7200 rpm HDD with shock absorber.
- 16 GB DDR4-3200 SDRAM (1 x 16 GB) DDR4 SDRAM (slot for 1no. additional RAM slot should be provided)
- 1024 MB Graphic Accelerator
- 1 x windows XP/7 Professional or latest & proven version of Windows OS with Multimedia
- Slim type DVD-RW/DVD ROM combo drive.
- Internal 10/100/1000Mbps Ethernet card
- IEEE 802.11B connectivity port
- IR port
- Optical mouse
- 2Nos. USB 3.0/2.0 ports & Wireless INTERNET & blue tooth interface
- External mouse connectivity and optical mouse
- Minimum 8 hrs battery backup.
- Recovery software tools.
- Sound cards
- Internal speakers
- General MS Windows latest, MS-Office Professional, Microsoft Visual Studio, Adobe Acrobat, anti-virus McAfee or equivalent, etc.
- Application engineering & HMI software - to suit project specific requirement.
- Carry Bag.

3.49.05 **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) | 78 inch – 85 inch |
| 2. | Type | LED illuminated Digital Light Processing (DLP) technology with rear projection configuration. |
| 3. | Resolution of each Screen | Minimum 1400 x 1050 pixels
(Contractor to ensure that the aspect |



- Ratio of OWS monitors are same as that of the LVS being supplied.)
4. Configuration of LVS
Single tier with Screens seamlessly combined with provision of expansion of one screen on each side.
 5. Control Unit
Same as operator work station without the LED 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, Owner's Live camera, VCP, Flame Camera

This Video signal shall be connected to video wall through Master controller.

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.
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
To be finalised during detailed horizontal & vertical engineering.
 9. 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 bidder at no extra cost.

10. Auto brightness & colour adjustment between each screen.
11. 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 'Functional Guarantee, Vol II, chapter 8 of specifications. If during any stage of the contract, the command response times as stated in specifications are not achieved, the bidder shall upgrade the hardware/software of the control unit in order to achieve the same at no extra cost to the Owner.
12. 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. Specification of Master controller unit shall be same as specified for server.
13. Complete LVS analysis & diagnostic software shall be provided.
14. LVS annunciation functionalities shall be provided with salient features of the conventional hardware annunciations, while presenting more flexibility.

3.49.06 Graphical Interface Unit

Minimum specifications of Graphical Interface unit shall be as follows:-

S.No.	Features	Description
1.	Power supply (Redundant)	230 V AC from UPS/24 V DC as per requirements thru redundant feeders.
2.	Display Size	15" minimum. (Industrial Grade) Actual size as per owner's approval.
3	Display Type	Coloured, LED high resolution screens
4.	Protection class	IP-65 for extremely dust prone area, otherwise IP-55. Enclosure shall be IP 67 for extremely dust prone area, otherwise IP-65
5	Keys	Function keys and numeric keys
6	Interfacing requirements	Interface with respective DDCMIS/PLC.
7	Functional requirements	Ability to do programming. Graphics display including alarms and operator guidance messages.
8.	Enclosures	Required as per site/process requirements.
9.	Other requirements	Industrial Grade, GIU shall be ruggedly designed to withstand hard environments like high temperature, shock and

S.No.	Features	Description
		vibration.
10.	Interfacing with control system	Redundant
11.	Configuration	<p>On board Intel – Xeon Octa core, 3.1 GHz latest processor or higher.</p> <ul style="list-style-type: none"> - 16 GB DDR4 RAM (min.) - 1 x 1TB IDE Hard Disc Drive of 7200 RPM or higher - 1024 MB Graphic Accelerator - System chipset: Intel Express - 2 x RS – 232 ports - 2 nos. USB 3.0/2.0 - 2 x Ethernet (10 / 100 / 1000MB) cards (Industrial Grade) - 1 x windows 10 /11 Professional or latest & proven version of Windows OS professional with Multimedia - Ethernet adapter - Third party operating system, graphical users interface and software, - 2 nos. graphic output crads minimum - Internal speakers - Redundant power supply (In built) - General MS Windows latest, Antii-virus software etc. Application engineering & HMI software - to suit project Specific requirement

3.49.07

Printers

S. 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	6 ppm (colour) 24 ppm (B&W)	4 ppm (colour) 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	–



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



S. No.	Features	Colour Laser Printer	Colour Laser Printer	Line Impact Dot Matrix Printer
5	First page out time (with full graphic display)	=<1 min for colour, <45 sec for BW	=<1 min for colour, <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	10
10.	<u>Four sets of print cartridges and Six ream of papers shall also be provided with each printer provided anywhere in the plant by bidder with each control system and any other system specified elsewhere in specification.</u>			

3.50.00

Switches :

Layer-2/3 switches shall have the following features:

- i. High Performance Industrial grade
- ii. In built diagnostic features
- iii. 30% spare ports
- iv. Inbuilt redundant 24 V DC power supply. The switch should not undergo reboot (no downtime) while adding/removing of redundant power supply.
- v. 48 X Gigabit Ethernet Port
- vi. 24 or 48 x 10/100/1000 Base TX ports (STP),RJ45 PoE /PoE+
- vii. SNMP, RMON, VOIP, VLAN, Multi link Trunk support
- viii. Broadcast/multicast storm control, Supervisor Engine redundancy capability, Redundant Power Supply, Integrated Security features (IPS, ACL, Firewall), 10 GB module support for future upgradeability
- ix. Expandability/stackability through a dedicated high speed expansion port. Routable, remotely manageable, configurable.
- x. Intelligent SNMP manageable mini-UPS for 60 minutes backup shall be provided with all accessories and software.
- xi. The switch should be stackable with a minimum stacking bandwidth of atleast 1200 Gbps. It should support stacking of atleast 9 units or higher or Virtual Switching System (VSS) or Equivalent technology.

- xii. The switch shall be able to work on both IPv4 and IPv6 (dual stack) and Open-Flow or equivalent software defined networking (SDN) protocol support from day one.
- xiii. Switch shall support minimum 82K MAC address.
- xiv. Switch shall be available with minimum 1.76 Tbps Switch Fabric.
- xv. Core Switch shall have minimum packet forwarding rate of 1309.44 million packets per second.
- xvi. It shall have hot swappable fan tray.
- xvii. It shall support for IP unicast routing capability (static, RIPv1, RIPv2 and OSPFv3 protocols) to forward IP traffic through configured interfaces.
- xviii. The Core Switch shall support classification and scheduling as per IEEE 802.1P on all ports. It shall support classification and marking based on IP type of Service (TOS) and DSCP.
- xix. It shall support VLAN ACLs (VACLs) on all VLANs to prevent unauthorized data flows from being bridged within VLANs. It shall also support port-based ACLs (PACLs) for Layer 2 interfaces to allow application of security policies on individual switch ports.
- xx. It shall support MAC Address based filters / Access Control Lists (ACLs) on all switch ports. Shall support Filters/ACLs based on Network Address, Mask, Protocol Type & Socket Type on all switch ports.
- xxi. It shall support unknown unicast and multicast port blocking to allow tight control by filtering packets that the switch has not already learned how to forward.
- xxii. It shall support Port Mirroring based on port basis / VLAN basis to support intrusion prevention system deployment in different VLANs.
- xxiii. It shall support port security to secure the access to an access or trunk port based on MAC address. After a specific timeframe, the aging feature should remove the MAC address from the switch to allow another device to connect to the same port.
- xxiv. It shall support multilevel security on console access to prevent unauthorized users from altering the switch configuration.
- xxv. The Core Switch shall support IEEE 802.1x to allow dynamic, port-based security, providing user authentication.

Secondary switches shall have the following features:

- i. 24 or 48 X 10/100/1000 Base TX ports (STP)
- ii. 2 or 4 X Gigabit Ethernet Port
- iii. SNMP, RMON, VOIP, VLAN, Multi link Trunk support. Support for stacking with high throughput Broadcast/multicast storm control.
- iv. Switch shall support IEEE 802.1Q VLAN up to 1000 VLANs.
- v. It shall support for Automatic Negotiation of Trunking Protocol, to help minimize the configuration & errors.
- vi. It shall support centralized VLAN Management. VLANs created on the Core Switches shall be propagated to all the other switches automatically, thus reducing the overhead of creating / modifying / deleting VLANs in all the switches in turn eliminating the configuration errors & troubleshooting. It shall support GVRP / **VTP** or any other industry standard protocol for VLAN pruning and management.
- vii. It shall support edge port in STP/RSTP/MSTP mode and Ethernet Ring Protection Switching (ERPS) (ITU-T G.8032) or Equivalent.
- viii. It shall support IGMP v1, v2 & v3 as well as IGMP v1, v2 & v3 snooping.

- ix. It shall support Link Aggregation Protocol (LACP).
- x. It shall support Detection of Unidirectional Links and to disable them to avoid problems such as spanning-tree loops and shall support UDLD or any other industry equivalent protocol for unidirectional link detection.
- xi. It shall be able to discover the neighboring device of the same vendor giving the details about the platform, IP Address, Link connected through etc, thus helping in troubleshooting connectivity problems. It shall support LLDP or LLDP-MED for network discovery.
- xii. It shall Support Optical Transceiver Digital Diagnostic Monitoring and Support 802.3ah link layer remote loopback and discovery, Loopback Detection (LBD) and Switch should support layer remote loopback and discovery.
- xiii. It shall support for Cross Stack Uplink Fast or equivalent technology to provide for sub second failover.
- xiv. It shall support Multicast VLAN registration.

3.51.00 **The Firewall shall meet following minimum requirements:**

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

- i. 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
- ii. The firewall must send log information to a separate log server via an encrypted connection. Firewall logging must not impact firewall performance.
- iii. Remote network access to the firewall should only be possible through the administration interface.
- iv. The firewall administration station must be capable of pushing firewall security policies and configurations to individual or multiple firewalls through a secure, encrypted connection to the firewall administration interfaces.
- v. Graphical User Interface (GUI) and a Command Line Interface (CLI) for making changes to the firewall rules set should be provided. (Access to the firewalls via the GUI or the CLI must be through a secure encrypted channel).
- vi. Any changes or commands issued by an authenticated user should be logged to a database configured on any of the machines in the LAN. The administration station must allow for a hierarchical architecture for rules set administration and viewing of firewall configurations Management.
- vii. The firewall must not support any unencrypted means of access to the firewall.
- viii. It should Monitor ALL network traffic-traffic at Firewalls (Internet and external networks), in the DMZ and detect known threat through deep packet inspection.
- ix. Detects unknown threats via anomaly scanning.
- x. Detect unknown threats via behavior pattern to protect from zero day attacks.
- xi. Keeps up-to-date on new threats and vulnerabilities.

3.51.01 Intrusion Detection System (IDS) & Intrusion Prevention System (IPS) 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 Station LAN Network, the recommended IDS/IPS should contain the following combined features. Any feature can be selected depending on whether it is to be configured as IPS or IDS.

- i. Able to analyze, detect and report on security related events.
- ii. Able to inspect traffic and to drop malicious traffic based on the configuration of security policy.
- iii. Able to inspect the content of network packets for unique sequences/signatures.
- iv. Able to detect and prevent known types of attacks such as worm or Trojan infections and hacks.
- v. Able to prevent denial of service (DOS) and Distributed Denial of Service attacks.
- vi. Able to prevent abnormal behaviors by monitoring and learning normal network behaviors.
- vii. Keeps up-to-date on new threats and vulnerabilities.
- viii. Should provide user friendly interface to queries and reports on threats and event data so that security administrators can gain a better understanding of their ability to protect their network.
- ix. Should provide detailed activity logs for auditing.
- x. Able to detect known threats via deep-packet inspection.
- xi. Able to detect unknown threats via anomaly scanning.
- xii. Able to detect unknown threats via behavior pattern to protect from zero day attacks.

3.51.02 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. If 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.

3.51.03 **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 Vol. V, Part A, Appendix-I. These switches are intended to be used only for keyboard multiplexing.

For extension of keyboard & mouse cables from OWS/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.

3.51.04 **Matrix KVM Switch**

A matrix KVM switch for accessing multiple Servers, Gateway, Workstations etc, via multiple user consoles placed in the Programmer Room in Server Rack. User consoles shall also be located in the same room. These switches will be used for Keyboard, Video and Mouse multiplexing. The KVM switch sizing should consider 20% spare capacity and associated spare server & user consoles. Refer drg no 114-01-0100 (sheet 2). For quantity of switches refer Vol. V, Appendix-I to Part-A.

Specifications:-		
The requirement of each Matrix KVM switch shall be as follows:		
1	Minimum Connections	16 Servers and 4 user consoles
2	System Cable	Cat 5/Cat6e
3	Port Selection	Hot keys, User Interface
4	Power Supply	230 V AC from UPS
5	Mounting	Rack Mountable in server rack.
6	Keyboard, Mouse Support (with/without convertor)	PS/2 , USB
7	Video	The video shall be displayed at the user stations without any distortion/skew etc.
8	Security	Password/ Multiple user profiles
		Allowing/disallowing access of particular machines to a user profile.
9	User to Switch Distance	30 Meters or less

10	Servers to Switch Distance	15 Meters or less
Computer connections (CPU End)		
1	Video Type	DVI or VGA as required
2	Keyboard and Mouse Type	PS/2 or USB as required
3	Mounting	The device shall be fixed with proper fixtures in the server rack.
User consoles		
1	Video Type	DVI or VGA as required
2	Keyboard and Mouse Type	PS/2 or USB as required
3	Mounting	Suitable mounting arrangement shall be provided.

3.52.00 **Special Requirements (Refer sub section Vol. V, Part A - scope of supply & services for applicability of this annexure)**

3.52.01 **Software for determination of optimum Controller parameters**

The programming station shall be equipped with a system/software to calculate the tuning constants i.e. P, I and D values of control loops automatically. Facility shall be provided to conduct open loop test (i.e. controller in manual mode) and closed loop (i.e. controller in auto mode) tests on control loops through GUI based user interface. It shall be possible for the user to adjust the step size of disturbance, sample time, duration of test. Facility shall be provided to choose the type of process being tuned i.e. PI, PID etc, controller type i.e. regulating or tracking, and the type of process being controlled i.e. integrating, non integrating. Further it shall also be possible to calculate the tuning constants by capturing process changes during normal process disturbance (without conducting any test). The calculation of tuning constants shall follow internationally accepted tuning procedures. The system shall be provided with facility to monitor the performance of control loops during normal operation of the plant and display important statistics and performance indices about the loops e.g. average absolute error, peak overshoot, no. of set point crossings, controller output saturation etc. and recommend retuning of the loop based on these parameters.

3.52.02 **(A) PERFORMANCE CALCULATIONS (CLASS I)**

The Class I calculations are generally for the purpose of detecting & alarming unit malfunctions. These shall be executed at the scan cycle of the inputs, for the calculation.

These shall include cold reheat steam approach to saturation temp, super heater spray outlet approach to saturation temp., turbine steam-metal temp. differences, turbine metal temp. rates of change, feed water heater

terminal temp. difference, feed water heater drain cooler approach, excess air deviation from standard, feed water heater temp. deviation from standard, any saturation temp. rate of change, metal temp. difference for SH 'Y' and RH 'Y' piece etc.

3.52.03 **(B) PERFORMANCE CALCULATIONS (CLASS II)**

Class-II Performance Calculations (which is the Plant / equipment efficiency calculation) for various equipment along with heat rate deviation & revenue calculation, availability tariff, etc. shall be provided as per list given below:-

Boiler efficiency

Gross turbine-generator heat rate

Gross unit heat rate

Net unit heat rate

H.P. turbine enthalpy drop efficiency

I.P. Turbine enthalpy drop efficiency

L.P. turbine enthalpy drop efficiency (using dry exhaust)

Feed water heater performance terminal temperature difference.

Feed water heater performance drain cooler approach

Condenser performance

Deaerator performance

Economizer performance

BFP performance

Air Preheater performance

Fan efficiency

Unit availability calculations

Deviation from expected values from each calculation.

In addition to the above, the net unit heat rate vs. load profile shall be calculated using the last values of heat rates at different load interpolating the results. Facility shall be provided for entering unit constraints like a particular mill not available by the operator.

3.53.00 **MESSAGING SYSTEM**

It shall be possible to send pre defined messages either periodically or on occurrence of certain events in the form of

- a) Operator guidance message to LVS/OWS.
- b) E-mail messages to various clients on the station LAN.
- c) Messages to pre-selected mobile nos. (around twenty numbers).

In case the faults as per Vol V , Part B, Ch.-3, Cl. 3.05.00 are not acknowledged/rectified within a certain interval, then the same shall also be reported to users through messaging system.

A configuration utility shall also be provided for the above providing facilities of configuring the events, grouping of events areas wise, priority of events within a group and configuring user groups for to which the event/event group can be assigned etc.

Adequate security in the system shall be built in the system to avoid any unauthorized access to DDCMIS system.

3.54.00 **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.

3.55.00 **Alarm Analysis**

DDCMIS shall provide fault alarm analysis guiding the operator to the most likely cause of fault. The alarm system shall be designed in such a manner that main auxiliaries tripping can be traced to the originating cause.

3.56.00 **Software package for Merit order rating programme**

Merit order rating calculation for this package shall be provided by the bidder.

The bidder however shall develop his own algorithms, which shall be finalized during detail engineering with approval from Owner.

Necessary signal exchange between this package and other sub-system covered under this package shall be provided, as defined in Vol. V, Part-A.

3.57.00 **Automatic Unit Startup & Shutdown**

It shall be possible to perform automatic unit startup & shutdown by issuing minimum number of command from the LVS/OWS. Thus, the unit level shall control all the Control System Blocks and issue appropriate startup & shutdown commands to various blocks of this Control System and SG/TG - C&I and receive corresponding check backs /feedbacks. All signals/points to HMIPIS for implementation of sequence, drive & other displays shall be made available from Control System.

3.58.00 **Replay Software for Trip/Disturbance analysis**



Proven software already tested in similar capacity power plants shall be provided. Software based trip/disturbance analysis utility shall be provided. The utility shall have the capability to acquire point information of last 48 hrs. from the Station LAN server or Unit historians on a continuous basis and using the acquired data, replay the actual plant mimics with auto updation every second. It shall be possible to select the time interval for which the data is to be replayed. Process alarms, commands from OWS/LVS, UCD commands, GIU commands etc. during the selected time interval shall also be suitably displayed for ease of analysis. Actual no. of points which is to be configured shall be decided during detailed engineering in consultation with the Owner.

3.59.00 **Other functions of Control System**

3.59.01 The major auxiliaries and equipment to be controlled from control system have been indicated in Part-A of specification. The exact implementation of the Protection and interlock logics, drive functions, monitoring etc will be to meet actual process requirements and as finalized 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.

3.59.02 The major control loops to be controlled from Control System have been indicated in Vol V, Part-A of specification. However, exact implementation of these control loops shall be finalized during detailed engg. Stage in consultation with main equipment supplier. The Bidder shall furnish his standard & proven implementation practices for similar control loops in power stations. The Bidders shall be responsible for final implementation of control loops which shall meet all specification requirements and the successful operation of the plant.

3.59.03 The measurement system of control system should be capable of acquiring data from various equipment & system in digital form through serial port, field bus / profibus, 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), field bus/profibus type temperature transmitters (optional) , fault/diagnostic signals from vibration monitoring system, UPS/24 V DC system etc. Requirement of such ports is indicated at appendix-I to Part-A.

3.60.00 **Security Policies/Procedures and Security Audits:**

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

For checking compliance to the above security policies & procedures in Station LAN/HMI of all DDCMIS, security audit by a certified auditor (as per CERT- IN panel) is to be arranged by the Bidder at the time of trial operation/PG test of plant in consultation with Owner. This shall include



vulnerability assessment of the workstations/ servers and penetration testing of the Station LAN 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 Bidder in consultation with the Owner.

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 Owner's personnel thereafter. All the responsibilities of information security team have to be discharged by vendor's team during tenure of the contract and Owner's 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 generally followed. Details of the same, as applicable, shall be provided during detailed engineering.

- 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

TABLE – 3.1

PERFORMANCE REQUIREMENTS FOR CLOSED LOOP CONTROL SYSTEM

S. No.	Load/Rate of load Change (% of MCR per min.)	Maximum Deviation Of Parameters from Set Point				
		Throttle pressure deviation (kg/cm ²)	Flue gas oxygen deviation (% O ₂)	Furnace pressure deviation (mmwcl)	S.H. steam temperature deviation (Deg.C)	R.H. steam temperature deviation (Deg.C)
A. Steady state condition						
1.	90% to 100%	±2.0	±0.4	±8.0	±5.0	±5.0
2.	60%	±2.0	±0.4	±8.0	±5.0	±5.0
B. Ramp test (change for max. duration of five minutes)						
1.	±3%	±3.0	±0.6/-0.4	±12.0	±8.0	± 8.0
2.	±5%	±3.0	±0.8/-0.4	±12.0	±10.0	±10.0
3.	±10%	±-4.0	±1.0/-0.5	±15.0	±15.0	±15.0
C. Step load changes						
1.	From 100% to 80% at the rate of 10% per minute	±5.0	±1.5/-0.5	±20.0	±15.0	±15.0

Notes:

- a. Sufficient time shall be allowed as setting period between conducting the tests.
- b. Plant operating condition, i.e. main equipment status, availability of auxiliaries, operational and equipment constraints, which can influence the test, shall also be recorded.
- c. Control system shall be running in the coordinated master control (CMC) mode i.e. boiler master, fuel flow, air flow, feed water and turbine load control shall be in automatic mode. Load set point, maximum and minimum load set point, rate of raise / lower of load shall be set through the LED, keyboard/conventional console.
- d. These tests will be conducted within 30 days of attaining 80% load.

TABLE – 3.2**DRIVE CONTROL PHILOSOPHY (Typical)**

S. No.	DESCRIPTION	Type of I/O	No of I/O
1.	DCS INTERFACE FOR UNIDIRECTIONAL HT DRIVE (Signal Exchange envisaged between DCS and Switchgear/Drives)		
a.	Start Command	DO	1
b.	Stop Command	DO	1
c.	ON Feedback	DI	1
d.	OFF Feedback	DI	1
e.	Electrical Trip (Lockout relay)	DI	1
f.	Emergency LPBS stop	DI	1
g.	Switchgear Disturbance (control supply fail)	DI	1
h.	Switchgear Available (breaker in service position, switchgear in remote & breaker spring charged)	DI	1
i.	Numerical relay unhealthy	DI	1
j.	Trip coil healthy	DI	1
k.	Pump / Fan/Motor driven drive bearing (DE & NDE) temperature measurement	RTD	2
l.	Motor Bearing (DE & NDE) temperature measurement	RTD	2
m.	Motor Winding temperature measurement	RTD	6
n.	Pump / Fan bearing/Motor driven drive Vibration measurement - DE & NDE (X & Y direction)	AI	4
o.	Motor Bearing Vibration measurement- DE & NDE (X & Y direction)	AI	4
p.	Speed input (For VFD Drives)	AI	1
q.	Speed output (For VFD Drives)	AO	1
r.	VFD mode/Bypass Mode selection (For VFD Drives)	DI	1
s.	VFD mode/Bypass Mode command (For VFD Drives)	DO	1
t.	Numerical relays (Refer Electrical Volume IV for the details.)	Interface through IEC 61850 protocol.	
2.	DCS INTERFACE FOR UNIDIRECTIONAL LT BREAKER CONTROL DRIVE (Signal Exchange envisaged between DCS and SWGR /Drives).		
a.	Start Command	DO	1
b.	Stop Command	DO	1
c.	ON Feedback	DI	1
d.	OFF Feedback	DI	1
e.	Electrical Trip (Lockout relay)	DI	1
f.	Emergency LPBS stop	DI	1

S. No.	DESCRIPTION	Type of I/O	No of I/O
g.	Switchgear Disturbance (control supply fail)	DI	1
h.	Switchgear Available (breaker in service position, switchgear in remote & breaker spring charged)	DI	1
i.	Numerical relay unhealthy	DI	1
j.	Trip coil healthy	DI	1
k.	Speed input (For VFD Drives)	AI	1
l.	Speed output (For VFD Drives)	AO	1
m.	VFD mode/Bypass Mode selection (For VFD Drives)	DI	1
n.	VFD mode/Bypass Mode command (For VFD Drives)	DO	1
o.	Numerical relays (Refer Electrical Volume IV for the details.)	Interface through IEC 61850 protocol.	
3. DCS INTERFACE FOR UNIDIRECTIONAL LT CONTACTOR CONTROL DRIVE (Less than 90KW)(Signal Exchange envisaged between DCS and PMCC / MCC / Drive related Equipment). Intelligent MCC are envisaged in these applications			
a.	Start Command	DO	1
b.	Stop Command	DO	1
c.	ON Feedback	DI	1
d.	OFF Feedback	DI	1
e.	MCC Disturbance (control supply fail)	DI	1
f.	Emergency LPBS stop	DI	1
g.	Intelligent controllers	Ethernet based soft interface	
4. DCS INTERFACE FOR BIDIRECTIONAL LT DRIVE- For Integral starters (Signal Exchange envisaged between Actuator and DCS.)			
a.	Open Command	DO	1
b.	Close Command	DO	1
c.	Integral starters Fault (Control supply fail / O/L relay operated / L/R selector switch selected in local / Phase loss).	DI	1
d.	Open limit switch feedback	DI	1
e.	Close limit switch feedback	DI	1
f.	Open Torque switch feedback	DI	1
g.	Close Torque switch feedback	DI	1
h.	Position Transmitter (For inching type Drive)	AI	1
5. DCS INTERFACE FOR BIDIRECTIONAL LT DRIVE-For Non-Integral starters (Signal Exchange envisaged between Actuator / SWGR and DCS.) SOOT BLOWER related.			
a.	Forward Command	DO	1
b.	Reverse Command	DO	1

S. No.	DESCRIPTION	Type of I/O	No of I/O
c.	Switchgear Disturbance (control supply fail)	DI	1
d.	Open limit switch feedback	DI	1
e.	Close limit switch feedback	DI	1
f.	Open Torque switch feedback	DI	1
g.	Close Torque switch feedback	DI	1
h.	Position Transmitter (For inching type Drive)	AI	1
6. DCS INTERFACE FOR SOLENOID DRIVE (Single coil)			
a.	Energise or DeEnergise	DO	1
b.	Open limit switch feedback	DI	1
c.	Close limit switch feedback	DI	1
7. DCS INTERFACE FOR SOLENOID DRIVE (Double coil)			
a.	Energise	DO	1
b.	DeEnergise	DO	1
c.	Open limit switch feedback	DI	1
d.	Close limit switch feedback	DI	1
8. DCS INTERFACE FOR PNEUMATIC DRIVE			
a.	Command to I/P converter (Smart Positioner)	AO	1 (R)
b.	Position Transmitter (Smart Positioner)	AI	1
c.	Open limit switch feedback	DI	1
d.	Close limit switch feedback	DI	1
e.	Command to Solenoid valve (Wherever applicable)	DO	1
f.	Solenoid to act as stayput function on controller signal failure (Wherever applicable)	DO	1
9. LT SWITCHGEAR-ELECTRICAL			
9.1. ACB INCOMER – 1/2			
a.	Breaker Close	DO	1
b.	Breaker Trip	DO	1
c.	Line PT under voltage	DI	1
d.	Line PT Fuse Fail	DI	1
e.	Breaker ON	DI	1
f.	Breaker OFF	DI	1
g.	Switchgear Disturbance (Control Supply Failed)	DI	1
h.	Numerical relay unhealthy	DI	1
i.	Trip Coil healthy	DI	1
j.	Switchgear Available (Breaker in service / Spring charged / Switchgear in remote)	DI	1
k.	Electrical Trip (Lockout relay operated)	DI	1
l.	Numerical relay (Refer Electrical Volume IV for the details.)	Interface through IEC 61850 protocol	1
9.2. ACB Bus Coupler			
a.	Breaker Close	DO	1
b.	Breaker Trip	DO	1

S. No.	DESCRIPTION	Type of I/O	No of I/O
c.	Incomer-1 check Syn	DO	1
d.	Incomer-2 check Syn	DO	1
e.	Bus Coupler check Syn	DO	1
f.	Breaker ON	DI	1
g.	Breaker OFF	DI	1
h.	Switchgear Disturbance (Control Supply Failed)	DI	1
i.	Numerical relay unhealthy	DI	1
j.	Trip Coil healthy	DI	1
k.	Bus -A Under voltage	DI	1
l.	Bus - A PT Fuse Fail	DI	1
m.	Bus-B Under Voltage	DI	1
n.	Bus - B PT Fuse Fail	DI	1
o.	DC Supply-1 Fail	DI	1
p.	DC Supply-2 Fail	DI	1
q.	Switchgear Available (Breaker in service / Spring charged / Switchgear in remote)	DI	1
r.	Electrical Trip (Lockout relay operated)	DI	1
s.	Numerical relay (Refer Electrical Volume IV for the details.)	Interface through IEC 61850 protocol	1
9.3. Outgoing ACB Feeder			
a.	Breaker Close	DO	1
b.	Breaker Trip	DO	1
c.	Breaker ON	DI	1
d.	Breaker OFF	DI	1
e.	Switchgear Disturbance (Control Supply Failed)	DI	1
f.	Numerical relay unhealthy	DI	1
g.	Trip Coil healthy	DI	1
h.	Switchgear Available (Breaker in service / Spring charged / Switchgear in remote)	DI	1
i.	Electrical Trip (Lockout relay operated)	DI	1
j.	Numerical relay (Refer Electrical Volume IV for the details.)	Interface through IEC 61850 protocol	1
9.4. MCCB INCOMER – 1/2			
a.	MCCB Close	DO	1
b.	MCCB Trip	DO	1
c.	MCCB ON	DI	1
d.	MCCB OFF	DI	1
e.	switchgear (Control Supply Fail)	DI	1
f.	Electrical Trip	DI	1
9.5. MCCB Bus Coupler			
a.	MCCB Close	DO	1
b.	MCCB Trip	DO	1
c.	MCCB ON	DI	1
d.	MCCB OFF	DI	1
e.	Switchgear Disturbance (Control Supply Failed)	DI	1
f.	DC Supply-1 Fail	DI	1

S. No.	DESCRIPTION	Type of I/O	No of I/O
g.	DC Supply-2 Fail	DI	1
h.	Electrical Trip	DI	1
10. HT SWITCHGEAR - ELECTRICAL			
10.1. INCOMER – 1/2			
a.	Breaker Close	DO	1
b.	Breaker Trip	DO	1
c.	Breaker ON	DI	1
d.	Breaker OFF	DI	1
e.	Switchgear Disturbance (Control Supply Fail)	DI	1
f.	Numerical relay unhealthy	DI	1
g.	Trip Coil healthy	DI	1
h.	Switchgear Available (Breaker in service / Spring charged / Switchgear in remote)	DI	1
i.	Electrical Trip (Lockout relay operated)	DI	1
j.	Numerical relay (Refer Electrical Volume IV for the details.)	Interface through IEC 61850 protocol	1
10.2. Line PT – 1 / 2			
a.	Line PT under voltage	DI	1
b.	Line PT Fuse Fail	DI	1
c.	PT in service position	DI	1
10.3. Bus Coupler			
a.	Breaker Close	DO	1
b.	Breaker Trip	DO	1
c.	Incomer-1 check Syn	DO	1
d.	Incomer-2 check Syn	DO	1
e.	Bus Coupler check Syn	DO	1
f.	Breaker ON	DI	1
g.	Breaker OFF	DI	1
h.	Switchgear Disturbance (Control Supply Fail)	DI	1
i.	Numerical relay unhealthy	DI	1
j.	Trip Coil healthy	DI	1
k.	DC Supply-1 Fail	DI	1
l.	DC Supply-2 Fail	DI	1
m.	Switchgear Available (Breaker in service / Spring charged / Switchgear in remote)	DI	1
n.	Electrical Trip (Lockout relay operated)	DI	1
o.	Numerical relay (Refer Electrical Volume IV for the details.)	Interface through IEC 61850 protocol	1
10.4. BUS PT – 1 / 2			
a.	BUS PT under voltage	DI	1
b.	BUS PT Fuse Fail	DI	1
c.	PT in service position	DI	1

S. No.	DESCRIPTION	Type of I/O	No of I/O
10.5. Outgoing Feeder			
a.	Breaker Close	DO	1
b.	Breaker Trip	DO	1
c.	Breaker ON	DI	1
d.	Breaker OFF	DI	1
e.	Switchgear Disturbance (Control Supply Fail)	DI	1
f.	Numerical relay unhealthy	DI	1
g.	Trip Coil healthy	DI	1
h.	Switchgear Available (Breaker in service / Spring charged / Switchgear in remote)	DI	1
i.	Electrical Trip (Lockout relay operated)	DI	1
j.	Numerical relay (Refer Electrical Volume IV for the details.)	Interface through IEC 61850 protocol	1
10.6. Transformer Feeder (Dry Type)			
a.	Breaker Close	DO	1
b.	Breaker Trip	DO	1
c.	Breaker ON	DI	1
d.	Breaker OFF	DI	1
e.	Switchgear Disturbance (Control Supply Fail)	DI	1
f.	Numerical relay unhealthy	DI	1
g.	Trip Coil healthy	DI	1
h.	Winding Temperature High (A)	DI	1
i.	Winding Temperature V High (T)	DI	1
j.	WTI Surveillance Unit unhealthy	DI	1
k.	Switchgear Available (Breaker in service / Spring charged / Switchgear in remote)	DI	1
l.	Electrical Trip (Lockout relay operated)	DI	1
m.	Numerical relay (Refer Electrical Volume IV for the details.)	Interface through IEC 61850 protocol	1
10.7. Transformer Feeder (Oil Type) Applicable only in case of Transformers having 11kV or 3.3kV secondary voltage.			
a.	Breaker Close	DO	1
b.	Breaker Trip	DO	1
c.	Breaker ON	DI	1
d.	Breaker OFF	DI	1
e.	Switchgear Disturbance (Control Supply Fail)	DI	1
f.	Numerical relay unhealthy	DI	1
g.	Trip Coil healthy	DI	1
h.	Oil Temp High (A)	DI	1
i.	Oil Temp V High (T)	DI	1
j.	Winding Temp High (A)	DI	1
k.	Winding Temp V High (T)	DI	1
l.	Buchh Relay (A)	DI	1
m.	Buchh Relay (T)	DI	1
n.	MOLG Alarm	DI	1
o.	PRD Trip	DI	1
p.	Switchgear Available (Breaker in service / Spring	DI	1

S. No.	DESCRIPTION	Type of I/O	No of I/O
	charged / Switchgear in remote)		
q.	Electrical Trip (Lockout relay operated)	DI	1
r.	Numerical relay (Refer Electrical Volume IV for the details.)	Interface through IEC 61850 protocol	1

NOTE: -

1. The above Drive Control philosophy is for reference and for estimating the DDCMIS IO quantities. The final drive control philosophy shall be provided to the BOP bidder during detailed engineering stage.
2. In addition to above, Redundancy of I/O cards for DDCMIS I/Os shall be provided as per NIT cl. No. 4.2.5 requirements.
3. The some critical application motors like barring gear motor, air heater motor, lube oil pump, jacking oil pump etc. irrespective of their kW rating, same shall be provided with a CT, ammeter and a current transducer with remote metering in DCS. Local start pushbuttons (for pump / fan, etc.) commands shall be connected to the control system to ensure interlock /protection requirement. The Drives, Critical Valves / Dampers shall be decided during detailed engineering.
4. Local stop push button status. (latched or unlatched) for HT pumps / HT fans shall be connected to DDCMIS in addition to local stop push button command connected directly to HT switch gear.
5. The Voltage rating of Interposing Relays / Coupling Relays / Solenoid Valves which are interfaced with DCS /PLC other control systems for all BOP Offsite packages shall be 24V DC.
6. Drive Control Philosophy for each BOP package shall be submitted separately by Bidder for approval during detailed engineering.
7. All drives (HT / LT / Electrical Actuators) shall be switched ON / OFF through 24 V DC coupling relays to be provided in HT / LT Switchgear panels. DCS/PLC panel/cabinet mounted coupling relays for Solenoid Valves are acceptable.
8. The following philosophy shall be followed for soft communication between HT/LT drives and DDCMIS/ DCS/ PLC
 - a) In the incomers, Bus couplers, Tie feeders, transformer feeders, drives of HT switchgear and for the ACB control incomers, bus couplers, drives of LT switchgear etc. which are provided with Numerical relays, IEC 61850 protocol will be used and shall be directly linked to DDCMIS/ DCS/ PLC without converters. The numerical relays shall be provided with dual redundant ports for IEC 61850 communication and the numerical relays shall be connected in ring topology for linking to redundant controllers of DDCMIS/ DCS/ PLC

For the above, network panel with required number of switches and cabling from Numerical relays upto network panel shall be provided by bidder.



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



- b) For LT drives which are provided with Intelligent controllers, Ethernet-based protocol shall be used for linking to DDCMIS/ DCS/ PLC and shall be linked to DDCMIS/ DCS/ PLC through direct data transmission without converters. The Intelligent controllers shall be connected in star topology to network switches which shall be connected to redundant controllers of DDCMIS/ DCS/ PLC in ring topology. However, the exact Ethernet based protocol to be provided shall be decided during detail engineering depending on which protocol both intelligent controller and DDCMIS/ DCS/ PLC can accept without converter.
- For the above, network panel with required number of switches and cabling from Numerical relays upto network panel shall be provided by bidder
9. Drive control philosophy shall be as per table above and as per drawing # 114-15-0100.

CHAPTER – 4

MAIN EQUIPMENT RELATED CONTROL AND INSTRUMENTATION SYSTEM

4.00.00 SG RELATED CONTROL & INSTRUMENTATION SYSTEM/EQUIPMENTS

4.01.00 FLAME MONITORING SYSTEM

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

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, 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 Bidder shall furnish the justification of selection of flame detector locations for Owners review.

4.01.02 Flame detector shall be working on the dynamic and static properties of primary combustion zone of each type of fuel and flicker frequency of flame. It shall pick up only the flame to which it is assigned and shall not respond to the adjacent and background flame or other radiation generated in the furnace. The design shall also take into account the absorption by a coal shroud, recirculated dust or other deposition on the flame detector head. The complete system shall provide the discrimination between oil and coal flame. Intensity indicators for main flame shall be provided in DDCMIS.

4.01.03 The system should be easily maintainable and include automatic self test facility at regular interval. Flame Monitoring System shall be provided with self diagnostic features, wide viewing angle, fast response time, and high detection range. The sensor fault, alarming, diagnostic and pre historised flame intensity value of flame monitoring system shall be hooked up to integral OWS with suitable software. Air cooling provision at local site for cooling of flame detectors (electronic part) shall be provided

4.01.04 In case of tangentially fired boiler, the Bidder shall arrange flame detectors in such a manner that coal flame detectors are available both above and below each coal burner and separate oil flame detectors are provided for each oil burner. In case Bidder has discriminating type flame detectors capable of detecting and discriminating both oil and coal flame, with the help of a single scanner, the same can also be utilized for monitoring both oil and coal flame per burner. For any other type of firing i.e. non-tangential type the flame detectors shall be provided for each coal and oil burner responding only to the flame of its associated burner.

- 4.01.05 Bidder shall furnish the details of the flame detector locations and justification for the same. Further, the flame detector to be used at each elevation of boiler should have rigid construction with minimum electronics and shall only be used to transfer flame intensity to amplifier installed in control room/ control environment. All the processing of signals and amplifying shall be done at control room in place of Boiler Site.
- 4.01.06 The Bidder 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 oil flame under varying oil pressure shall be checked. In load test, the detector shall be able to detect when only oil is present, only coal is present and both coal and oil are present. It shall be ensured that the detectors are able to detect the proven flame at very low load with oil guns withdrawn. The above tests shall be performed for every coal and oil elevation.
- Provision of scanner air for cooling the flame detectors by 100% redundant Scanner Air Fans, one AC and other DC operated, shall be provided. The dampers associated with scanner air fans shall be pneumatically operated with DC solenoid valves. Pneumatically operated scanner emergency damper shall be erected to safeguard all the flame scanners even in case of failure of both FDs and both scanner air fans.
- 4.02.00 **FLAME DETECTOR TESTING KIT**
- 4.02.01 The Bidder shall also provide a portable flame detector testing kit with built in stabiliser, capable of simulating both oil and coal flame, and testing of flame detector head unit at field. The testing kit shall also have facility for testing all type of electronic cards as being used in the flame monitoring system.
- 4.03.00 **COAL FEEDERS CONTROL AND INSTRUMENTATION**
- 4.03.01 Bidder shall provide a microprocessor based coal 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 Owner's approval during detailed engineering.
- 4.03.02 Bidder shall provide a minimum of two independent speed sensors, pulser units and associated amplifiers, etc. for each of the coal feeders. Output from the speed sensors will be used to provide at least four number isolated 4-20 mA DC analog signals corresponding to coal flow rate in tons per hour and any other signals that may be required for the control of the coal feeder.
- 4.03.03 All associated electronics like buffer amplifiers, frequency to current converters etc. shall be provided for each RC feeder with local speed indicators. The speed sensors shall be totally enclosed, fire, dust and weather proof, suitable for the service conditions.
- 4.03.04 The control cabinet shall be provided with Reset push buttons and individual lights to signal the individual Internal trip conditions. All electronics cards of coal feeders shall be enclosed in control cabinets located away from coal feeding system to avoid damage due to heat and coal leakage.

- 4.03.05 Each feeder shall be provided with a four position switch located at the feeder for remote off, local run (when there is no coal on conveyor) and calibration purpose. Calibration kit for coal feeders should be provided by the bidder.
- 4.03.06 If there is any electronic modules mounted local to the feeder body then these shall be suitable for operating in a non-air-conditioned area in a suitable enclosure to combat the effect of noise, vibration, entry of dust etc. No electronic module should be mounted at local site due to heat, dust and other critical atmospheric conditions in feeder areas. Provision shall also be foreseen to place electronic modules of coal feeders in control room, as per feasibility.
- 4.03.07 All necessary paddle switches and other detectors to monitor coal on belt, feeder discharge plugged, coal motion monitor etc. should be provided to ensure safe operation of the feeders.
- 4.03.08 If the system does not measure coal flow on loss of any signal, alarm has to be given to DDCMIS and initiating the feeder to run on volumetric mode from the gravimetric mode. All Critical analog/digital signals viz. Run, Remote, Coal on belt, Feed rate etc. shall be hooked to main plant DDCMIS.
- 4.03.09 For safe operation of feeder controls, provision for necessary contact outputs from paddle switches to detect "Coal on Belt", "Feeder Discharge Plugged ", signal from Coal Motion Monitor sensor for sensing belt motion and contacts of selector switches mounted on Remote Control Panel & Local Control Panel (mounted on the feeder body) shall be provided.

Also to ensure safe operation, Acoustic Coal Flow Monitor shall be mounted in down spout of bunker for detecting material flow or flow interruption in downspouts. Necessary contact outputs from coal flow monitor shall be generated to feeder controls for alarm purpose.

Required signals like "Feeder Run", "Feeder Stop", "Coal Flow Rate", "Totalizer", "Clean out Conveyor Run & Stop", "Coal Chute Plugged" etc. shall be available in Main Plant DDCMIS for control & monitoring. Coal Feeder Start/ Stop operation shall be envisaged from BMS. The system shall have the capability for data logging and storage of process parameters like total coal consumption, historic density and trip details and recovery of data in the event of power interruption.

The control panel shall be provided with self-diagnostic facility and provision to display alarms for abnormal conditions. Bidder shall facilitate to display the diagnostic alarms on the OWS in Unit Control Room.

The feeder controller shall also have communication facility with Plant DDCMIS (Unit DDCMIS) through redundant soft-link.

4.04.00 **ELECTROMATIC RELIEF (SAFETY) VALVES**

- 4.04.01 The Electromatic safety valve shall be an automatic, electrically actuated pressure relief valve. It shall be possible to set the value for one percent or less differential between opening and closing pressure. The Electromatic safety valve shall be provided complete with all accessories like pressure measuring devices, controller units, local PB station, solenoid assembly,

impulse piping etc. Provision shall also be kept to operate the Electromatic relief valves from the SG C&I part of DDCMIS LVS/OWS and miniature PB stations. The operation of the valve shall be accomplished by operator command or by means of pressure sensitive element which shall precisely and automatically relieve the pressures within very close limits.

4.05.00 **FURNACE TEMPERATURE PROBES**

Bidder shall provide two numbers of furnace temperature probes before platen super heater and/or before Reheater regions and shall be electrically operated, fully retractable type. The furnace temperature probes shall be furnished with complete actuating mechanism and all the logics required for the actuating mechanism. The probe shall be provided with position transmitters, limit switch & indicator for remote indication. Each temperature probe shall have a duplex thermocouple suitable for the measurement range. Bidder shall furnish complete details of the temperature probe along with all the technical catalogues including the details of the actuating mechanism, position transmitters and limit switch which shall be subject to Owner's approval. The logics for furnace temp. Probe shall be implemented in the SG C&I part of DDCMIS.

4.06.00 **Coal Mass Flow & Velocity Measurement System**

On line Fuel flow & velocity measurement facility in each Pulverized Fuel (PF) pipe for each coal pulveriser shall be provided by bidder for accurate, absolute and simultaneous measurement of coal velocity, coal density, coal mass flow rate and air-to-fuel ratio. The equipments shall comprise of sensors working on Micro wave resonance technology for measuring density and electro dynamic correlation method for evolving the velocity. The system shall not be dependent on any sort of comparative measurement for initial calibration at site.

The error in the measuring system (Coal mass flow and velocity) for individual PF pipe shall not be more than +/- 5%, which shall be demonstrated relatively by comparisons with isokinetic measurements as per ISO 9931. The total error in measuring system (Total coal mass flow and air flow out of mill) shall not be more than 5%, which shall be demonstrated by comparisons with gravimetric coal feeders and primary air flow in to the mill irrespective of moisture variation. In case any measurement is required for coal moisture correction in the coal, then the input for same shall be arranged by bidder.

The scope of each steam generator shall include four (04) nos or more of erosion free measurement sensors for each PF pipe from each coal mill as per system requirements, redundant control units (including processors, communication modules, power modules etc), visual display unit, connecting cables etc for making system complete.

For the purpose of above fuel measurement each PF pipe shall be provided with two nos. or more of tapping points of suitable size, 1 no. of tapping for density measurement sensor, 1 more tapping if required for range extender, with necessary plugs/dust proof dummies etc as required.

Automatic Motorised Adjustable valve/orifice of erosion resistant/ceramic coated material suitable for highly abrasive pulverized coal applications shall be provided on each PF pipe at pulveriser outlets and the system shall enable onload adjustment of coal flow in PF pipelines to achieve balanced coal flow.

The system shall also provide 4-20mA DC output for SG C&I and BOP C&I part of DDCMIS and soft link also. Panel protection class shall be IP65. Panel shall be provided with inbuilt laptop for data analysis. Specification of Laptop shall be same as specified elsewhere in the Specification. System shall work on UPS redundant power supply. The offered system shall have a record of trouble free performance of minimum two (2) year in min 1 (one) nos. coal-fired boiler of size 500 MW or above where the firing arrangement is similar to the offered boiler.

4.07.00 **FURNACE AND FLAME VIEWING SYSTEM**

4.07.01 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 coal and oil flame and condition of the furnace internals including slagging of the water walls 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 bidder appropriate to his boiler design subject to minimum 4 nos. camera. Separate set of cameras shall be provided for viewing flame and furnace internals based on proven technology for the intended application. The system shall comply to NFPA requirements.

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

- (a) OWS with 29" High resolution colour LED monitor.
- (b) Facility for zooming and adjustment of iris from the monitor for view of furnace internals.
- (c) Proper cooling arrangement (preferably air) and protection against cooling medium failure (with advance/retract facility mounted).
- (d) Weatherproof IP 65 local control box for mounting of electronics.
- (e) All necessary remote/ local programming tool.
- (f) All interconnecting cable, armored video cables and termination device.
- (g) All necessary software.
- (h) Automatic camera extraction system from the furnace in case of camera cooling arrangement fails.
- (i) Any other accessory like interfacing cables, Remote control unit, Video signal distributors etc. to make the system complete.
- (j) Operation of camera system shall be done through DDCMIS also. All the necessary interface hardware, cables, items, software, accessories to be provided by Bidder for same.

4.07.03 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 1600 deg C.

- 4.07.04 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.
- 4.07.05 The offered flame camera system shall have a record of trouble free performance of minimum one (1) year in a coal-fired boiler of size 500 MW or above where the firing arrangement is similar to the offered boiler.
- 4.07.06 The system shall be capable of transmitting the image to the plant DDCMIS system where it should be possible to display the same on the monitors of Operator workstation and the Large video screen.

4.08.00 **SEPARATOR DRAIN LEVEL CONTROL AND MONITORING**

Bidder shall provide, including all primary and secondary instruments, triple redundant electronics transmitters for separator level and pressure measurements, local gauges, process actuated switches along with all the required control valves & actuators & other accessories. Further, at least Sixteen (16) nos. thermocouples are to be provided for separator metal temperature measurements. Further, if the separator materials call for stress evaluation of separator, the same has to be provided by the Bidder.

4.09.00 **CONDUCTIVITY TYPE LEVEL SWITCHING SYSTEM**

For Drip legs level, etc. used for alarm & protection purposes, conductivity type level probes shall be provided. Each of the switching systems shall be furnished complete with up to 2 nos. conductivity probes for Drip legs column for mounting the conductivity probes, isolating valves, drain valves, vent valves, electronic units & racks for mounting the electronic hardware, twisted & shielded pair interconnecting cables. The conductivity probes & the column for mounting these probes shall be designed for the respective pressure and temperature conditions. The material of column & probes etc. shall be subject to Owner's approval during detailed Engineering Stage.

The electronic unit shall be separate & dedicated for each of the switching system. Each switching system shall have independent and separate redundant, internally fused Power supply pack/converter.

The electrodes shall be designed in such a manner that they sense the rising water level and that they do not give faulty indication due to falling condensate on the electrodes. Also, each system shall incorporate proper validation circuits that eliminate spurious or unwanted alarm/trip actions due to a single channel fault. The system shall have fault diagnostic features such as process faults, system hardware fault, probe failure, circuit board failure, shorted wire etc. Further the system should be able to distinguish between a cable fault & electrode fault.

For each of the levels sensed by each of the switching systems, the Bidder shall provide 2 nos. potential free changeover contact rated for 5A at 240V AC and 0.25 A at 220V DC.

The system shall be proven & approved by factory mutual USA or equivalent, IBR etc.

4.10.00 MILL AND AIRHEATER FIRE DETECTION SYSTEM

4.10.01 Adequate number of thermocouples type fire detection system for each Mill and Air-heater shall be provided as a composite & complete units with all required signals & accessories with adequate redundancy shall be provided

4.10.02 The controls & protection required for the Mill detection system and air heater fire detection system shall be implemented using rate-of-rise algorithm taking care of manufacturer's recommendation.

4.10.03 For measurement of pulveriser outlet temperature, tungsten carbide block thermo wells or abrasion resistant of tungsten carbide coated thermo wells shall be used.

The terminals of temperature sensors shall not be at the top of mills itself. The temperature sensors wires are to be laid up to JB though SS tube of required diameter and the head shall be placed nearer to the JB, as Extension cable exposed to atmosphere in the conventional method melts away due to high temperature at the top of mill or due to coal burning.

4.10.04 The measurement of various temp point of air heater fire detectors system shall be provided in control room for both cold & hot end.

4.11.00 ACOUSTIC STEAM LEAK DETECTION SYSTEM

Acoustic Steam Leak Detection system shall monitor steam tube conditions for any possible tube leakages by monitoring various tube zones in the boiler on continuous on line basis and provide necessary feedback to plant operation personnel regarding the occurrence of, location & extent of tube leakage at the initial stage itself, to enable the plant personnel to take necessary remedial measures early.

The system shall perform the following functions:-

- i. Able to detect the tube leakage at the earliest so as to minimize the secondary damage caused to furnace internals due to steam leakage.
- ii. Capable of Real time detecting and pinpoint the steam tube leakage anywhere in the boiler.
- iii. Monitor tube leakage continuously and showing the leak frequency spectrum.
- iv. Following the leak growing trends.
- v. Real time monitoring noise in the boiler.
- vi. Recording the trend of the leak history.
- vii. Watching operation condition of ash blowers & Soot blowers.
- viii. Self detection of device.
- ix. Judging ash blocked condition of the conductive tubes.
- x. Having mechanical blowing and electric ash cleaning ways in the conductive tubes.
- xi. Digital Filtering of sound signals, Frequency spectrum analysis, trends analysis, bar graph and mimic.
- xii. Automatic air purge system.
- xiii. Alarms to DDCMIS in case of system failure.

- xiv. To be able to filter out atmospheric and other background noise associated with steam leakage such as a valve gland stem leakage noise and combustion noise etc. so as to avoid false steam alarms.
- xv. Shall be able to distinguish between the soot blowing noise and steam leakage noise. 'Soot Blowing On' contact shall inhibit the false alarm/indication and mark the 'Soot Blowing On' event on the display.

Bidder shall provide OWS based Acoustic Steam Leak Detection system with Air Borne Sensors including all Signal amplifiers, calibrators, signal processing hardware and software, power supply distribution cables, Instrumentation cables for the entire system including special cables. Junction boxes, all erection hardware etc. The number and location of the sensors shall be as per Bidder's standard practice subject to Owner's approval during detailed engineering. However minimum number of sensors shall be thirty (30) nos. However, It shall be possible to perform calibration of sensors without disconnecting the sensor. The system shall be expandable to accommodate additional 25% sensors over the qty. of sensors installed initially.

Sensor head shall be protected from hot gas, particulate matter, and corrosive elements in the flue gas by suitable protective tube and enclosure which will however not block the sound waves. The probes shall have a minimum life of 20,000 hours of operation. All the parts coming into contact with hot gas shall be designed to withstand the high temperature. Air purging arrangement for sensors including solenoid valves, piping, SS-tubing, hoses, root valves, isolation valves, air filter regulators shall be provided.

The following shall be the minimum features for monitoring the boiler steam tubes:-

- i. Mimic of overall boiler or in zones of the boiler where one or multiple sensors are located for each sensor shall be displayed on the OWS. System shall also be able to display a 3D model of the furnace, location of each sensor, signal level, alarm status.
- ii. Bar graph display shall be provided for each sensor noise and frequency with respect to time. Trend graph for each individual channel with data and time stamped on single display. Simultaneous trend graph for each of the sensor in a group of 8 sensors. Display shall be updated every 5 seconds.
- iii. The system shall continuously monitor the sound level of all the channels and will activate an alarm at a predetermined sound level.
- iv. The system shall have facility for storing & displaying the historical data on demand regarding the history of each sensor signal amplitude and frequency. The historical data shall be displayed in bargraph and trend form. The data storage shall be with adjustable duration of 1 minute to 1 hour. The data display shall be selectable with a resolution of 1 min. to 1 hour for displaying the history upto 1 year. It shall be possible to retrieve and display historical data concurrently with real time monitoring.
- v. The system shall have facility to store bulk data for 5 years duration with facility for retrieval of same. The system shall have facility to share all the data in the hard disk/ back up media and provide user friendly utilities to retrieve and analyse stored data.

Suitable means shall also be provided so as to listen to any channels so as to check and monitor the sound level, especially during an alarm. The ASLD system shall be connected to SG C&I system through Unit LAN.

4.12.00 COAL BUNKER LEVEL MONITORING SYSTEM (CBLMS):

Two nos. of 3D Acoustic wave level transmitters shall also be employed for measuring the levels of coal bunker available above the coal feeder/mill.

In addition to above, Coal bunker level monitoring system (strain gauge type level measurement) shall also be supplied resulting in triple redundant measurement. Median or average coal bunker level will be chosen for monitoring and for process operations.

Complete Coal Bunker Level Monitoring System consisting of all necessary semiconductor strain gauge sensors, electronic units comprising of signal conditioner, amplifier, signal booster, isolated output signal (4-20mA DC) transmitters, limit value monitors, redundant power supply modules, bar graph type digital displays indicators for continuous level indications, complete weather & flame proof enclosures, any necessary intermediate electronics, interconnecting cables, junction boxes, softwares & any type of hardwares etc. The number & location of the strain gauge sensors shall be selected by the bidder to ensure that overall accuracy (including sensors & electronics units, transmitters, indicators) of the system is +/- 10% or better in spite of possible interaction between support system of adjacent bunkers. Complete system shall operate on UPS redundant power supply only.

The electronic units shall be mounted in a cubicle located in CER in TG building. These shall provide two isolated 4-20mA DC output for the DDCMIS and to bargraph type digital displays indicators to be provided by bidder at floor for each bunker. In addition one no. spare isolated 4-20mA DC output shall be included for each bunker. In addition to 4-20 mA signals, relay output for low & high level shall be provided for each bunker. These bunker level signals shall also be transmitted to Coal handling system DDCMIS through redundant soft link interfacing between plant DDCMIS & CHP DDCMIS or station wide LAN as applicable.

Separate set of sensors and separate electronic unit and separate display unit shall be provided for each bunker.

Electronic unit and Level Indicators:

Each electronic unit shall include signal conditioners, amplifiers, limit value monitors, power supply for all the strain gauge sensors of the respective coal bunker, controls for Zero and span adjustments, high and low set adjustments, transmitter for 4-20mA DC galvanically isolated output signals.

Strain Gauge Sensors:

The Bunker level sensors shall be of semiconductor strain gauge type with Nickel plated stainless Steel base suitable for bolting on the structural member, strain on the sensor represents weight/level of each bunker. The elongation/compression of the sensor base is sensed by two semiconductor elements forming a half bridge circuit. The sensor shall be encapsulated

hermetically with 3 wire flexible lead for external connections. The sensor base material shall be matched with that of its mount. The strain gauge sensor shall be rugged, immune to temperature variations, vibrations, & shock, and easy to install and shall meet the following performance specifications as a minimum:

- i. Non-linearity : ± 0.1 %
- ii. Repeatability & Hysteresis : ± 0.05 %
- iii. Compensated temperature range : 0-55°C

NOTE: If it is found that the offered system does not meet the accuracy of $\pm 10\%$ during commissioning, additional sensors along with all necessary accessories to be supplied by the bidder without any cost implication to meet the $\pm 10\%$ accuracy.

4.13.00 On Line Carbon in Ash Analysers System

The system shall utilize non sampling/extraction type microwave technology for online monitoring/measurement of the unburnt carbon in fly ash with minimum 4 nos. probes measurement to have complete profile per location. The system shall measure a fly ash at a representative location (The Locations shall be decided & Finalised by owner during detailed engineering). In order to maximize the reliability, the number of moving parts on the sensor shall be minimized. Accuracy shall be ≤ 0.6 % minimum. The system shall also provide 4-20mA DC output for SG C&I and BOP C&I part of DDCMIS and thru redundant soft link also. Panel protection class shall be IP65. Panel shall be provided with industrial grade 7" LCD display. System shall work on UPS power supply. "On Line Carbon in Ash" Analysers System shall be used in optimization package also. Necessary arrangement for ash collection shall also be provided by bidder for analyser. Material of ash funnel/collector shall be same as provided for "main application/ the body of the sensor intruding inside the process". The offered system shall have a record of trouble free performance of minimum one (1) year in a coal-fired boiler of size 500 MW or above where the firing arrangement is similar to the offered boiler.

4.14.00 Acoustic Pyrometers

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

For each temperature measurement plan/section, A system complete with all required software, comprising of minimum eight nos. of acoustic transreceivers or minimum two nos. acoustic transmitters & minimum twelve nos. acoustic receivers, signal processors/controllers, interface unit, Operating WORK STATION & A4 sized Colour LaserJet Printer shall be provided. The minimum specification of the WORK STATIONS & printer shall be as specified in specification. The system shall be able to eliminate the varying high noise environment both in and out of an operating boiler

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 redundant interface devices. 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 nos. of acoustic transreceivers or two nos. acoustic transmitters & twelve nos. acoustic receivers should be less than one minute.

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 $\pm 2\%$, & $\pm 4\%$ of reading respectively or better. The system shall provide 4-20mA DC outputs for DDCMIS. The system shall be time synchronised with master clock system.

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. The components to be located at Boiler Area shall be able to withstand the stringent environmental condition expected at such locations with operating Boiler.

System shall be provided with high speed technology, so that system can collect minimum 24 paths simultaneously. The system shall be capable to measure every path in both directions simultaneously. Every path shall be measured two times (back and forth) after the transmit cycle (each transceiver has transmitted once).

Special attention shall be given in the design for inspection, removal, replacement, cleaning and protection of any of the component parts of the Acoustic Pyrometer.

Bidder shall also supply 10% or 2 no. (whichever is more) of each type of sensor & instrument, each type of Electronic card/processor, each type of power supply card, each type of instrumentation/ mechanical fittings etc for Acoustic Pyrometer system.

4.15.00 TG RELATED CONTROL & INSTRUMENTATION SYSTEM/EQUIPMENTS

4.15.01 TURBINE SUPERVISORY SYSTEM (TSS)

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, Ext./compensating cables, SS junction boxes etc. for Steam Turbine and Turbine Driven BFP.

Operating Temp. for sensors and extension cables shall be 0-177 deg. C.

2. Following minimum measurements are envisaged to be provided by the Bidder for supervisory purpose. However based on Bidder's standard and proven practice, the Bidder shall clearly identify and bring out the applicable measurements for his equipments in techno commercial stage I – bid for owner's review/approval.
 - (a) Shaft eccentricity detection.
 - (b) Absolute as well as relative shaft vibration measurement, of each

- bearing in both X & Y direction (both for Turbine and Generator bearing).
- (c) Differential expansion of rotor and cylinder for HPT, IPT and LPT.
 - (d) Overall expansion of HPT and IPT.
 - (e) Absolute bearing vibration measurement of each bearing in both X & Y directions (both for turbine and generator bearings).
 - (f) Axial shift of the rotor, (minimum four sensors).
 - (g) Turbine speed (minimum four sensors).
 - (h) Emergency stop and control valve position.
 - (i) Main steam and hot reheat steam inlet temperature and pressure.
 - (j) Generator bearing metal temperatures, Generator bearing oil drain temp.
 - (k) In case of vibration, shaft mounted reference detectors and required supervisory instrument circuitry shall also be provided.
 - (l) Bearing metal, turbine casing temp. and turbine bearing oil drain temp.
 - (m) Casing vibration
 - (n) Generator winding temp
 - (o) Any other measurement recommended by the Turbine OEM 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 other Control Systems. The system should suitably interface with HMIPIS system supplied by Bidder.
 4. For all vibration measurements indicated above, a Microprocessor/computer based system (with dedicated colour Operating station with 29" industrial type LED monitor & A4 Color LJP) shall also be provided to achieve the functions described under following items a) to e). This system shall also have the feature to accept minimum 100 nos. (or as per actual requirements in case higher quantities) buffered raw input from the vibration monitors of all the auxiliary drives & motors for SG, TG & CW auxiliaries and provide the following functionality for these machines as well. In case the make of TSS is same as that of Vibration monitoring system defined under Part A, Vol. V, measuring Instrument", there is no need to bring the raw buffer input to TSS if the analysis is possible within respective system modules/ racks.
 - a. TSS shall have sufficient DI & AI channels for inputs like Turbine bearing temp, Unit load etc. for analysis of related information.
 - (a) On-line spectrum / harmonic analysis, Mechanical imbalance and Oil-Whirl, Corbit/ 3 D plot, Spectrum Plot and Spectrogram Plot.
 - (b) Identification of the exact nature of failure resulting in increase in bearing vibration and direct message on the monitor indicating the exact nature of fault e.g. mal-alignment, shaft crack, bearing looseness etc through use of intelligent software packages.
 - (c) Storage and comparative analysis of vibrations.
 - (d) Generation / analysis of Bode Plot/ Orbit Plot and time waveform/ Nyquist plot/shaft centre line plot/ cascade and water fall plot.

- (e) All the vibration parameters as well as Turbine supervisory parameters shall also be fed to the Turbine Control System through hardwiring or through suitable link so that all these parameters are suitably displayed on the TG control OWS/LVS. All required I/O cards and other processing modules etc. shall be provided for this purpose. Further, necessary interface for hooking up these signals to BOP C&I System shall also be provided.
- (f) In addition to the vibration analysis and diagnostics system's specification requirement specified, facility for adding rules for fault shall be provided. Facility shall be provided for protecting the rules. Vibration analysis and diagnostics system shall take care of predictive maintenance of machine/equipment and guide the plant maintenance personnel regarding the nature of fault and the maintenance action required. Latest Automated Machinery analysis and Diagnostics software shall be supplied.
5. In case make for Vibration monitoring system and Vibration analysis and diagnostic system is separate from TSS for the auxiliary drives & motors for SG, TG, CW auxiliaries and BOP auxiliaries per unit, then separate Microprocessor/computer based system (with dedicated colour Operating station with 29" industrial type LED monitor & A4 B/W LJP) considering geographical distribution shall be provided to achieve the functions described above items a) to f).
 6. Test calibration jigs for site calibration of all sensors of TSS shall be provided.
 7. The Turbine Supervisory Instrumentation monitoring system and Vibration analysis and diagnostic system shall meet the requirement of API-670- (Latest edition) and BS: 4675, Part-2.
 8. The TSS system shall be fed from UPS 230 V AC, 50 Hz supply. All the necessary power supply packs and other devices required to convert the above supply to the levels required by monitors / transducers / other electronics shall be redundant & shall be provided by the Bidder.
 9. Complete TSS shall be time synchronized from Master clock system.
 10. All the sensors shall be provided with max + 5 % sensitivity tolerance.
 11. 2 relay modules shall be provided separate for vibration & position measurements. Each point shall be provided with min. 2 outputs one each for alarm & trip.
 12. Two (2) nos. Buffer output shall also be provided per measurement for TSS /VMS system.
 13. Following feature shall be incorporated by Bidder for TSS/VMS as per API 670, 4th Edition, Cl. no. 5.4.1.5 & 5.4.1.6.
 - i. Vibration Monitor front face status indication shall be available for indication of health conditions of pickup circuit, monitor circuit and

power supply. Also set point indication with set point adjustment facility for setting alarm & trip levels shall be provided.

- ii. The facility shall be available from front of mounting rack for functional checking of monitors with inhibition of alarm of alarm and trip contact outputs during test.
14. Vibration monitoring system and Vibration analysis and diagnostic system shall be separate from Unit's TSS & Unit's auxiliary drives & motors for SG, TG, CW auxiliaries and BOP auxiliaries for Common BOP System. Separate Microprocessor/computer based system (with dedicated colour Operating station with 29" industrial type LED monitor & A4 B/W LJP) considering geographical distribution shall be provided to achieve the functions described above items a) to f). VMS & TSS shall preferably from same OEM. Separate Server/ OWS shall be provided for TSS system.

**4.16.00 TDBFP RELATED CONTROL & INSTRUMENTATION SYSTEM/
EQUIPMENTS BFP TURBINE SUPERVISORY INSTRUMENTS**

- 01 Following minimum measurements are envisaged to be provided by the Bidder for TD BFP supervisory purpose. However based on Bidder's standard and proven practice, the Bidder shall clearly identify and bring out the applicable measurements for his equipments in techno commercial stage I – bid for owner's review/approval.
- i). Shaft eccentricity
 - ii). Axial shift, (with three pickups)
 - iii). Differential expansion.
 - iv). Overall expansion.
 - v). Speed (with three pickups)
 - vi). Turbine casing and bearing metal temperature for all bearings.
 - vii). Stop valve metal temperature
 - viii). Bearing pedestal vibration (both in horizontal and vertical direction).
 - ix). Absolute as well as relative shaft vibration measurement of each bearing in both x & y direction.
 - x). Any other measurement recommended by the Turbine manufacturer as required for the safe and reliable operation.
- 02 Duplex K-type thermocouples/duplex 100 ohm platinum RTDS shall be provided for the metal temperature and on the thrust bearing faces.
- 03 Separate and independent hardware/electronics shall be employed for each of the TDBFP.
- 04 Also refer item (4) of clause no 4.15.01 above.
- 05 Test calibration jigs for site calibration of all sensors of TSS shall be provided.

4.17.00 Viscosity Meter

S. No.	Description	Specification
1.	Standards	Hazardous-area approved (ATEX) All versions conform to the latest international standards for EMC, and are compliant with EN 61326/IEC 61326.
2.	Measurements	i. Dynamic viscosity ii. Integrated density iii. Temperature
3.	Vibration Sensor Type	Vibrating fork sensor piezo drive with density and viscosity measurement.
i.	Materials	Wetted parts: 316L Stainless steel
ii.	Tine finish	PTFE/PFA Coated
4.	Temperature sensor	Integral PT100, IEC 60751 Class A/ DIN 43760 Class A.
5.	Electronic Enclosure	SS316/Die Cast Aluminium/Cast low copper alloy with Polyurethane paint finish
6.	Process connections	1.5" Cone seat or as per system requirements.
7.	Viscosity Range	0.5 to 100 cP
8.	Viscosity accuracy	Min. $\pm 1\%$ span (± 0.2 cP up to 10 cP)
9.	Viscosity repeatability	$\pm 0.5\%$ of reading
10.	Temperature range	Process : -40 °C to $+200$ °C Ambient : -40 °C to $+85$ °C
11.	Pressure range	As per Process requirements. Test pressure - Tested to 1.5 x the maximum operating pressure
12.	Density calibrated range	0.6 to 1.25 g/cc (38 to 78 lb/ft ³)
13.	Density accuracy	Min. ± 0.001 g/cc (± 0.0624 lb/ft ³)
14.	Density repeatability	± 0.0001 g/cc (± 0.0062 lb/ft ³)
15.	Power supply	Redundnat 24 V dc / Redundnat 240 V AC UPS.
16.	Analog outputs	2 x 4-20 mA, isolated (self-powered by default) Power supply: 15-28 V dc Accuracy: $\pm 0.1\%$ reading, $\pm 0.05\%$ FSD @20 °C Repeatability: $\pm 0.05\%$ FSD over range -40 to $+85$ °C
17.	Communication	RS-485 (Modbus)
18.	Electrical connection	Screw terminal, cable entry to suit 1/2" NPT double compression cable gland
19.	Protection	IP66 (Explosion proof for NEC Class-1, Division 1 area)/Flame proof (IEC - 79.1, Part I).
20.	Software	Complete Software Tools as required.
21.	Location	At each HFO heater outlet.

4.18.00 Boiler Feed Pumps Instrumentation

Each BFP turbine shall be equipped with a redundant DDCMIS microprocessor based electro hydraulic governing (EHG) system, and Turbo supervisory Instruments (TSI). The speed demand signal is fed from the feedwater control loop to the speed controller of the EHG systems. This signal, in turn, is fed to the valve lift controller which modulates the opening of the valve admitting steam into the turbine.

For the purpose of BFP turbine supervision, Turbo supervisory Instruments for measuring eccentricity, axial shift, differential axial expansion, overall expansion, bearing pedestal vibration, speed, Absolute & relative shaft vibration measurement of each bearing, turbine and stop valve metal temperature shall be provided as per above cl. No. 4.15.00 & 4.16.00.

Controls of Electro-hydraulic governing system, Turbine Protection, TDBFP auxiliaries like drain valves, EOP, JOP etc. and Turbovisory Instruments (TSI) shall be implemented in DDCMIS. Control of MDBFP shall also be totally from DDCMIS.

- 4.18.01
- a. The BFP Turbine speed shall be controlled by Electro-Hydraulic Governor, Stable and satisfactory speed control over full speed range from 0% to 100%. The Electro-Hydraulic governing system hardware shall be microprocessor based with hot backup. Two (2) set of three (3) speed sensors with transmitters i.e one set for governing system in separate rack & another set for over speed protection in other separate rack and one spare speed sensor with transmitter shall be provided for speed measurement. Separate speed sensors shall also be provided for turning gear operation as per manufacturer's recommendation.
 - b. When the Governing system is in auto mode, it will receive speed demand signal from FW control loop and in manual mode shall be fed either from OWS or through Auto/manual stations. The actual speed of the turbine should be measured by three independent speed sensors and three independent speed measurement channels. These three signals shall be fed to the speed controller. The speed controller output shall be fed to the valve lift controller. The output of valve lift controller shall be fed to the electro-hydraulic convertor which shall vary the position of the control valve admitting steam into the turbine. The Electro hydraulic controller shall be designed such that the transfer between different steam sources should be bumpless:
 - c. A 220 V Split-series field, reversible, totally enclosed DC motor along with an electronic controller, shall be provided for remote speed changing operation.
 - d. In addition to specification requirement and bidder's recommended instruments, following instruments & equipment shall be provided for remote monitoring of parameters in DDCMIS. Instruments shall also follow the redundancy criteria mentioned elsewhere in the specification.
 - i) Pump recirculation flow & balance leak off pressure & flow.

- ii) Lube oil tank level.
 - iii) Lube oil temperature & pressure at strainer outlet.
 - iv) DP across lube oil strainer and feed pump suction strainer
 - v) Differential temperature across pump suction & discharge
 - vi) Seal water inlet & outlet pressure
 - vii) Cooling water pressure at inlet & outlet of lube oil cooler.
 - viii) Cooling water & lube oil flow at outlet of lube oil cooler.
 - ix) All bearing oil pressure & temperature.
 - x) Lube oil temperature at inlet & outlet of lube oil cooler.
 - xi) Open & close indication of all manual isolating valves related to feed water, seal water, DM cooling water.
 - xii) Lube flow elements and transmitters for lube oil, cooling water, or any other auxiliary system as required. Bidder may consider turbine type flow meter as cooling water and oil flow measurements. Flow nozzle for feed water flow measurement.
 - xiii) Feed pump recirculation valves of suitable size and capacity and having proven background for BFP recirculation flow service for similar operating condition with pneumatic (0.2-1 kg/cm² full stroke) actuators.
 - xiv) Duplex RTD's/Thermocouples for bearing temperature, thrust bearing of main and booster pumps, journal bearing of main and booster pumps , suction & discharge of main & booster pumps and differential temperature, bearing drain oil, bearing temperature of driven & non-driven end of pumps and motor, seal water outlet at driven and non-driven end.
 - xv) Triple Steam pressure Transmitters, Triple steam temperature Element, and dual steam flow transmitters to each BFP steam turbine.
 - xvi) Motorized isolation valves at inlet of each TDBFP from CRH, PRDS & HPH.
 - xvii) Pressure Transmitter, Temperature Element, Pressure Gauge And Temperature Gauge at inlet of each TDBFP from CRH steam line, Aux steam line and Extraction steam line.
 - xviii) Dual redundant Position Transmitters for stop valves and governing control valves.
 - xix) Gland steam pressure control valves, exhaust hood temperature control valves, lube oil temperature control valves.
 - xx) Temperature elements & temperature gauges at drain lines.
 - xxi) Turbine casing metal temperature measurement at 50% and 100%.
 - xxii) DP transmitter and switch across oil strainer
 - xxiii) Differential temperature protection 2/3 logic through Differential temperature transmitter
 - xxiv) Triple measurements for Suction water flow and Discharge water flow.
 - xxv) Any displacement transducer since the size of the turbine will be bigger.
 - xxvi) Vibration measurements.
- e. Digital/Electronic Over speed protection & Monitoring system shall be provided with TMR configuration. This system shall comply the requirements of latest edition of IEC 61508, IEC 61508, API 670 and API 612 requirements.

4.18.02 **BOILER FEED PUMP (MD BFP)**

- i. Boiler Feed pumps Motor driven shall be controlled & monitored from the DDCMIS' operators' station at central control room.
- ii. Feed pump shall have start permissive and trip interlocks configured in DDCMIS. All critical instruments shall be configured in 2 of 3 voting philosophy.
- iii. Conventional temperature switches have not been envisaged. Temperature switch function for pump and process safety shall be derived in DCS as software switch from RTD/Thermocouples.
- iv. One (1) set of three (3) speed sensors with transmitters and one spare speed sensor with transmitter shall be provided for speed measurement.
- v. Boiler feed Pump system shall generally include but not be limited to the following:
 - a) Smart type pneumatic actuators for hydraulic coupling system with all mounting accessories. Standard 4-20mA DC signal input for I/P converter (with stay-put feature) and position transmitter signal interface to be embedded in the smart positioned with HART protocol. **Separate moisture separator unit** for ensuring the quality of air entering the I/P convertor shall be supplied.
 - b) Pump and motor bearing vibrations, axial play, speed both at local and remote and key phasor for complete machine monitoring & protection with required signal exchange with DDCMIS, Pump and motor bearing temperatures shall also be used for monitoring, interlocks and protective functions.
 - c) All pressure & temperature stubs, thermo wells, root valves, impulse lines, gauges, manometers, thermometers, analyzers, sample retrieval system and other instruments for performance guarantee test measurements. Stubs and take off points for performance guarantee test measurement shall be separate and shall not be shared with online measuring instruments.
 - d) Pressure and temperature gauges, RTDs, Transmitters and switches for lube oil, working oil, cooling water and heat exchangers and other important systems and auxiliaries related to basic system performance and safety and for the purpose of monitoring critical parameters in DDCMIS.
 - e) In addition to local gauge board, necessary remote reading in DDCMIS are to be provided for following local gauges and instruments ensuring safety of BFP pump
 - i) Oil supply pressure and drain oil temperature gauges of each bearing.
 - ii) Differential pressure across feed water suction strainers, cooling water strainer & oil strainer discharge pressure of main and booster pump, suction pressure of the booster pump, balance leak-off pressure.

- iii) Lube oil and cooling water temperature at the inlet and outlet of coolers.
 - iv) Inlet and outlet temperature of seal water and its cooling water.
 - v) Suction and discharge temperature of feed water pump.
 - vi) Pressure switches for main & booster pump suction and discharge, balance leak-off, lube oil-permissive & trip, aux oil pump cut-in and cut-out.
 - vii) All bearing temperatures.
 - viii) Lube oil/working oil level.
 - ix) Working oil temperature.
 - x) DP transmitter and switch across oil strainer
 - xi) Differential temperature protection 2/3 logic through Differential temperature transmitter.
 - xii) Triple measurements for Suction water flow and Discharge water flow.
 - xiii) Vibration measurements.
- (f) Local start-stop facility for feed pump, auxiliary oil pumps, open & close operation facility of cooling water discharge valve, feed water discharge valve, re-circulating valve.

CHAPTER – 5

STEAM AND WATER ANALYSIS SYSTEM

5.00.00 **STEAM AND WATER ANALYSIS SYSTEM (SWAS)**

5.01.00 The Bidder shall provide centralized SWAS for online analysis and monitoring of purity of condensate, feed-water and steam.

The SWAS system shall comprise of primary sample coolers, secondary sample coolers, thermal shut off valves, bulk head, back pressure regulators, high & low pressure regulators, switches & indicators for pressure, temperature and flow measurement/alarms, sample isolation valves, cooling water throttling/ diverting/isolation valves, relief valves, grab sample, sink and analysers for measuring Specific conductivity (SC), Cation conductivity (CC), pH, Chloride (Cl), Turbidity, Hydrazine, Silica (Si), Sodium (Na) and Dissolved oxygen (DO₂) and any other analyser as per latest rules/regulations etc.

5.01.01 All system components and accessories required for completeness of this system shall be furnished by the Bidder 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.

5.01.02 The complete steam and water sampling, conditioning and analysis system shall conform to the following standards and requirement specified herein.

Standard	Guidelines
ASME PTC19.11	Standard Practice for steam and water sampling, conditioning and analysis in power plant
ASTM D3370	Standard Practice for sampling water from closed conduits
ASTM D1066	Standard practice for sampling steam
ASTM D5540	Standard Practice for flow control and temperature control for on- line water sampling and analysis
BS 6739	Code practice for instrumentation in process control system: Installation, Design and Practice

5.01.03 The SWAS panels shall comprise of two panels viz. Sample Conditioning Panel and Analyser Panel located in centralized SWAS room. The grab sample facility and quick disconnect patch board facilities shall be provided on sample conditioning panel. Analyzer Panel (Dry Section) shall house cells, analyzers, monitors etc. All the SWAS panels shall be located in air conditioned area.

5.01.04 Sample conditioning panel and analyser panels shall be designed as per good engineering practice ensuring safe accessibility for maintenance, distance of analyser from the process line and aesthetic layout.

5.01.05 Cooling water required for SWAS system equipments shall be closed circuit equipment cooling water using DM water. Further, 2X100% chiller system shall be provided by the bidder for ensuring chilled water supply to sample conditioning system.

- 5.01.06 The purity of condensate, feedwater, steam etc shall continuously monitored through online analysis system as per the Drg No # 114-14-0101, Rev 00 attached. The online chemical analysis for pH, conductivity, Hydrazine, sodium ion, silica, dissolved oxygen, chloride; 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 Owner. The system shall be generally designed in accordance to the recommendation of ASME PTC 19.11 Part-II, water and steam in power cycle.
- 5.01.07 The bidder shall provide the chemical analysis system as a composite system including sample piping, valves, grab sample collection facility, gauges/indicators, coolers, on-line analysers etc. The SWAS shall include the following meeting the technical requirement as indicated herein.
- 5.01.08 The bidder shall be fully responsible on the 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 bidder although these may not be individually specified herein. All the 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.
- 5.01.09 All piping, tubing, fittings, valves, filters and other wetted parts in the sampling and analyzing system shall be of type 316 H stainless steel or other suitable material for the service approved by the Owner only. No plastics or rubber shall be permitted except within analyzers as furnished by the manufacturer. Double ferruled compression type fittings shall be used only.
- 5.01.10 Information and alarm signal from SWAS system including analysers/monitor output signals, chiller system etc shall be hooked up to DDCMIS for monitoring purposes as well as for control of dosing systems through remote input/output modules.
- 5.02.00 **SWAS PANELS**
- 5.02.01 The SWAS Panels shall comprise of two panels viz. sampling conditioning Panel and Analyser Panel. 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 the front of the panel. The grab sampling facility and quick disconnect patch board facilities shall be provided on this panel.
- 5.02.02 Analysers Panel (Dry Section) shall house cells, analysers, monitors etc.
- 5.02.03 (i) The above panels shall physically separate from each other and shall be mounted in the air-conditioned SWAS room. Sample conditioning panel shall be corridor type with walkway construction with side doors and removable type plate at the back. The analysers panel shall be standing and totally enclosed type plate at the back doors. The panels shall be constructed of 2.5 mm thick steel except for doors. which shall be 2.0 mm, thickness. The panel

floor shall be made of SS 316 stainless Steel sheet of 5 mm 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. All piping shall be concealed/through trenches. All SWAS panels shall be furnished with 100 mm base angle for bolting to 100 mm high concrete curb furnished by the Owner. The foundation details, layout and general arrangement of these panels shall be subject to Owner's approval. Panel colour shall be as per Vol V, Part B, Chapter 6.

(ii) Lighting

- a. Illumination level in the shelters will be at a minimum of 300 lux at 750mm Elevation inside the shelter. Maintenance factor shall be 0.65.
- b. External dome type lighting shall be under the overhangs to provide sufficient Illumination for maintenance work.
- c. Power switches for internal and external lighting will be provided near to the Main entrance on the outside of the Sample conditioning panel.

5.02.04 Arrangement of equipment shall be generally as per enclosed drawing no. # 114-14-0101, Rev 00 or owner approved alternative arrangements.

5.02.05 Operator work station, with A4 sized colour laserjet printer for monitoring and alarming (Hooked up to station wide LAN of the DDCMIS system) (for OWS specification, refer in Vol. V, Part B, Ch-3, DDCMIS) shall be provided by the bidder.

5.02.06 Fire & smoke detection devices shall be provided with pot. free contact to DDCMIS and suitable interfacing to connect with local work station for alarm purpose.

5.02.07 Power distribution board with external surge protection devices for distribution of Redundant UPS power supply with auto changeover circuitry & Non UPS 240/230 V AC power supply for all individual consumers as individual analyzers, auxiliary equipment inside and around the wet panel and Dry panel. Lighting receptacles and redundant fans shall be provided in each section of Dry panels. Each of the main systems shall have an individual isolation circuit breaker 2 pole type mounted nest to the individual power users. Panel fan failure, UPS feeder failure and 24 V DC feeder failure alarm shall be provided to DDCMIS.

5.03.00 **SAMPLE CONDITIONING SYSTEM**

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

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

- a) Primary sample cooling (wherever specified) in the field.
- b) High pressure reduction (wherever specified) in the field.
- c) Two nos. racks shall be provided by the bidder 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 finalised during detail Engineering stage.
- d) Sample Filtering.
- e) Secondary sample cooling and temperature control.
- f) Pressure reduction and control and measurement as required.
- g) Flow rate control and measurement.
- h) Other treatment as required by individual analysers or as specified herein.

5.03.03 All samples having a temperature in excess of 45 deg C shall be cooled by use of primary sample cooler. Primary sample coolers shall be part of SWAS system only and shall not be shared with any other system. Field sample coolers specified for grab sample of boiler area anywhere in the specification shall be separate from SWAS system. Inconel-625 coil primary coolers will be supplied for each high pressure and high temperature sampling lines.

The sample cooler shall use DMCW water as cooling water. This cooling water is tapped from DMCW system whose temperature may vary from 20 deg C to 40 deg C. A maximum cooling water temperature of 40 deg C shall be considered for design of sample cooling system. Capacity of cooler shall be adequate to cool the sample within 5 deg C of cooling water inlet temperature considering the combined flow of each analyzer connected to sample cooler and one manual grab sample at flow rate of 500 cc per minute and assuming adequate fouling factor of 0.2. Cooler capacity calculations shall be submitted by bidder during detailed engineering. Provision shall be made for heat exchanger shell drain duly valved and piped to waste drain header to the nearest building drain. Temperature switches shall be provided in the sample lines at the primary coolers outlets for sample outlet temperature high annunciation and Thermal shut-off valve shall be provided in the sample lines at the primary coolers outlets for shut down of high temp. Sample at inlet to secondary cooler.

Provision shall be made for adjusting the temp. of each sample individually at an optimum value.

Sample cooler shall be of submerged Helical coil type of shell and tube design with removable shell. The sample tube shall be of seamless with no welds and other joint inside the cooling jacket. Unions shall be provided to facilitate removal of coils. All sample coolers shell, coil, tubing and fittings, other components shall be constructed of type 316 stainless steel or better as per process requirements. Cooler design shall conform to requirements of ASTM D1192- 1998 (Equipment for sampling industrial water and steam). IBR certificate is required wherever applicable. The shell relief valve shall be built in type.

5.03.04 Each sample stream with the required flow rate shall be finally cooled from approximately 45 Deg C to 25 Deg C \pm 1 Deg C or to a preset temperature required by the analyser through an individual secondary cooler before passing the sample to the respective measuring cells and analyser even in case, the corresponding analyser is rated for higher sample temperature. The capacity calculation (considering fouling factor of 0.2) shall be subject to Owner's approval during detailed Engineering. The secondary cooler shall also use condensate quality chilled water at 20 Deg. C. Chilled water provided by packaged refrigeration unit (chillers) to be furnished by the bidder. All samples will be passed through cartridge type filters before being cooled in respective secondary coolers. The secondary coolers will also be of submerged helical coil type of shell and tube design meeting the intent of ASTM D 1192-1998. All sample coolers shell, coil, tubing and fittings, other components shall be constructed of type 316 stainless steel or better as per process requirements. Secondary cooler shall be protected by a relief valve on the cooling water jacket of each cooler in addition to a relief valve at the cooling water header. Provision shall be made for heat exchange shell drain duly valved and piped to waste drain header to be supplied by the bidder.

Wherever primary coolers are not required for sample temperature less than 45 deg C, Temperature switches shall be provided in the sample lines at the secondary coolers outlets for sample outlet temperature high annunciation and Thermal shut-off valve shall be provided in the sample lines at the secondary coolers outlets for shut down of high temp. sample at inlet to the Analysers.

5.03.05 **Chiller System**

- 1) Two (2) 100% capacity water cooled chillers shall be provided.
- 2) Each chiller Unit shall be designed with sufficient refrigeration capacity to ensure each sample stream temperature to 25 Deg C \pm 1 Deg C when all streams are simultaneously at maximum flow rate and maximum temperature. Chiller capacity shall have a provision of 25 % spare capacity for future samples.
- 3) Suitable temperature monitoring and control systems shall be provided for maintaining the chilled water temperature at chiller outlet at 20 Deg C or at a designed preset value and within the desired band.
- 4) The compressor shall be readily accessible for service and shall include low noise hermetically sealed motors. Compressor assembly shall also include crank case heaters, suction and discharge valves, oil sight glasses, forced feed lubrication system and an integrated motor protection system along with the necessary instruments.
- 5) The condenser shall be water cooled, cleanable shell and tube with water regulating valve. The cooling water shell be arranged by bidder from equipment cooling water/DMCW system of TG Package. All the pipes, fittings & valves required to take the water from customer tapping point to the chiller shall be in bidder's scope.
- 6) Chiller shall be of direct expansion type with refrigerant tube inside a shell, completely insulated and to be constructed in accordance with the ASME code for unfired pressure vessels.

- 7) Refrigerant circuit shall be complete with a thermostatic expansion valve.

Liquid line solenoid valve, sight glasses, filter dryer, refrigerant shut off and charging valves.
- 8) The chiller water pump shall be of the centrifugal type, close coupled, bronze fitted construction, complete with motor. Pump & motor shall be designed for continuous operation.
- 9) Vibration dampeners shall be mounted between the packaged chiller and the channel base.
- 10) Cooling water and chilled water piping shall be provided with block valves.
- 11) The bidder shall provide detailed calculation for chiller capacity and other technical particulars like foundation details/mounting etc. and the same shall be subject to owner's approval.
- 12) The chiller system 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 instrumentation/equipments required for smooth, convenient operation of the system, which shall also be furnished by the bidder.

5.03.06 The steam and water Analysis system shall be provided with the sample shut off valves, blow down valves, solenoid actuated valves, thermal shut off valve, pressure reducing valves, safety relief valves, back pressure regulating valves, high pressure reducing valves etc as indicated in diagram of SWAS (drg No # 114-04-0101, Rev 00) . The requirement 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 400 bars and an operating temperature of 400 Deg C.

All critical components like sample coolers, PRV, sample shutoff valves, blow down valves, thermal shutoff valve, sample relief valves, shell relief valves and all type of fittings on sample lines etc.

- 2) The back pressure regulating valve shall be globe type and shall be suitable for a pressure range of 0-50 psi. 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. SS trim with linear flow characteristics shall be provided. Bidder shall submit the data sheet of these valves and these shall be subject to owner's approval during detailed engineering stage.

- 3) The cooling & chilled water header shall be provided with pressure gauges, temperature gauges, Temperature switches, flow switches, safety relief valves, flanges and isolating valves etc and instruments as indicated in NIT's SWAS drawings.

5.03.07 Gauges

- 1) Temperature gauges shall be of 100 mm Hg in steel/inert gas type thermometers with SS316 capillary of length required for installation, bimetallic type thermometer will not be acceptable.
- 2) Pressure Gauges shall be of 150 mm diameter, SS316 movement and bourdon tubes and nylon bearings.
- 3) Level Gauges shall be tampered, borosilicate transparent type of minimum pressure rating 300 psig.
- 4) Each gauge shall have a dial engraving or separate phenolic name plate to identify the service. Service engravings make model, ranges and other technical features shall be subject to owner's approval. Gauges shall be located on the front of the sample conditioning panel.
- 5) Accuracy of measurement shall be $\pm 1\%$ of full scale or better.
- 6) Instruments shall also meet the technical specification requirements mentioned in Vol. V, Part B, chapter 2.

5.03.08 Switches

- 1) Flow indicator cum switches shall be provided, on the primary cooling water outlet and on the chilled water outlet as indicated in the drawings for SWAS. Accuracy/repeatability shall be $\pm 2\%$. Make & model of flow indicator cum switch shall be of owner's approved one.
- 2) Temperature switches shall be provided on the sample lines as indicated in the drawings for SWAS. All switches shall be repeatable within $\pm 1\%$ of full scale range.
- 3) All the flow switches shall be wired to the remote I/O cabinet (situated in SWAS room) by the bidder.
- 4) Potential free contact shall be provided for annunciating loss of cooling/chilled water.
- 5) Instruments shall also meet the technical specification requirements mentioned in Vol. V, Part B, chapter 2.

5.03.09 Sample patch board

A quick disconnect patch board shall be furnished on the SWAS panel. The patch board shall allow sample to be routed to any analyser through quick disconnect valve at patch board on the sample conditioning panel. The area shall consist of a patch board with bulk head fittings with double end shut off and hose inserts. Body protector plugs shall be provided for each bulkhead tube fittings. Number of hose inserts, disconnect fittings etc shall be as shown in SWAS diagram and other specification documents.

The plug shall be of type SS 316 construction. Sufficient length of 6 mm ID, 9.5mm OD tubing shall be provided for complete spanning of the patch board area for interconnection of the bulkhead tube fittings. Each connection shall be provided with a phenolic name plate engraved with a legend acceptable to the owner.

5.03.10 Grab samples

Grab samples valves on the front of SWAS panel shall be provided to direct grab samples to tough through grab sample nozzles or to the drain header. Approximately 300mm of flexible tubing shall be provided for each sample to allow grab sample collection and prevent splashing. Grab sample nozzles shall be provided with adapter and panel mounting flanges. All these items i.e. nozzles, adapter and flanges shall be owner approved make.

5.03.11 Sample Sink

A continuous sink, located at the place of grab sample analysis, shall be provided. The sink shall be SS 316, 14 gauge minimum. The sample sink shall be connected to waste drain header. Sample sink shall contain an integral SS ledge to accommodate sample container. DM water connection shall be provided for cleaning of sample containers.

5.04.00 SPECIFICATION OF ANALYSERS

Field proven reputed international make microprocessor based monitors/analysers with LCD/TFT display and with necessary fault diagnostic features shall be employed. All analysers shall provide 4-20 mA HART output signal capable of driving a load impedance of 500 Ohms minimum and minimum 2 nos. relays with 2SPDT Contacts.

For sodium, silica, iron and Chloride analyzers, Vendor may provide the Modbus RS 485/Profibus connectivity in addition to 4-20mA signals with DDCMIS/PLC without daisy link for all diagnostic facility in case same are not available with HART protocol.

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 in line with technical specification and shall be subject to owner's approval. The power supply to all analysers/monitors shall be supplied by bidder from plant UPS system with redundant feeders & auto changeover, all necessary switches, 2 Pole MCB, fuses, wiring/cablings and other required accessories etc for distribution to individual requirements.

Air conditioning environment as required for analysers /analysers panels/ analyser room shall be provided by Bidder with 2x100% Air Conditioning system(1 working & 1 standby). Air conditioner shall be able to work continuously under ambient worst conditions. All Air conditioners shall be BEE 5 star rated. Air conditioner (condenser unit) and any other equipment installed outside the analysers panels /analyser room shall be placed under proper sun/rain protection shade/canopy.

These specification of analysers shall be applicable for complete plant.

5.04.01 **Minimum specification of Analyzers:**

Measurement	Type	Accuracy	Response time (90% of full scale)
Conductivity/ TDS/ Concentration	For Hotwell - Two removable Type of Cells. For Others - Continuous flow through type	$\leq \pm 1\%$.	≤ 5 Sec
pH	Cell flow through sample	$\leq \pm 1\%$. Accuracy of pH sensor shall be 0.1 pH and resolution/repeatability shall be 0.01 pH.	≤ 5 Sec
Chloride <u>before CPU and Plant water system</u>	Continuous flow through type with chloride & sulphate responsive electrodes / solid state sensing electrode, or Microcapillary	$\leq \pm 5\%$ of reading or ± 5 ppb, whichever is greater.	≤ 5 Min
Chloride after CPU	Continuous flow through type with chloride & sulphate responsive electrodes/ solid state sensing electrode or Microcapillary electrophoresis	$\leq \pm 5\%$ of reading or ± 0.5 ppb, whichever is greater.	≤ 15 Min
Turbidity	Light reflection principle	$\leq \pm 2\%$ for 0-50 NTU $\leq \pm 5\%$ for 50-200 NTU	≤ 5 Min
Hydrazine	Automatic continuous electrochemical type	$\leq \pm 5\%$	≤ 3 Min
Si	Continuous colorimetric type	$\leq \pm 5\%$	≤ 15 min
Na	Continuous flow through type with sodium responsive electrode and reference electrode having pH adjustment facility.	$\leq \pm 10\%$	≤ 4 Min
DO2	Continuous flow through type	$\leq \pm 5\%$	≤ 30 Sec
Total Iron (Fe)	Continuous Flow Through Sample	$\leq \pm 5\%$ of reading or ± 0.005 ppm	≤ 15 min. (including sample switching)

The measuring range for the above analysers shall be suitable for the process requirement. Automatic temperature compensation shall be provided for all the analysers.

All the analysers/cells shall have open corrosion resistant drain to waste header.

Dual Cation exchange column shall be provided for cation conductivity.

Conductivity analyser shall be provided with automatic ammonia (NH₃) removal facility.

Silica Analyser shall be provided with auto reagent shut off solenoid valve feature (in case of sample loss or power loss) and built in phosphate inhibition feature.

Hydrazine Analyser shall be provided with auto reagent shut off solenoid valve feature (in case of sample loss or power loss).

For Hot well conductivity measurement, direct insertion/withdrawal type conductivity cells shall be provided, whereas for all other samples it shall be flow through type. Monitors for hot well conductivity shall be suitable for field mounting.

Make of complete assembly including sensor, analyser & monitor shall be same.

ASTM D5128, the standard test method for on line pH measurements shall be complied by Bidder.

Conductivity analyser shall be provided with automatic ammonia (NH₃) removal facility. ASTM D5391, the standard test method for conductivity shall be complied by Bidder.

Make of chemical/reagents and analyser shall be same or Make of chemical/reagents shall be as recommended /certified by Analyser manufacturer. Buffer solutions for pH and conductivity analysers shall be provided with certificate/ lot number, certified value, expiration date, ASTM and NIST traceability data.

5.04.02 The sample points and the type of measurement for each sample shall be as per Contract quantities of SWAS, Appendix-I to Part-A, Vol. V of technical specification.

5.04.03 All analysers shall be supplied with chemicals/regents required for 12 months operation in phased manner depending on shelf life, in addition to that indicated under mandatory spares. Bidder shall also provide start up kits, buffer solution for pH and conductivity analyzer. The analyser supplier shall submit the preparation procedure / formula of the reagent to be used in analyser solution.

5.05.00 **SAMPLE PIPING SYSTEM**

Application	Piping material
Sample tapping point to primary cooler (including root valves and fittings)	As per process pipes.
All the sample pipe after primary cooler	ASTM A213 TP316H
Blow down header and misc. drain receiver holder	ASTM A312 Type 304
Closed CW piping except grab sample and water purge line, sample through drain piping and waste header piping	ASTM A53 Gr. A
Purge air piping/ tubing and fitting valves	Brass/ Copper

Size and Schedule number of sample pipes shall be suitable for particular application. Pressure reducing valves, Isolation valves before the primary sample cooler and all the isolation valves for pressure and flow indicators shall be needle valves. Cooling water and chilled water supply and return valves shall be block valves.

All sample piping shall be ¾"NB seamless type of material ASTM A213 TP 316H, conforming to ANSI B36.19. The schedule number shall be suitable for the particular application.

All fittings shall be socket welded type and of material ASTM A182 F316H confirming to ANSI B16.11.

The valves to be used in sample piping shall be of globe type, forged construction and stainless steel confirming to ASTM A182 with pressure and temperature ratings as per ANSI B16.34. The valve design shall be such that the seats can be reconditioned and stem and disc can be replaced without removing valve body from the line.

All the components, piping, tubing, fittings, valves, filters and other wetted parts in the sampling and analyzing system shall be designed to handle the over range of One Fifty (150) percent of operating process parameters.

All materials, furnished shall conform to the latest editions of America National Standard Code for Pressure piping, Power piping, ANSI B31.1, ANSI B16.11, ASME Boiler and Pressure Vessel Codes, IBR and other applicable ASME, ANSI and Indian Standards. Schedule numbers, sizes and dimensions of all carbon steel, stainless steel and alloy seamless steel pipe shall confirm to ANSI B.36.10 and of stainless steel pipe shall confirm to ANSI B 36.19 unless otherwise specified.

5.05.01 **Material Specifications for Pipe Lines**

The piping to be furnished and installed for water and steam analysis system and for BOP packages shall be as indicated below:-

S. No.	Piping System	Material
a)	Piping from the sample inlet bulk-head fittings to the shut-off valve for low pressure samples	Stainless Steel, ASTM A-213 Type 316H, ¼" OD 16 SWG seamless tubing.
b)	Piping from the sample inlet bulk-head fittings to the pressure reducing valves for high pressure samples and sample blowdown piping	Stainless Steel, ASTM A-213 Type 316H, ½" OD 14 SWG seamless tubing.
c)	Blowdown header	Stainless Steel, ASTM A-312 Type 316, 2" NB, Sch. 160 minimum, pipe header flanged to ANSI B 16.5, class 3000 # R/F SS 316 flange.

S. No.	Piping System	Material
d)	Miscellaneous drains receiver header	Stainless Steel, ASTM A-312 Type 316, 2"NB, Sch 40, pipe header flanged to ANSI B 16.5, class 150 # R/F SS 316 flange.
e)	Piping from the shut-off valves for low pressure samples and from the pressure reducing valves for high pressure samples to the terminal points including branch piping	Stainless Steel, ASTM A-213 Type 316H, 1/4" OD 16 SWG seamless tubing
f)	Closed cooling & chilled water piping header	Stainless Steel, ASTM A-312 Type 316, 2"NB, Sch. 40 minimum, pipe header flanged to ANSI B 16.5, class 150 # R/F SS 316 flange.
g)	Sample through drain piping and waste header piping header.	Carbon Steel, ASTM A- 106 Gr. B, 2"NB, Sch. 40 minimum, pipe header flanged to ANSI B 16.5, class 300 # R/F SS 316 flange.
h)	Sample impulse piping from field up to SWAS wet panels	SS316H, 1" NB size.
i)	The closed cooling & chilled water piping.	Stainless Steel, ASTM A-312 Type 316, 3/4" OD 16 SWG seamless tubing.
j)	Purge air piping/tubing and filing valves	Brass/copper
k)	For water analysers – material of pipes, tubes & erection hardware	SS316/Super duplex SS depending upon application.

CHAPTER – 6
**SUPERVISORY CONTROL PANELS, SUPERVISORY CONTROL DESKS,
EQUIPMENT PANELS****6.00.00 CONTROL DESK & PANELS****6.01.00 General**

6.01.01 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.

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.

6.01.02 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.

6.01.03 The design shall conform to the EN ISO 11064-6:2005 (Ergonomic design of control centres, Part 6/latest). Bidder shall furnish documentary proofs/evidences/certifications in support of same along-with the Bid, stating compliances for the entire aspects covered under the ISO standard.

6.02.00 CONTROL DESK & PANEL

6.02.01 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 Owner's Approval. For bidding purpose, the minimum length of the desk/ panel and CD mounted devices are given in Appendix-I to Part-A, Volume V.

6.02.02 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.



6.03.00 CONTROL DESK (CD)

6.03.01 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 monitors & mice for SG, TG, BOP (irrespective of scope of supply) and synchroscope. 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.

6.03.02 All operator monitors & mouse for SG, TG, BOP shall be mounted on this CD.

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

6.03.04 All the control desk shall be equipped with Anti vibration pad of min. 15 mm size thickness. Cable gland plate thickness shall be 3 mm. Base support frame height shall be min. 100 mm.

Doors shall be provided with neoprene/polyurethane gasket only.

**6.04.00 HARDWIRED DEVICES ON CONTROL DESK (CD)
(DRAW OUT SECTION)**

6.04.01 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.

6.05.00 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. The size of the push button stations & A/M stations shall be 24 x 48 mm or 25x 50 mm and shall have service inscription details at the front.



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

6.06.00 UNIT-INCHARGE DESK

Profile and construction of the Unit Incharge Desk shall be same as that of CD. Provision for Operator Work Station and PA system/ telephone handset etc. shall be provided similar to the Control Desk..

6.07.00 INTERNAL PANEL/DESK ITEMS

6.07.01 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.

6.08.00 FURNITURE

6.08.01 Bidder shall 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.

a. 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.

b. Server Rack

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

c. OWS/PC rack

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

d. Chairs

Industry standard revolving chairs with wheels and with provision for adjustment of height (hydraulically/gas lift) shall be provided for the operators, unit-in-charge, shift in charge & other personnel in control room area & BOP's control rooms, Chief Engineer room and all other executive rooms, simulator rooms, Conference room, DMS room, SWAS room, CEMS room, meeting room, documentation room, staff room, CAAQMS shelters, CAAQMS rooms etc. These shall be designed for sitting for long duration such that

these are comfortable for the back. Chair pedestal shall be made of 5mm thick MS plate covered with poly-propylene cladding. Arm-rests in one piece shall be of poly-urethane and twin wheel castor of glass filled nylon. The exact details shall be finalised & approved by Purchaser during detailed engg.

e. Tables

- a. Industry standard computer tables shall be provided & shall be as approved by Owner during detailed Engineering.
- b. Conference Room standard tables shall be made of teak wood top quality only with industry standard glass top and provided with acrylic coat for good finish. Details shall be finalised & approved by Owner during detailed engg.
- c. Glass top teak wood office table with lockable drawers shall be provided for shift in Charge room, Chief Engineer room and all other executive rooms.

f. Almirahs

Minimum 4 nos. vertical Steel Almirahs shall be provided for keeping documents in the documentation room. Vertical Steel Almirahs shall also be provided for the following rooms.

- a. Conference room – Two (2) nos. min. (double doors)
- b. PADO Room – One (1) no. min. (double doors)
- c. Shift In charge room – Two (2) nos. min. (double doors)
- d. Simulator Room – Two (2) nos. min. (double doors)
- e. BOP/Offsite control rooms – Two (2) nos. min. (double doors)
- f. Head of Station Room- Two (2) nos. min . (double doors)
- g. Conference Room – Two (2) nos. min for each conference room
- h. Server Room - Two (2) nos. min . (double doors)

Final quantity shall be decided by owner during detailed engineering

Thickness of steel almirah sheet shall be 18 gauges with neat finish. Tentative size of Almirah shall be 78”(H) x 36”(W) x 19”(D). 4-5 mm thick Glass doors for each rack shall be provided such that the documents are visible from outside. Minimum 5 no. horizontal partition/rack shall be provided in the almirah. 3 point locking system shall be provided. Size of the rack shall be sufficient to easily fit technical manuals. The exact details shall be approved by owner during detailed engg. One uniform colour shall be finalized during detailed engineering by owner.

g. Keypad

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

h. 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.

6.09.00 LVS PANEL

6.09.01 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 Vol-V Part-A of specification.

6.09.02 The profile, dimensions and the general arrangement shall be finalized & approved by Owner 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 Bidder in his offer, along with all relevant details/basis.

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

6.10.00 CONSTRUCTIONAL FEATURES OF LOCAL CONTROL PANELS, CONSOLES, CONTROL Desk, CUBICLES & ENCLOSURES

- i. All type of panels, control panels, cubicles, consoles, SOV panels, GIU panels, Fire alarm panels and enclosures provided anywhere for subject plant per this specification shall be of free-standing type with modular construction and shall be constructed of specified gauge of sheet steel (Industrial grade- Grade D) as per IS 513 depending on location with Multi-folded frame-based structure (Minimum 9-folded Profile) made from a single sheet. Panels with multi folded profiles shall be mandatory for all types of DDCMIS, DCS and PLC panels. The minimum sheet thickness of panels shall be as follows unless otherwise specified herein.

Side and top – not less than 1.5 mm

Door – not less than 2.0 mm

Mounting plate –3mm GI

Base metal plate - 2.5 mm

Gland plate – 3 mm

- ii. The panels, consoles/desks shall be reinforced as required to ensure true surfaces and adequate support for instruments mounted thereon. All instrument cutouts, mounting studs, and support brackets shall be accurately located. All welds on the exposed panel surfaces shall be ground smooth. Finished panel surfaces shall be free from waves, bellies, or other imperfections. Unless specified, otherwise, panel doors shall be 4 points hinged and shall have turned back edges and additional bracing where required to ensure rigidity. Door hinges shall be of the concealed type. Doors shall be reversible type, left hinged as a default, with 130-degree swing. Door latches shall be of the four - point type to ensure tight closing. Door locks shall be furnished which



will allow actuation of all locks by a single master key. All panels shall have removable lifting eyebolts for safe lifting from top during storage and installation handling. Doors should come with double bit cam locks to ensure rigid and inposition locking which provides consistent IP protection and avoids entry of external substances/dust/water.

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

- iii. All panels shall be mounted on vibration dampers, which are secured to C- channels mounted on the floor. The channels shall be field welded to steel plates set into the concrete flooring. The steel plates shall be located such as to approximate the outline of panel bases. The exact mounting details shall be as approved by the owner during detailed engineering stage. All panels shall be provided with adequate ventilation and packaging density of components shall be restricted so as to limit the temperature rise above ambient to 10°C under the worst conditions. All panels shall have auto on/off switch for internal lighting. All the power supply circuit for control panels shall be provided with auto changeover circuitry. Properly installed grounding and potential equalization of various electrically conductive parts in order to compensate for voltage differences between conductive parts shall be preliminary design requirement for all the panels/enclosures to be met by the Bidder.
- iv. In each panel /cabinet installed in common control room a 24 VDC/ 230 VAC Voltmeter digital type shall be provided to check all the (AC/ DC) Field Interrogation voltage.
- v. Exhaust Fans with louvers & filters shall be provided on upper side to remove hot air in all consoles and panels.
- vi. Fire & Smoke detectors shall be provided inside the Control room mounted system/control cabinets.
- vii. Feeder failure/ healthy indication shall be provided in each cabinet & remote indication shall be hooked up to DDCMIS/PLC/annunciation & suitably grouped.
- viii. All the panels shall be equipped with Anti vibration pad of min. 15 mm size thickness. Cable gland plate thickness shall be 3 mm. C Channel height shall be min. 100 mm.
- ix. Doors shall be provided with polyurethane gasket only (Durometer hardness as per ASTM D2240-97/e1) with sustainable IP throughout product life. The front and rear doors shall be of full height.



- x. Protection class shall be as specified at Vol. V, Part B, chapter 1.
- xi. All the cable entries shall be at the bottom of electronic cubicles/control Panels.
- xii. Control panels shall be provided with proper arrangement and hardware to terminate the inert gas required for fire protection.
- xiii. 25x6 mm copper ground bus to be provided for each panel/control desk.
- xiv. Terminal blocks shall be Rail mounted 650 V AC grade Terminal blocks (Screw less cage clamp type) with markers and 20% spare wired terminals of each type.
- xv. For Panels/cubicles internal wiring details, Bidder to refer Vol. V, Part B, Chapter 9.
- xvi. Salt spray tests shall be conducted in accordance with ISO 9227:2012(en) i.e. Corrosion tests in artificial atmospheres.
- xvii. Enclosure Protection class against external mechanical stresses shall be of IK09 standard as per EN 50102/IEC 62262 for all type of panels/enclosures. Dynamic material strength and vibration resistance shall be as per IEC 60068-2-6.
- xviii. Complete panels/enclosures for project plant shall be tested and certified according to manufacturing standard IEC 62208. (the IEC 62208 standard requires the IP and IK to be declared and verified)
- xix. Complete panels/enclosures for project plant shall be tested and certified for level C4H, high corrosivity according to ISO12944 (> 15 years to first major maintenance)
- xx. Complete panels/enclosures for project plant shall be RoHS compliant, UL and TÜV Rheinland certified and shall be tested/certified according to IEC 60529 and latest IEC 62262 standard (i.e the latest applicable standard at the time of bid opening)
- xxi. Complete panels/enclosures for project plant shall be Tested and certified according to Electrical protection Class II IEC 60950-1, IEC 61439-1 standard, UL508A standard, IEC 60297-3-100 standard and IEC 61696-3 standard.
- xxii. In each panel /cabinet installed in Common Control Room (CCR) a temperature indicator digital type shall be provided for monitoring of temperature of individual panels/ cabinet.
- xxiii. All the control panels shall be separated power and instruments/ electronic grounding.
- xxiiii. The design of panels, cabinets, enclosures and packaging density of components mounted therein shall be such that the temperature rise

does not exceed 10 deg. C above the ambient under the worst conditions.

- xxiiv Enclosures for peripheral equipment like printers, etc. shall take care of noise and shall ensure minimum possible noise disturb to the working personnel.
- xxiv All panels, desks, shelters, cabinets, consoles & enclosures installed under the open/outdoor environment shall be provided with lightening protection system as per system requirements.
- xxivi Guards, barriers and access doors, covers of plates shall be marked to indicate the hazard, which may occur upon removal of such devices. Danger or caution signs shall be used to warn of specific hazards such as voltage or current. The marking shall be permanently affixed to the equipment.

6.11.00 **TERMINATION/MARSHALLING CABINETS & INTERPOSING RELAY PANEL**

Marshalling/Termination cabinets for the control system shall be supplied for terminating all cables originating from the field, MCC/SWGR or any other source of signal and for distributing the signals to different functional panels, MCC/SWGR and control cubicles.

Incoming cables from the field, MCC/SWGR or any other source of signal shall be terminated in suitable terminal blocks in logical sequence.

Prefabricated cables with plug in connectors at both ends shall be used for extending the signals to the functional panels. Matching plug sockets shall be provided in the termination cabinets for terminating the plugs.

Interposing relay panels for the system shall be supplied for mounting interposing relays & terminating all cables originating from the DO cards in case of solenoid valves, HW Annunciation windows and other required services etc. IPR panels shall be placed in CER and LCR.

Interposing relay shall be mounted in respective SWGR/MCC/integral starter required for commands signals of HT/LT unidirectional drives and bidirectional drives, breakers, isolators, bus couplers etc from DDCMIS/DCS/PLC or any control system.

Terminal blocks shall be located inside the cabinets on support wings fabricated of metal plates.

The plug socket shall be mounted on hinged plates to provide an access to the rear pins of the plugs.

General features of termination cabinets and accessories shall conform to the general design and construction specification of panels. Terminal blocks shall be Rail mounted 650 V AC grade Terminal blocks (Screw less cage clamp type) with markers and 20% spare wired terminals.

Wiring shall be 650V grade. PVC insulated FRLS stranded copper wire.



6.12.00 SURFACE PREPARATION AND PAINTING

All panel exterior steel surfaces shall be ground smooth, and painted as specified below:

Suitable filler shall be applied to all pits, blemishes and voids in the surfaces. The filler shall be sand blasted so that surfaces are level and flat, corners are smooth and even. Exposed raw metal edges shall be ground burr free. The entire panel surface shall be sand blasted to remove rust and scale and all other residue due to the fabrication operation. Oil grease and salts etc. shall be removed from the panels by the process like DI water by pressure spray method, one or more RoHS approved solvent cleaning methods. Alternatively 7/9 tank process shall be followed.

Two spray coats of inhibitive epoxy primer – surface shall be applied to all exterior and interior surfaces; each coat of primer surface shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish colour (Catalysed epoxy finish) shall be applied to all surfaces of dry film thickness 2.0 mil. 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 1.5 mm. Galvanized powder coating shall also be provided.

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 the following shades:

- a) Exterior - Glossy/Texture RAL 7032/RAL 7035 Glossy/Texture as finalized by owner.
- b) Interior - Glossy Brilliant white /RAL 7035 two coats
- c) Base Frame – Black.

One uniform colour shade as finalized by owner during detailed engineering shall be applicable for complete plant.

Paint films, which show sags, checks, blisters teardrops, fat edges or other painting imperfections, shall not be acceptable and if any such defects appear, they shall be repaired by and at the expenses of the Bidder.

6.13.00 PANEL ILLUMINATION

Panels/cabinets/desk/consolas shall be provided with LED based illuminating lamps with door switch and six (6) point 6/16A, 240V AC universal type power sockets with switch for maintenance purposes. LED Lightning/Luminaries shall be industrial grade and shall comply safety & performance requirements as per the relevant standards like IS, CIE, EN, IEC and all other international standards. Copies of required certifications shall



also be furnished by vendor. LED lamps shall be provided with plug in type connections with locking facility. These switches shall be with quick make and break mechanism. 100 % spare LED lamps shall be provided with each panel, these are in additional to mandatory spares.

6.14.00 **Panel Cooling Fans (for ventilation of the DDCMIS/ PLC / DCS & other cabinets/ control panels, consoles)**

Filter Fan for cabinet and enclosure shall be of 230 V AC version having very low acoustic noise and lower power consumption. To effectively protect the equipment against electromagnetic disruptions, fan shall be equipped with a steel frame covering the plastic elements (self-extinguishing ABS according to standard UL94 V0), a metal grille attached to the frame, a beryllium gasket guaranteeing conductivity between the perimeter of the fan unit and the enclosure.

The Fan shall have air flow volume as per cabinet requirement. Complete Fan unit with EMC shielding shall meet requirement category 2 to EN 61587-3 for tool less operation. The Operating ambient temperature range shall be -30⁰ C to +55⁰ C. Direction of airflow changes possible with tool less operation. Filter material shall be synthetic fiber with progressive construction, temperature resistant to (+)100⁰ C, self-extinguishing, Class F1 as per DIN 53438 Standard. Minimum Working hours of fan shall be indicated, Operating Ambient Temperature shall be checked and Degree of Protection shall be mentioned by fans OEM.

6.15.00 **Panel/cabinets/console/desk Thermostat (for temperature control of the DDCMIS/PLC/DCS panel/control panels – to be connected to switch On/Off Fan/Heater)**

The Panel thermostat shall be DIN rail mounted or on the mounting plate using the supplied adaptor. Thermostat shall be Bi-metal controller ideal for temperature control of space heaters with Time saving connection technique using a terminal strip with a screw connection from the outside. Principle of operation- Single-pole change-over contact as a quick-break contact i.e. A single pole, single throw, normally closed circuit breaks (opens) on rise of temperature. Thermostats shall be UL certified..

Enclosure heaters shall regulate relative humidity, prevent temperatures from dropping below the dew point, stop condensation forming inside the enclosure and shall prevent consequential damage associated with corrosion or electrical short circuits. Space heaters shall be based on PTC (Positive Temperature Coefficient) type technology with Output 10 Watt - 800 Watt as per requirement. Space heater should be used along with fans / without fans as per application requirement. Connection of heaters shall be quick connection terminals. Range of thermostat to be indicated, operating Ambient Temperature to be indicated and electrical life at rated load to be defined by Thermostat OEM.

6.16.00 **Panel Air Conditioner**

For remote I/O / Outdoor cabinets mounted in non-AC areas, energy efficient panel mounted AC units shall be provided. Panel mounted AC units shall be TUV /UL/CSA certified. Panel mounted AC with EC fan technology shall have



ECO mode facility to optimize consumption of energy. Useful cooling output shall be as per DIN 3168. Nano coating on the condenser and electric condensate evaporation shall be provided as a standard. Temperature control and monitoring shall be via comfort controller. Protection category for Panel AC shall be as per EN 60 529/10.91 with internal circuit which shall be minimum IP-54 to IP-56. Refrigerant should be R134a. Panel AC may be linked to the IoT interface via IoT adaptor for cooling unit's controller. For Chemical / Corrosive areas, Panel AC shall be suitable as per environmental condition with protection category UL type Nema 4/4X.

6.17.00 **FUSES & MCB**

All fuses shall be fast acting semiconductor types for AC supply and compatible to the UPS fuses. For all DC Powered devices, similarly the fuses shall be fast acting compatible to DCDB fuse provisions. All the AC power supplies shall be provided with the protection of Fast acting semiconductor fuses & 2 P thermo magnetic type MCB. For all the DC power supply circuits, electronic type DC MCB shall be used only. Make of DC MCB shall be Siemens, Phoenix contacts, Murr, Weidmuller, or Lutze.

50 % spare fuses shall be provided with each panel, these are in additional to mandatory spares.

6.18.00 **NAME PLATES AND LABELS**

Name plates of adequate size shall be provided for each panel on front and rear of the panel. Instruments/other accessories mounted inside the panels shall have identification marking clearly visible from inside.

Devices to be mounted on the panels shall also be labeled on the panels shall also be labeled on the outside of the panel. Name plates shall be of polyamide sheets with black letters on white background. Name plates shall be attached to the boards by means of stainless steel panhead screws. Fuses provided for protection of various boxes shall be accessible for replacement. Fuse boxes shall be provided with circuit label and fuse rated current and voltage.

Markings/Labels

All markers/labels shall be made of halogen & silicon free polyamide material with inflammability class V2 as per UL 94, ensuring scratch proof printing with the use of environment friendly solvent free ink & latest BLUEMARK UV technology so as to comply the WIPE RESISTANCE according to DIN EN 61010-1/VDE 0411-1.

6.19.00 **Design Criteria for Control Rooms:**

The interiors of the each control Room shall be aesthetically designed with modern designs and technologies. The bidder shall have 2-D and 3-D software for designing the control room layouts. The bidder shall have thorough knowledge on Indian power plant control room requirements. Control rooms shall also be designed as per standard "ISO 11064 (1-7) - Ergonomic design of control centres".



- 6.19.01 The TG building operating floor area and other elevations shall be partitioned to different rooms suitably by bidder with approval from owner to house the following equipment/panels/cabinets for each unit:
- (a) Unit Control Desk (UCD), Printers, Electrical Control Panel (ECP), LVS, Fire Alarm Panel, Plant CCTV monitoring System, etc. in the main central control room.
 - (b) The system cabinets, marshalling cabinets and electrical auxiliary cabinets, TSI & VMS panels, Electrical panels, DAVR panels, GCP, DDCMIS/DCS Network panels, & other aux. system cabinets etc. in the electronic cubicle room.
 - (c) Maintenance Engineer & Shift Incharge's OPERATING STATIONS with keyboards, printers and other peripherals in Maintenance Engineer room (Computer Room) and Shift Incharge's Room respectively. A separate air conditioned room shall also be provided for PADO.
 - (d) Uninterrupted Power Supply (i.e., inverters and distribution boards) (UPS) in UPS room and 24 V DC charger with DCDB in 24 V DC charger room. A separate room shall also be provided for Batteries.
 - (e) Similarly OPC servers, MIS server & station LAN Network panel shall be located in separate Air conditioned room.
 - (f) SWAS Room.
- 6.19.02 Every control room layout shall be designed in line with guidelines given below.
- (a) Lighting shall be designed for maximum comfort and minimisation of OPERATING STATION/LVS glare and shall be adjustable.
 - (b) Co-ordinated colours and material for floors, walls and ceiling shall be provided.
 - (c) Room designs shall absorb noise in the control room and engineers/shift supervisor room.
 - (d) Positively pressurised and filtered air conditioning shall be provided for all control rooms.
 - (e) Designs and material will be in accordance with NFPA Fire protection for Power/Electric Generating plant.
 - (f) All control Rooms shall be designed to minimise dust ingress. Air locks shall be provided at main entry.
 - (g) Double Doors and the corridors shall be of sufficient size and layout to allow access of 2750 mm height for equipment.
 - (h) Fire and Smoke detection equipment shall be located in all ceilings.

- (i) Temp. & humidity monitoring system in each control room, cubicle room, meeting room, training room, & conference room etc.
- (j) Industrial Grade and fully automatically controlled (with On/Off control with door switch, Heat On/Off control with room thermostat and Fan speed control with two phase thermostat), Air Curtains with minimum velocity in accordance to ISO 27327-1 shall be provided at each entrance to Main Control room & BOP control room. The main door entry shall be mirror image type only.
- 6.19.03 Item (a) to (e) referred above at cl. No. 6.19.01 shall be mounted in an air-conditioned control room having false roof and false flooring. In addition SWAS dry room shall also be air conditioned only. The control room will be partitioned with toughened glass/insulated glass between the following rooms:
- (a) Main Control Room and Maintenance Engineer's Room/Computer Room.
- (b) Maintenance Engineer/Computer's Room and Electronic Cubicle Room
- (c) Main control room and Shift Incharge room.
- (d) Main control room and Electronic cubicle room.
- (e) Main control room and Operating Floor.
- 6.19.04 In additions to above following rooms (unit wise) shall be provided at operating floor-
- 1) C&I Staff air-conditioned room.
- 2) Shift Supervisor air-conditioned room.
- 3) Documentation air-conditioned Centre for storage for all Plant O & M manuals, control system software backup, & all others operating / maintenance files, logs, records etc.
- 4) Conference air-conditioned sound proof Room.
- 5) Pantry room.
- 6) Toilets/refreshing room.
- 6.19.05 Following C&I rooms shall be provided in service building -
- 1) Meeting Room/ Conference air-conditioned sound proof Rooms.
- 2) DMS air-conditioned Room.
- 3) C & I Maintenance/laboratory air-conditioned Room.
- 4) DDCMIS/DCS Simulator air-conditioned sound proof room.
- 5) CAAQMS air – conditioned room.

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- 6) Training air-conditioned sound proof Room.
- 7) Officers/Executive air conditioned Rooms
- 8) UPS air conditioned room with ventilated battery Room.
- 9) PLC Air conditioned Control room for Air conditioning System.
- 6.19.06 Following rooms shall be provided at Local control room building for respective BOP/offsite packages-
- 1) Control room and Electronic cubicle room (air-conditioned).
 - 2) UPS room (air-conditioned).
 - 3) UPS Battery room.
 - 4) Toilets/refreshing room.
 - 5) Locker & staff air-conditioned room.
 - 6) Pantry Room.
- 6.19.07 Quantities of above mentioned rooms are minimum to be met by bidder, however actual quantities & size of rooms shall be finalised by owner during detailed engineering.
- 6.19.08 Any other rooms/Buildings that are not mentioned above but requiring air condition shall also be provided with suitable air conditioning system.
- 6.19.09 Shoe racks with minimum 3 tier & minimum 4 nos. cushioned chairs outside the central control room.
- 6.19.10 Shoe racks with minimum 3 tier & minimum 2 nos. cushioned chairs outside the BOP/Offsite package control room.
- 6.19.11 One set of Conference Table and 25 no's industrial grade executive class Chairs shall be provided in each conference room at CCR Floor in TG building. Conference table shall be elliptical in shape and made of teak wood top quality only with industry standard glass top (Glass thickness minimum 12 mm).
- 6.19.12 One set of Conference Table & 60 no's industrial grade executive class Chairs shall be provided in main conference room in Service building. Conference table shall be elliptical in shape and made of teak wood top quality only with industry standard glass top (Glass thickness minimum 12 mm).
- Ist row surrounding the conference table shall accommodate the 30 nos. chairs. Subsequently elevated rows shall be provided to accommodate the balanced chairs.
- 6.19.13 One set of meeting/discussion Table & 25 no's industrial grade executive class Chairs shall be provided in each meeting/discussion room in Service building. Meeting/Discussion table shall be made of teak wood top quality only with industry standard glass top (Glass thickness minimum 12 mm).
- 6.20.00 **Interior Architectural requirements of CCR**
- The interiors of the Central control Room (CCR) shall be aesthetically
-

designed with modern designs and technologies. Bidder's scope shall include designing, engineering, supply, erection & installation of all Central Control room interior such as Flooring, Raised Flooring for Shift In-charge area, False ceiling, Paneling of all the interior walls, front exterior walls of CCR, Glass walls / Glass portioning, kiosk type paneling for LVS, paneling of columns, illumination system for normal and emergency conditions, etc.

Bidder shall design the Central Control room properly in terms of Aesthetics, Ergonomics and Functionality. Various aspects should be considered while designing Control room layout so as to create ideal work place, considering physiological aspects such as line of sight and field of vision and cognitive factors such as concentration and perceptivity. Also, the design of CCR shall reflect human factors requirements such as Satisfactory environmental conditions for operator personnel, including noise, air flow, temperature and humidity, and precautionary measure under uncontrolled conditions (like fire or earthquake) beyond acceptable limits.

The bidder shall be reputed and have already executed at least three (3) super critical power plant control Rooms in India. The bidder shall have 3-D software for designing the control room layouts. The bidder shall have thorough knowledge on Indian power plant control room requirements.

6.20.01 Design Requirements

- i. The Central Control Room shall be provided with combination of perforated and non perforated metal panels False Ceiling, modular pre-fabricated sliding 3D metal Lampre type Panel cladding wall cladding with acoustic property on the overall interior and exterior walls, Non-skid, fully vitrified flooring and skirting, Full Toughened glass wall partitions round bent glass with frameless structure, Special frameless Glass doors, Flush doors and Automatic Sliding doors, Air Lock Room, Illumination with modern LED based modular round ceiling lights, Strip Lighting to match the aesthetic look of CCR and Emergency Lighting.
- ii. The interior design of Central Control Room shall match with the CCR furniture such as Unit Control Desk (UCD), LVS and other furniture. Bidder shall submit 3D views of the proposed CCR with at-least 3 colour options during detailed engineering. The final option shall be decided by the purchaser during detailed engineering stage.
- iii. CCR shall be designed as a dead zone in acoustical terms, threshold should be lower than the normal. Use of Acoustics and psychoacoustics measurements shall be considered and the same shall be highlighted the same in drawings. Fire retardant grade material shall be considered and shall be supplied.

6.20.02 False Ceiling

- i. Designer based Acoustic modular curved type False Ceiling shall be provide with a combination of perforated and non-perforated metal panels (300 mm X 900 mm X 0.7 mm), Formed Fiber Reinforced Plastic panel, Linear Ceiling, Mineral Fiber ceiling, curved perforated



steel, gypsum ceiling including painting, acrylic solid surface, etc. designed to enhance visual feel, with provision for easy installation and maintenance, integrated lighting and scope for integration of building services like HVAC diffusers, smoke detectors & fire detection / fighting system. Overall Aesthetic look of the ceiling shall be provided.

- ii. The Designer acoustic ceiling should have straight linear planks. The ceiling system should consist of linear box shaped perforated and non-perforated panels fixed to an adjustable suspension system out of GI wire (4 mm thick) ceiling supported by Roll plug and soffit cleat holding metal runner as per the panel system used. Provision for diffused LED lighting shall be accounted for, as an integral part of ceiling.
- iii. Minimum clear height between finished floor Level & False ceiling shall be 3600 mm for aesthetical purpose.
- iv. The panels should be secured in position on GI frame duly supported from horizontal planes. The ceiling panels shall have locking redundancy to enhance seismic impact resistance and shall be free of any dents and undulations. Panels shall have fire resistant properties. It shall be seamless and no joints shall be visible.
- v. Ceiling panels shall be duly powder coated (50-60 microns) of approved make and color. The colour of the ceiling shall aesthetically match with the CCR furniture. The ceiling should suffice the acoustic requirements of the CCR.

6.20.02.1 **Metal Perforated False Ceiling**

Lay in Tile of 600 x 600 mm perforated false ceiling system exposed on "T" grid system. Panel shall be fabricated from 0.56 mm thick (TCT) Aluminum / GI and powder coated on external surface shall have flange on all four sides to rest on the exposed grid system to given 600x600 mm centre to centre of 'T'. Panels will be plain for flush look with 'T'; Tiles shall have 2.5mm dia at 5 mm centre to centre in square pattern. The 'T' shall be hot dipped GS Tee section 3600 mm long main Tee 24mm wide, Cross Tee 1200 mm & Cross Tee 600mm to form grid of 600x600mm. The installation to be carried out with main runners spaced at 1200mm centres securely fixed to the slab / Truss by means of Roll Plug and 4mm dia GI rod at 1200 mm maximum and not more than 150mm from sliced joint. The last runner should not be greater than 600mm from the adjacent wall, 1200mm Cross Tee & 600 mm Cross Tees to be interlocked between two main Tees to form grid 600 x 600mm. Panels are then placed individually on the 600 x 600 mm exposed grid frame work created by Tee. GS edge profile shall be fixed on the perimeter of walls and columns. The carrier shall be suspended from slab by 4mm dia galvanized rod with special height adjustment power coated clips made out of spring steel at maximum 1.2 to 1.5 mtr. Centre to Centre. Clips shall be with double locking arrangements and Key requirement. It shall be easily open to access above ceiling services. Special connection joineries to take care of seismic vibration. The 4mm dia galvanized rod shall be fixed to slab by forming one end "j" shape with roll

inserts. The edge profile formed out of G.I. sheet of the size 18mm × 20mm shall be fixed on the perimeter of the walls.

- i. NRC (Noise Reduction Co-efficient) value of min. 0.50,
- ii. Light reflectance value of min. 60%,
- iii. Fire performance conforming to Class A,
- iv. Humidity Resistance at RH100,
- v. Hot dipped galvanized steel,
- vi. Baked Polyester Paint surface

6.20.02.2 **Linear Ceiling**

Linear pre-coated aluminum alloy ceiling; stove enameled on both sides with suspension system as per manufacturers details. The false ceiling work shall take care of all illumination, fire detection & fighting, HVAC and all other service requirement. False ceiling shall be provided with 25 mm thick insulation of resin bonded mineral wool conforming to IS: 8183.

6.20.02.3 **Modular Acoustic Mineral Fiber Ceiling**

It consists of hot dipped galvanized steel sections and Pre-finished coated mineral fiber board ceiling tiles 15mm thick of size 600 mm X 600 mm or 600 mm X 1200 mm with durable edging.

6.20.02.4 **Gypsum board ceiling**

Seamless False ceiling with 12.5mm thick of GYP board, fixed to the underside of suspended grid formed of GI perimeter channel of size 20 X 27 X 30mm (MF6A) fixed along the wall at the height of 2.70M from the floor level by using wood screws and metal expansion raw plugs. The GI intermediate channel of size 45x15x0.9mm (MF7) shall be fixed to the perimeter channel at intervals not more than 1220MM. The suspended GI ceiling angle is to be connected with GI soffit cleat of size 37x27x25x1.6mm and should be fixed on the roof slab/beam, by using metal expansion fasteners (w.t type) of 12mmdia.to a length of 35mm with 6mm dia. Bolt/screw at top ends. The GI ceiling section of size 80x26x0.5mm is to be provided across the intermediate channel at intervals not more than 457mm centers at bottom and the same shall be fixed by GI connection clips 2.64mm dia. at the intersection points. The ends on intermediate channel by adopting on overall length of minimum 100mm, covering with intermediate channel and main supporting section. The board shall be fixed to the underside of the suspended grid by using 25mm long dry wall screws. The joints paper tape by using jointing compound of India Gypsum board Ltd. and applying over it 3 layers of the filter compound to provide a smooth surface. The work shall also include making cutouts for tube-lights, spot lights, duct doors, for specified size, grills, etc. to the customer satisfaction for which no extra cost shall be paid separately. Work shall include providing additional supports from ceiling where main/cross members are cut out for light fittings etc.

6.20.02.5 **Acrylic solid surface (ASS)**



“1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
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12mm thick ASS sheets of duly approved shades/color by the purchaser and duly cut on high precision CNC machines for decoration and aesthetic view purpose.

6.20.03 **FLOORING & SKIRTING**

Bidder shall provide entire flooring of CCR with High Graded Vitrified Flooring. The colour of the flooring shall be aesthetically match with the ceiling and wall cladding colors. Also 100 mm Skirting shall be provided at the bottom of the walls and the colour of the skirting shall match with the Flooring. The test certificates to be provided before commencement of the work at site.

6.20.03.1 **Granite Flooring**

The floor of the control room and other rooms shall be done with Granite Stone. The stone shall be of approved make and shall be machine cut, machine polished (pre polished), 18mm thick which will be laid over 20mm thick bedding of cement mortar 1:4, jointed with Laticrete including rubbing, curing etc. The colour of the granite shall aesthetically match with the control desk, CCR walls & Ceiling.

6.20.03.2 **Raised Floor in the Shift In-charge Area**

Raised floor shall be provided for shift In-charge area at a height of about 450mm-600mm (1.5' to 2' approx.) above the RCC floor. The False Flooring shall be of size 600mm X 600mm X 30mm thk. Steel filled cement Vitrified tile with PVC liping on the edges for protection. The steel bottom of the panel shall be embossed in hemispherical shape to give strength and flexural rigidity. Following minimum Load bearing capacities shall be considered during designing.

- i. Uniform Load capacity: 23000N/sqmt
- ii. Concentrated load capacity: 450 Kgs

The material shall require minimum / no maintenance at all and can be easily cleaned whenever required. Replacement of tiles shall be easy and should not require special tools except vacuum lift which are easily available. These tiles shall be finished with acoustic laminate and colour shall aesthetically match with the CCR flooring.

6.20.03.3 **Skirting:**

100mm high skirting, similar to the kind of flooring done in the given area.

6.20.04 **CLADDING**

The overall Interiors and exteriors of CCR walls shall be provided with metal Lampre cladding and Formed ACP cladding depending upon the requirement to match aesthetically. The colour of the flooring shall be aesthetically match with the ceiling and wall cladding colors. The Project Name and the Room name shall appear on the Exterior side of the CCR above the



entrance Doors towards TG Deck. The details shall be provided during detailed engineering stage subject to purchaser's approval. The words shall be in Metal Panel and shall fix to the Wall cladding. All the cladding / paneling structures shall be seismically qualified and the test certificates to be provided before commencement of the work at site.

6.20.04.1 Acoustic Designer Laminated (Metal paneling)

Bidder shall provide 'Providing & Fixing' factory made removable type self inter lockable metal panels of preformed textured PVC coated GI sheet lampre panels.

The panel shall be durable & environment friendly, acoustic laminate shall be made up of natural products should not emit any volatile organic compounds & should be Sustainable & 100% biodegradable. Also it shall be Impact, chemical & fire resistant with anti-bacterial & anti-static properties with Colors & patterns permeate through the surface to reduce noticeable wear.

The Panels shall have the following features:-

1. Permanently Bacteriostatic,
2. Repairable,
3. Made up of exclusive natural raw material,
4. Invisible multi-colored welding,
5. Extremely durable,
6. Permanent anti-static,
7. Good acoustic properties,
8. withstands heavy loads and indoor wheeled traffic,
9. Resistant to cigarette burns,
10. Acoustic laminate should be a twin-layered laminate designed to achieve 14db impact sound reduction (ISO 717-2).
11. Impact sound reduction in accordance with ISO 717-2:14 db. Residual indentation is $\pm 0.30\text{mm}$, exceeding EN433 (requirement: $\leq 0.40\text{mm}$)
12. Reaction to fire EN 13501-1 Cfl, s1 EC certificate 0432 – CPD – 13 5779/ Cfl, s1
13. The material should meet the requirement of EN548, EN 687 & EN686.

Panel shall comprise of specially designed combination of perforated and non-perforated panels through CNC bending, punching & laser Cutting. Panel should be 0.75mm thick (sheet thickness: 0.6mm and PVC fill: 0.15mm) galvanized metal panel of approved color.

Floor Mounting cladding shall be 3mm thick C channels which are welded together to form a 'I' section having minimum height of 150mm. The "I" section shall be welded on 3mm thick MS grouting plate. This assembly shall be grouted on the floor with the help of M10 Anchor Fasteners. These Floor Mountings shall be the base support to the vertical uprights spaced at a

center to center distance of 1200mm maximum. Bidder shall ensure proper marking before proceeding with any floor grouting.

End Cap shall be of minimum 0.6mm thick C shaped tile; similar to the tile, shall be bolted on the extreme end Uprights so as to hide the grid structure.

The panels of the cladding shall be hooked on the uprights. And shall have integrated hooks. The gap between the panels of the cladding shall not be minimum 5 mm so that the panels can be replaced and installed easily. The hooks of the Panels shall have a length of 20mm (for the upper hook) and 10 mm for the bottom hook. So that these panels are firmly held on the uprights during seismic vibrations.

On the extreme ends of the control room the wall connector (L-profile) shall be fixed on the perimeter walls. This L-section shall be snap fitted and then bolted to the walls.

As per design panel should comprise of micro perforation for making the cladding and partitions acoustically sound. Acoustic grade fire retardant fabric (min 1.5mm thick) will be fitted at some parts of the control room with LED recessed lighting as per design.

Panels shall be designed to achieve shape and design as per the purchaser's requirement. Panels should be fixed using snap fitting or any other dry cladding system.

Panel design shall ensure that when the tiles need to be removed for service maintenance of Lighting & AC ducts & itself cleaning, the risk of tile damage should be minimized. Provision of Electronic White Board should be provided on the paneling.

The Support structure will be of modular aluminum extrusions firmly fixed / grouted on all planes as per the requirement. Structure will be made of 50 X 25 X 2 mm thick aluminum extrusion. Structure will be filled with glass wool of 50 mm thickness for thermal and sound insulation.

The metal sheet shall have possibility of being formed mechanically, according to the specific needs of the project. The PVC film in 150 µm may undergo stretching up to 100% and therefore follow (adhere to) bend with the steel in all its deformation. The sheets shall have specific fire retardant additives as an important barrier to slow down the combustion processes. The panels shall have good electrical insulation property. It should be sustainable and easy to maintain.

6.20.04.2 **Formed Aluminum Composite Panel (ACP) Cladding**

Modular pre-fabricated sliding 3D metal wall cladding with acoustic property to enhance the overall interiors of walls.

Tile size of 600mm x 600mm with back support of aluminum extrusion frame to slide on main frame. 3D metal tile shall be made by designer 3D embossing raised to max. 43mm.



Main frame aluminum extrusion and tile frame extrusion are designed to get fully pre-fabricate building material. Tile can be designed to get asymmetrical or symmetrical formations by color/impressions as per approval.

Designer paneling:

Modular easy and fast to assemble concept wall to meet the acoustics of the rooms and lobbies. 42mm x 37mm 3D triangular extrusions with 60 micron Powder coating for its resistance in extreme conditions. 3D Extrusions are divided by acoustic micro perforated sheets or other composite material like fabric and acrylics with acoustic properties.

System should have arrangement so that the tiles can be fixed in all directions.

Also Bidder shall provide Project logos on the cladding to enhance the aesthetic look of the CCR subject to purchaser's approval.

6.20.04.3 **Pebbles Lattice Concept Paneling**

Designer 600X600mm composite tiles of ASS with 5mm thick laminated toughened glass encased by extruded aluminum sections for fitment. Structure should be made from heavy duty powder coated modular steel frame (minimum wall thickness 1.6mm to 2.0mm). The frame should be securely grouted from roof and floor with flexible joints to absorb seismic vibration. The tiles will be having cut-outs in such a way that when the tiles are rotated by 90 degrees the design pattern of the entire wall shall be changed. Using the same tiles and different orientations shall have multiple design possibilities. Options for corporate logos on this paneling shall be provided.

6.20.05 **PARTITION**

Bidder shall provide Toughened Round bent Full Glass partitions and Insulated Glass partitions in the CCR subject to purchaser's approval.

In addition to the Glass partition, Large Video Screens (LVS) shall be enclosed with Lampre metal panel Partition. Bidder to note that the LVS are under GA3 contractor scope. Suitable flush doors (Shutter with hinges) with louvers to dissipate heat from LVS shall be provided at rear side of the LVS partition to access LVS Display controllers and CPUs, which are place inside LVS stand. Provision for mounting CPUs below the LVS shall be done including fulfillment of necessary electrical and instrumentation requirements as per drawings. This shall be covered with 8 mm thick black tinted toughened glass with patch fittings of approved make to facilitate opening of the same.

6.20.05.1 **Glass Partition**

The Glass partition Between CCR and Computer Room, CCR and Equipment Room, Shift In-Charge Room, etc shall be made of 12 mm toughened glass partition.



The glass will be firmly fixed through extruded aluminum extrusions on top, bottom and extreme sides. To give a visually light look, the glass holding system shall have a floating feel there by concealing open ends of tile / carpet flooring. The glass panels shall be easily removed and refitted (during breakage) without using any special tools. The junction of glass to glass shall be neatly secured using extruded PVC or sealant. Sealant shall be neatly filled using molded rubber pattern /tool. Finish: anodized or powder coated as per architects drawings / specs. Safety film shall be applied on the glass to avoid shattering.

6.20.05.2 **Insulated Glass Partition**

The Glass partition towards TG deck and Air Lock Room shall be Insulated Glass Unit (IGU) based clear Glass partition. Insulated Glass Unit (IGU) with multiple layer glass panels and gap between them.

Providing IGU system with Powder coated aluminum frame glass structural glazing shall consist of 24 mm thick double glazing of two layers of glass, 6mm thick outer clear glass, 6mm thick clear inner glass separated for 12mm dehydrated with desiccant air gap provided with 12mm thick anodized aluminum spacer fixed with primary seal of hot melt butyl and secondary seal of structural silicon (if required). Both the glasses shall be toughened glass. The glass to be used should be from the manufacturers of glass like Hard Glass, ASI or Saint Gobain make and the glass should withstand a basic wind speed of 50m/sec. The glass shall be distortion free and free from thermal stresses. The window system should be fixed only and the glass size shall be adopted as per the approved drawing. If any gap is raised in between wall face (Jamb, soffit and sill) and frame; the same to be filled as per the requirement.

6.20.05.3 **Partition for LVS:**

Providing & Fixing factory made removable type self inter lockable metal panels of Preformed textured PVC coated GI sheet lampre panels. Kiosk type partitioning shall be provided for LVS.

Make should comprise of specially designed combination of perforated and non-perforated panels through CNC bending, punching & laser Cutting. Panel should be 0.75mm thick (sheet thickness: 0.6mm and PVC fill: 0.15mm) galvanized metal panel of approved color.

Panels should be designed to achieve shape and design as per the Purchaser's Approval. Panels should be fixed using snap fitting or any other dry cladding system.

The metal sheet should have possibility of being formed mechanically, according to the specific needs of the project. The PVC film in 150 µm may undergo stretching up to 100% and therefore follow (adhere to) bend with the steel in all its deformation. The sheets should have specific fire retardant additives as an important barrier to slow down the combustion processes. It should have electrical insulation property. It should be sustainable and easy to maintain.

6.20.06 **DOORS**



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



Air Lock type Door arrangement shall be provided at the entrance of CCR. The outside double leaf door shall be automatic sliding type with Air curtains. The inside double leaf door shall be provided with door spring. All other doors of CCR shall be provided with door spring.

6.20.06.1 **Glass Doors**

Special frameless doors with patch fittings for doors shall be with door spring, locking arrangement and both way S.S. handles including SS patch fittings.

Glass Thickness	:	12mm Toughened.
Width of double glass door	:	2000 mm
Width of single glass door	:	1000 mm
Height of the Door	:	2400 mm

Glass doors shall consist of glazed surfaces (with design etching film having Project / Purchaser's Logo and other design). Safety film shall be applied on the glass to avoid shattering subject to purchaser's approval.

6.20.06.2 **Flush Doors**

35mm thick consisting of solid core block bonded with phenol formaldehyde synthetic resin conforming to IS: 848. The shutters shall be faced on both sides with 3mm thick water proof plywood finished with 1mm thick laminate of approved shade and make. 35x20mm second class Teak wood lipping shall be provide all around the shutter by means of approved quality neoprene based adhesive and nailing at 300mm (maximum). Teak wood lipping shall be French polished (lacquer finish) as per specifications. The shutter shall be fixed to frame by means of 125mm long MS butt hinges conforming to IS: 1341 @ 600mm CC maximum. With door spring and locking arrangements and both way handle.

Width of double glass door	:	2000 mm
Width of single glass door	:	1000 mm
Height of the Door	:	2500 mm

6.20.07 **PLASTIC EMULSION PAINT**

The surface shall be free from dust, dirt, grease and other foreign matter and shall be made smooth by sand paper. The primer coat shall be alkali resistant primer or emulsion primer and shall be same manufacture as plastic paint. After the Primer coat, the base preparation shall include applying two or more coatings of oil based putty in paste form. After the base preparation coats have dried, surface shall be lightly sand papered. The plastic emulsion paint shall confirm to IS: 5411 (Part-I).

6.20.08 **ILLUMINATION FOR CENTRAL CONTROL ROOM:**



The Illumination for CCR shall be provided with modern designer lighting with modern technologies used in Modern Power plant Control Rooms. The illumination shall include CFL based modular round ceiling lights, LED based Strip lights, CFL based Direct luminaries and Emergency Lighting with all required accessories of Desired Lux Level in CCR shall average 500 Lux on operator desk. Lux calculation shall be submitted to purchaser for approval. Elegant designer based Switches and sockets shall be provided to match the aesthetics of walls. Bidder shall also refer Electrical specification Volume -IV for Illumination, cables, cabling, power supply, accessories, etc of CCR.

6.20.08.1 **CFL based modular round ceiling light**

CFLs for modular round ceiling lighting shall be of reputed make. Lumen Output shall be min. 2000. Power Consumption will be 36Watt. The Color of light shall be natural White of 4000K, operating voltage 220V-240V AC and Frequency 50Hz. The CFL system shall have Constant current driver integrated in separate box. Chrome plated mirror finish front reflectors & Dual finish internal reflector with matte at bottom and diamond at sides for higher light output with IP20 Protection. Enclosure shall be Die-Cast housing acting as heat sink Detachable from frame made from High quality engineering plastic. Life of each CFL shall not be less than 50000 burning hrs (At L70) and CRI shall be greater than 80.

6.20.08.2 **CFL based modular Square (2'X2') ceiling light**

CFLs for Modular Square ceiling lighting shall be of reputed make. Lumen Output shall be min. 4000. Power Consumption will be 72 Watt. The Color of light shall be natural White of 4000K, operating voltage 220V-240V AC and Frequency 50Hz. The CFL system shall have Constant current driver/Electronic Ballast integrated in separate box. Detachable curved white powder coated perforated CRCA sheet with wide paralite P5 louvers to achieve direct lighting with low glare / high efficiency with IP20 Protection. Enclosure shall be Die-Cast housing acting as heat sink Detachable from frame made from High quality engineering plastic. Life of each CFL shall not be less than 50000 burning hrs (At L70) and CRI shall be greater than 80.

6.20.08.3 **LED based Strip light**

LEDs for Strip lighting shall be of reputed make. LED system shall have Minimum 250 lumen/Meter output & 9.8W/Mtr. The Color of light shall be natural White of 4000K, operating voltage 12 V AC and Frequency 50Hz. The CFL system shall have Constant current driver integrated in separate box. Optics shall be Sand-blasted matt finish reflector type. Enclosure shall be Die-Cast housing acting as heat sink Detachable from frame made from High quality engineering plastic. Life of each CFL shall not be less than 40000 burning hrs (At L70) and CRI shall be greater than 80.

6.20.08.4 **LDBs**

Comby consumer units are designed to suit installations in domestic, commercial & Industrials installations, easy to install, attractive and highly reliable. Fitted with either sheet steel flap or clear plastic flap for visual inspection of components. Complete with neutral and earth terminals and din rail.



LDBs shall comply to IEC 439-1&3 and BS 60439-1&3 standards with Max. Load: 100 amps and Max. Voltage: 230 V AC / 415 V AC 50 Hz. Range shall be 7, 10, 16 and 20 modules. Degree of protection of each LDB shall be min. IP 30. Enclosure material shall be Cold rolled sheet steel Box and with cover of 1 mm thick. LDB colour shade shall be as per Requirement (shall be powder coated)

6.20.08.5 **Sockets & Switches**

Elegant designer based sockets and switches comply to stringent quality norms, Dual shutter mechanism for easy & better fitment Wide & flat switch knob for easy operation. FR grade polycarbonate with high impact resistance, shock proof & UV rays stabilized. Rating shall be 230V, 16A, 50Hz AC sockets of Heavy Duty type with 6A/16A Single phase Sockets & Switches, 2 pin and earth. Enclosure shall be Heavy duty conforming to IP 32 min. Number of socket outlets per circuit - 2 max. The no of sockets and switches shall be finalised during detailed engineering.

6.20.08.6 **Wiring**

The system wiring shall consist of PVC insulated copper conductor stranded flexible FRLS wires of 1100 volts grade of insulation, in metallic conduits for all exposed wiring and PVC/ metallic conduits for all concealed wiring. Minimum size of copper conductor shall be 2.5 sq. mm for lighting and 4 sqmm for power (Also refer Vol. V, Part-B, Chapter 9 for details). Color code shall be maintained for the entire wiring installation that is Red/Yellow/Blue for the all single phases, Black for neutral and Green for earthing. Appropriate ferule will be used in both the side (LDB Side & Switches Side)

Note – Each Light Fixture will have 3 Wires: Phase, Neutral & Earth individually.

6.20.08.7 **Conduit**

Conduits shall be provided for all Lighting Control Wiring and Power Socket Wiring. Electrical conduit shall be of metal (GI – High Class). Flexible conduit shall be provided as per application requirement. 25 mm Dia GI conduit shall be used in ceiling & it will be BS 4568/BS EN 50086 Part 1 Class 4 finish hot dipped galvanised inside & outside Conduit. All Surface conduits shall be GI Type & Flexible GI will used from ceiling to footing. Below false Ceiling all the conduits shall be concealed & will be 25mm Dia PVC Conduit. All conduits shall be accessed by removing the modular wall / paneling planks.

6.21.00 **ASSEMBLY AND INSPECTION**

As soon as the panel's fabrication is over, Owner shall inspect the panels and further work on the panels, namely assembly, wiring and assembly of components shall be carried out only after the inspection.

6.22.00 **Documents to be submitted by the contractor during detailed Engineering stage:**

1. 2D Engineering drawing of CCR & each LCR.
2. 3D Views of CCR & each LCR.

3. Ceiling Layout
4. Flooring Layout
5. Partition Layout
6. GA Drawings
7. Lux calculation reports
8. Illumination Layout
9. Ergonomic report of Control Room Design.
10. Bill of Material.
11. Test Certificates of ceiling material, Cladding Material, Flooring Material, Illumination Material etc.

6.22.00 CONTRACT QUANTITIES

Refer Appendix-I to Part-A, Vol.-V of Technical Specifications. Quantities indicated are the minimum requirements, however each & every item shall be provided as per system requirements.

CHAPTER – 7

UNINTERRUPTIBLE POWER SUPPLY SYSTEM & 24 V DC SYSTEMS

7.01.00 ELECTRICAL POWER SUPPLY

7.01.01 The requirements of Electrical Power Supply system are specified herein on system basis.

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

The Bidder shall furnish all required equipment cubicles and wiring required for conversion and/or stabilization of the power sources provided by the Owner to all other levels which may be necessary for meeting the individual requirement of equipment/system furnished by him including the panel/desk mounted equipment.

7.01.02 The power supply system shall be designed to meet the electrical power requirements of various 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.

7.01.03 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, Vol. V of contract quantities: -

(A) 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 and 1x100% Microprocessor controlled Battery Health Monitoring System (BHMS).

The specifications for this configuration shall be as per Cl.No.7.02.01 to 7.05.00 as a minimum.

(B) In case parallel redundant power supply module/power packs with 24 VDC output are used, the input power supply to the same can be either of 24 VDC/110 VAC/230 VAC/220 VDC, to be finalized during detailed engineering.

Parallel redundant 24 V DC convertor with automatic 50% load sharing & 125 % capacity shall be provided for 24 V DC power supply in each cubicle separately as per requirements.

The input power supply shall be extended to Parallel redundant 24 V DC convertor thru redundant feeders.

AC/DC to DC convertor shall be SMPS based with 3rd party like UL approval and shall have wide range of AC/DC input voltage (85-264 V AC, 18-32 VDC & 90-350 VDC). It shall have the necessary diagnostic functions like indications for DC OK, automatic overload monitoring etc. The MTBF for the power supplies shall not be less than 500,000 hours (in Accordance with (IEC - 1709) with operating temp. from - 25deg. C to 70 deg. C.

There should not be Diode oring for switch over. There should be separate power supply with parallel redundant features with automatic 50% load sharing and indication & alarm on convertor failure.

Pot free contacts shall be provided for convertor Fail alarm, 24 V DC under voltage alarm, 24 V DC over voltage alarm etc. Make shall be Phoenix contact, Cosel (Japan), Weidmuller, Omron or Siemens.

- (C) For remote locations, separate 24 V DC system shall be provided in the remote local control room.

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 Owner's approval during detailed engineering.

- 7.01.04 Bidder shall also provide local power supply distribution boxes on as required basis for sub-distribution of all 230V AC and 24V DC utility feeders for various field mounted instruments/devices (e.g. Analysers etc.) supplied by the Bidder, Remote I/O Cabinets and also for the instruments/devices provided by the Owner. The power supply distribution box shall include necessary change over circuitry (as applicable), MCCB, switch fuse units, MCB, terminal blocks etc suitable for the application. The sub distribution of feeders in a local power D.B. shall be finalized during detailed engineering.

- 7.01.05 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-I to Part-A, Vol. V and chapter 3, 14, 15, 16, 19, 20, 21 & 22 of Part B, Vol. V of Technical specification.

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 owner's approval during detailed engineering.

- (A) UPS System for critical system like DDCMIS & associated items, PLC & associated items, simulator, C&I Lab, Communication system, PSSS etc. shall consist of 2 x 100% parallel redundant chargers and inverters with input isolation transformers, 1 x 100% Ni Cd battery bank for one (1) hour backup, Bypass line transformers & static 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.

The specifications for this configuration shall be as per Cl. No. 7.06.00 to 7.10.00 as a minimum. UPS system shall be separate for each system.

- (B) UPS system for non critical system like AAQMS, Weigh bridge, non redundant microprocessor/microcontroller based system etc. shall consist of 1 x 100% charger and inverter, 1 x 100% Ni Cd Battery Bank for 1 hour, Bypass Line Transformers and Static 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.

The specifications for this configuration shall be as per Cl.No.7.06.00 to 7.10.00 as a minimum.

- (C) On line UPS for DMS, OWS, Video conferencing System, cameras etc. with remote monitoring system having a battery back up of 30 minutes and minimum 3 nos. output power sockets as per Control System supplier's standards subject to owner's approval. Surge protection device shall be provided at input side of the UPS. Battery life/warranty shall be minimum 5 years.

The UPS shall be designed at a load factor of 0.8 lagging at 50 deg C keeping a 10% design margin over the actual load requirement.

- (D) For common system with in the TG building, redundant feeders shall be provided with unit UPS.
- (E) Redundant feeders (minimum 5 nos. feeder in each ACDB) shall also be provided with unit UPS for owner's use within TG building. Minimum 5 KVA load shall be included by bidder with unit UPS for owner's use accordingly.

7.01.06 The batteries for 24/48VDC power supply systems shall conform to requirements specified at Cl. No. 7.11.00.

The batteries for UPS system for configurations as per clause 7.01.05 (A) and (B) shall conform to requirements specified at Cl. No. 7.11.00. The batteries for UPS system for configuration as per clause 7.01.05 (C) shall be Sealed Maintenance free type as per Control System Supplier's Standard.

7.02.00 **DC POWER SUPPLY SYSTEM (24 V and 48 V)**

7.02.01 Microprocessor based, Intelligent, Modular Power Supply

7.02.02 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.

10% design margin has to be considered over and above the load requirement. 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. The exact sizing of the rectifiers in one bank shall be subject to Owner 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 selecting the components and finalizing the cooling arrangements, Bidder to note that these rectifier modules are required to operate at 30-40% of the rated load for most of the time. 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." 24/48 V DC system rating shall be submitted by bidder for approval considering full load operation. 24/48 V DC system output voltage accuracy/regulation shall be +/- 1% at no load to full load.

- 7.02.03 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 $\pm 1\%$ or better from no load to full load with an input power supply variation of $\pm 10\%$ in voltage and $\pm 5\%$ in frequency. In addition to indications/display on rectifier 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/PLC. 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 Owner during detailed engineering. Necessary provision shall be done in DDCMIS/PLC end also.
- 7.02.04 The rectifier module shall be fed from 415V AC, 50 HZ, 3 phase, 3 wire system.
- 7.02.05 "Float/Boost" charge functions shall be provided with alarm/indications. In Boost mode, each of the chargers shall be able to re-charge the fully discharged battery within 8 hours. However, each charger shall be able to supply full load current requirements plus the battery charging current in boost mode. Complete operation shall be in auto mode. Operator intervention shall not be required for 24/48 V DC system operations
- 7.02.06 The rectifier module shall be current limited for circuit protection and protection of battery from overcharge. The current limit shall be continuously programmable.
- 7.02.07 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 energized.

- 7.02.08 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.
- 7.02.09 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.
- 7.02.10 All Software as required for smooth operation and monitoring of rectifier modules in conjunction with Controller & BHMS shall be provided by the Bidder.
- 7.02.11 Bidder shall furnish the equipment complete in all respects along with rectifier module rating & voltage drop calculations, supporting curves/data etc.
- 7.02.12 MCCB shall be provided at input, output, battery side, & DCDB side etc with ON, OFF & Trip indication.

7.03.00 **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 Owner. However, 25% spare feeders (min. 1 no. of each type & rating) with LED indication, MCB and fuses for each rating shall be provided in each DCDB.

7.04.00 **Battery Health Monitoring System (BHMS)**

BHMS, wherever applicable, shall include microprocessor based hardware and software to monitor the condition of each battery cell of 24/48 V DC systems & UPS battery banks on-line. With BHMS it shall be possible to measure & analyse the minimum and maximum voltage values of each battery-cell so that any damage to battery shall be prevented by pro-active maintenance. BHMS shall communicate with the DDCMIS/PLC and provide alarms as finalized by Owner during detailed engineering.

Complete hardware like detector units, Battery clips, cables, monitor (power control unit) and other accessories etc as required to complete the system shall be provided by bidder. LED indication shall be provided on detector units for power, alarm and RUN indication etc. Data from Online Battery Health Monitoring System shall be communicate/transferred to respective DDCMIS/respective PLC for Monitoring and analysis using different protocol like RS485 Modbus/OPC etc. thru redundant connectivity. ON line battery health monitoring system shall have ports suitable for connecting laptops locally.

Necessary Software for communication between battery health monitoring system and DDCMIS/DCS/PLC/microprocessor based control system etc as well as for analysis of stored data shall be provided by bidder. The software for analysis shall be capable of showing graphical representation of various stored parameters and shall give some corrective suggestion based on the abnormal parameters. The software shall calculate and show the battery Ah during charge/discharge cycles.

Logging of cell/battery parameters (Voltage, current and temperature) and alarm conditions as well as event log of all activities affecting the battery bank shall be possible with date/time stamp. Logged data can be exported in MS Excel format.

- 7.05.00 Power Supply shall be sized to meet connected load requirements and keep the connected battery full charged in Float/ Boost mode. The rectifier module output regulation shall be $\pm 1\%$ or better from no load to full load with an input power supply variation of $\pm 10\%$ in voltage and $\pm 5\%$ in frequency. In addition to indications/display on the panel, potential free contacts for alarms like O/P voltage high & low, AC Input supply failure, battery feeding the load etc shall also be provided for use in respective control system i.e., PLC/Remote IO etc. Further isolated 4-20 mA signals shall be provided for important parameters like rectifier module voltage, rectifier bank current, battery voltage etc. The list of alarm output & 4-20 mA signals shall be as approved by Owner during detailed engineering. The exact design, rating & number of feeders of the DCDB shall be as finalised during detailed engineering and as approved by Owner. However, 25% spare feeder (min. 1 no. of each type & rating) with LED indication, MCB, fuses for each rating shall be provided in each DCDB.

7.06.00 **UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM**

The UPS shall be designed at a load factor of 0.8 lagging at 50 deg C keeping a 10% design margin over the actual load requirement. UPS load rating shall be submitted by bidder for approval considering full load operation. UPS system output voltage accuracy/regulation shall be $\pm 1\%$.

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.

Acoustic noise at rated linear load shall be < 75 dBA at 1 meter distance from UPS as per ISO 3746.

The industrial grade UPS system for main plant & for each individual BOP/offsite package shall include the following equipment:

S. No.	Descriptions	Configuration for UPS of main plant DDCMIS Package and BOP/Off-site DDCMIS package.	Configuration for UPS for Off site / BOP package PLC based system.
1.	100% capacity of IGBT based PWM Inverter with output Voltage, current, frequency, KVA & KW digital display/meter.	2 nos.	2 nos.

S. No.	Descriptions	Configuration for UPS of main plant DDCMIS Package and BOP/Off-site DDCMIS package.	Configuration for UPS for Off site / BOP package PLC based system.
2.	100% capacity static switches with input Voltage, current, frequency digital display/meter at bypass line.	(As required) 2 no. (Min)	(As required) 2 no.(Min)
3.	Manual by-pass switch	1 no.	1no.
4.	100% capacity floats-cum-boast full wave Chargers. Rectifier and charger shall be a single combined block. Rectifier, Inverter and Battery must be connected to each other directly. There must not be any buck-boost converter in the middle.	2 nos. 12 Pulse	2 nos. 6 Pulse
5.	Battery Set with accessories each	1 set for 1 hour back-up at 100% of selected UPS rating.	1 set for 1 hour back-up at 100% of selected UPS rating.
6.	Step-down transformer (415 V, three phase , to 230V, single phase) of required capacity)	1 no	1 no
7.	Static Voltage Stabilizer with input & output ON Red indication and input & output Voltage, current, frequency digital display/meter.	1 set	1set
8.	Input isolation transformer with input & output ON red indication and input Voltage, current, frequency digital display/meter. Out put isolation transformer	1 no each	1 no each
9.	A.C. Power Distribution Panels (including 20 % spare feeders on each panel with 2 nos. minimum spare feeder of each rating) and digital type Ammeter, Voltmeter, Frequency meter, PF meter, Watt meter & VA	2 sets (Quantities of feeders shall be as on required basis).	2 sets (Quantities of feeders shall be as on required basis).

S. No.	Descriptions	Configuration for UPS of main plant DDCMIS Package and BOP/Off-site DDCMIS package.	Configuration for UPS for Off site / BOP package PLC based system.
	meter		
10.	Interconnecting Armored FRLS ST2, PVC type C insulated Copper conductor Cable between UPS equipment & battery, UPS & ACDB, ACDB & loads.	As required	As required
11.	MCCB (At input, output, battery side, bypass & ACDB side etc) with ON, OFF & Trip indication.	1 no. each	1 no each
12.	Online Battery Health Monitoring System	1 set	1 set
13.	Battery Junction Boxes with MCCB, Voltmeter & Current meter.	1 set each	1 set each
14.	Any other equipment necessary for completion of the system shall be provided by bidder.		

All equipment, enclosures and accessories for UPS system shall be designed, arranged assembled and connected in accordance with the requirements of this specification.

7.06.01 **Chargers**

7.06.01.01 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 automatically. The charger output regulation shall be $\pm 1\%$ from no load to full load with an input power supply variation of $\pm 10\%$ in voltage and $\pm 5\%$ 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 Owner during detailed engineering.

7.06.01.02 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.

- 7.06.01.03 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.
- 7.06.01.04 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.
- 7.06.01.05 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.
- 7.06.01.06 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.
- 7.06.01.07 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.
- 7.06.01.08 Each charger shall be furnished with a ground detector system consisting of a relay and a center tapped resistor. The resistor shall be connected between the positive bus and the negative bus.
- The relay coil shall be connected between the center tap of the resistor and ground. The relay shall be furnished with one normally open and one normally closed contact wired to terminal blocks for connection to external circuits.
- 7.06.01.09 Rectifier output voltage going to Inverter as well as Battery must have stability less than or equal to +/- 1%.

7.07.00 **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 +/-1% and transient voltage regulation (on application/removal of 100% load) shall be +/-20%. Time to recover from transient to normal voltage shall not be more than 50 msec. Frequency regulation for all conditions of input supplies, loads and temperature occurring simultaneously or in any combination shall be better than $\pm 0.5\%$ (automatically controlled). The total harmonic content shall be 5% maximum and content of any single harmonic shall be 3% maximum. The inverter efficiency shall be at least 85% on full load and 80% on 50% load. The 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.

7.08.00 **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.

7.09.00 **Step Down Transformer and Static Voltage Stabiliser**

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

The overload capacity of the transformer and Static voltage stabilizer shall not be less than 300% for 200 millisecond duration. The voltage stabilizer shall employ solid state circuitry and shall maintain the specified output voltage for 0-100% load with maximum input voltage variations as indicated above and output voltage accuracy/regulation at \pm 1%. The efficiency of the stabiliser shall be 95% or better.

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

7.10.00 **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 approved by Owner during detailed engineering. Each feeder shall have fast acting semi conductor fuse, MCB & LED indication for ON status. ACDB shall be designed to cater to the requirements of all the loads.

7.11.00 **Batteries**

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 conform to latest edition of standards like IEC 60623, IEC 62259, IEEE 485, IEEE 1115, IEEE 1106, and IS:10918. For sizing calculation, design margin, 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 Bidder 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 Owner during detailed engineering. The Bidder shall consider a voltage drop of 2.5V from battery room to DCDB and DCDB to load, while sizing the battery for 24/48 V DC Charger System and 4V from battery room to the inverter input while sizing the battery for UPS System.

The system shall also be suitably designed to overcome any over voltage that may arise during low-load operation of the charger. The bidder shall clearly bring out in his offer how the same is being implemented.

The battery size shall be calculated taking UPS/24/48 V DC system capacities as base load. Bidder shall also consider voltage drop from battery room to UPS/24/48 V DC systems, while sizing the battery.

Nickel coated copper connectors shall be used for connecting up adjacent cells and rows. Bolts, nuts and washers shall be effectively Nickel coated to prevent corrosion.

All the terminals and cells inter-connectors shall be fully insulated or have insulation shrouds. Necessary supports and lugs for termination of cables shall be provided by the bidder.

All connectors and lugs shall be capable of continuously carrying the 180 minutes discharge current of the respective batteries and fault short circuit current which the battery can produce and withstand for the period declared.

7.11.01 The following information/details shall be indelibly marked on outside of each cell:-

- i) Manufacturers' name and trade marks.
- ii) Country and year of manufacture.
- iii) Manufacturer type designation.
- iv) AH capacity at 5 & 8 hour discharge rate.
- v) Serial Number.
- vi) Warning Marking.
- vii) Polarity Marking.

7.11.02 One complete set of all accessories and devices required for maintenance and testing of batteries shall be supplied for each set of the batteries of each unit/plant auxiliary system. Each set include at least the following:

- | | | |
|----|---|--------|
| a) | Hydrometer | 5 Nos |
| b) | Set of hydrometer syringes suitable for the vent holes in different cells | 5 Nos |
| c) | Thermometer for measuring electrolyte temperature | 5 Nos |
| d) | Specific gravity correction chart | 5 Nos |
| e) | Wall mounting type holder made of teak wood for Hydrometer & thermometer | 5 Nos |
| f) | Cell testing voltmeter (3-0-3 V) | 5 Nos |
| g) | Alkali mixing jar | 5 Nos |
| h) | Rubber aprons | 5 Nos |
| i) | Pair of rubber gloves | 5 Nos |
| j) | Set of spanners | 5 Nos |
| k) | No smoking notice for each battery room | 2 Nos |
| l) | Goggles (industrial) | 5 Nos |
| m) | Instruction card | 10 Nos |

n)	Minimum and maximum temperature indicator for battery room	1 No.
o)	Cell lifting facility	1 Set
p)	Vent Caps	2 set
q)	Terminal Bolts & Washers	1 Set
r)	Plastic Filling Bottles	10 Nos.
s)	Alkali resistant funnel & Mugs	10 Nos.

7.12.00 **AUXILIARY EQUIPMENTS**

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

7.12.02 Manual Discharge Resistance bank of adequate capacity for UPS & 24/48 V DC Power Supply System batteries as indicated in Appendix-1 to Part-A of contract quantities shall be provided by the Bidder.

7.12.03 Cell booster charger shall be provided with main plant's UPS & 24/48 V DC charger system batteries and UPS & 24/48 V DC charger system batteries for BOP's each DDCMIS set to charge the new & sick cell for revival of cell. The cell booster shall be built in separate portable panel.

7.12.04 Class of insulation of wound components (All transformers, chokes/inductances etc.) shall be class H with temp rating up to class B.

7.12.05 The UPS, 24/48 V DC system equipment and the complete system shall have surge withstanding capability (SWC) to meet the requirements of ANSI C 37.90a – IEEE Standard 472 –1974. UPS should be provided with Class C type surge protection device. The Class C type surge arrester should be single MOV type , pluggable, should have fault indication and should be tested as per IEC 61643-1 to withstand 40KA 8/20 μ s pulse. The arresters should have potential free contact to ensure maintainability.

7.12.06 **UPS Signal interfacing with DDCMIS/DCS & PLC**

a) The bidder shall provide alarms and status indications, current, voltage, frequency, PF etc through serial link with MODBUS or another compatible protocol.

b) The Bidder shall furnish 4-20 mA signals to DDCMIS/DCS/PLC for the following:

- i) Inverter A & B output voltages
- ii) Inverter A & B output currents
- iii) Inverter A&B output frequency
- iv) Static Stabilizer Voltage
- v) Static Stabilizer Current.

- c) List of alarms (min.) to DDCMIS/DCS/PLC through potential free contacts shall be as follows:-
- i. Rectifier – 1 Trip.
 - ii. Inverter – 1 Trip.
 - iii. UPS battery low.
 - iv. Rectifier – 2 Trip.
 - v. Inverter – 2 Trip.
 - vi. Load on static Bypass.
 - vii. Static Bypass failure
 - viii. ACDB – 1 Incomer Tripped.
 - ix. ACDB – 2 Incomer Tripped.
 - x. UPS – 1 Fan Tripped.
 - xi. UPS – 2 Fan Tripped.

7.12.07 Battery voltage and other parameters must be adjustable from UPS Front Panel MIMIC.

7.13.00 **BATTERY RACKS**

Battery racks provided for battery shall be 2 tier made from high strength good quality fresh unused heavy teak wood/Stainless steel to bear 150% over load, and anti-acid paint etc. as per approved coating process to provide a non-peel able protective coat with good ground clearance of minimum 150 mm. AISC

Specification shall apply in the absence of another design specification.

One no. 2 sided Folding Aluminum ladder (height 180 cm) for maintenance & removal of battery cells and mounting bracket for ladder shall be provided by bidder with each battery set.

7.14.00 **DRAWINGS/DOCUMENTS REQUIREMENTS**

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

7.15.00 **CABINETS / ENCLOSURES**

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

- (1) The Construction details for UPS & 24/48 V DC charger system cabinets/enclosure shall conform to the requirements indicated in chapter 6.
- (2) The temperature rise inside all the cabinets/enclosures shall not exceed 10 deg.C above ambient temperature. The cabinets shall be IP-32 protection class.
- (3) The Colour shade of Panels exterior/interior shall be as per Vol. V, Part B, Chapter 6.

7.16.00 **COOLING SYSTEM**

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

- (1) Reserve cooling equipment shall be furnished for each assembly. Reserve fan capacity shall be equal to 100 percent of cooling fan requirements for full load operation with only one bank of rectifier/inverter in service at the specified maximum ambient temperature.
- (2) Completely independent duplicable wiring and control systems shall be provided for the normal cooling fan system and the reserve cooling fan system.
- (3) Each cooling fan shall normally run continuously and shall be powered from the output of the inverter whose enclosure it serves (for cubicles housing inverters). For other cubicles, fan power supply shall be as finalised during detailed engineering. Each cooling fan supply circuit shall be separately fused.
- (4) Each cooling fan shall be equipped with a switch having an alarm contact that closes upon failure of airflow or rise of temperature.

7.17.00 **Grounding**

Normal, AC power supply will be grounded at the source. For grounding other than this, I/P and O/P isolation transformers shall be furnished with the UPS and 24/48 V DC charger system

7.18.00 **SITE TESTS**

The Bidder shall also carry out the site tests on Uninterruptible Power Supply System and 24/48V DC Power Supply System for demonstrating the specification requirements. In case any other site test is required to be conducted as a standard practice of the Bidder and mutually agreed between the Bidder and the Owner, the same shall also be carried out.

7.19.00 VOID.

7.20.00 **12 V DC CONTROL POWER SUPPLY SYSTEM FOR FIRE PROTECTION AND DETECTION PACKAGE**

7.20.01 The bidder shall offer a completely separate parallel redundant system with 50 % load sharing on each charger to cater to 12 V DC requirements. 12 V DC system shall consist of

1.	100% capacity 6 Pulse float cum booster charger	2 nos. charger in parallel redundant configuration
2.	Battery Bank each for 100 % load	1 Bank (100% capacity) each for 60 minutes back up
3.	DCDB (including 20 % spare feeders on each panel with 2 nos. minimum spare feeder of each rating)	2 set, (Quantities of feeders shall be as on required basis).
4.	Armored FRLS ST2 (inner & outer sheath), PVC type C/XLPE insulated	Complete power cables for 24 V DC system with battery, DCDB

	stranded copper conductor Cables. For emergency trip push buttons, Fire alarm system, safety critical circuit, trip protection circuit and for other services specified elsewhere in the specification shall be fire survival power cable conforming to IEC 60331, BS6387 (CWZ), BS6207 standard and this specification.	and loads.
5.	MCCB/MCB (At input, output, battery side, & DCDB side etc) with ON, OFF & Trip indication.	1 no. each
6.	Input isolation transformer with input & output ON indications and input Voltage, current, frequency digital display/meter.	1 no. each
7.	Battery Junction Boxes with MCCB, Voltmeter & Current meter.	1 set each
Any other equipment necessary for completion of the system shall be provided by bidder.		

Input for 12 V DC systems shall be from 3 phase MCC system. 12VDC power supply to load will be through MCCB, MCB, and redundant feeders DCDB - 1 and DCDB - 2. Grounding cubicle for 24 V DC system shall be included in scope of supply.

7.20.02 **Float cum boost chargers:**

- 7.20.02.01 Each of the redundant chargers shall be sized to meet connected load requirements and keep the connected battery full charged (Float mode). In Boost mode, each of the chargers shall be able to re-charge the fully discharged battery within 8 hours. However, each charger shall be able to supply full load current requirements plus the battery charging current in boost mode. Complete operation shall be in auto mode. Operator intervention shall not be required for 12 V DC system operations
- 7.20.02.02 The chargers shall be self regulating, SCR controller, full wave 6 Pulse type 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 and filters on both input and output to minimize harmonics. The charger output regulation shall be $\pm 1\%$ from no load to full load with an input power supply variation of $\pm 10\%$ in voltage and $\pm 5\%$ in frequency. In addition to indications on charger panel, potential free contacts for alarms like charger O/P voltage high, battery isolated, charger failed etc., shall also be provided and the same shall be further connected to DDCMIS for indication. Further isolated 4-20 mA signals shall be provided for important parameters like charger voltage, current etc. Bidder shall provide list of alarm outputs & 4-20 mA signals list for owner's approval during detailed engineering.
- 7.20.02.03 A auto/manual selector switch and "FLOAT/BOOST" mode selector switch in case of manual mode selection shall be provided for either trickle charging the battery (while supplying the load) or boost charge the battery (isolated from load) respectively. In boost charging mode, the chargers shall operate

in constant current mode building up the voltage across the battery as per requirements.

- 7.20.02.04 Each of the two 100% capacity chargers shall be adequately rated to ensure that 50% load sharing shall be ensured during normal conditions and in case any one of these chargers fails, the other charger shall work at 100% load.
- 7.20.02.05 The charger circuitry shall be of fail-safe design and failure of any component should not result in any charger output voltage to increase beyond acceptable limits of the C&I system being fed from it.
- 7.20.02.06 The charger shall be current limited at 125% of full load to reduce output voltage for charger circuit protection and for protection of battery from overcharge. The current limit shall be continuously adjustable from 80% to 125%.
- 7.20.02.07 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.
- 7.20.02.08 The chargers shall be fed from 415V AC, 50 HZ, 3 phase. The Bidder shall provide all required power cables from 415 V AC power supply system to his power supply system.
- 7.20.02.09 The minimum full load efficiency at nominal input and output shall be 90%.
- 7.20.02.10 Charger design shall ensure that there is no component failure due to fluctuations of input supply or loss of supply and restoration. This feature shall be demonstrated during factory testing at various loads.
- 7.20.02.11 Bidder shall furnish the equipment complete in all respects along with charger rating & voltage drop calculations, supporting curves/data etc.
- 7.20.02.12 12 V DC Charger sizing calculation shall be submitted for approval) at 50 deg. C ambient. Each Individual parallel redundant 12 V DC charger system shall be designed considering 20% design margin.
- 7.20.03 The 12 V DC charger system design shall ensure that in case of one of the charger failure, the other healthy charger, shall continue to charge the each DC battery banks at all load conditions. The bidder should note that this situation should not in any way lead to the discharge of the DC battery and maintain the 12 V DC power supply to all loads.
- 7.20.04 **Batteries And Accessories**

The 12 V DC system batteries shall be one (1) set of **heavy duty Nickel-cadmium plated type** as specified at clause no. 7.11.00. Battery sizing calculation shall also be submitted for approval as per factors specified at clause no. 7.11.00. All other items shall also be furnished by bidder as specified at clause no. 7.12.00.

The sizing of the battery shall be as approved by owner during detailed engineering. However, Bidder shall consider a minimum 2.5 volt drop from battery room to 12 V DC charger system and a minimum 2.5 volt drop from 12 V DC charger system to loads, while sizing the battery.

7.21.00 **FACTORY TESTS**

7.21.01 The UPS system & 12/24/48 V DC system and batteries shall be factory tested under various stages of manufacture and upon full completion as per Owner approved quality Assurance plan, the tests shall include, but shall not be limited to the following:

7.21.02 Type and Routine Tests

Type and routine tests for various components and sub assemblies in accordance with IS and/or NEMA, IEEC & IEC Test Standards.

7.21.03 Functional Tests

Functional tests to demonstrate compliance with all specified requirements and published specifications, such as frequency regulation, voltage regulation, current limiting, fuse clearing capability of inverters, demonstration of phase and frequency control of inverters for synchronisation with range of adjustments; transfer and retransfer of static switches under influence of under voltage and over current, tests on charges, batteries and other system components to confirm compliance with specification.

7.21.03.1 **UPS (Factory Acceptance Test)**

- i) Power Efficiency (IEC 146-2, IEC 146) at 100% load, 50% load.
- ii) Load test (Approved Procedure)- load regulation test
- iii) Audible noise test (IEC 146-2)
- iv) Fuse clearing capability (Approved Procedure)
- v) Relative harmonic content (IEC 146-2)
- vi) Synchronous transfer & synchronization test (IEC 146-4)
- vii) Temperature rise test without redundant fans (IEC 146-2)
- viii) Input voltage variation test (Approved Procedure)
- ix) Overload test on inverter & charger (Approved Procedure)
- x) Insulation test (IEC 146)
- xi) Restart test (IEC 146-2)
- xii) Short circuit current capability (IEC 146-2 clause 5.10)
- xiii) Output voltage & frequency tolerance (IEC 146-2)
- xiv) Voltage current division (IEC 146-2)
- xv) Relative harmonic content (IEC 146-2)
- xvi) Parallel redundancy (* Simulation of Parallel redundant fault (IEC 146-4)
- xvii) Overload test (final acceptance test)
- xviii) Any other required as per national international standard or QAP

7.21.03.2 **Battery Charger for UPS & 12/24/48 V DC System**

- i. Short circuit current capability (IEC 146-2).
- ii. Temperature rise test without redundant fans (Approved Procedure)
- iii. SWC test (Approved Procedure)
- iv. Efficiency / PF (IEC 146-2, IEC 146)

- v. Audible noise test (IEC 146-2)
- vi. Fuse clearing capability (Approved Procedure)
- vii. Relative harmonic content (Approved Procedure)
- viii. Temperature rise test without redundant fans (IEC 146-2)
- ix. Overload test on charger (Approved Procedure)
- x Restart test (IEC 146-2)
- xi. Output voltage tolerance (Approved Procedure)
- xii. Output voltage harmonic content (Approved Procedure)

7.21.03.3 The batteries shall be tested for acceptance and routine tests in line with IS : 10918 & IEC : 62259 (latest versions).

The above test shall be witness by owner/owner's representative.

7.21.04 **Burn-in Tests and Temperature Rise Tests**

Each component of UPS & 12/24/48 V DC system shall undergo burn-in test for 50 hours continuously.

All equipment provided under this specification shall be operated under rated conditions and maximum ambient temperature for not less than 120 hours prior to release for shipment. In addition, static switches shall be subjected to not less than 1000 "Transfer/retransfer" cycles at full load.

During temperature rise test final rise in temperature of semiconductor and devices will be measured at rated conditions and the temperature shall be within stipulated limits for components. After manufacture, the system shall be subjected to routine tests as per standards. The bidder shall indicate all these routine tests in their offer. These shall include insulation resistance test, die-electric with stand test (by applying voltage of 2000 V for one minute) noise test, interference noise test, surge with stand capability.

7.21.05 **Type test**

Bidder shall submit following type test report along with final acceptance report.

- a) Battery as per IS-1652, IS 10918 & IEC 62259 – latest version.
- b) UPS/Charger/24 V/12 V/48 V DC Charger
 - i. IP degree
 - ii. Surge withstand capability (SWC)
 - iii. Dry heat test (IEC-68.2.2)
 - iv. Dump heat test (IEC-68.2.3)
 - v. Vibration test (IEC-68.2.8)
 - vi. EMC test (IEC-61000.4.2)

The above all type test shall be conducted at National / international laboratories only.

7.21.06 Bidder shall submit following documents along with Factory Acceptance Test (FAT) report:

1. Internal test report along with heat run test report.
2. Calibration certificate of measuring instruments

7.21.08 Copies of all test reports shall be submitted to the Owner as per procedure to be finalised during contract award. The owner reserves the right to witness all tests.

7.21.09 **Testing at site**

Full load test shall be demonstrated after commissioning of UPS & 12/24/48 V DC charger with batteries at site for 72 Hrs.

7.22.00 **CONTRACT QUANTITIES**

Refer Appendix-I to Part-A, Vol.-V of Technical Specifications. Quantities indicated are the minimum requirements, however each & every item shall be provided as per system requirements.

CHAPTER – 8**PROCESS CONNECTION AND PIPING****8.00.00 PROCESS CONNECTION PIPING**

8.01.00 The Bidder shall provide, install and test all required material for completeness of Impulse Piping System and Air Piping System as per the requirements of this chapter, enclosed installation drawings and source connection drawings on as required basis for the connection of instruments and control equipments (provided by the bidder) to the process on as required basis for the connection of all instruments and control equipments of entire plant.

The installation and source connection of various items shall generally as per NIT installation drawings (Drawing No. 114-04-0000, 0100 to 0113 and 114-18-0100), however, the bidder shall furnish during detailed Engineering. Installation drawings, GA and fabrication drawings of LIES/LIRs, other relevant drawings, material and tech data sheets of various items service wise for owner's approval/information.

8.01.01 All material, furnished under this chapter and the installation there of shall conform to the latest editions of American National standard Code for pressure piping, power piping ANSI B 31.1, ANSI B16.11, ASME Boiler and pressure Vessel codes, IBR and other applicable ASME, ANSI and state standards.

8.01.02 All material supplied under this chapter shall be suitable for intended service, process, operating conditions and type of instructions used and shall fully conform to the requirements of this specification. The bidder is responsible for the performance of equipments furnished under this specification on system basis. The bidder may offer suggestions for improvement based on his experience, during detailed engineering, which shall be subjected to the Owner's approval.

8.01.01 IMPULSE PIPING, TUBING, FITTINGS, VALVES AND VALVE MANIFOLDS

8.01.02 All impulse pipes shall be of seamless type conforming to ANSI B36.10 for schedule numbers, sizes and dimensions etc. The size of impulse pipe shall be 1/2" for steam and water applications and 3/4" for air and flue gas applications. The material of impulse pipe shall be same as that of main process pipe. For various applications specification of impulse pipe materials and associated fittings and valves shall be as given in table 8.1. For protection against sea environment, all impulse pipes, fittings etc shall be provided with durable epoxy coating with poly urethane finish.

8.01.03 SS tube shall be provided inside enclosures & racks from tee connection to valve manifold and then to instrument. For high pressure/temperature applications (piping class A, B, C & D of the table no 8.1) the material shall be ASTM A 213 TP 316H it and for other applications material shall be ASTM A 213 TP 316L. The wall thickness of the tube shall be in accordance with the

ANSI B31.1 standard. The bending radius of the tube shall be greater than 6D.

8.01.04 All fittings shall be forged steel and shall conform to ANSI B16.11. The material of forged tube fittings for shaped application (e.g. tee, elbow etc) shall be ASTM A 182 Gr 316 H for high pressure/temperature applications (as defined above) and ASTM A 182 Gr 316 L for other applications. The material for bar stock tube fitting (for straight application) shall be SS 316. Metal thickness in the fittings shall be adequate to provide actual bursting strength equal to or greater than those of the impulse pipe or SS tube, with they are to be used.

The source shut off (primary process root valve) and blow down shall be ½ 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. For various applications the valve body material, stem material and pressure class shall be as given in table 8.1. The end connections of valves shall be of socket welded type unless otherwise specified in the instrument installation diagrams. The disc and seat ring material of carbon Steel and alloy steel valves be ASTM-A-105 and ASTM-A-182 Gr F22, hard faced with satellite (minimum hardness-350 BHN). The surface finish of 16 RMS or grater is required in the area of stem packing. The valve design shall be such that the seats can be reconditioned and stem and disc may be replaced without removing the valve body from the line.

For Pr/D.P. gauges in fluid application two way globe valve on each impulse line to the instrument and in air/flue gas application two way gate valve on each impulse line to the instrument shall be provided near the instrument. These shall be in addition to the three ways gauge cock provided along with the Pressure/Differential pressure gauges.

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 Pipe, Tube (material & rating)	ANSI B31.1, ANSI B31.1a, ANSI/ISA 77.70
Valves (Material Pr. Class, size)	ASTM A 182/ ASTM A 105 as per ASME 16.34
Fitting (Size, rating, material)	ANSI B31.1, ANSI B31.1a, ASME B16.11-2009
Installation Scheme	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 $\geq 40 \text{ Kg/cm}^2$ or Temp $\geq 280 \text{ deg C}$. The end connections of valves shall be of socket welded type.

- 8.01.03 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 .

- 8.01.04 Double ferruled compression type fittings shall be used only, wherever required.

8.02.00 **AIR SUPPLY PIPING**

- 8.02.01 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.

- 8.02.02 Instrument air and Service air supply shall be provided for continuous and intermittent purging respectively for all transmitters of mill, dirty air and flue gas applications. Purging scheme shall be as per drawing no. 114-04-0112.

- 8.02.03 The Bidder shall also provide and connect pneumatic tubing to E/P convertors and then to control valves. For individual supply line and control signal line to control valve, 1/4-inch size light drawn tempered copper/SS tubing conforming to ASTM B75 shall be used. It shall be at least 0.065 inch and shall be PVC coated. The fittings to be used with copper/SS tubes shall be of cast brass/SS, screwed type. 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.

- 8.02.04 The instrument/service air supply to each equipment/devices requiring air supply shall be provided by a well designed air distribution scheme comprising of 2" GI Pipe Header with isolation valve from the instrument air and service air terminal points. In the boiler/turbine area the 2 inch head shall be provided upto most elevation of boiler/turbine floor and from this 2 inch header, 1 inch sub header shall be branched off at each floor with isolation valve. From this 1 inch sub-header, branch line of ½ inch, with

isolation valve shall be provided upto various devices. Similar system is to be followed for service air required for intermittent purging in the local instrument enclosures (LIEs) Instrument air filters cum regulator set with mounting accessories shall be provided for each pneumatic device requiring air supply except for Ash Handling System wherein it shall be provided on instrument air header at each location. The filter regulators shall be suitable for 10 kg/cm² max. Inlet pressure. The filter size shall be 5 microns and of material sintered bronze. The air set shall have 2 inch size pressure gauge and built in filter housing blow down valve. The end connection shall be ¼ inch/1/2 inch / 3/4 inch NPT as per the requirement to be finalised during detailed engineering. The 1 inch Sub Header shall be of SS316.

8.02.05 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.

8.02.06 Purge Air Connection for Air & Flue Gas applications

The continuous purging with instrument air shall be done, for all air and flue gas measurements, at the process source connection end. Necessary arrangements required for continuous purging shall be provided inside all instruments enclosures and instrument racks for Aot and flue gas applications.

For intermittent purging with service air, necessary arrangements inside all the air and flue gas enclosures shall be provided. The SS316 four ways valve provided in the SS316 tubing shall be used for isolating the transmitter and connecting the service air quick disconnect line.

Purging arrangement is not required for instrument air and service air measurement applications. Purge air lines shall be of mild steel hot dipped galvanised inside and outside as per IS1239, heavy duty with threaded ends.

8.03.00 **Process Connections**

The type of instrument source connection shall depend upon the process parameters and the tapping size. The source connection drawings shall be finalised during the engineering stage.

Size of tapping point stub, number and size of root valves for different types of measurements are as follows:

S. No.	Quantity of root valves	Size of stub and root valve	Service Condition
Pressure and Differential Pressure Measurement			
(i)	2	25NB	≥ 40 bar(g) OR 280°C
(ii)	1	15NB	< 40 bar (g) AND 280°C.

S. No.	Quantity of root valves	Size of stub and root valve	Service Condition
Level Measurement			
(a)	Level Gauge & Switch		
(i)	2	25NB	≥ 40 bar(g) OR 280°C
(ii)	1	25NB	< 40 bar(g) AND 280°C
(b)	Level transmitter (displacement type)		
(i)	2	40NB	≥ 40 bar(g) OR 280°C
(ii)	1	40NB	<40 bar(g) AND 280°C
(c)	Stand pipe for level measuring instrument		
(i)	2	80 NB	≥ 40 bar(g) OR 280°C
(ii)	1	80 NB	< 40 bar(g) AND 280°C
Flow Measurement			
(i)	2	25NB	≥ 40 bar(g) OR 280°C
(ii)	1	25NB	< 40 bar(g) AND 280°C
Sampling system measurement (Steam and Water Service)			
(i)	2	25 NB	≥ 40 bar(g) OR 280°C
(ii)	1	25 NB	< 40 bar(g) AND 280°C

8.04.00 **INSTALLATION AND ROUTING**

8.04.01 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.

Instrument piping & tubing shall not be routed across equipment removal areas, above or below monorails, cranes, removable gratings, cable trays.

For steam and liquid measurements, the impulse pipe should preferably slope downward from source connection to instrument and instrument shall be installed below the source point. If due to any reason instrument is installed above the source point, the impulse pipe should slope upwards continuously and a 'pigtail' should be provided at the instrument to assure water seal for temperature protection. For vacuum measurements instruments shall be installed above source point and impulse pipe should slope upwards.

Impulse piping for air and flue gas shall slope upwards and instrument shall be installed above source point. If this requirement cannot be met special venting or drain provision shall be provided with vent and drain lines along with isolation valves and other accessories including drain pipes this drain is to be connected to plant drain through open funnel also. Horizontal must have a slope of not less than 40 mm per meter and must be adequately supported to maintain a constant slope and to prevent sag in piping.

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

Special accessories such as condensing pots/reservoirs shall be provided and installed wherever required. In any case condensing pots shall be provided for all level measurements in steam and water services and all flow measurements in steam and water services above 120 Deg. C. For drum level measurement required balancing chamber shall be provided and installed.

Colour coding of all impulse pipes shall be done by the bidder in line with the colour coding being followed for the parent pipes.

Instrument Air & Service Air piping/tubing system

The air supply headers, sub headers and branch pipes shall be supported properly by clamps or supports to be provided and fabricated by the bidder. Air supply piping shall be installed with a slope of over 1/100 to prevent accumulation of condensed water within the pipe. Signal/control air tubing shall run with the minimum number of changes in direction. Suitable identification tags shall be provided for easy link up and checking of proper connections. Single and multi tubes shall run with the minimum number of changes in direction. Suitable identification tags shall be provided for easy checkups and for connections.

PIPING /TUBING SUPPORT

Impulse piping and sample piping shall be supported at an interval not exceeding 1.5 meters. Each pipe shall be supported individually using slotted angle mounted clamps with necessary fixtures. Tubing shall run in proper perforated trays with proper cover. Tubing shall be supported inside the trays by aluminium supports.

Hangers and other fixtures required for support of piping and trays shall be provided, either by welding or by bolting on walls, ceilings and structures. Hanger clamps and other fastening hardware shall be of corrosion resistant metals and hot-dip galvanised.

8.05.00 SHOP AND SITE TESTS

8.05.01 The equipment and work performed as per this chapter shall be subject to shop and site test as per requirements of Vol. II & Vol. V (Quality Assurance & Inspection) other applicable clauses of this chapter and Owner approved quality assurance plan.

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

8.05.03 Hydrostatic testing

All instrument piping/tubing shall be hydrostatically tested upon completion of erection. The test pressure shall be 1.5 times the maximum process pressure. The test shall be performed either with the testing of associated process piping or without the associated process piping (by closing the root valve). In both the cases the instrument shall be isolated by closing the shut-off valve.

Air testing

All air headers & branch pipes shall be air tested by pressure decay method as per ANSI B31.1. Flexible hoses and short signal tubing shall be tested at normal pressure for leakage. Long signal tubing shall be tested by charging each tube with air at 2 Kg/sq.cm through a bubbler sight glass. The boiler draft and vacuum piping shall be air tested by the same method as long signal tubing.

8.06.00 **LOCAL INSTRUMENT ENCLOSURE AND RACKS**

All transmitters, switches etc. in Boiler Turbine Generator measurements (except for all fuel oil applications) shall be suitably grouped together and mounted inside (i) Local instrument enclosures in case of open areas of the plant like boiler area, etc. and (ii) In local instrument racks in case of covered areas like Turbine/Generator area.

These local instrument enclosures and racks shall be furnished as per the actual requirements finalised during detailed engineering stage. The exact grouping of instruments in a particular instrument enclosure/instrument rack shall be as finalised during detailed Engineering stage subject to owner's approval. The GA of LIR should be similar to LIE except for front/rear doors and side panels. Vol. V, Part B, Chapter no. 6 shall also be referred for designing of LIE & LIR.

Sufficient spacing among adjacent transmitters shall be maintained to offer easy accessibility and operational convenience. The enclosure shall be designed with sizes to suit the grouping and to completely include all the hardware for hooking up the transmitters to the process on the basis of approved installation diagrams. A maximum of five (5) transmitters are envisaged to be grouped in one enclosure.

The internal layout shall be such that the impulse piping/ blow down lines are accessible from back side of the enclosure / rack and the transmitters etc. are accessible from front side for easy maintenance. Bulkheads, especially designed to provide isolation from process line vibration shall be installed on instrument enclosures/racks to meet the process sensing line connection requirement.

Vibration dampeners shall be installed for each enclosure / rack. The Degree of Protection of LIE shall be IP-55.

The enclosure shall be constructed of 1.6 mm sheet plate and shall be of modular construction with one or more modules and two end assemblies bolted together to form an enclosure. Cable glands, Channel and frame shall be 3 mm thick. Double inter locking doors shall be provided. The doors shall be the three point locking type constructed of not less than 1.6 mm thick steel. Doors shall have concealed quick removal type pinned hinges and locking handles. Door locks shall accept the same key.

Neoprene/Polyurethane Gaskets shall be used between all mating sections to achieve protection class of IP-55.

The instrument racks shall be free standing type constructed of suitable 3 mm thick channel frame of steel and shall be provided with a canopy to protect the equipment mounted in racks from falling objects, water etc. The canopy shall not be less than 3 mm thick steel, and extended beyond the ends of the rack.

Bulk heads, especially designed to provide isolation from the process line vibration shall be provided. Exact fabrications details shall be as finalised during detailed Engineering stage. The junction box for LIE/LIR shall conform to IP -65 protection class.

Enclosures/Racks shall be reinforced as required to ensure true surface and to provide adequate support for instruments and equipment mounted therein. Centre posts or any member which would reduce access shall not be provided.

Each Transmitter enclosure housing instruments requiring purge air for continuous air purging, shall be provided with common purge air header, redundant air filters regulators of sufficient capacity , required pressure gauge, valves, fittings, SS tubing and individual purge meters for each purge line etc as required and indicated in instrument installation drawings enclosed herewith.

A 15 mm NB service air header shall be furnished in each instrument enclosure housing air and flue gas and coal mill instruments. The header shall be furnished complete with a pressure regulating valve, pressure gauge and quick disconnect connections. A hose for connecting each header to the draft instrument line four way valves shall be furnished. The hose shall be self storing nylon tubing having a burst pressure of 15 Kg/sq Cm the size of the hose shall be ½ " min. The service air header shall originate at a bulkhead penetration or fitting located on one of the bulkhead plates.

The bidder shall prepare the piping drawings and the general arrangement layout drawings for each of the enclosures and racks. The special attention shall be given in the piping layout to avoid air traps liquid filled piping or water pockets in piping intended to be dry. Drawings shall indicate the arrangement of all equipment, piping, valves and fittings within the enclosures/racks and shall be subject to owner's approval.

All liquid Filled Blow down lines, except those measuring vacuum shall be connected to a two inch header which is extended through one end of the enclosure and turned downward for directing the blow down into a drain. The material of the blow down header shall be carbon steel as per ASTM A 106 Gr C or as indicated in NIT's hookup drawings whichever is better.

The bidder shall submit to the owner with his proposal a copy of his welding procedure specification together with proof of his compliance with the latest applicable welding ANSI code. Prior to any welding being performed the bidder shall submit the qualifications of the craftsmen who will perform the work.

Bidder shall provide not more than three variants for LIE/LIR with respect to max. no. transmitters mounted in each LIE/LIR.

Each enclosure shall be provided with universal type 6/16 Amp. power receptacle, light fixture & LED lamps with wire guard and lighting switch etc. Lighting switches shall be door actuated & mounted inside the panel. Outlet box, switch box and device covers shall be of galvanized stamped steel. Light switches and power receptacles shall be installed inside the enclosure on the wall near the latch side of the enclosure door. Light fixtures shall be installed on the ceilings of the enclosures.

Power Supplies for miscellaneous devices shall be provided with 2P MCB located within the enclosures. MCB shall be mounted in Fuse blocks. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.

Technical Specifications for C&I Systems-Table-No. 8.1

S. No.	System/Line Description	Piping Class	Impulse Pipe material	Schedule (Size)	Materials for fitting/ valve body	Valve stem material	Rating of Piping Fitting	Pressure Class of valve
1	Main steam, Up stream & down stream of HP bypass and up stream of auxiliary steam pressure reducing valve, separator level.	A	ASTM-A335 Gr.P-91/22 (Note-2)	XXS (½ Inch)	Note-3	Note-3	9000lb	3000 SPL
2	BFP discharge/ superheater attemperator/spray to PRDS, Phosphate dosing, P/P discharge, BCW pumps.	B	ASTM-A106 Gr. C	160 (½ Inch)	Note-3	ASTM-A-182 Gr.F6a	6000lb	2500 SPL
3	Reheater attemperator	C	ASTM-A106 Gr. C	160 (½ Inch)	ASTM-A-105	ASTM-A-182 Gr.F6a	6000lb	1500 SPL
4	Hot. Reheat/Down stream of Aux.Steam pressure reducing valve upto desuperheater/flash tank drain manifold, HRH upstream & down stream of LP Bypass valve, HP	D	ASTM-A335 Gr.P-91/22 (Note-2)	160 (½ Inch)	ASTM-A182 Gr.F-22	Note-3	3000lb	2500 SPL

S. No.	System/Line Description	Piping Class	Impulse Pipe material	Schedule (Size)	Materials for fitting/ valve body	Valve stem material	Rating of Piping Fitting	Pressure Class of valve
	heater level.							
5	Cold reheat upto Tee-off for HP bypass.	E	ASTM-A335 Gr.P-22	80 (½ Inch)	ASTM-A182 Gr.F-22	ASTM-A-182 Gr.F6a	3000lb	800
6	Cold reheat down steam of Tee-off (HP Bypass)	F	ASTM-A106 Gr. C	80 (½ Inch)	ASTM-A105	ASTM-A-182 Gr.F6a	3000lb	800
7	BFP suction/condensate system/Extraction to LPH/HPH and Extractions to BFPT, Deaerator, auxiliary steam, service air, instrument air, DMCW/ECW pumps, and other low pressure water services.	G	ASTM-A106 Gr. C, ASTM-A335 Gr.P-11/22	80 (½ Inch)	ASTM-A105	ASTM-A-182 Gr.F6a	3000lb	800
8	Air/Flue gas outside furnace, coal-air mixture.	M	ASTM-A106 Gr.C	80 (¾ Inch)	ASTM-A105	ASTM-A-182 Gr.F6a	3000lb	800
9	Air flue gas inside furnace	N	ASTM-A335 Gr.P-22	80 (¾ Inch)	ASTM-A182 Gr.F-22	ASTM-A-182 Gr.F6a	3000lb	800
10.	Purge Air	O	ASTM-A106 Gr.C	80 (¾ Inch)	ASTM-A105	SS316	3000lb	800
11.	DM Cooling water	P	ASTM-A312 TP 316	80/40 (½ Inch)	ASTM – A 182 F 316	SS316	3000lb	800
12.	CW & ACW	Q	ASTM-A106 Gr.C	80 (½ Inch)	ASTM-A105	SS316	3000lb	800

Note:-

- 1). Above requirements are minimum to be complied by bidder. Rating of piping / fittings / valves etc. is subjected to be approved by owner as per the final design pressure & temperature finalized during the detailed engineering, as per ANSI B 31.1.
- 2). In case temperature is more than 540 deg C, the material shall be P-91 only.
- 3). Material shall be compatible with that of the impulse pipe material and design parameter.
- 4). For DM Plant or DM water services, complete erection Hardware material shall be SS316 only.
- 5). Separator related impulse piping material shall be as per main process pipe/tank material.

CHAPTER – 9

INSTRUMENTATION AND CONTROL CABLES

9.01.00 INSTRUMENTATION AND CONTROL CABLES

9.01.01 General

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

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

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

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

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

9.01.02 **SPECIFICATION AND STANDARDS**

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

9.01.03 **Cables – Design Criteria**

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

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

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

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

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

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

9.01.03.05 All cables shall be provided with marking including owner's name, manufacturer's name, insulation material, conductor sizes, no of pairs, voltage ratings, type of cable, etc, progressive markings to read marking of the length of the cable at each meter interval and "FRLS/FS".

9.01.03.06 All cables shall be suitable for continuous operation at 85 deg C except for high temperature heat resistant Teflon insulated cables, which shall be suitable for continuous operation at 205 deg C. High Temperature cables shall also meet the complete specification requirements mentioned for normal / low temperature instrumentation cables except the specific requirement of material for insulation, inner sheath & outer sheath of High Temperature cables.

9.01.03.07 The allowable tolerance on overall diameter of cable shall be +/- 2 mm (maximum) over the declared value in data sheet

- 9.01.03.08 The variation in diameter shall not be more than 1.0 mm throughout the length of the cable.
- 9.01.03.09 The ovality at any cross-section of cable shall be not more than 1.0 mm
- 9.01.03.10 The repaired cables shall not be acceptable.
- 9.01.03.11 All type of the cables used for emergency trip push buttons, Fire alarm, detection & protection system, safety critical circuit, trip protection circuit and for other services specified elsewhere in the specification shall be fire survival cable conforming to IEC 60331, BS6387 (CWZ), BS6207 standard and this specification. The instrumentation cables in the other area shall be FRLS conforming to IEC 60332 standards and this specification.
- 9.01.03.12 All external field signals for DDCMIS/DCS/PLC shall be terminated in separate marshalling/termination cabinets. Under no circumstances, Field cabling to be directly terminated in DDCMIS/DCS/PLC system cabinets.
- 9.01.03.13 All cables shall be paired cables with voltage grade rating of 660/1100V.
- 9.01.03.14 All cables shall be provided with anti termite, Anti Rodent, Anti Fungal & moisture resistant properties.
- 9.01.03.15 All spare contacts/terminals on relays, control switches, limit switches or similar devices, process switches, duplex RTDs & Duplex T/Cs shall be wired to accessible terminal blocks/JBs for future connections. All wiring leaving a junction box or enclosure shall leave from terminal blocks and not from other devices in the enclosure. Two (2) pair (individual & overall shielded) cables shall be provided for terminating the thermocouples, transmitters & switches i.e Analog & Binary signals to local JB.
- Similarly four (4) pair (individual & overall shielded) cables shall be provided for terminating the Duplex RTD to local JB.
- Four (4) pair (individual & overall shielded) cables shall be provided for terminating the individual switch to local JB, where both NC & NO contacts are used in DDCMIS/DCS/PLC.
- The cable interconnection philosophy to be adopted shall be such that extensive grouping of signals by large scale use of field mounted group Junction Boxes (JBs) at strategic locations is done and consequently cable with higher numbers of pairs are extensively used between field and Marshalling cabinets.
- Separate mutipaired cable shall be provided for each drive between MCC/SWGR and DDCMIS/PLC.
- 10% spare pairs or min 1 pair cable (which ever is more) shall be provided with all type of cables, when the number of pairs of cables are more than four pairs, except for pre-fabricated cables which shall be as per manufacturer's standard..
- 9.01.03.16 Cable size & type shall be finalized depending upon
- (i) Binary & Analogue signals.
 - (ii) Different voltage level Signals.

Cable size & type shall be as below for different type of signals and control system.

- a) Cables for analog signals shall be instrumentation paired cable of 0.5 sq. mm copper conductor size, with individual pair shielding & over all shielding as per cl. No. **9.02.02** mentioned below.
- b) Cables for binary signals shall be instrumentation paired cable of 0.5 sq. mm copper conductor size as per cl. No. **9.02.02** mentioned below with over all shielding only.
- c) Cables for binary signals used in relay based control system and Fire Protection & detection system shall be instrumentation paired cable of 1.5 Sq.mm conductor size, as per cl. No. **9.02.01** mentioned below with over all shielding only.
- d) Cable for power supply to each solenoid valves shall be control cable of 3C x 2.5 Sq.mm copper conductor size for all voltage level. Specification shall be as mentioned elsewhere in Electrical part, Vol. IV.
- e) Above mentioned conductor size are minimum, however Conductor size may also increased further depending upon distance between source & destination. For cables single length more than 500 meters, the size of conductor shall be 1.5 sq. mm only irrespective of type of signals.
- f) In above cables types, Fire survival cables properties shall also be considered as per conditions and area defined elsewhere in technical specification.

9.01.03.17 Type & Construction of cable drums shall be as per IS 10418.

9.01.03.18 **Derating Factors**

Cable sizes indicated in the specification are minimum to be complied by bidder. Derating factors for various conditions of installations including the following shall also be considered while selecting the cable sizes:

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

9.01.03.19 Size of cables conductor specified elsewhere in the specification is minimum, same shall be followed by bidder. Further size of cables conductor shall be finalized based on voltage drop, voltage rating, current rating and distance between source & destination based on applications.

9.01.04 **MATERIAL SPECIFICATIONS**

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

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



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

9.01.05 **Specification of Control & Power supply cables**

Refer Electrical sub section (Electrical part, Vol. IV).

9.02.00 **Cable Specifications**

Cable shall have the following specification: -

9.02.01	<u>Sr.No.</u> <u>Description</u>	<u>Cable N</u>
	1. Voltage Grade and Type	660 V/1100 V grade, multipair Annealed tinned copper conductor overall shielded armoured instrumentation cable.
	2. IS Reference	IS: 1554 (Part-I Generally)
	3. Conductor	Nominal 1.5 Sq. Area concentric lay Annealed tinned high Conductivity stranded 7x0.53 mm dia. Electrolytic Copper conductor as per IS:8130.
	4. Insulation 5831	Extruded HR PVC type – C to IS:
	5. Shield	Minimum 0.06mm thick Aluminum mylar tape shall be provided on each pair with hundred percent coverage, 25% overlap and tinned copper drain wire of diameter 0.8mm with 7 strands.
	6. Inner sheath	FRLS HR PVC type ST-2 to IS: 5831, Colour - Black.
	7. Armouring	Galvanized steel wire/strip to IS:3975 & IS 1554 Part II
	8. Outer sheath	FRLS HR PVC type ST-2 to IS: 5831, Colour – Grey.
	9. Tests for FRLS Properties	1. <u>Flammability Test</u> The cables shall pass the requirement of IEEE-332 part B fire propo- gation test in this

- regard.
2. Smoke generation by Sheath under fire
When tested as per ASTM-2843, the cable shall meet the requirement (60%) smoke density.
 3. Acid gas generation of sheath during fire
When tested as per IEC-754-1, the maximum Acid gas should be less Than 20% by weight.
 4. Oxygen Index Test
The oxygen index when tested under ASTM 2863 shall be minimum 29%.
 5. Water immersion test shall be carried out as per VDE 0815
 6. Swedish Chimney Test
 7. Temperature Index – Min. 250 deg C as per ASTM 2863.

Other Tests:

1. Fire resistance test to IS-5831/IEC60331 for 20 minutes. (PVC insulation & sheath of electrical cables)
2. Thermal stability at 200 deg. C to IEC-540 for 100mts.
3. Rodent and termite proof.
4. Heat shock test to IEC-502.

10. Colour Coding : The wires of pairs shall be coded by base colours on insulation which are repeated in every unit as per VDE 0815. Base colours of the pairs in a unit shall be as follows:

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

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

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

Unit: Ring Colour: Ring Group

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

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

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

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

- | | | |
|----|---|---|
| a) | Conductor resistance of the loop not greater than | 73.2 Ohms/Km
for 0.5 sq mm.
Conductor size. |
| | | 24.6 Ohms/Km for
1.5 sq mm.
Conductor size. |
| b) | Insulation resistance not less than | 100 Meg
Ohms/Km |
| c) | Mutual capacitance at 0.8 KHz not greater than | 100 nF/Km |
| d) | Test Voltage-cond/cond. and cond/shield | 2000 Vrms |
| e) | Characteristic impedance at 0.8 KHz | 320 Ohms for 0.5
sq mm. Conductor
size. |
| | | 230 Ohms for 1.5 sq
mm. Conductor size. |
| f) | Image attenuation at 0.8 KHz | 0.11 dB/100 m |
| g) | Image attenuation at 10 KHz | 0.29 dB/100 m |
| h) | Cross talk attenuation at 0.8 KHz greater than | 70 dB/Km |
| i) | Coupling capacitance at 0.8 KHz not greater than | 200 pF/100 m |

- j) Min Vol. Resistivity 3.5 x 10¹⁴ at 27 deg
C 3.5 x 10¹¹ at 85 deg
C

- k) **High Voltage Test** **Duration**
Conductor to Conductor 2000 Vrms, 50 Hz for 1 min.
Conductor to Shield 2000 Vrms, 50 Hz for 1 min.
l) **Capacitance unbalance**

The capacitance unbalance between any two pairs of different cabling elements shall not exceed 400 pF per 500 m length of cable. The method for measurement of capacitance unbalance is specified in 5.5 of IEC 60189-1.

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

- | | | |
|-----|--------------------------|--|
| 9. | Outer sheath | FRLS HR PVC type ST-2 to IS:5831
Colour – Blue. |
| 10. | Test for FRLS properties | “See details as specified in
Cable Type N”. |
| 11. | Colour Coding & Marking | - do- |
| 12. | Electrical Properties | - do- |

9.02.03 **Specification for Co-axial Cables Cable-C**

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

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

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

9.02.04 **Extension & Compensating Cables**

- | | | | |
|----|----------------------|---|--|
| 1. | Applicable Standards | : | ANSI MC96.1; IS:1554
(Part-I) IS:5831-1984 |
| 2. | Type | : | Single / Multipair twisted and
Shielded type as per ANSI MC96.1 |
| 3. | Conductor Size | : | 1.31sqmm, solid alloy (16 AWG) |
| 4. | Conductor Diameter | : | 1.29 mm |
| 5. | Insulation | : | PVC insulated, heavy duty, |

Self extinguishing type. Black Colour coded extruded PVC inner sheathed with overall PVC sheathed Type ST2 FRLS IS: 5831. Insulation of each wire with high grade 0.6 mm 85 deg.C Extruded HR PVC Type C as per IS: 5831, voltage grading shall be 1.1 kV.

6. Lay lay. : Twisted pairs within 50 mm max.
7. Shield : Single pair cable assembly only. Multiple pair - each pair and cable assembly. Each conductor shall be individually and overall shielded Through aluminum mylar tape min 0.06 mm (0.075 mm) with min 25% overlap & 100% coverage and 7 strand 20 SWG minimum size tin coated copper drain wire.
8. Outer sheath : FRLS HR PVC type ST-2 to IS:5831 Colour as per ANSI standard.
9. Conductor Identification : See "Cable Details" as below
10. Armour : Galvanised steel wire/strip to IS:3975
11. Multiple pair identification : Each pair numbered every 250 mm
12. **Electrical Parameters:**

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

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

Insulation Resistance (min) : 100 M ohm x KM

Mutual Capacitance at 0.8 resp. 1KHz (max):

- Single pair and pair screened : 120nf/KM
- Up to 4 pair overall screened : 96 nf/KM
- Above 4 pairs overall screened : 80 nf/KM

13. CABLE DETAILS

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

14. Tests to be conducted:

- Thermo-e.m.f characteristics
- Continuity test
- Measurement on capacitance, inductance and loop resistance.
- Insulation resistance
- High voltage tests as per IS (latest)
- Tensile and elongation tests
- Flame retardency as per IEC 332
- Oxygen index test
- FRLS characteristics
- Flammability test as per IEC-332 Part -3 (Category-B) and IEEE-383
- Swedish Chimney test as per SEN-SS 4241475 class F3

9.02.05

Fiber Optic Cable

A	Fiber: The optical fiber core shall be of ultra pure fused silica glass coated with UV-cured acrylate suitable to withdraw temperature of about 80 Deg C (continuous). Fiber Optic cables shall be suitable for installation on cable tray, duct bank, cable trench, and direct burial as necessary.	
	Multimode fiber optic cables shall be used for shorter distance. For large distance i.e. more than 500 meter of single run, single mode Fiber optic cables shall be used.	
1	Type	Multiple single mode & Multi-Mode Fiber to

		avoid usage of any repeaters.	
2	Core Diameter	Multimode Fiber cable	Singlemode Fiber cable
		62.5 ± 2 microns or 50 ± 2 microns depending upon distance between source & destination and bandwidth @ wavelength.	9 ± 1 microns
3	Cladding Diameter	125 ± 2 microns	
4	Fiber Proof test	As per IEC/EIA & other international standard.	
5	Coating Diameter Test	As per IEC/EIA & other international standard.	
6	Number of Fibers/core	Four/Eight/Twelve (Colour Coded) with min. 100% spare core (Fibers)	
B1	Optical Characteritics – Bandwidth, Attenuation & Numerical Aperture	For multimode fiber cable with core diameter 62.5 ± 2 microns:	For multimode fiber cable with core diameter 50 ± 2 microns:
1	Bandwidth @ 850 nm Bandwidth @ 1300 nm	160 MHz-Km min 500 MHz-Km min	500 MHz-Km min 500 MHz-Km min
2	Attenuation @ 850 nm Attenuation@ 1300 nm	3.0 dB/Km max 0.8 dB/Km max	3.0 dB/Km max 0.8 dB/Km max
3	Numerical Aperture	0.275 ± 0.015	0.200 ± 0.015
B2	Optical Characteritics - Attenuation	for Singlemode fiber cable outside plant:	for Singlemode fiber cable inside plant:
1	Attenuation@ 1310 nm Attenuation@ 1550 nm	0.35 dB/Km max 0.2 dB/Km max	1 dB/Km max 1 dB/Km max

C	Cable Construction:	
	<p>Fiber Optic cable shall be of loose tube design. Typically, fibres shall be housed in groups of 4/8/12 (as per requirements) within gel-filled buffer tubes to protect against ingress of moisture and vibration. The tubes shall be manufactured with industry standard material tools & practices. The buffer tubes shall be stranded around the central strength member utilizing reverse oscillating lay (ROL). Blank fillers shall be used as necessary to maintain circular cable structure. Fillers shall be flame retardant and moisture resistant.</p> <p>The cable shall be of dual jacket & armoured. Optic Fibre cable shall be polymer coated, Electrolytically chrome plated corrugated steel taped (ECCST) armoured, fully water blocked with central dielectric material for outdoor/indoor application so as to prevent any physical damage. Two highly visible ripcords are placed under the jacket to aid in sheath removal. A co-polymer coated steel tape is corrugated and wrapped around the inner jacket to provide additional cable compression strength and Termite & rodent protection. A ripcord is also placed underneath the armour for easy outer jacket removal.</p> <p>Each buffer tube shall be filled with a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. The gel is free from dirt and foreign matter. The gel can be readily removed with conventional non toxic solvents.</p>	
1	Outer Colour	Orange
2	Outer Jacket	Polyethylene minimum 1.5mm thick, Flame retardant & UV resistant.
3	Inner Jacket	Core-locked flame retardant polyethylene
4	Filler / Strength member	As per Manufacturer's standard
5	Central Strength member	FiberGlass reinforced plastic (FRP) and Buckle resistant material to provide both tensile and anti bucking strength to the cable.
6.	Details marked at every meter on outer sheath.	Manufacturer's Name, Month and Year of Manufacturer, Coded description of the cable based on telcordia's (bellcore) SR-2014 suggested optical cable code (SOCC), Sheath identification Number, Sequential Length marking in meter, A telephone Handset symbol to distinguish communication from power cable as per NESC section-35G.
7.	Life Expectancy	Fiber Optic cable shall provide a long life expectancy of minimum 25 years under continuous operation without degradation to optical or mechanical performance.
8.		Spliced/Repaired cables are not acceptable.
D	Stripping Ability	
	All layers easily removed with Commercially available tools	
E	Installation:	
1	Minimum bending radius	20 X D (D=core Diameter) - During

		Installation , Short Term , loaded 15 X D (D=core Diameter) – Installed, Long Term , No load
2	Maximum Tensile Load/Strength	During Installation: 2200 N Installed: 1500N
3	Method of laying	Directly laid in cable trays / duct bank / clamped with available structure
4	Pulling	Ordinary cable grips
F	Storage Temperature	- 20 ° C to 70 ° C
G	Operating Temperature & Humidity	- 20 ° C to 70 ° C & 100%
	Maximum Cable weight	46Kg/1km
	Maximum cable length	1 km
H	Data Speed performance	10 Gbps minimum
I	Test Specification (EIA/TIA – STD455/IEC standard):	
1	Impact Resistance	2000 Impacts minimum
2	Crush Resistance	4000 N/10cm minimum
3.	Compressive Strength	3000 N minimum
J	Moisture/Water Resistance as per IEC standard.	Water blocking layer, Cable shall withstand water penetration when tested with a one meter static head or equivalent continuous pressure applied at one end of a one meter length of filled cable for one hour. No water shall leak through the open cable end.
K.	Optical time Domain reflectometer	<p>a. A recording optical time domain reflecto meter (OTDR) will be utilized to test for end-to-end continuity and attenuation of each optical fiber. The OTDR shall be equipped with data storage, printer, help feature, compare trace features and OTDR software. The data storage unit must include a built-in floppy disk drive capable of storing a minimum of 100 test traces.</p> <p>b. Data traces saved to disk shall include the following labels.</p> <p>i. Fiber Identification (ID) with a minimum of 10 characters.</p> <p>ii. Cable ID with a minimum of 10 characters</p> <p>iii. OTDR location with a minimum of 20 characters</p>

		<ul style="list-style-type: none"> iv. Far End location with a minimum of 20 characters. v. Test operator initials with a minimum of 3 characters. c. The printer shall preferable be internal. The printer shall be able to print data traces within 30 seconds or less. The machine setting used to repeat tests at a later time shall include index, range, wavelength, average time, pulse width and scale settings. The test results (on printout) shall provide information including: loss, distance, reflectance, data and time. d. The requirements for the compare trace feature include the ability to recall two historical traces from a diskette and display them simultaneously for analysis and printing. The compare trace must compute and display a single graph representing any differences between two traces. The compare trace must be able to recall historical traces from a discrete and perform the same tests on connected live fibers. The compare trace shall perform a two point loss measurement test for any two particular fibers in a comparison analysis. The losses between the two points on the each fiber shall be displayed, and the differences between the two readings clearly shown. e. The OTDR must be equipped with software to support all of the required functions. The software shall provide for printing of whole set of traces (batch print) with minimal commands eliminating the time spent for printing traces individually. f. Bidder shall provide all mounting accessories, cables and connectors required to establish data communication.
<p>L.</p>	<p>Fiber Optic splicer, terminator and tool kit box</p>	<p>Bidder shall provide new unused tools comprise of splicer and fusion jointer and tool kit comprise of cutter, stripper, polishing tool, handheld microscope, heat</p>

		shrinkable sleeve, scissor, knife etc as required for maintenance and commission.
M.	Standards	<p>Optical cable shall be conform to</p> <ol style="list-style-type: none"> i) IEC 60794/IEC 60793 & EIA/TIA 455. ii) Low smoke (IEC 1034 -light transmittance of 80%). iii) Halogen free (IEC 754: 1&2-maximum acid gas generation shall be 2% by weight and PH >4.3). iv) Fire & flame retarded (IEC 331, IEEE 383). v) Rodent resistant. vi) Crush Resistant (EIA -455-41). vii) Impact Resistant (EIA -455-25). <p>Bidder shall submit Type test report for review, conform to IEC 60794, IEC 60793, IEEE 383, and IEC 754: 1 & 2, IEC 331, IEEE 1034 and EIA/TIA standard.</p> <p>Colour codes shall be as per EIA/TIA 598-A.</p>
N.	TESTS	<p>Following minimum test as per any approved standard shall be carried out on the cables for witness of owner:</p> <ol style="list-style-type: none"> a. Attenuation and Dispersion characteristics tests b. Proof Tests c. Macro-Bend resistance Test d. Mechanical Test e. Low and High Temperature cable Bend Test f. Impact resistance Test g. Compressive strength Test h. Tensile strength Test i. Cable Twist test j. Cable cyclic flexing test k. Environmental characteristics Test l. Temperature cycling test m. Colour permanence Test n. Cable Aging test o. Water penetration test p. Lightning Test q. Kink Test r. Crush Test

9.02.06

Data Cable:

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

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

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

9.02.07 All type of Instrumentation & extension cables near high temperature zone shall be high temperature heat resistant cables, which shall be terminated at a junction box in normal temperature zone. Thermocouple extension cables and Instrumentation copper conductor cables for high temperature applications shall be with insulation of individual conductor and outer sheath of extruded FEP (i.e. Teflon) as per VDE 0207 Part 6 and ASTM D 2116. The thickness of insulation shall be 0.5 mm nominal (i.e. 0.4 mm minimum). These cables shall be single / Multipair twisted & shielded. Other parameters/properties shall remain same as specified for Instrumentation and extension cables.

9.02.08 For the applications specified at cl. No. 9.02.08.03 (a to f and h), FS cables shall be similar to the Fire survival control cables specified in electrical section (Vol. IV) except that conductor material shall be annealed tinned copper conductor. Size of conductor shall be same as defined at cl. No. 9.01.03.16. In addition the cables shall have high degree of immunity from electro-magnetic interference.

Fire Survival cables (Instrumentation, Power & control) for the applications specified at cl. No. 9.02.08.03 (g, i & j) shall be heavy duty mineral (Compressed MgO) insulated, solid copper sheathed, twisted annealed high electrolytic solid copper conductor and outer sheath covering with LSF/LSZH material.

Outer sheath covering colour shall be red for control cables. Outer sheath covering colour shall be orange for power cables. Fire Survival cables shall be UL or LPCB approved. 10% spare cores or min 1 core (whichever is more) shall be provided for FS cables.

For Fire alarm, detection & Protection System, requirements for FS cables indicated in Vol. III shall also be complied by bidder. Complete cables for FDPS shall be Fire survival only..

9.02.08.01 Following test shall also be included for FS cables:-

- i. Fire Test on Bunched Cable as per IEC: 60332-3.
- ii. Toxicity Index (max 5%) test as per ES 713, IEC : 60754-2 & EN-50267-2-1.
- iii. Corrosive Gases (pH > 4.3 & Conductivity < 100 micro Siemens/cm) test as per IEC : 60754-2 & EN-50267-2-1.
- iv. Oxygen Index at Room Temp. – Min. 30 as per ASTM D 2863.
- v. Temperature Index – Min. 280 deg C as per ASTM D 2863.
- vi. Acid Gas Generation Max. 2% as per IEC – 60754-1.
- vii. Smoke Density Rating Max. 20% as per ASTM D 2843.

- viii. Flammability Test as per IEC:60332-1 & 2.
- ix. Swedish Chimney Test & Flammability Test on multiple cables as per BS EN 50266, Cat B or IEC/EN 60332-3-23:2009)..
- x. Fire Resistance Characteristics shall meet the requirements of circuit integrity test for min. 3 hours at 950 deg. C as per IEC 60331.
- xi. Test as per UL standards UL 1581, UL 1666 & UL 910 (NFPA -262) and IEC 60332-1 & IEC 61034-2.
- xii. Emission of Halogen as per IEC 60754-1.

9.02.08.02 Following Electrical properties shall also be furnished by bidder for FS cables:-

- i. Minimum insulation resistance constant at 27 Deg. C (mega ohms.km).
- ii. Minimum volume resistivity for insulation at 27 Deg.C (Ohm.cm).
- iii. Minimum volume resistivity for insulation at 85/90 Deg.C (Ohm.cm).
- iv. Minimum tensile strength (N/mm²).
- v. Minimum elongation percentage at rupture.
- vi. DC conductor resistance at 20° C per 1000 meters (ohms).
- vii. A.C. resistance of conductor at 85° C (ohms /km).
- viii. Reactance per phase at 50 Hz (ohms/km).
- ix. Electrostatic capacitance per phase at 50Hz (micro farads/ km) Approx.
- x. Maximum charging current for cable at nominal voltage (Amps/km.) Approx.
- xi. High voltage tests (KV)
- xii. Water immersion test (KV) as per IS 9968(Pt-1)/88 & IS10810, latest.

9.02.08.03 Fire survival cables (Power, Control and Instrumentation) shall be provided for the following applications, as these cables can withstand 750°C temperature for three (3) hours:

- a) DC emergency lube oil pumps
- b) DC seal oil pump
- c) DC emergency lighting cables for main plant building.
- d) Batteries to battery chargers and DC distribution boards and as well as incoming DC cables to switchgears located in main plant building and firefighting switchgear.
- e) Turbine lube oil pumps
- f) Jacking oil pumps
- g) Emergency turbine trip push buttons in control room.
- h) Boiler turbine: Generator inter-trip, which includes the inter-connecting cables between:-
 - Boiler master fuel trip and turbine trip relays

- Generator trip relays and turbine trip relays
 - Generator trip relays and 400 kV circuit breaker
 - Generator trip relays and generator field breaker
 - Generator trip relays and UAT breakers
- i) Fire alarm, annunciation and protection system.
- j) Any other system like safety critical circuit, trip protection circuit and for drives required for safe shut down operations of the plant.

9.02.09

Twisted Pair Cable:

Items	:	Cat - 5e cable	Cat - 6 cable
Conductor			
No of Pairs	:	4 Pairs	4 Pairs
Material	:	Annealed Bare Copper	Annealed Bare Copper
Size	:	24 AWG	23 AWG
Insulation			
Thickness	:	0.254 mm	-
Material	:	PO – Polyolefin / FRPE (PVC)/HDPE	PO – Polyolefin / FRPE (PVC)/HDPE
Outer Shield			
Binder Tape	:	Binder Tape	Unshielded
Binder Tape			
Thickness	:		
Material	:	Aluminum Foil-Polyester Tape	Aluminum Foil-Polyester Tape
Coverage	:	100%	100%
Drain Wire			
		Yes	Yes
Thickness	:	Stranded (7/32) , 24 AWG	Stranded (7/32) , 24 AWG
Material	:	Annealed Tinned Copper	Annealed Tinned Copper
Outer Jacket			
Material	:	Industrial Graded PVC FR	Industrial Graded PVC FR
Outer Jacket Nominal wall thickness	:	0.762 mm	0.5-0.6 mm
Outer Jacket Ripcord	:	No	Yes
Mechanical Characteristics (Overall)			

Items	:	Cat - 5e cable	Cat - 6 cable
Installation Temperature Range:	:	-25 to +70 Deg.C	-25 to +70 Deg.C
Operating Temperature Range:	:	-40 to +70 Deg.C	-40 to +70 Deg.C
Tensile strength	:		
Max. Recommended Pulling Tension	:	177.928 N	200.169 N
Min. Bend Radius/Minor Axis	:	12.700 mm	63.500 mm
Min. Bend/Installation	:		
NEC/(UL) Specification	:	CMR	CMR
Electrical Characteristics			
Nominal Mutual Capacitance	:	49.215 pF/m	50.8555 pF/m
Nominal Velocity of Propagation (VP)	:	70%	67%
Max. Delay	:	538 ns/100 m	538 ns/100m
Max Delay Skew	:	45 ns/100 m	38 ns/100m
Max. Conductor DC Resistance @ 20deg. C	:	9.38 Ohm/100m	8.2 Ohm/100m
Impedance	:		
Attenuation min. At 100m	:	22 dB at 100 Mhz	18.9 dB at 100 Mhz
Applicable standards	:	EU Directive 2011/65/EU(RoHSII), MII Order # 39 (China RoHS)	EU Directive 2011/65/EU(RoHSII), MII Order # 39 (China RoHS)
Test			
Flame Test	:	UL 1666 Vertical Riser, CSA FT4, IEEE 1202/IEC60332-1	UL 1666 Vertical Riser, CSA FT4, IEEE 1202/IEC60332-1
Pair Colour Code			
1st Pair		White / Blue Strip & Blue	White / Blue Strip & Blue
2nd Pair		White / Orange Strip & Orange	White / Orange Strip & Orange
3rd Pair		White / Green Strip & Green	White / Green Strip & Green
4th Pair		White / Brown Strip & Brown	White / Brown Strip & Brown

9.02.10. LINEAR HEAT SENSING CABLE

1.00.00	Manufacturer	:	As per approved make
2.00.00	Type	:	Non electrically operated Optical Fibre type linear heat sensing cable. It shall be totally immune to EMI/RFI.
3.00.00	Operating voltage	:	24 Volt D.C. thru automatic changeover arrangement from redundant 24 V DC power feeders or from redundant UPS power feeders & redundant 24 V DC convertor.
4.00.00	Ambient temperature	:	-20o C to 70o.C.
5.00.00	Operating temperature:	:	Programmable type, with combination of fixed temperature and Rate of Rise in temperature
6.00.00	Cable Optical Parameter:	:	50/125 µm graded index, Multimode Fibre.

9.03.00 INSTRUMENTATION CABLE INTERCONNECTION AND TERMINATION PHILOSOPHY

The cable interconnection philosophy to be adopted shall be such that extensive grouping of signals by large scale use of field mounted group Junction Boxes (JBs) at strategic locations is done and consequently cable with higher numbers of pairs are extensively used between field & Marshalling panels. The details of termination to be followed are mentioned in the given table below:-

Application		Type of Termination	
FROM (A)	TO (B)	END A	END B
Valves/Dampers Drives (Integral Junction Box)	Marshalling/ Marshalling- cum Termination Cubicle/ Local group JB	Plug in connector	Post mount cage clamp type
Transmitters, Process Actuated switches mounted in LIE/LIR	Integral Junction Box of LIE/LIR	Plug in connector	Cage clamp (Rail mount type)
RTD heads	Local Junction Box	Plug in Connector	Cage clamp (Rail mount type)
Thermocouple	Local Junction Box	Plug in Connector	Cage clamp (Rail mount type)
Other Field mounted Instruments	Local JB/ Group JB	Plug in Connector	Cage clamp (Rail mount type)

Application		Type of Termination	
FROM (A)	TO (B)	END A	END B
RTD heads	Temperature transmitter	Plug in Connector	Screwed Cage Clamp Type
Thermocouple	Temperature Transmitter	Plug in Connector	Screwed Cage Clamp Type
Local Junction box, Temperature Transmitter, Int. Junction box of LIE/LIR/Group JBs.	Group JB	Cage clamp (Rail mount type)	Cage clamp (Rail mount type)
Local Junction box, Temperature Transmitter, Int. Junction box of LIE/LIR/Group JB/ MCC/SWGR	Marshalling/ Marshalling – cum Termination Cubicles.	Cage clamp (Rail mount type)	Cage clamp (Post mounted type)
Marshalling cubicle/Termination Cabinets	Electronic system Cabinet/Control system/ DDCMIS/PLC cabinets	Cage clamp (Post mounted type)	Plug-in connector/other system as per Mfr's standard
Marshalling/ Termination System Cabinets	UCD mounted equipments	Cage clamp (Post mounted type)	Plug in Connector/ Cage clamp Type (rail mounted)
DDCMIS/PLC cabinets	OWS, Printer etc.	Plug in connector	Plug in Connector

Notes

1. For Analog signals, individual pair shielding & overall shielding & for Binary signals, only overall shielding of instrumentation cables shall be provided.
2. Signal and Electrical connection shall be screwed connection with double compression type Nickel-plated brass/SS316 cable glands for Explosion proof area, Flame proof area and high vibration prone area.
3. All screwed connections shall be provided with double compression type Nickel-plated brass/SS316 cable glands.

9.04.00 **TERMINAL BLOCKS**

For all inputs to the system emanating from the field or other systems, the bidder shall furnish terminals suitable for correct size of field cables.

- 9.04.01 All outputs going to MCC/SWGR terminal blocks, shall be rated 600 volts minimum and shall have strap screw less terminals suitable for connection of wires with ring tongue type lugs. Standard terminal blocks shall be rail mounted screw less spring loaded cage clamps type.

The terminal blocks for DDCMIS/DCS/PLC input/output connections from/to SWGR/MCC, Actuators with Integral Starter (for Coupling relays and check back signals of 11 kV and 3.3 kV auxiliaries, LT drives/valves & dampers/solenoids, CT&VT, etc.) shall be provided with built in test and disconnect facilities complete with plug, slide clamp, test socket etc. The exact type of terminal blocks to be provided by the bidder and the technical details of the same including width etc. shall be subject to owner's approval.

Terminal blocks shall be approximately sized for larger wire size of higher voltage insulated incoming conductors as necessary. All the TBs used shall be high quality non-flammable insulating material of melamine suitable for working temperature of 105 deg C and 6.6 polyimide to withstand corrosion and the metallic portion shall be coated against rust /corrosion. All metal parts should be non –ferrous in nature.

- 9.04.02 All the Terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, partions, small partions, test plug bolts and test plug (as specified above for SWGR connections) transparent covers, support brackets, distance sleeves, warning label, marking etc.

The marking on terminal strips shall correspond to the terminal numbering on wiring diagrams.

- 9.04.03 Fuses shall not be mounted on terminal blocks. Neither step type terminal blocks nor angle mounting of terminal blocks will be acceptable. The terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks and between terminal blocks and junction box walls.

- 9.04.04 At least 20 per cent spare unused wired terminals shall be provided on each terminal block for circuit modifications and for termination of all conductors in a multi-conductor control cable with each panel, enclosure, cubicle, Junction Boxes, SOV Boxes, instrument racks/enclosures, termination/marshalling cabinets, etc.

All terminal blocks shall be numbered for identification and grouped according to the function. Engraved labels shall be provided on the terminal blocks.

For terminating each process actuated switches, drive actuators, control valves, thermocouples, RTD, etc. in local junction boxes etc. refer NIT's interfacing & wiring drawings.

- 9.04.05 For ensuring proper connections, Bidder shall provide suitable accessories, along with insulation sleeves. The exact connecting accessory shall be finalised as per application during detail engineering stage subject to owner's approval without any cost repercussions.

9.05.00 INTERNAL PANELS/ SYSTEM CABINETS WIRING

- 9.05.01 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.

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

- 9.05.03 All external connection shall be made with one wire per termination point. Wires shall not be tapped or spliced between terminal points.
- 9.05.04 All floor slots of desk/panels/cabinets used for cable entrance shall be provided with removable gasketed gland plates and sealing material. Split type grommets shall be used for prefabricated cables.
- 9.05.05 All the special tools as may be required for solder less connections shall be provided by Bidder.
- 9.05.06 Wiring to door mounted devices shall be provided with (49 strand minimum) adequate loop lengths of hinge wire so that multiple door openings will not cause fatigue braking of the conductor.
- 9.05.07 Power supply wiring, and interconnecting cables between devices shall pass the following tests.
- a) Flammability test IEEE 383/1974
 - b) When tested under UITPP test method or ASTM 2893/77 light transmittance of 80%
 - c) When tested under IEC 754-1 maximum acid gas generation shall be 2% by weight
 - d) Oxygen index not less than 30 as per ASTM D 2863.
- 9.05.08 Following **cable**/Wire size shall be utilized for internal wiring & UPS power cables (In addition, voltage drop calculation and distance between source & destination shall also be considered by bidder, while finalising the cable/wire size) :
- a. Current (4-20 mA)
Low voltage signals
(AI/AO & DI signals) : 0.75 sq.mm
 - b. DO signals, Ammeter/
voltmeter circuit, control
switches, indicator, recorder : 1.5 sq.mm
 - c. Internal Illumination
& 24 V DC Power supply : 2.5 sq.mm
 - d. Size of Power supply cables shall be as below:-
- | | Load | Size |
|------|---------------|--------------|
| i. | 1 to 16 Amp. | - 2.5 sq. mm |
| ii. | 17 to 20 Amp. | - 4 sq. mm |
| iii. | 21 to 32 Amp. | - 6 sq. mm |
| iv. | 33 to 40 Amp. | - 10 sq. mm. |
| v. | 41 to 60 Amp. | - 16 sq. mm |

9.06.00 **INSTRUMENTATION CABLE INSTALLATION & ROUTING**

- 9.06.01 Immediately prior to the installation of each cable or cable group, the

raceway route to be followed shall be inspected and ascertained to be complete in installation and free of all materials detrimental to the cable or its placement. 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 Owner.

9.06.02 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

9.06.03 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. Double compression cable glands shall be provided.

9.06.04 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.

9.07.00 **CABLE LAYING AND ACCESSORIES**

1 Cables shall be laid strictly in line with cable schedule.

2 Identification tags for cables.

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

3 Cable tray numbering and marking.

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

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

5 Buried cable protection

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

6 Road Crossings

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

- HT power & LT power cables,

- LT power & LT control/instrumentation cables,

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

7 Segregation (physical isolation to prevent fire jumping)

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

8 Cable clamping

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

9 FO & Network Cable shall be laid on separate cable sub-trays/through permanent lubricated rodent & termite proof HDPE protection pipe @ 53% fill factor with support from cable tray/Tressle structure inside building area. When the cables are laid outside buildings area, GI conduits/permanent lubricated rodent proof HDPE protection pipe @ 53% fill factor with shall be used with support from cable tray/Tressle structure.

In areas where the same are required to be buried, the same shall be buried in separate trench approx. 1.0 mtr. Depth to be laid in 2" permanent lubricated rodent proof HDPE protection Pipe @ 53% fill factor covered with sand, brick laid breadth-wise and soil along the pipe line route by bidder.

While crossing roads- to be laid in permanent lubricated rodent proof HDPE protection pipe @ 53% fill factor with sand filling at bottom and sand, soil filling at top with cement concrete by bidder. While crossing canals/river to be laid in permanent lubricated rodent proof HDPE protection Pipe within hume pipe and same shall be in the scope of bidder.

Cutting, Jointing, Bending, Fittings and Clamping required for laying of FO & Network Cable through rodent proof HDPE Pipe shall be part of laying of HDPE Pipe.

Fiber Optical Cables shall be routed through suitable grade permanently lubricated HDPE protection pipe as per above guide lines and as per IS 4984, IS 12235 & TEC.G/CDS-08/01 of suitable size @53% fill factor.

Outside Building Area - to be laid necessarily inside GI conduit with support from cable tray/Tressle structure

Inside Building Area – to be laid on separate cable sub-trays

While buried- in separate buried trench approx.1.0 meter depth, to be laid in 2" rodent proof HDPE conduits covered with sand, brick breadth wise and soil along the pipe line route by bidder;

While crossing roads - to be laid in rodent proof HDPE conduits with

sand filling at bottom and sand, soil filling at top with cement concrete by bidder;

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

10 Laying of Network Cable (UTP/STP) :

Out side Building Area- to be laid necessarily inside GI conduits with support from cable tray / Tressle structure.

Inside Building Area- to be laid necessarily inside GI conduits on separate cable sub-trays.

9.07.01 Bidder shall supply and install all cable accessories and fittings like Light Interface Units, Surge suppressors, Opto isolators, Interface Converters, Fibre Optic Card Cage, Fibre Optic Line Driver, Repeater / Modem (for Optical Fibre Cables), cable glands, grommets, lugs, termination kits etc. on as required basis.

9.07.02 Cables, which terminate in cabinets of draw out sections shall have sufficient cable coiled in the bottom of the cabinet to permit full withdrawal of draw out sections without disconnecting the cables. When prefabricated cables with factory connectors on both ends are longer than required, the excess cable shall be coiled in the bottom of one or both termination cabinets.

9.07.03 The Bidder shall be responsible for proper grounding of all equipment under this package. Further, proper termination of cable shields shall be verified and the grounding of the same shall be coordinated so as to achieve grounding of all instrumentation cable shields at same potential. This shall be completed prior to system tests.

9.07.04 The Bidder shall take full care while laying / installing cables as recommended by cable manufacturers regarding pulling tensions and cable bends. Cables damaged in any way during installation shall be replaced at the expense of the Bidder.

9.07.05 **Cable Glands**

Cables shall be terminated using double compression type cable glands. Cable glands shall conform to BS: 6121 & IP-67 and be of robust construction capable of clamping cable and cable Armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy-duty brass machine finished and nickel chrome plated OR SS316 (As approved by owner). Thickness of plating shall not be less than 10 micron. All washers and hardware shall be made of brass with nickel chrome plating OR SS316 (As approved by owner). Rubber components shall be of neoprene and of tested quality.

9.08.00 **Field Mounted Local Junction Boxes details and cable termination criteria**

- i. Junction Boxes material shall be stainless-steel SS-304 with 1.5mm thickness, IP66 rating, RoHS compliant, UL / TÜV Rheinland certified and manufactured in accordance with IEC 62208, ensuring the highest quality

- ii. Type of Enclosure shall be IP-66 rated Flame proof/Weatherproof /Explosion Proof as per area classification. Design shall be as per NEC-370 Article 18, 19 & 20 with IK-08 Enclosure Protection class against external mechanical stresses as per EN 50102/IEC 62262.
- iii. No. of Ways shall be 12/24/36/48/64/72/96/128 with 20% spare terminals.
- iv. Each junction box shall be provided with sufficient terminals for the individual termination of all spare cores within the interconnecting cabling. As minimum, additional 20% wired terminals shall be provided for future use.
- v. Cable entry shall be Bottom or Side.
- vi. Cable glands shall be Double compression type – Nickel plated Brass/SS316 with PVC hoods.
- vii. Mounting shall be Indoor/ Outdoor and IP55 rating for Junction Boxes shall apply for Indoor applications only.
- viii. Terminals shall be from Phoenix/Wago (screw less rail mounted cage clamp type spring loaded suitable for conductor size up to 2.5 sq. mm)
- ix. Corrosion testing shall be conducted form high capacity corrosion testing laboratory with fast response time and same shall be a TÜV Rheinland’s accredited corrosion testing laboratory. Relevant regulations, codes and standards related to corrosion testing shall apply like ASTM A262, SEP 1877, ISO 9227, ISO 3651-1, ISO 3651-1 etc. Salt spray tests shall be conducted in accordance with ISO 9227:2012(en) i.e. Corrosion tests in artificial atmospheres.
- x. Doors shall be hinged /lockable type. The door hinges shall be easily swappable to opposite side for single-door enclosure at 130° opening angle as per relevant applicable VDI standards. Doors shall be provided with double bit cam locks to ensure rigid and in position locking. Lock insert shall be of Die-cast zinc type, nickel-plated with 3 mm cam lock and double-bit insert in accordance with DIN 43668
- xi. Terminals shall be from Phoenix/Wago (screw less rail mounted cage clamp type spring loaded suitable conductor size up to 2.5 sq. mm) Grounding should be two terminals for body shield ground.
- xii. Suitable mounting clamps and other accessories shall be in scope of Bidder.
- xiii. The brackets, bolts, nuts, screws, glands, lugs required for erection shall be of SS304, included in Bidder scope of supply.
- xiv. High voltage & insulation resistance test shall also be conducted.
- xv. M6 Ni plated Brass earthing stud shall be provided (external 2 nos. internal 1 no.)
- xvi. Colour shall be decided during detailed engineering & shall subject to owner’s approval.
- xvii. Gasket (Normal)- Neoprene/Polyurethane thickness 6.0 mm. Silicon for high Temp. area. shall be provided.

9.09.00 **Conduits**

Conduits shall be generally used for interconnecting cables from field instruments to local JB's. All rigid conduits, couplings and elbows shall be hot dipped galvanised rigid mild steel in accordance with IS:9537 Part-I (1980)

and Part-II (1981). The conduit interior and exterior surfaces shall have continuous zinc coating with an overcoat of transparent enamel lacker or zinc chromate. Flexible conduit shall be heat resistant lead coated galvanised 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 application, water leak, fire and rust proof flexible GI conduits shall be provided. The temperature rating of flexible conduit shall be suitable for actual application.

The Bidder shall install conduits according to the general routing as approved by owner and shall coordinate conduit locations with other works.

All grounding bushings within all enclosures shall be wired together and connected internally to the enclosure grounding lug or grounding bus with 8 AWG bare copper conductors. Conduit runs to individually mounted equipment shall be grounded to the Owner's cable tray grounding conductor with 12 AWG bare copper conductor. All grounding bushing, clamps, and connectors shall be subject to approval of the owner.

All rigid conduit fittings shall conform to the requirements of IS: 2667, 1976. Galvanised steel fittings shall be used with steel conduits. All flexible conduit fittings shall be liquid tight, galvanised steel. The end fittings shall be compatible with flexible conduit supplied.

All individually mounted equipment and devices shall be connected to the supply conduit, using not more than one meter of flexible conduit adjacent to the equipment or device. Flexible conduit shall be installed in all conduit runs, which are supported by both building steel and structures subject to vibration or thermal expansion. This shall include locations where conduit supported by building steel enters or becomes supported by the turbine generator foundation and where conduit supported by building steel or foundation becomes supported by steam generator framing.

Special areas, such as control rooms in which external noise is to be minimized, shall have flexible conduit in conduit runs where the runs cross from the main Building framing to the control room framing.

Conduit supports shall be furnished and installed in accordance with these specifications. Support material shall comply with the following requirements.

- i) Hanger rods shall be 12 mm diameter galvanized threaded steel rods.
- ii) Single conduit supports shall be one-hole cast metal straps and clamp backs unless other types are acceptable to the Owner. Multiple conduit bank supports shall be constructed of special galvanized support channels with associated conduit clips.

Conduit sealing, explosion proof, dust proof and other types of special fittings shall be provided as required by these specification and shall be consistent with the area and equipment with which they are installed. Fittings installed outdoors and in damp locations shall be sealed and gasketed. Hazardous area

fittings and conduits sealing shall conform to NEC requirements for the area classification.

Bidder shall provide double locknuts on all conduit termination not provided with threaded hubs and couplings. Water tight conduit unions and rain tight conduit hubs shall be utilised for all the application which shall be exposed to weather. Moisture pockets shall be eliminated from conduits.

Conduits shall be securely fastened to all boxes and cabinets.

9.10.00 **CABLE SUB-TRAY & SUPPORT**

9.10.01 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 Bidder. 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).

9.10.02 The covers on the cable sub-trays shall be used for protection of cables in areas where damage may occur from falling objects, welding spark, corrosive environment, etc. & shall be electrically continuous and solidly grounded.

9.10.03 The cable trays shall not have sharp edges, burns or projections injurious to the insulation or outer sheath of the cables.

9.10.04 All cables shall be carefully laid or pulled in the trays so that neither the cable nor the trays are damaged. Cable may be laid along the side of the tray system during installation provided; it is protected from dirt, water, oil, or other detrimental materials and from mechanical injury.

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

9.11.01 Applicable standards shall be minimum specified as per table hereunder. Type and acceptance tests shall be conducted complying all the relevant latest industrial standards and requisite number of copies of test certificates, test reports as per Distribution Schedule shall be furnished.

S. No.	Standard	Description
1	IEC 332-3 Part 3	Tests on bunched wires and cables.
2	ASTM D 2863	Oxygen Index
3	BS 5308 Part 2	Specification for PVC insulated cables.
4	DIN 50049	Document material testing.
5	IEC 60331 and IEC 60332-3	Resistant Cables
6	ISA/ANSI MC96.1	Thermocouples and extension wires
7	IEC:502	Mechanical Test
8	NEMA-WC-5	Accelerated Water absorption test
9	ASTM D 2863	Oxygen Index Temperature index
10	IEC 754-1	Acid gas generation
11	SS-424 14 75 (Class F3) IEEE 383	Flammability
12	ASTM D 2843	Smoke Generation
13	API-550 Part -I SECTION VII	Physical separation of power and signal cables
14	IS:3975 and IS:2633	Armour material and uniformity of galvanization

9.11.02

I. TYPE TESTS (also Refer Vol. V, Part B, Chapter 13):

- A. Submission of type test , results, and certificates shall be acceptable, provided for following points
- i. The same has been carried within last ten years from the date of bid opening.
 - ii. The same have been carried out by the bidder/ subvendor on exactly the same model/rating of equipment.
 - iii. There has been no change in the components from the offered equipments and tested equipments.
 - iv. The test has been carried out as per the latest standards along with amendments as on the date of bid opening.
 - v. The test should have been either carried out at any Govt. approved laboratory and test witnessed by a client of Government Department / Government
- B. In case the approved cables are 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 owner on this account. The type tests shall be carried out on one drum out of every 10 drums or less for each size of cable in each lot, in presence of Owner’s representative as per

applicable standards in Govt. approved Laboratory if adequate testing facility is not available at works of the supplier.

No.	Name of Test	Governing standard	Special requirements as per Owner's specification
1.	Annealing test (for copper)	IS : 8130/84	As per IS: 8130/84
2.	Conductor resistance test & Diameter test	IS : 10810	As per approved G.T.P.
3.	Per sulphate test (for tinned copper wire)	IS : 8130/84	As per IS: 8130/84
4.	Test for armours wires / strips consisting of :- i) Measurement of dimension ii) Tensile test iii) Elongation test iv) Torsion Test (for round wires only) v) Wrapping test (for aluminum wires/ formed wires only) vi) Mass of zinc coating test (For GS formed wires/wires only) vii) Uniformity of zinc coating (For GS formed wires/wires only) viii) Adhesion test (For GS formed wires/wires only)	IS : 3975	As per IS:3975
5.	Test for measurement of DC resistance of armour	IS: 1554 (I)	As per approved GTP
6.	Test for measurement of thickness of insulation & sheath & other dimensions.	IS : 1554 (I)	As per approved GTP
7.	Measurement of volume resistivity of HRPVC insulation	IS : 5831-1984	i. 3.5×10^{14} Ohm-cm at 27°C / room temp. (Min). ii. 3.5×10^{11} Ohm-cm at 85°C (Min.)
8.	Tensile strength and elongation test for insulation & sheath before ageing and after ageing	IS:5831/1984	As per IS:5831/84
9.	Ageing test for insulation & sheath.	IS:5831/1984	As per IS:5831/84

No.	Name of Test	Governing standard	Special requirements as per Owner's specification
	Loss of mass test for PVC insulation & sheath.		
10.	Shrinkage test for PVC insulation & sheath.	IS:5831/1984	As per IS:5831/84
11.	Hot deformation test for PVC insulation & sheath	IS:5831/1984	As per IS:5831/84
12.	Cold bend test for PVC insulation.	IS:5831/1984	As per IS:5831/84
13.	Insulation Resistance Test (Volume Resistivity method)	As per GTP	As per approved GTP
14.	Cold impact test for PVC sheath.	IS:5831/1984	As per IS:5831/84
15.	Heat shock test for PVC insulation & sheath.	IS:5831/1984	As per IS:5831/84
16.	Thermal stability test for PVC insulation and sheath.	IS:5831/1984	As per IS:5831/84
17.	Test for bleeding and blooming of pigments for PVC insulation of sheath.	IS:5831/1984	As per IS:5831/84
18.	Colour fastness to water.	IS:5831/1984	As per IS:5831/84
19.	Colour fastness to day light.	IS:5831/1984	As per IS:5831/84
20.	High voltage test (water immersion test)	IS:1554(I)	IS:1554(I)
21.	Test for rodent & termite repulsion property of sheath.	-	Presence of lead shall be detected.
22.	Oxygen index test on inner & outer sheath material.	ASTM:D-2863/77	Min.29
23.	Temp. index test on inner & outer sheath material	ASTM:D-2863/77	Min.250°C
24.	Acid gas emission test on inner & outer sheath material.	IEC-754-1	Acid gas generation shall be less than 20% by weight.
25.	Smoke Density test on inner & outer sheath material	ASTM-D-2843/77	Min. 40% light transmission during test.
26.	Flammability test on finished cable samples as per following methods: i. Swedish chimney test	SS-424-14-75 Cl. F-3 IEEE-383 IEC-332 Part -	SS-424-14-75 Cl. F-3 IEEE-383 IEC-332 Part -3

No.	Name of Test	Governing standard	Special requirements as per Owner's specification
	ii Vertical tray flame propagation test. iii. Single vertical cable fire resistance test.	3 (Category-B)	(Category-B)
27.	Tests for all electrical properties at 20°C & maximum operating temp. as per GTP.	As per GTP	As per approved GTP
28.	Oxygen index test & Acid Gas generation test for Fillers	ASTMD – 2863, IEC 60754-1	As per approved GTP
29.	Continuity test, Shield thickness, Overlap test of Al Mylar shield	As per GTP	As per approved GTP
30.	Noise interference test, Cross talk test, Mutual capacitance, Drain wire continuity test.	IEEE Transaction, VDE 0472	As per approved GTP
31.	High Voltage Test	As per GTP	As per approved GTP

II Routine Test:

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

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

III Acceptance Tests:

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

- | | | |
|------------------------------|--------------|---|
| 1. High voltage test | IS:1554 (I) | 2 KV (RMS) for one minute |
| 2. Conductor Resistance Test | IS:8130/84 | As per NIT |
| 3. Volume Resistivity | IS:5831-1984 | (i) 3.5×10^{14} -cm at 27 deg C/room temp (Min)
(ii) 3.5×10^{11} ohm-cm at 850C Min. |

- | | | | |
|------|--|---|--|
| 4. | Measurement of Mutual capacitance at 0.8 KHZ | | 100NF/Km (max) |
| 5. | Calculation & Verification of Characteristic impedance on the basis of value obtain for mutual capacitance at 0.8 KHZ with the help of following formula | | |
| | $Z = \frac{R}{2fc}$ | 320 | Ohms(nominal) |
| | where Z | = | characteristic impedance in ohm |
| | R | = | Loop resistance of cable per km in ohms at 20 °C |
| | f | = | Frequency of test in Hz (800) |
| | c | = | mutual capacitance per km. |
| 6. | Measurement of thickness of insulation and sheath & other dimensions | IS:1554 (I) | As per NIT |
| 7. | Tensile strength and elongation at break of insulation & sheath | IS:5831/84
IS:5831/84 | |
| 8. | Oxygen index test on inner & outer sheath at room temp. | ASTM-D-2863 Min.29 | |
| *9. | Temp. index test on inner & outer sheath | --do-- | |
| *10. | Acid gas emission test on inner sheath & outer sheath. | TEC-754-1 | Max.20% by weight |
| 11. | Smoke density test on inner sheath & outer sheath | ASTM-D-2843 | Min.40% light transmission during test. |
| 12. | Flammability test | (i) SS-424-14-75
Class F-3
(ii) IEC-332 Part -3 (Category-B) and IEEE-383 | SS-424-14-75 |
| 13. | Additional Test | IEC 331 | for fire survival characteristics |

14.	Anti-Rodent and Termite Repulsion test.	-
15.	Anti Fungal Test	-
16	Test for Conductor	IS 10810
	Annealing Test	Pt 1
	Tensile Test	Pt 2
	Wrapping Test	Pt 3
	Resistance Test	Pt 5
17	Test for Round Steel Wires/Strips	IS 101810
	Measurement of Dimensions	Pt36
	Tensile Test	Pt 37
	Elongation Test	Pt 37
	Torsion Test	Pt 38
	Winding Test	Pt 39
	Resistivity Test	Pt 42
	Uniformity of Zinc Coating Test	Pt 40
	Mass of Zinc Coating Test	Pt 41

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

9.11.03 Following mandatory requirements shall be complied at SIGNAL/CONTROL CABLE manufacturing unit.

1. Online UPS shall be available for feeding power to extruders. This is essentially required to ensure uninterrupted insulation & sheathing process. During normal operation, power supply to extruders shall be fed through on-line UPS (30 minutes back up). At the time of unplanned power shutdown or interruption due to bad weather etc, power supply to extruders can be changed over to DG SUPPLY. This methodology will ensure uninterrupted power supply to the extruders.
2. Wire drawing facility needs to be available with online annealing. Aluminum/copper rods to be procured directly from the material supplier (manufacturer).
3. Test equipment of water absorption test shall be available as per NEEMA WC 70, DIELECTRIC RETENTION TEST AS PER NEEMA WC 5, UV RADIATION TEST AS PER DIN 53387, ASTM-G-154.
4. DIGITAL ONLINE thickness measurement instrument for measuring thickness of insulation.

CHAPTER – 10**MAINTENANCE AND CALIBRATION EQUIPMENT****10.00.00 MAINTENANCE AND CALIBRATION EQUIPMENT**

10.01.01 The Bidder shall be responsible for supplying all accessories and any necessary additional tools as required for proper maintenance and calibration of the installed C&I devices/systems.

10.01.02 Electrical power supply requirement of the instruments offered under this Sub-section shall be UPS, 230 V AC, and 50 Hz nominal, single phase.

10.01.03 The relevant M&C items shall be microprocessor based and shall have the data logging facility for keeping calibration/maintenance records with proper communication facility for downloading these data on the Lab work station as detailed in the item wise specifications.

10.01.04 The calibration standards of all M&C equipment furnished under this sub-section shall be traceable to National Bureau of Standards, USA or NPL, India or to the applicable standards existing in the country where the equipment is manufactured.

10.01.05 Bidder to note that these maintenance & calibration equipment shall be for Owner's use for normal operation & maintenance of the plant & shall not be used by the bidder for calibration etc during commissioning. During commissioning, for calibration and other activities, Bidder shall bring his own equipment.

10.01.06 The accuracy of the M&C equipment shall be better than the instrument being calibrated.

The range of all the M&C equipment shall cover the entire range of the instruments being provided under this contract. Dustproof carrying case and rechargeable battery along with external charger shall be provided with relevant portable and battery-operated equipment as detailed in the item wise specifications.

10.01.07 Bidder shall ensure with appropriate documentation that direct service/support from the M&C item supplier/manufacturer shall be available to the owner for all M&C items for a minimum period of 10 years after the expiry of defect liability period. User Manual shall be provided for each instrument.

10.01.08 Computer Aided Calibration system offered, shall meet the demands of high precision transfer / secondary standards for automatic testing & calibration of temperature, pressure & electrical parameters in quick time and for issuance of simple, error free, reliable, fully traceable calibration certificates conforming to ISO standards / Protocol. Complete lab software with life time validity shall be provided by bidder, which shall be loaded on Lab operating station. Any lab software mentioned or not, however required for C&I lab, same shall be provided by bidder. Any software required for any lab

instrument/equipment shall also be provided by bidder. Software with latest version and its update for minimum next 10 years after the expiry of defect liabilities shall be provided.

10.01.09 Computer Aided Calibration system shall also have the following facilities: -

1. Automatic Testing and Calibration:
 - i) Pressure instruments like pneumatic/hydraulic pressure/differential pressure vacuum gauges/indicators / transmitters/ switches/controllers, electro-pneumatic instruments P/I, I/P converters.
 - ii) Pressure/differential/temperature/flow transmitters current/pH converters.
 - iii) Analog instruments, such as indicators for pressure, current, voltage etc.
 - iv) Digital panel indicators with additional port for DC current measurement.
2. Automatic testing and calibration of all types of temperature measuring instruments including temperature indicators/ recorders/controllers, thermo switches, RTD and Thermocouples of all international standards (range from -20 Deg.C to 1200 Deg.C).
3. An automatic temperature calibration system for simultaneous calibration of multiple temperature sensors.
4. Automatic calibration and system documentation through Personal Computer offered with compatible calibration software.

10.01.10 Microprocessor based lab instruments shall be offered wherever applicable. All the microprocessor based maintenance and calibration units should also have provision for data logging facility for keeping calibration/maintenance record with proper communication facility to down load these data on the lab WORK STATIONS.

10.01.11 All the calibration instruments shall have a common Lab WORK STATIONS along with A3/A4 sized coloured Laser jet printer cum scanner cum Copier for calibration and report generation. Specification for WORK STATIONS and Printer shall be same as specified elsewhere in the specification, Vol. V, Part B, Chapter 3.

The Bidder shall provide dual redundant interfacing for monitoring on OPC Protocol with DDCMIS for all the microprocessor based items.

All the calibration instruments shall be provided with RS232C port for Lab WORK STATIONS interface with their own interfacing cables & software.

All the portable type lab instruments shall be provided with own rechargeable battery & charger.

10.01.12 **Instrument Work Shop**

The scope shall include the arrangement and installation of instrument workshop equipment supply and connection of all electric power supply including air distribution system.

10.02.00 **Electronic Test Bench**

Self-contained test bench made of anodised aluminum for testing and repair of electronic instruments and gadgets shall be furnished. The test bench shall be of modular design, enabling easy change of arrangement/ layout as and when required. This shall include necessary isolating switches, power supply switches, holding brackets, etc. Test bench shall be furnished with thick laminated top. Desk with drawers shall be included.

The test bench shall include necessary power modules to feed the following sockets mounted on the test bench:

(Voltage rating is tentative and shall be matched to supply requirements of Bidder's range of products).

S. No.	Items	Qty
i.	3 pin socket, 240VAC, 4A low-voltage output, earth leakage circuit breaker etc. for whole workstation	1
ii.	240V AC $\pm 0.5\%$, 1 phase, 50 Hz, 3 kVA supply socket, circuit breaker, as an Isolated supply module	6
iii.	110 V AC, 10 Amp. 50Hz supply socket & 0-260V AC, 1ph, 50Hz (Variac), 10amps with Digital meter for current (resolution 0.01 A) and voltage (Resolution 0.1 V).	1 no. each
iv.	Voltage stabilizer 230($\pm 0.5\%$) VAC, 1ph, 50Hz, 3KVA	4
v.	$\pm 48V$ DC, 3A with Digital meter for current and voltage	2
vi.	$\pm 24V$ DC, 6A with Digital meter for current and voltage	2
vii.	$\pm 12V$ DC, 10A with Digital meter for current and voltage	2
viii.	$\pm 5V$ DC, 20A with Digital meter for current and voltage	2
ix.	0-220V DC (variable) stabilized output 1 Amp No load to full load regulation shall be $\pm 0.2\%$ or better with Digital meter for current and voltage	1
x.	Plant UPS power point/sockets.	2

The test bench shall include socket holders where the electronic gadgets under test may be plugged. The front equipment shall include multipoint connectors and test jacks for interconnection. There shall be connection between the connector and holder in which device under test shall be plugged in. All power points must be labeled. Electronic test bench should have instrument earth tapping points. 2 nos. Air guns shall be provided for cleaning the instrument in test bench tools.

Power cable with necessary sizing shall be supplied & laid by bidder from plant UPS ACDB1 and UPS ACDB2 to C&I lab at a centralized location in C&I lab and from there the required distribution board with UPS feeders including

20 % spare feeders shall be provided for distribution purpose inside the laboratory. Required MCB's & fuses and LED lamps shall be provided at distribution board.

3 phase, 415 VAC power supply with proper distribution board for electric actuator motor testing should be available in the lab by bidder. Also three (3) nos. of tables shall be offered by bidder with required regulated 24 VDC power supply socket for testing of transmitters on these tables.

Complete cables required for power supply in lab shall be in bidder scope of supply.

The standard high accuracy resistors shall be included to load and measure the current output of devices. Necessary control devices for voltage and current adjustments/ control switches for power supplies to feeders, isolation etc., shall be included. All electric circuits shall be protected against overload by fuses, whose holders are located on front of the panel. All electrical circuits and metal structures shall be properly grounded.

The following facilities shall also be provided on the electronic test bench:

- a) One DC voltage stabilizer - Regulation +/-0.02% for (0 to 220V, 1 Amp) 0-100% load variation.
- b) One AC voltage stabilizer - Regulation +/-0.5% for (input 230V AC nominal, output 230V AC +/-0.5%) . 0- 100% load variation
- c) One no. 5 1/2 digits digital - Accuracy 0.1 +/- 1 digit Multimeter for display of voltage, current, resistance and having at least 24 measuring ranges
- d) Standard Current Source (0-55mA)
- e) Digital AC and DC ammeters and voltmeters.
- f) Multifunction Calibrator shall be mounted on the test bench as per the below specifications:

S. No.	Parameters	Technical specification
1	Functional Requirement	<p>1. The offered Calibrator shall be able to source AC/DC voltage, AC/DC current, AC/DC Power, frequency, resistance, capacitance and inductance.</p> <p>Calibrator capable of calibrating the below mentioned list of Instruments.</p> <p>Multimeters up to 5.5 Digit.</p> <p>Digital AC/DC Voltmeter & Analogue Voltmeter</p> <p>Digital AC/DC Ammeter & Analogue Ammeter</p> <p>Resistance bridge</p>

S. No.	Parameters	Technical specification
		LCR Meters. Frequency Counter. Insulation Tester. Optical Tachometer Power Meter. Power Quality Analyser. Temperature Indicator. Data Logger. Clamp Meter. Oscilloscope
2	Calibrator (Source) Specifications	
	DC Voltage	Range:(0 to ±1025V) Best 1 Year Measurement Accurcay:25 PPM
	AC Voltage	Range: (20mV to 1000V,10Hz to 500 KHz) Best 1 Year Measurement Accuracy (±0.035%)
	DC Current	Range: (0 to ±30A) Best 1 Year Measurement Accuracy:50PPM
	AC Current	Range: (20µA to 30A,10Hz to 10kHz) Best 1 Year Measurement Accuracy (± 0.06%)
	Capacitance (decade)	Ranges:(1nF-10µF) Best 1 Year Measurement Accuracy:(0.25%)
	Inductance (decade)	Ranges: (1mH-10H) Best 1 Year Measurement Accuracy (0.5%)
	Decade Resistance	Range: (0.1Ω to 1GΩ) Best 1 Year Measurement Accuracy:(±40PPM)
	Variable Resistance	Range:10Ω to 10MΩ Best 1 Year Measurement Accuracy:(±0.03%)
	T/c Simulation	Range: -200°C to 1800°C Best 1 Year Measurement Accuracy: ±0.09°C Types: J,K,T,R,S,B,N,E,L,U,C (11-Types)
	RTD simulation	Range: -200°C to 800°C Best 1 Year Measurement Accuracy: ±0.02°C
3	Oscilloscope calibration	
	Amplitude	Range:2mV/Div to 50V/Div Best 1 Year Measurement Accuracy: (0.01%±20µV)

S. No.	Parameters	Technical specification
	Time base	Range: 2ns to 5s Best 1 Year Measurement Accuracy: ± 20 PPM
	Bandwidth	Range: 300MHz Best 1 Year Measurement Accuracy: 1dbm
4	M/s Desein informed that Resistance Thermometer is not required as Digital Thermometer is provided under Cl. No. 70, hence comment withdrawn.	AC/ DC up to 30KW. Phase :360° , Frequency: 400Hz.
5	Clamp Meter Calibration	2/10/50 Turn Maximum Up to 1500A AC/DC.
6	Interfaces	USB
7	Operating temperature range	Operating temperature range: 10°C to 40°C Relative Humidity: < 80% non-condensing
8	Mains power supply	Single Phase 230V, 50Hz
9	Insulation Tester Calibration	Voltage Range: 50V to 1KV Best 1 Year Measurement Accuracy: (0.5% \pm 20mV) or better Insulation Resistance Range: 0 to 2G Ω Best 1 Year Measurement Accuracy : (3%)
10	Accessories	All standard accessories like Test lead set & clips, PC interface cable, BNC test leads, thermocouple connectors, calibration certificate & User manual
11	Software	The application software compatible with the calibrator should have pre-written test procedures method of electrical measuring instruments of different makes/models like multi meters, Tong testers/clamp meters, Tachometers, Portable calibrators , Oscilloscopes etc.

10.03.00 **Pneumatic Test Bench**

Pneumatic test bench made of anodised aluminium, modular in design, enabling easy change of arrangement / layout as and when required, shall be provided. Test bench shall be complete with industrial grade oil free air

compressor or alternatively shall get the Instruments air from Plant Instrument Air compressor, shut OFF valves, air filter cum pressure regulators, and pressure gauges for testing E/P converters, controllers, power cylinders, control valves etc.

Low & medium Pressure Pneumatic Controller:

- Dual Simultaneous Output Range1: -1 to 3.5 barg/abs
- Range2: -1 to 20barg/abs
- Pressure Media: Clean Dry air or Nitrogen
- Input: Air supply by N2 Cylinder and vacuum by Electrically operated vacuum pump.
- Mounting: Panel mount
- Display: Touch screen display with 7-digit resolution or better
- Measurement Precision: 0.001% of FS for 3.5barg/abs
- Measurement Precision: 0.0015% of FS for 20barg/abs
- Control stability: 0.001% of range minimum.
- Pressure connections: The pressure output connection will be on the front of the instrument panel with quick coupling/connector on the test bench for easy access
- Pressure Units: Multiple Engineering units including psi, bar, mbar, kg/cm², kPa, mmHg, mmH₂O etc. Display in 24 engineering unit - any pressure
- Overpressure Protection: Each measurement and control module should have separate pressure relief valve for safety protection.
- Interface/ Automation: The Automatic Pressure controller will be automated through software directly. It can be operated as a standalone device and will be the master for the Pneumatic pressure.
- Primary remote interfaces: Ethernet/ RS232/ USB
- Pressure Switch testing Facility should be provided.
- Automatic Leak test facility.
- Operating temperature: 15 Deg C to 35 Deg C
- Storage Temperature: up to 50 Deg C
- Operating Humidity: 0 to 95% RH
- Power: 230 V AC+/-10%, 50 Hz, Single phase
- Accessories: Operating Manual, Power supply cable, Interface Cable
- Quantity: 1 No.
- Calibration certificate: The vendor should Provide Traceable Calibration Certificate traceable to National/International Lab Standards

The test bench shall also include the following:

S. No.	Items	Qty
i.	DC voltage power pack (220V)	1
ii.	DC voltage stabilizer 0-60V	1
iii.	4½ digit digital multimeter (Accuracy :0.1%)	1
iv.	0 - 260 V AC socket	1

S. No.	Items	Qty
v.	220 V DC socket	1
vi.	0 - 60 V DC socket	1
vii.	Current source (0 - 55 mA) True $\pm 0.025\%$ of reading Read and Source 0.000 to 50.000 mA Display current or -25.00 to 125.00% of 4-20mA or 10-50mA Bar graph displays % of 4-20mA or 10-50 mA Read 0.00 to 60.00 volts with 2X over range ability Simulate 2-Wire Transmitters Power 2-Wire Transmitters and Read 0.000-50.000mA Read 0.00 to ± 30.00 VDC with 4X over range ability Source 0.000 to 24.000 VDC with up to 20mA output Direct Calibration 1.000V to 5.000V Loop Compliance Voltage ≥ 43 Volts Auto Step or Ramp with HIGH accuracy and repeatability designed in collaboration with Nuclear plants Selectable step sizes, time in-between steps & soak time Stop watch like EZ-Check™ switch Full 5 Digit Display Fuseless protection from accidental connection to 240 volts AC/DC Rugged handheld enclosure with optional lanyard and Velcro® hand strap Uses 4 AA Lithium Ion batteries or AC Adaptor (included) Superior battery life of 40 hours under typical continuous usage Easy access to battery compartment NIST Traceable Test Data, A/C Adaptor, and Carrying Case included FREE	1

The standard high accuracy resistors shall be included to load and measure the current output of devices. Necessary control devices for voltage and current adjustments control, switches for power supplies to feeders, isolation etc., shall be Included. All electric circuits shall be protected against overload by fuses, whose holders are located on front of the panel. All electrical Circuits and metal structures shall be properly grounded. Pneumatic test bench should have instrument earth tapping points.

The test bench shall be complete with overload protection valve, precision pressure regulators, filter reducing unit for the air supply and all necessary accessories Including 1 set supports for instrument under test, desk with drawers etc.

10.03.01 Each workbench suitable for Electronic Work and pneumatic work with wood top approximate size 75 x 300 cms with side drawers (fitted with lock) and

board on back of the bench top with electric fittings. Each workbench shall be fitted with all essential tools as described under for electronic workbench and for pneumatic work bench. Each bench shall also be fitted with electrical fittings - sockets and colour coded banana jacks for each kind of voltage used in the power station control system and one 20-watt fluorescent lamp at each table.

10.04.00 The instrument lab room shall be air-conditioned.

The instrument lab shall have glass partitioned cabins for lab in-charge and testers separately along with furniture's.

The instrument lab shall be provided with necessary cub-boards for storing instruments and documents.

One no. 2 sided opened & Folding Aluminium ladder (height 180 cm or better) for maintenance and mounting bracket for ladder shall be provided by bidder in C&I lab room.

10.05.00 The bidder shall ensure with appropriate documentation that direct service/support from the lab instruments/equipment supplier/manufacturers shall be available to the owner for all type of lab instruments/equipment/items for a minimum period of Ten (10) years after the expiry of defect liability period.

10.06.00 **Technical Specification for Laboratory Instruments**

1. **Portable Calibrator for Vacuum**

Range	:	-0.95 to 1 barg
Accuracy	:	+/- 0.0185%FS
Display	:	LCD with 4 1/2 digit
mA Input	:	4-20 mA
Accessories	:	Charger/Adapter Test Leads Carrying Case Manual

Other Features	:	Built in relief valve; Internal/integral Hand Pump Simultaneous display of pressure and measured mA/V Shall source 10V/24V DC; 0-20mA Other Features: mA ramp/step, display in various pressure units USB Interface
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2. **Portable Digital Multimeter**

Portable digital multimeters, with high voltage grade leads/probes and suitable casing including carrying strap are envisaged. Digital multimeter shall have 4 1/2 digits read out indicator with automatic decimal point and polarity indicator. Indication shall be in seven segment LCD display. Meters shall be complete with accessories

for high voltage, DC current, temperature, capacitance and frequency measurements.

Instruments offered, shall have built in overload protection feature. These shall have high resolution and low response time. For AC signals (True RMS) digital multimeter shall have good fidelity over a large range of frequencies. Signals and ranges required to be measured

by the meter are furnished in a tabular form below :-

S. No.	Signal type	Range	Accuracy
i.	DC voltage	100 mV	+/- 0.3% +1 digit or better
		1 V	-do-
		10 V	-do-
		100 V	-do-
		500 V	-do-
ii.	AC voltage	1000V	-do-
		Same as DC voltage	+/-0.5% of reading + 2 Digits or better
		200 micro amp.	+/-0.75 % of reading + 2 Digits or better
		1 mA	-do-
		10 mA	-do-
iii.	Direct Current	100 mA	-do-
		1 A	-do-
		10A	-do-
		Same as Direct Current	+/-1.0% of reading or better
		0.1 K ohm	+/- 0.5% of reading + 2 digit
v.	Resistance	1 K ohm	-do-
		10 K ohm	-do-
		100 K ohm	-do-
		1 M ohm	-do-
		10 M ohm	-do-
vi	Input resistance	10 Meg ohms	
vii	Ambient temp.	0-50 deg.C	
viii	Ambient Temp.	± 0.1% of reading error from 0-50 deg.C	
ix.	One red indication lamp shall indicate the overload.		
x.	Handheld		

- xi. IEC CAT III 600V Safety rating.
- xii. Drop protected to 1 meter
- xiii. Easy access battery door to change the battery without breaking the calibration seal.
- xiv. Accessories : Test leads per mutimeter
One set of spare test leads per
multimeter Rechargeable Alkaline battery
per multimeter
Software & hardware for interfacing per
multimeter.

3. **Digital Multimeter (Table Mounting Type)**

High standard multimeters are envisaged for the instrument shop. The multimeters shall offer simplicity in operation. The multimeters shall have a built in automatic overload protection. The meter shall offer ease and simplicity in operation to render the instrument in use after overload protection being operated. The instrument shall offer a good fidelity over a large range of frequency. Temperature compensation shall be built in.

The components inside the instrument shall be impervious to moisture. The multimeters shall be complete with suitable cover.

Each multimeter shall include two (2) high voltage grade loads which shall be interchangeable. Spare loads/probes with clips shall be supplied with multimeter. Voltage multiplier, high and low resistance range extension unit with suitable replaceable battery may be offered. Ranges and accuracy of the multimeters shall be as per the table below: -

i. **For 7 1/2 digit multimeter**

S. No.	Signal type	Ranges	Accuracy
1.	DC voltage	100 mV to 1KV	+/- 0.025% Best
2.	AC voltage	100 mV to 700V	+/- 0.025% Best
3.	DC current	10 Micro amps to 10 Amps	+/-0.2% Best
4.	AC current	1mA to 10A	+/-0.01% Best
5.	Resistance	1 Ohms to 1 G ohms	+/-0.003% Best

ii. **For 5 1/2 digit multimeter**

S. No.	Signal type	Ranges	Accuracy
1.	DC voltage	100mV to 1000V	+/- 0.025%

S. No.	Signal type	Ranges	Accuracy
2.	AC voltage	100 mV to 750 V	+/- 0.025%
3.	Alternating current	1 mA to 10 A	+/-0.2%
4.	Direct current	-do-	+/-0.01%
5.	Resistance	100 Ohms to 100 Mohms	+/-0.003%

iii. Other functions:

Power supply : 240V single phase
 Display : 5 ½ digit, 7 ½ digit
 Resolution : 100 micro Volts for 0-1KV DC
 Auto/Manual ranging facility.

Meters shall be complete with accessories for high voltage, DC current, temperature, Capacitance and frequency measurements.

iv. SPECIAL FEATURES:

Self test Mode
 Diode/Zener Test
 Max/Min functions
 Continuity Testing
 A.C./D.C. Coupled facility
 Countdown and sample beep on long filter periods
 Oxygen free copper input terminals

v. Accessories : Test leads per mutimeter One set of spare test leads per multimeter Rechargeable Alkaline battery per multimeter Software & hardware for interfacing per Multimeter.

4. Manometers

4.1 U-Tube Manometer

Item No.	Range
1.	0- 1000 mmwc (- 500 mmwc to + 500 mmwc)
2.	0- 2500 mmwc (- 1250 mmwc to + 1250 mmwc)

This type of manometer shall be mercury filled clear Borosilicate glass U tube intended to be used for low static differential pressures or vacuum. The scale shall be graduated in mm and smallest division shall be 1mm.



Zero adjustment facility shall be provided. The manometer shall be tested for safe operation up to 7.0 Kg/cm² pressure.

All 'wetted parts & fitting's material other than U tube & manifold shall be 304SS. All required accessories such as 3 valve manifolds & 5 valve manifold of 316SS, tripod stand, spirit level etc. shall be provided. Cases shall be of Aluminum on three sides and aluminum cover with clear acrylic front. Packing material shall be Teflon. End connection shall be ½ NPT (F), with check valves. The scale shall be provided with vernier arrangement. Liquid drain plug shall be provided. Coloured liquid & storing bottle, fillup pump, fill up funnel and nylon tubes shall also be included.

4.2 Inclined Tube Manometer

Item No.	Range
1.	50-0- 50 mmwcl
2.	100-0- 100 mmwcl
3.	200-0-200 mmwcl

Portable inclined tube manometers of free standing type for above ranges shall be supplied by bidder. The scale shall be graduated in mm and accuracy shall be 0.1 % of FSD.

This type of manometer shall be mercury filled clear Borosilicate glass U tube intended to be used for measurements of draft, air velocity and air pressure around atmospheric pressure. Indicating tube and oil chambers shall be drilled and reamed in a solid block of clear acrylic plastic material. Cases shall be of Aluminum on three sides and aluminum cover with clear acrylic front. These manometers shall have leveling screw at the bottom and spirit level bubbles for accurate leveling. Packing material shall be Teflon. Each manometer shall be complete with connecting tubes, ½ " NPT process adaptors, range scale, tube chamber, fillup pump, fill up funnel, mounting box, zero adjustment, aspirator, manometer liquid & drain plugs etc. All 'wetted parts & fitting's material other than U tube & manifold shall be 304SS. 3 valve manifolds & 5 valve manifold of 316SS, shall also be provided.

5 Test Manometer

This type of manometer shall incorporate mercury well and extended 1500mm transparent plastic tube with graduated scale for the measurement of pressure. The scale shall be graduated in both mm of Hg and Kg/cm² and shall be compensated for liquid level changes within the manometer well. The vent or vacuum connection at the top of the extended tube shall include an in-line liquid check valve to prevent mercury spills. The manometer shall be tested for safe operation up to 17.5 Kg/cm² pressure. The manometer body shall be of steel channel construction and moisture proof.

6. Digital Manometer

The range shall be 0 to 2 kg/cm²(2000hpa) and accuracy shall be 0.05% or better.

Technical specification
Ranging from 0 to 2 kg/cm ² . It is used to high and low differential pressure instrument.
Accuracy- 0.05% or better
7 pressure units to choose from: kPa, hPa, mm H ₂ O, mmHg, psi, inch H ₂ O, inch Hg,kg/cm ²
Resolution : 1 hPa
Overload : ±4000 hPa
Battery operated digital manometer mainly use for air and gas (vacuum) services.
Accessories- Battery, Tubing, Adapters, Storage Pouch

7. Dead Weight Tester

- Applicable Standard : ASME PTC 19. 2-1964 except as modified in this specification.
- Type : Dual range (High Range & Low Range) allowing an automatic change of scale of 10:1 ratio.
- Piston Material : Hardened 420 SS
- Ranges : 0-60 & 0-600 Kg/cm²
- Accuracy : ± 0.02 percent of actual reading
- Calibration : ±0.01% traceable to NBS
- Connection : Suitable for 1/8, 1/4, 3/8 and 1/2 inch NPT
- Accessories : i. Following weights of each type shall be provided:
- a. 10 & 100Kg/sq.cm 4nos.
 - b. 9 & 90kg/sq.cm 1no.
 - c. 5 & 50kg/sq.cm 1no.
 - d. 2 & 20 kg/sq.cm 2nos.
 - e. 1 & 10kg/sq.cm 1no.
 - f. 0.5 & 5 kg/sq.cm 1no.
 - g. 0.2 & 2 kg/sq.cm 2nos.
 - h. 0.1 & 1 kg/sq.cm 1no.
 - i. 0.05 & 0.5 kg/sq.cm 1no.
 - j. 0.02 & 0.2 kg/sq.cm 2nos.
 - k. 0.01 & 0.1 kg/sq.cm 1no.
- ii. Tools like wrenches, spanners etc.
- iii. Hard storage Carrying case



- iv. Oil filters to prevent contamination and wear
- v. Spirit level, spare seals, keys, spare oil
- vi. Instruction manual
- vii. Software shall be provided to correct for effect of environment factors such as gravity & temp. to determine the pressure generated by dead weight tester.
Software & hardware for interfacing.
- viii. Master pressure gauge required with digital indicator and with range to match above.
- ix. Instrument shall be fitted with priming lever pump, hand wheel pressure adjustment, leveling screw and built-in spirit indicator.
- x. Adaptor for gauges of 1/8, 1/4, 1/2"NPT and BSP type, 8 bonded seals, bottle of technical grade oil and dust cover.

Application : Laboratory calibration of pressure and differential pressure gauges/ transmitters, pneumatic transmitters and controllers.

7.1 Vacuum Tester

Applicable Standard : ASME PTC 19. 2-1964 except as modified in this specification.

Air operated, dead weight type vacuum tester shall be furnished. This shall include leveling screw, gauge post, spirit level, vacuum adapter, spanners, pointer remover, pointer punch, 1/2 inch, 1/4 inch and 1/8 inch NPT adapters, dust cover, adapter seals and all other necessary accessories. The vacuum tester shall have measuring range of 50-1000 m bar and accuracy of 0.02% or better for range 100-1000 m bar. Vacuum tester shall be provided with following weights :

1 weight corresponding to 5 mbar, 3 weights corresponding to 20 mbar, 2 weights corresponding to 10 mbar, 6 weights corresponding to 50 mbar, 6 weights corresponding to 100 mbar.

In addition, an electrically operated vacuum pump to achieve the vacuum level required in vacuum tester shall be provided.

8. Standard Pressure Gauges

Applicable standard : ASME PTC 19.2-1964 except as modified in this specification

Type : Bourdon tube

Material

- Bourdon	: 316 SS
- Movement	: 316 SS
- Case	: Die-cast aluminum/carbon steel
Dial size	: 300 mm
Scale details	: Graduations in black lines on white dial
Ranges	: (-) (+) 1 Kg/cm ² 0-1.6 Kg/cm ² 0-2.5 Kg/cm ² 0-4 Kg/cm ² 0-6 Kg/cm ² 0-10 Kg/cm ² 0-16 Kg/cm ² 0-25 Kg/cm ² 0-60 Kg/cm ² 0-100 Kg/cm ² 0-250 Kg/cm ² 0-400 Kg/cm ² 0.2-1 Kg/cm ²
Accuracy	: ± 0.1 percent
Connection	: Quarter (1/4) inch NPT Male bottom
Application	: For field testing of pressure instruments and Calibration of pressure instruments

Hydraulic Pressure Gauge Tester shall also be provided to compare the gauge under test with above mentioned standard Pressure Gauges and shall be designed for use with a light hydraulic mineral oil for pressure up to 1200 Kg/cm² with accuracy of 0.015% of reading.

9. Fluidized Temperature Bath (Microprocessor Based)

Range	: 50°C to 650°C
Accuracy	: +/- 0.1°C
Stability	: + 0.05°C to + 0.07°C
Power Supply	: 230/240 V AC, 50 Hz
Features	: Temperature of furnace is set and controlled by self tuned PID controller with automatic super fine adjustment
Accessories	: Set of test cables Insertion tubes Carrying case Instructions for use
Computer Interface	: RS 232
Standards	: Designed as per latest IEC safety standards

9.1 Portable Dry Block type Temperature Calibrators

Portable Dry Block type temperature calibrator with microprocessor based controller heater shall be supplied for field calibration of temperature instrumentation viz. T/C, RTD, switches, gauges, indicator, recorder, surface sensors, IR thermometers etc. Calibrator shall be supplied in three ranges as follow (One no. for each range):-

Low Temp Portable Dry block type Calibrator :

Instrument shall meet the following requirements as a minimum.

Range	:	-55°C from ambient temperature to 140°C
Type	:	Removable Insert type.
Stability	:	± 0.03°C
Uniformity	:	± 0.02°C
Measuring volume	:	Sufficient to allow calibration of sensors With thermowells and to avoid stem conduction error.
Serial Interface	:	RS232 with necessary software.
Accessory	:	Standard RTD traceable to International Standard.

Medium temp Portable Dry block type Calibrator :

Instrument shall meet the following requirements as a minimum.

Type	:	Removable Insert type
Range	:	35°C to 650°C
Stability	:	± 0.03°C
Radial homogeneity	:	± 0.081°C
Measuring holes	:	Bore size ranging from 5 mm to 15 mm
Accessories	:	Standard Thermocouple traceable to International Standard.
Calibration volume	:	Sufficient to accommodate above bore sizes in single insert

High temp Portable Dry block type Calibrator :

Instrument shall meet the following requirements as a minimum.

Type	:	Removable Insert type
Range	:	150°C to 1200°C
Stability	:	± 0.2°C
Radial homogeneity	:	± 0.2°C
Measuring holes	:	Bore size ranging from 5 mm to 15 mm
Accessories	:	Standard Thermocouple traceable to International Standard.
Calibration volume	:	Sufficient to accommodate above bore sizes in single insert

10. Precision RCL Bridge/Analyser

The unit should be a Precision analyzer suited for accurate testing of any passive component or for various other applications to a high resolution and accuracy.

FEATURES:-

- 0.02% basic measurement accuracy
- High measurement accuracy on dissipation factor
- Characterize to 3 MHz
- Fast automatic testing
- Fast measurement speed
- Large LCD display and intuitive user interface
- Comprehensive measurement functions, Graphical sweep on all measurement functions

Measured parameters :

- DC Resistance (R_{dc})
- AC Resistance (R_{ac})
- Impedance (Z)
- Phase Angle (∅)
- Inductance (L)
- Capacitance (C)
- Quality Factor (Q)
- Dissipation Factor (D)
- Admittance (Y)
- Conductance (G)
- Reactance (X)
- Susceptance (B)

Series or Parallel Equivalent Circuit

Series equivalent circuit only

Parallel equivalent circuit only

Polar Form

Graphical sweep should be available for all measurement functions up to 3 MHz and should be selectable – linear or logarithmic

The unit should be able to characterize / analyse and create a graph of the parameter value against frequency or AC drive level.

Marker facility should be there on graph which can be positioned at any point on the graph using the navigation keys. The MAX (maximum) and MIN (minimum) keys should be able to position the marker at the peak or trough of the graph.

Unit should be user friendly allowing the user to toggle between major and minor terms.

Frequency range: 20 Hz to 3 MHz > 1800 steps, Accuracy of set frequency $\pm 0.005\%$

DC bias voltage (internal) : 2 V with rapid charge capacitor bias

Basic measurement accuracies: R $\pm 0.02\%$, Rdc $\pm 0.1\%$, L/C $\pm 0.05\%$, Q $\pm 0.05\%$ (Q + 1/Q), D $\pm 0.0002(1+ D2)$

Mains operation: 230 V AC $\pm 10\%$, 150VA max., 50 Hz

Display: High contrast monochrome LCD, 320 x 240, backlit, viewable area 115 x 86 mm with a viewing angle of 45°

Interfaces: The unit should have a printer connectivity port so as to send a single parameter, table of results or a logarithmic graph to the printer – Centronics / Parallel printer port (if connected). GPIB interface port should be also available.

Protection: The unit should have the necessary protection features built-in specially against charged capacitors from up to 25 Joules of charged energy.

Accessories: Manual, conformity certificate, Kelvin Lead (large jaw), 4 terminal lead set, BNC-4 Terminal Component Fixture,

11. In Circuit Tester

This shall be provided for functional testing & various types of ICS used in different electronic modules. It shall also be possible to functionally test various industry standard ICs. Proven test methods, like signature I V-I trace methods shall be used. Suitable PC (as per latest trends) with SVGA colour monitor 19" LED monitor shall be provided along with the necessary software for achieving the same. The testing shall be possible both in In circuit and Out circuit modes. The system shall be complete including all necessary hardware, Software, Cabling, Power packs etc.

12. Function Generator

Operational Mode : Continuous, Triggered, Gated, Burst mode

Frequency range : 0.002 Hz – 80 M Hz

Waveforms : Sine, Triangle, square, Negative square.

Amplitude : 100 mV to 20 V p-p (into open circuit)
50 mV to 10 V p-p (into 50 ohms)

Frequency accuracy : $\pm 1\%$

Sine wave distortion : less than 0.5%

Frequency stability : $\leq 0.05\%$ for 10 min.
 $\leq 0.1\%$ for 1 hr.
 $\leq 0.5\%$ for 24 hrs.

Power : 110V AC / /230V AC / 24V DC

13. Digital Oscilloscope

Dual beam storage type oscilloscopes with color LCD display shall be supplied for the instrument shop. It shall incorporate latest state of art in design. Low watt dissipation and light weight shall be preferred. Simple direct reading controls arranged functionally shall be there in the front of the cabinet. Positive and negative triggering circuit selection shall be done easily by a selector switch. Auto range, auto set menu, automatic wave form measurement, shall be inbuilt features. Intensity/brightness shall be controlled from the front. Oscilloscope shall have a bandwidth from DC to 200 MHz (minimum). The oscilloscope shall have a minimum sensitivity of 2 mV/div.

Time Base

Sweep rate : 5 nano seconds/div.
 Raise time : 3.5 nano seconds
 Accuracy : $\pm 5\%$ or better
 Power supply : /230V, 1 μ H, 50 Hz

Horizontal Amplifier

Input impedance : 1 M ohms (min.)
 Band width : DC to 200 MHz
 Operating Station : 8 x 10 cm, P31 phosphor operating station with 0.45 cm/division
 Display modes : Coloured display with Nonstore, bistable, variable persistence, fast bistable, Fast variable persistence
 Calibration : Rectangular wave for calibration and probe adjustment
 Accessories : a. One trolley with one lower rack is envisaged for Carrying the OPERATING STATION from one point to other.
 b. High voltage grade, probe with suitable screening etc.
 Software & hardware for interfacing.

14. Tachometer

Digital Tachometer with contact and optical measurement facility in single instrument shall be supplied. Tachometer shall have measurement unit selection facility for rotational and linear velocity measurement and the same shall also be displayed. This instrument shall be offered with contact and non-contact pickup tips.

Following requirements as a minimum shall be fulfilled:

- a) Range:
 - i) Optical mode : 10 to 99,999 rpm
 - ii) Contact mode : 10 to 20,000 rpm
 - iii) Linear mode : 1 cm/sec. to 1000 m/min.
- b) Accuracy : $\pm 0.01\%$ of indicated reading for optical mode & $\pm 0.05\%$ of indicated reading for contact & linear mode
- c) Display : 5 digit LCD for measurement+ Measuring unit
- d) Sampling rate : 0.5-0.8/1.0 second (over 60 RPM)
- e) Operational Mode : Sample
 - Hold
 - Lock
- f) Operating temp. : 0-50°C range
- g) Power supply : Built-in Rechargeable battery
- Accessories : Carrying case
One set of spare battery with Chargers Tripod & adopter
: Contact adapter, surface-speed wheel, convex and concave tips, reflective tapes, battery carrying case, etc.

15. Soldering iron

Use & performance : Electronic soldering iron specially engineered for long Lasting heavy duty and production line use fast heat up and quick recovery timing efficient heat transfer assure steady tip temperature and superior performance. All micro-electronics soldering application. Low current leakage and infinite heat insulation of element eliminates risk and damage to transistor integrated circuit and other electronic components and assure the safety of the operator.

Wattage & Qty. : 10 Watts - 1
25 Watts - 1
40 Watts - 1

Supply voltage : 230V, 50 Hz

Accessory : Soldering iron stand

16. Solder Sucker

Solder sucker shall be provided for removal of molten solder from terminal connections.

17. Soldering Desoldering station

The soldering! Desoldering station shall have the following features:

Two adjustable temperature controllers with maximum setting of 430 deg C (for soldering purpose) and maximum setting of 385 deg C (for desoldering cum sucking purpose)

Digital displays for the temperature settings and actual temperatures (A common display unit with provision for selection of settings or actual temperature may be provided.)

Vacuum pump with analog gauge meter having range of -1 bar to 0 bar.

All required accessories like soldering! Desoldering attachments. Soldering bits of various sizes, magnifying glass etc. shall be provided.

18. Potentiometer/Rheostat

Wire wound continuously variable rheostat/potentiometer shall be provided. Sliding part & brush shall be rated to withstand the current flowing. Insulation resistance shall be more than 5 M ohms at 500 V DC between the terminal and case.

Quantity	:	2A : 2 Nos. (5000 Ω)
		5A : 2 No. (47 Ω)
		2A : 2 No.. (470Ω)
		10A: 2 No. (470Ω)
		2A : 2 No. (2200Ω)

19. Blank

20. Mercury Thermometers

Applicable Standard : National Bureau of Standards & ASTM PTC 19.3-1961

Type

- Bulb/Stem	:	Mercury in Glass
- Scale	:	Mercury in glass Red reading mercury tubing with figures and graduations clear bold and precisely placed

Material

- Bulb/Stem	:	316 SS
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- Scale	: Hardened Borosilicate glass
Range	: -30 to \pm 20 deg.C 0 to 50 deg.C 50 to 100 deg.C 100 to 150 deg.C 150 to 200 deg.C 200 to 250 deg.C 250 to 300 deg.C 300 to 350 deg.C 350 to 400 deg.C 400 to 450 deg.C 450 to 500 deg.C 500 to 550 deg.C 550 to 600 deg.C
Accuracy	: \pm 0.5 of graduation
Graduation	: 0.1 deg c for lower range & 1 deg C. for range > 200deg c.
Connection	: M 20 x 1.5
Application	: For field testing of performance of local Instruments.

21. Flow meter Calibrator

Accuracy	: \pm 2%
Range	: a. 0 – 1000 mmwcl b. 0 – 6000 mmwcl c. 0 – 30000 mmwcl
Display	: 3 digit LCD

22. Stop Watch

Type	: Handheld, non- magnetic bevelled movement With two hands
Resolution	: 1/5 seconds
Range	: 30 minutes

23. Digital Thermograph/Hygrometer

A microprocessor driven thermograph/hygrometer with inbuilt sensor powered by rechargeable batteries shall be provided. Suitable charger (inbuilt / stand alone type) shall also be provided. This shall be able to display temperature and RH simultaneously, Maximum/Minimum memory for RH & temp. and Temperature Compensated RH measurement.

The Digital Thermograph/hygrometer shall meet as a minimum the following requirements:

Range	:	-20°C to + 50°C
	:	2% RH to 98% RH
Temperature Sensor	:	Thermistor
Humidity Sensor	:	Resistive Polymer
Resolution	:	0.1°C, 1% RH
Accuracy	:	Temp. $\pm 1^\circ\text{C}$ Humidity $\pm 5\%$

24. Portable Flue gas Analyser

Parameter	Sensor Type	Range	Resolution	Accuracy	Sensors supply
Temp. °C	K-Type T/c	-40 to +1200 °C	0.1	$\pm 0.5\%$ mv	Built in with standard probe
O ₂	Electrochemical	0- 25%	0.01%	$\pm 0.8\%$ of Full scale or better	Built in with Analyzer
CO	Electrochemical	0- 10000 ppm	1 ppm	$\pm 1-2\%$ of Full scale or better	Built in with Analyzer
CO ₂	Calculated	0 -20%	0.01%	Calculated from O ₂	Built in with Analyzer
NO	Electrochemical	0 - 4000 ppm	1 ppm	$\pm 1-2\%$ of Full scale or better	Built in with Analyzer
SO ₂	Electrochemical	0- 5000 ppm	1 ppm	$\pm 1-2\%$ of Full scale or better	Built in with Analyzer
Draught Measurement		-40 to +40hPa	0.01hPa	$\pm 0.03\text{hPa}$ (-2.99 to +2.99hPa) $\pm 1.5\%$ MV	Built in with Analyzer
Differential Pressure Measurement		-200 to +200hPa	0.1hPa	$\pm 0.5\text{hPa}$ (-49.9to +49.9hPa) $\pm 1.5\%$ of MV	Built in with Analyzer
Efficiency		0 to 120 %	0.1 %		Built in with Analyzer
Flue gas loss		0 to 99.9 %	0.1 %		Built in with Analyzer

- The system shall be provided with auto controlled pump able to collect sample from -200mbar to +50mbar. 3.5" Large high contrast and lighted graphical display and the display unit shall integrated within the analyzer.
- Memory of the analyzer shall be of 1,00,000 readings or more & Automatic recording in selected time interval function require without PC connection for 1-2 hours interval.
- The instrument shall calculate Efficiency, flue Gas Loss & Excess Air.
- Shall be operated with Built in rechargeable battery or Main.
- All gas readings shall be simultaneously displaced.

- Supply Probe length shall be minimum 2000 mm long & it shall be able work up to 1000 °C temp. 1000mm long in two parts and 3 filter in flue gas path for one filters in probe inlet. Probe must be OEM make only.
- Supplier must supply additional filter as a spare mainly two high temp. top filter which can work at least 1000 °C temp.
- The system analyzer shall have an integrated moisture removal system to ensure that gas is
- Automatic fresh air rinsing / zeroing system shall be available.
- Analyzer shall be able to measure Ambient & Flue Gas Temperature.
- Instrument must be capable to store data automatically on site in specific time interval without contacting pc or laptop.
- The gas readings can be displayed as ppm or mg/m³ or %.
- Evaluation software compatible with Window 2000 / XP/Vista./window7/window 8 with all features like excel, pdf & graphical analysis shall be provided.
- Accuracy for O₂, CO shall be EN50379 , Part 2 compliant
- Measurement of CO at high concentration (up to 50000 ppm) shall be possible with automatic range extension with fresh air.
- Advanced instrument diagnosis function for gas path check, sensor check and error diagnosis.
- Easy replacement of cells/sensors without tools, within seconds.
- Auto Range extension of all Sensors, at least 5 times
- Supplier show all features on site before processing PO if user require
- Supplier must give performance certificate from any reputed PSU at last 1 year old for quoted Model
- Supplier must have calibration & service center in India

25. Aneroid Barometer

Range	:	660 to 800 mmHg
Accuracy	:	0.33% of full scale
Sensitivity	:	0.2% of full scale
Scale length	:	16" through 1 pointer revolution
Dial diameter	:	4"/6"
Dial calibration	:	Standard are mm Hg or inches Hg calibration in other units and Two sets of graduations on a single dial are extra cost options.
Min. graduation	:	0.5 mm or 0.02"

26. Miscellaneous Items

Bidder shall include the items given below as miscellaneous to be supplied for instruments shop. Minimum requirements are stipulated here under the following table :-

Sl. No.	Description	Size/Range	Qty.
1.	Tool maker clamp jaw	50 mm wide	1
		100 mm wide	1
2.	Hand operated wire wrap tool	-	1
3.	Trimmer & Alignment Tool Kit	-	1
4.	Magnetic screw driver	-	2
5.	SS & copper tube cutter/blender	-	2
6.	Standard tool box (refer detail below)	-	6
7.	Coil winding machine single phase motor driven to wind wires of dia 0.001" to 0.036".	-	1
8.	Electrically operated wire wrap	0.2 mm to 1 mm	1
9.	Panel wiring tool Kit (refer detail below)	-	5

Each Standard tool box must include

- 1 no. mallet,
- 1 no. hammer of each type,
- 1 no. adjustable spanner,
- 1 no. each file like flat, semi-circle, round type,
- 2 no. Teflon tape,
- 2 no. insulation tape,
- 2 no. Allen key (mm and inches),
- 2 no. soldering lead.
- 1 no. Vernier caliper (digital indicator),
- 1 no. screw gauge, 25mm 1 no. spirit level

Each Panel wiring tool kit must include

- 1 no. Combination pliers (straight),
- 1 no. Crimping tool (up to 6 sq. mm),
- 1 no. Stripping tool (up to 10 sq. mm),
- 1 no. Stripping tool (up to 40 sq. mm),
- 1 no. insulation removal tool,
- 1 no. Cutting tool (up to 50 sq. mm),
- 1 no. Flat bladed screw driver uninsulated,
- 1 no. Flat bladed screw driver insulated,
- 1 no. Star type screwdriver,
- 1 no. Torque screw driver,
- 1 no. Universal control cabinet key,
- 1 no. Electrician plier (AC/DC),
- 1 no. Tool kit bag,

Note: 1 no. each Mandatory spares for crimping and stripping tools in addition to standard items to be provided as above.

27. mV Calibrator

This instrument shall provide an accurate and reliable measure of millivolt thermocouple signals and shall generate millivolt signals for calibration of receiver type instrumentation. The instrument will contain built in electronic null detector and standard cell. Manual/automatic reference junction compensation shall be provided for thermocouple measurements. The instruments shall meet or exceed the following requirements:

Input range – selectable	:	0 – 1000 mV DC 0 – 2000 mV DC
Output range – selectable	:	0 – 1000 mV DC 0 – 2000 mV DC
Protection	:	0 – 2000 mV DC
Accuracy	:	0.02% for 100% range
Ambient temperature	:	-20– 60°C
Temperature effect	:	≤ ± 0.005 %/°C of Full Scale

28. mA Calibrator

This instrument shall provide an accurate and reliable measure of milliamp signals for use in calibrating receiver type instrumentation. The instrument shall be power by a self-contained rechargeable battery pack and shall include a battery charging circuit which operates automatically when the instrument is connected to a 240/230V AC supply. The instrument shall be designed to operate from a 240/230V AC, 50 Hz supply with the battery pack removed. The instrument shall meet or exceed the following requirements

Input range – selectable	:	0 – 24 mA 0 – 52 mA
Output Range – selectable	:	0 – 24 mA 0 – 52 mA
Protection	:	100% range
Accuracy	:	0.02% of selected span
Ambient temperature	:	-20 – 60°C
Ambient temp. error	:	≤ ± 0.005 %/°C of Full Scale

29. Thermocouple Calibrator

Thermocouple calibrator shall be capable to accept all types of thermocouples (type J,K,T,E,R&S). Calibrator shall be digital LCD display and shall operate from built in battery source. This shall be capable of both measurement and calibration mode of operation. Cold junction compensation shall be built in

Accuracy	:	Measure: 0.5deg C for K Type T/C Between (-)150 to 750 deg C; 1.0deg C for R/S Type T/C between 400 to 1750 deg C; 0.4deg C for T Type T/C between 0 to 400 deg C;
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Simulation	:	0.4deg C for K Type T/C between 190 to 1250 deg C; 0.4deg C for R/S Type T/C between (-)50 to 800 deg C; 0.5deg C for T Type T/C between 150 to 400 deg C;
Ambient temperature	:	50°C (max.)
Temperature effect	:	0.01% per degree C or better
Power supply	:	240/230V AC 50Hz with built in Rechargeable battery for field operation
Voltage protection	:	Equipment shall be protected against external voltage upto \pm 110V DC
Accessories	:	<ul style="list-style-type: none"> i. Carrying case ii. Connector leads iii. Extension cable iv. calibration certificate v. Battery with charger vi. Instruction manual

30. RTD Calibrator

RTD calibrator shall be capable to accept 2, 3 & 4 wire platinum resistance thermometers of 100 ohms and copper resistance thermometer of 53 ohms. Calibrator shall be digital LCD display and shall operate from built in battery source. This shall be capable of both measurement and calibration mode of operation.

Accuracy	:	\pm 0.1% of full scale \pm 0.05°C or better
Ambient temperature	:	50°C (max.)
Temperature effect	:	0.01% per degree C or better
Power supply	:	240/230 V AC 50Hz with built in chargeable battery for field Operation
Voltage protection	:	Equipment shall be protected against external voltage upto \pm 110V DC
Accessories	:	<ul style="list-style-type: none"> i. Carrying case ii. Connector leads iii. Extension cable iv. calibration certificate v. Battery vi. Instruction manual

31. Pressure & Diff. Pressure Calibrator

Type	:	Precision Electronic with digital display
Range	:	i. 0-500 mmwcl ii. 0-2500 mmwcl iii. 0-1.6 kg/cm ² g iv. 1.6-10 kg/cm ² g v. 0 – 200 Kg/cm ² g vi. 0 – 400 Kg/cm ² g
Accuracy	:	±0.05 % of Reading
Resolution	:	1 mm
Over range protection	:	20 percent of span
Pressure sensing	:	Capacitive transducer element
Display		
- Type	:	LCD
- Digit	:	5
Function	:	Display for actual value and percentage error.
Other functions	:	1. 24V DC supply for two wire transmitter 2. Contact monitoring for switch devices 3. Capability to read negative pressures upto (-) 0.8 kg/cm ²
Power supply	:	240/230 V AC, 50 Hz with rechargeable Ni-cd batteries
Operating temp.	:	60 deg.C
Pressure connection	:	1/8 and 1/4 inch BSP and NPT
Accessories	:	1. Calibration pressure pump 2. Current output modules 3. Instruction Manuals 4. Carrying case
Application	:	Calibration of pressure/diff.pr. transmitters, pressure switches and converters etc.

32. Vacuum Calibrator

Range	:	- 12 to 0 psi
Accuracy	:	± 0.025% FS
Display	:	LCD Seven Segment
mA Input	:	4-20 mA
Power supply	:	9V Alkaline Battery
Accessories	:	Charger/Adapter Calibration Vacuum Pump Test Leads Carrying Case Manual

33. Multi Function Calibrator

The portable unit is intent to measure electronic transmitters, RTD's, Thermocouples and act as a source for calibration of secondary instruments and system inputs. The instrument shall be digital LCD display and shall display simultaneously both input measured value and output signal. Multi meter shall be small stream lined shape, MAKES IT EASY TO CARRY. It shall be rugged, reliable design stand up to field use. It will be easy to read measure/source screen and view input and output simultaneously.

Data entry shall be through numeric entry function keys. Instrument shall have built in diagnostic and shall also be capable of measuring voltage, current, thermocouples, RTD's & frequency and stimulation of corresponding primaries including two wire transmitters.

Accuracy	: $\pm 0.02\%$ typical
Thermocouple	: Type J,K,T,E,R&S
RTD	: Pt-100 Ohms
Volts	: 0-10V, Resolution 0.2 mV
Millivolts	: -10-120 mV, Resolution 2 Microvolts
Current	: -5-60m Amp Resolution 1 micro amp.
Ohms	: 0-4000 Ohms
Frequency	: 20KHZ
Power supply	: 240/230 V, AC 50 Hz
Common Mode	: 80 db at 60 Hz or better rejection
Normal mode rejection	: 40 db at 60 Hz or better
Ambient temperature	: 50 deg.C
Input protection	: Upto 140V DC
Input/output isolation	: 60V DC, 50 M Ohm

Calibrator shall be furnished with RTD simulation facility, external charged battery pack, test leads, set of fuses, instruction manual. In addition one set of spare battery pack as well as charger for spare battery pack shall be supplied with each instrument. Unit should also perform calibration automatically on HART protocol transmitters.

34. Pressure & Vacuum Air Pump

Type	: Double stage, combination pressure and Vacuum Pump
Range – Pressure	: Upto 25 kg/cm ² for intermittent duty Upto 10 kg/cm ² for continuous duty
- Vacuum	: Upto 760 mm of mercury
Capacity	: 0.03 mm ³ per minute at 1 kg/cm ²
Drive	: Fan cooled motor suitable for 415V, 50 Hz, 3 phase AC power supply with cable and starter
Accessories	: i) Bleeder valves in inlet outlet lines For Desired vacuum or pressure setting

- ii) 50 mm dial pressure gauge of range 0-25 kg/cm²
- iii) 50 mm dial vacuum gauge of range 0-760 mm of mercury
- iv) Lubricator exhaust trap
- v) Hose nipples
- vi) Intake filters
- vii) Other necessary accessories

Application : Calibration of draft gauges, vacuum gauges / Transmitters and compound gauges

Other Particulars : Pump seals shall be self adjusting type Without Packing

35. Digital Insulation Tester

Measurement - up to 100 Mega ohm at 500 V
Accuracy - 0.5% of reading over the range

36. Sound Level Monitor

Sound level range : 50-100 dB, 80 to 130 dB
Resolution : 0.01 inches/sec.
Frequency Range : 20 Hz – 8 KHz
Vibration Meter Range: 0.05 to 3.93 inches/sec. At 10 – 1000 Hz

Display : LCD Digital Type
Accessories : Rechargeable Batteries, Software, interfacing cables & Ports

37. Air Set

Filter element : 5 micron sintered bronze filter element

Max. primary press. : 28 kg/cm²
Secondary pressure : 0-2.1 kg/cm²
Connection : ¼" NPT (F)
Accessory : O/P Gauge

38. Portable Electro-Pneumatic Calibrator

Range : 0-10 bar.
0 - 700 bar

The electro-pneumatic calibrator shall provide an accurate and convenient means for calibration of electronic and pneumatic instrumentation as supplied by the bidder. The calibrator shall have the following features as a minimum:

- Measurement & indication of pressure signal with accuracy of 0.025%
- Generation of regulated pressure signal by using external air supply. In the absence of external air supply, the same shall be

generated by an internal built-in pressure and vacuum generator for low pressures. Suitable pressure generating unit (external) shall be provided for higher pressures.

- Measurement, generation and indication of current and voltage (mV, V and mA) signals.
- Digital read-out of electrical as well as pressure signals.
- Selection facility for reading pressure in five engineering units.
- Generation of DC supply voltage to electronic transmitters.
- Over pressure protection

The instrument shall have re-chargeable battery as power back-up and shall be complete with all accessories viz. Battery Charger etc

39. **Portable Analogue & Digital Vibration Meter**

This instrument shall measure vibration of machinery in terms of displacement, velocity and acceleration. Power supply shall be by self contained replaceable & rechargeable batteries.

Displacement – 20 microns, 200 microns, 2,000 microns pk-pk

Velocity – 20 mm/sec, 200 mm/sec, 2,000 mm/sec pk or RMS on demand

Acceleration range : 0 to 100 g's. (in eight full range from 0-0.03 g to 0-100 g).

The instrument shall be furnished complete with vibration pick-up, straight probe, chargers, battery Carrying case and one meter cord for connecting pick-up to meter. Vibration Meter shall be of digital & Analogue type separately.

Note: Analogue meter is used to find out any vibration due to electrical problem in the motor by measuring the transient vibration.

40. **PORTABLE VIBRATION/ SHOCK PULSE ANALYSER cum Data Collector cum Balancer**

Type : Portable type dual channel.

Frequency Range : DC and 1 Hz to 50 KHz.

Voltage Input : 30 V DC (Aux. 2 I/P)

5 V DC (Aux. 1 I/P)

Power : 240 V AC and 6 volt, 2.4 A hr rechargeable battery

Min. operating time - 6.5 hrs.

Environment : Operating temp. Range -18°C to 60°C

Relative Humidity : 0-95% non-condensing

Splash: Resistant, sealed case

Output : USB Port

Accessories : Accelerometer - 2 pcs. Magnet for accelerometer - 2 pcs. Cables for accelerometer - 4 pcs.

Tacho probe , Cable for tacho - 2 pcs. Holder for tacho, Charger Interface cable, USB to Ethernet adapter, Protective case Flash card with software, Manual Carrying case, software for vibration analyzer

Application : Analyzing bearing condition, measuring machine vibration & checking of rotational speed.

Type of Measurement : Acceleration, Velocity, Displacement, Phase, FFT, CPB, HFD spectrum, Temperature, Thrust, Axial position etc. with auto ranging in RMS, peak to peak, bearing fault analysis feature, balancing kit for in situ dynamic balancing and required software for 1 plane, 2 plane balancing, route generation and maintenance facility with off route data collection and analysis.

Averaging Type : Linear, Exponential, Peak Hold

Memory : Internal & Flash Memory (Minimum 512 MB).

- The Analyser shall be able to perform easy condition monitoring of equipment with high resolution of 50,800 lines, high accuracy of 0.01% of measured value & high speed of processing of 16bit (96db) dynamic range using the latest technology.
- The Analyser shall be provided with data collector as an integral part of the instrument, which is capable of collecting various user defined data.
- The Analyser cum data collector shall also be provided with Predictive maintenance software which shall store and manipulate data. Also user defined upload communication and down loading data to condition monitoring software shall also be provided.

Frequency ranges shall cover all machinery speed and high frequency multiples 1 Hz to 50KHZ.

41. Decade Resistance Box

This should be three no. analog type decade box with resistance range of 1 ohm to 1.2M ohm, $\pm 1\%$ accuracy, all resistors rated to 0.75W, and shall use stable metal film resistors with complete electrostatic screening. This shall be supplied with certificate traceable to National /International Standards.

This shall be two nos. digital type decade resistance box with resistance range of 1 ohm to 1.2M ohm, $\pm 0.05\%$ accuracy.

One no. digital type variable resistance device shall provide an accurate resistance source for calibration of RTD elements and

receiver devices. The range shall be 0-100 ohm with increments of 0.001 ohm. Accuracy shall be +/-0.05% or better.

42. LAN/ Coaxial Cable Meter/ Tester

This portable unit is used to check the quality of cable and test and troubleshoot coaxial and twisted pair cable in Local Area Network (LAN) installations. It shall be powered by standard AA alkaline battery allowing minimum 8 hour of operation. The cable meter shall meet the following requirement as minimum.

- | | | | |
|-----|---|---|---|
| (a) | Display | : | Backlit LCD Display for observing result in sheet dark environment and emit audible tone to assist in pass/fail indication. |
| (b) | Test Standard | : | IEEE-802 & EIA/TIA 568 |
| (c) | Range | : | For unshielded twisted pair (UTP) - 6 to 600 m
For shielded twisted pair (STP) - 6 to 600 m
For Coaxial cable - 6 to 1200 m |
| (d) | Accuracy | : | 6 m to 60 m - ± 0.6 m
60 m to 1200 mm - $\pm 1\%$ |
| (e) | Resolution | : | 1 m |
| (f) | Storage | : | allows storage of 400 complete test results for printing |
| (g) | Near end cross talk (Next TP only) | : | 0 to 50 db |
| (h) | Characteristics impedance range with accuracy of ± 10 W | : | TP Cable 75 W - 180 W
Coaxial - 40 W - 120 W |
| (i) | Accessories | : | Carry case, printer cable, battery & instruction manual. |

43. Portable Ultrasonic Flow meter

This ultrasonic flow meter is used for non-intrusive flow measurement, indication, totalizing and transmitting of the flow in a full pipe. It should be a Top of the line "Full Function" 32 character dual line Alphanumeric LCD SMART display. On screen "Easy Prompting and Key Pad entry makes all programming "Effortless." Built in Microcomputer gives instantaneous readouts in velocity, rate, and totalization in virtually all engineering units.

- | | | |
|--------------|---|---|
| Sensors | : | Dual transmitting / Receiving clamp-on, for pipes of size 50 mm to 1000 mm and other pipe size as available in subject plant. |
| Power | : | Built-in rechargeable battery and external charger |
| Data Storage | : | Internal data logger (which can |

STATIONS		be downloaded to a WORK later.
Measuring Range	:	0 to + 0.3 to + 32 m/s
Accuracy	:	± 1.0% of rate
Linearity	:	+/- 0.5%
Repeatability	:	+/- 0.1%
Response	:	1 second
Temperature	:	- 50 deg.C to 250 deg.C
Communication	:	RS323C Interface
Display	:	Graphic LCD, Flow in m ³ /Hr. Velocity in m/sec.
Totaliser	:	12 digit LCD
Analog input	:	4-20 mA
Analog output	:	4-20 mA, RS 232, Digital Pulse.
Battery	:	Usable continuously for 5 hours (min.)
Printer	:	Fixed – internal automatic printout of Measured data
Accessories	:	Carrying case, power Adapter, converter, paper roll, SS Fastening belt, Propagation medium gel, High Temperature heat sinks.

44. EARTH RESISTANCE TESTER

- i. It shall be able to measure earth resistance of various earth installations and the resistance of low resistance conductor.
- ii. Suitable to test earth resistivity and earth voltage.
- iii. LCD Digital Display
- iv. It shall be able to operate with the minimum influence from earth voltage.
- v. Low power consumption and powered by batteries.
- vi. Low batteries indication.
- vii. If the testing current has no return loop or the resistance value of auxiliary resistance exceeds the upper limitation, a display indication shall be available
- viii. Dust-proof and damp-proof construction suited for outdoor use.
- ix. The unit shall be supplied complete with test leads (red, yellow, green, black - each 1.5m), Two bars, Test wires (20m & 40m), Instruction Manual, Carry-case, Screw driver and other accessories as required.
- x. Earth Resistance Test
 - a. Measuring Ranges : 20.0 to 199.9Ω and 200~1999Ω

- | | | | |
|-----|---------------------------|---|--|
| | b. Accuracy | : | Base Error \pm (5% of reading \pm) |
| | | | 2d) Error from earth voltage \pm 2% ACV 50Hz \leq 5V |
| xi. | Earth Voltage Measurement | | |
| | a. Measuring Ranges | : | 0.00 to 19.99V |
| | b. Accuracy | : | \pm (5% of reading +2d) |
| | c. Insulation Resistance: | | \geq 20M ohm(500V) |
| | d. Withstand Voltage | : | AC 1.5kV 50Hz 1min |
| | e. Power Supply | : | 1.5V (R6 or AA) batteries/
rechargeable batteries. |

45. PORTABLE INFRARED RADIATION THERMOGRAPH

Portable infrared thermometer shall be provided for detecting infrared radiated by all bodies above 0°C. The item shall be powered by 9V Rechargeable battery and emissivity control and display hold shall also be provided.

Temperature Range : 0-1200 ° C (with 3 split ranges)
 Detector Type : 640 x 480 pixels focal plane array
 (Uncooled microbolometer) Upgradable to
 1280 x 960 pixels thermal resolution

IFOV or Spatial Resolution

Standard Lens : 1.2 mrad or lesser

Telephoto Lens : 0.45 mrad or lesser

Lens Standard / Normal Lens: 40° or more

Telephoto Lens : 15° or less.

Sensitivity : 0.04 °C or less at 30 °C

Focus Auto and manual both required.

Image Refresh Rate 9 Hz minimum

Voice / Text annotation 60 seconds per image voice recording or provision to attach pre-defined text

Digital Camera Minimum 3.1MP

Spectral Range 7.5 μ m to 14 μ m

Power Source : 9V Rechargeable Battery

Accessories : Hard Carrying Case

Instruction Manual

Lens Cap

Data Log facility, 2 GB memory card, batteries, battery chargers safety wrist straps, output interfacing cable etc.

46 Thermocouple Test Furnace

Purpose: For testing & calibrating temp. sensors in particular thermocouples and resistance thermometers by comparative measurement. Holes drilled in the insertion section accept the test probe (min. 6 nos) and the reference sensors. The controller should be highly advanced with digital filter circuit ensuring high integrity of measurement correcting for drift, rejecting 50Hz pick-up and filtering out other sources of input noise.

Insertion length	:	Upto 160 mm in a zone of constant temp.
Inser. pieces material	:	Heat resistant steel for temp. upto 1000°C (temp. difference inside the insertion piece 0.4 K)
Technical Data		
a. Connection voltage	:	240/230 V, 50 Hz
b. Power connection	:	3 KW (approx.)
c. Maximum temp.	:	1100°C x 1200°C
d. Temp. constancy	:	Approx. ± 0.1 K over an hour Approx. ± 1 K over one day
e. Accuracy	:	± 0.35 deg C at 1000 deg C

1. STANDARD 'S' TYPE THERMOCOUPLE

T/C Type	-	S (Platinum Vs Platinum 10% Rhodium)
Uncertainty	-	0 to 1100degC – 0.9degC 1100degC to 1300deg C – 2.2degC
Hot sheath temperature Range	-	0degC to 1500degC
Hot Junction measuring assembly	-	6mm dia x 450mm long gas tight 99.7% recrystallized alumina sheath
Copper Extension wire	-	2000mm thermoelectrically free multistrand (Teflon coated)
Immersion	-	100mm min
Response time	-	5 minutes min
Calibration Certificate	-	5 point calibration from accredited lab with National/International. traceability
Carrying case	-	To be supplied

2. ICE POINT REFERENCE SYSTEM FOR THERMOCOUPLES

The Temperature Reference Unit should provide a stable and accurate 0°C suitable for referencing of upto 20 thermocouples.

This system should be compact in design.

It should be a self-contained solid state unit utilising peltier technology which provides maintenance free operation and features rapid cool down from high ambient temperatures and becomes stable within 15 minutes from switch on.

Thermocouple Reference Junctions should be located in a reference block and connected to their respective input and output terminals in an isothermal enclosure which has a uniform temperature throughout thereby ensuring no thermoelectric EMFs at the terminals.

Accuracy	:	±0.1°C
Feature	:	Errors introduced by thermocouple loading can be removed by adjusting controller offset
Stability	:	±0.03°C at 20°C ±10°C
Stabilising time	:	15 minutes
Thermocouple Capacity	:	Up to 20
Monitor / Fitted PRT	:	4 wire Connected PT100, 1/3 Din, ±0.1°C Accuracy

47 Portable H2 Gas Analyser (Microprocessor based):

Case Purity	:	0 to 100% H2 in Air.
Purge	:	0 to 100% H2 in CO2 0 to 100% air in CO2
Hydrogen Flow rate	:	100 to 700 CC/min.
Output Signal	:	4-20 m Amp.
Display	:	Digital with Gas Purity in real time.
Power	:	With rechargeable battery
Accessories	:	As required i.e Flow meter, flow control valve , pump with complete software.

48 Fiber Optic Testing Tool Set

- a. Source and Power Meter – Optical Loss Test set (OLTS)
- b. Reference Test Cables
- c. Fiber Tracer and Visual Fault Locator
- d. Optical Time Domain Reflectometer (OTDR)
- e. Cleaning material like Lint free Cleaning wipes.
- f. Optical Fibre Cable Joining Kit.

49. Industrial Grade portable Vacuum Cleaner :

A compact, mains powered industrial grade Wet & Dry type portable vacuum cleaner designed for 240V AC, 50 Hz with all accessories shall be supplied.

Application	:	With blowing and sucking facility for cleaning
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the control panels, C&I Lab instruments, house keeping of C&I Lab etc.

50. Tong Tester

Electronic type tong tester shall be suitable for measuring the current range of 0-5/10-15/30 Amps AC and DC. Auto ranging and 3 ½ LCD facility shall be available. It shall have swiveling joint between tongs and meter to facilitate easy reading.

51 Stroboscope

Power Supply	:	240/230 V AC 50 Hz supply
Display	:	4 ¹ / ₂ Digital LCD
Accuracy	:	±0.1%
Low range	:	100-1000 rpm.
High range	:	100-10000 rpm.
Sampling line	:	1 sec or better
Flash tube	:	Xenon lamp with Flash color white 6500K. with automatic flash control
Accessories	:	Adopter, rechargeable Batteries, Charger, case etc.

52 Test Temperature Detector

TEST RTD

Sensor type	:	Platinum resistance element, Three/Four wire type
Minimum Diameter	-	6 - 7.5 mm
Minimum Length	-	450 mm
Accuracy/Stability	-	0.3 °C
Temperature range	-	-80°C to 400°C
Accessories	-	Connecting cable, carrying case.

53 Auto Transformer

53.1 Single Phase Auto Transformer

Max. input voltage	:	250V, AC 50Hz, Single phase
Max. output voltage	:	0-112%, Single Phase
Rated current	:	20 Amp., Single Phase
Insulation resistance	:	Greater than 5 M ohm at 500 VDC
High voltage test	:	1.5 KV
Feature	:	Voltage scale around the voltage varying knob of auto transformer shall have white lettering and graduation as black back ground.

53.2 Three Phase Auto Transformer

Max. input voltage	:	415V, AC
Max. output voltage	:	470 V AC, Three Phase

Rated current	:	10 Amp., Three Phase
Insulation resistance	:	Greater than 5 M ohm at 500 VDC
High voltage test	:	1.5 KV
Feature	:	Voltage scale around the voltage varying knob of auto transformer shall have white lettering and graduation as black back ground.

54 Radial Drilling Machine:

Drilling capacity	:	up to 25 mm
2 speed Motor	:	1 HP/ lighting of Arm - 0.5 HP, 1400 rpm.
Spindle speeds	:	100 – 2000 rpm

55. Portable Multi-Function Counter

55.1 The bidder shall furnish crystal-controlled oscillator based, dual channel multi-function counter to measure frequency, period, frequency ratio, time interval and unit count. The equipment shall be complete with test leads, spare fuses and all other accessories.

55.2 This instrument shall meet the following requirements as a minimum:

a. Ranges:

i)	Frequency	:	5 Hz to 150 MHz
ii)	Period	:	0.5 m sec. to 200 m sec.
iii)	Count	:	0 to 99,999,999
iv)	Totalizer Function	:	5 Hz to 10 m Hz sine wave

b) Accuracy for frequency/: ± 1 count + time base error period measurement

c) Resolution:

i)	Frequency	:	0.1 Hz at frequency below 10 MHz 0.5 Hz at frequency above 10 MHz
ii)	Period	:	100 p sec. to 100 n sec. in decade steps

d) Line Voltage Stability : $< \pm 1$ ppm with 10% line voltage variation

e) Oscillator Temp. Stability: ± 10 ppm for 0-50°C

f) Display : 8 digit

g) Power Supply : 240 VAC, 50 Hz

56 Electronic Bench vice:

Size : 6" for holding the PCB

57 Fortins Barometer (Mercury)

Range : 660 to 800 mm Hg
 Accuracy : 0.33% of full scale
 Communication : Interface connector RS232 or IEEE 488 or compatible to system.
 Sensitivity : 0.2% of full scale
 Scale length : 16 inches through 1 pointer revolution
 Scale : Vertical
 Calibration : Standard are mm Hg or inches Hg. Calibration in other units and two sets of graduations on a single dial are extra cost options
 Min. Graduation : 0.5mm or 0.02 inch

Fortin Barometer" shall be mercury filled barometer instead of aneroid bellows based sensor barometer

Accessories : All accessories shall be provided as per requirement and shall be decided during detailed engineering

58. Phase Sequence Meter

Electronic type with LCD digital display phase sequence meter shall be provided by bidder.

Nominal Voltage - 40 to 600 V AC
 Frequency Range - 15 to 400 Hz
 Current Pickup - 1 mA
 Accessories - Leads, Test Probes, Clips, User manual, carrying case.

59. Portable pH Calibrator/Simulator

To Check & calibrate the pH analysers/measuring equipments, compact portable pH simulator/calibrator with LCD digital display shall be supplied by bidder.

Range : 0-14 pH in steps of 1 pH
 Accuracy/Resolution : +/- 0.01 pH
 Temp. Coefficient. : 0.001 pH/Deg c
 Power Source : Built in chargeable Nicd battery with battery
 Accessories : Check switch and indicator.
 Connector leads, Carrying case etc.

60. Oil Condition Monitor

Display : LCD Display

Memory Storage	:	Up to 100 per measurements
Output Ports	:	USB port & RS 232
Data Management	:	interfaced with external operating station/Laptop.
Printer	:	In built
Power Supply	:	90 to 230 V AC and rechargeable Battery Operated
Wetted material	:	Aluminium/SS
Accessories	:	All type of leads/cords, printer paper rolls (6 nos), Analysis & diagnostic software, water saturation bottles, sampling system, carrying case.

Operating Parameters:-

Viscosity	:	20 to 780 mm ² /s
Oil Temp.	:	0 to 70 deg C.
Protection Class	:	IP 67 (with cover closed)

Measurement Parameters:-

Automatic Particle Counting	:	8 Channels
Calibration	:	As per international Standard ISO MTD in Oil (ISO 11171)
Accuracy	:	+ 1 (Contamination class)
Water Saturation	:	0 to 100%
Dynamic Viscosity	:	18 to 700 mPas
Relative dielectric Constant	:	1 to 10
Coincidence Limit	:	10000 particle/ml.
Standards	:	As per international Standard

Features :-

- i. Built in diagnostic system for determining the aging condition of oil in hydraulic and lubrication systems by measuring solid contamination, water saturation, temperature, viscosity and relative dielectricity.
- ii. Theoretical water contents in ppm.
- iii. Applicable for on line and offlines pressure lines, suction lines, foamed oils and tanks.
- iv. Enables the owner/end user to make a precise assessment of the condition of a system and perform timely & cost effective maintenance.

61 Logic Probe

Logic probes shall be furnished to test the computer systems. It shall operate in pulse & normal mode. It must be capable of testing all digital logics such as CMOS, TTL; DTL etc. logic probes are envisaged to check the status of the binary logic modules. These shall be LED

with current limiting resistor etc. with each of the logic probe and shall captures 50 ns pulses.

62 Marker Printers:-

For Printing of silicon and halogen free labels of Polyamide, marker printers with high-speed UV hardening technology shall be provided by bidder. The printing method is based on a printhead with a LED UV Unit for hardening the fluid. The Labels printed with UV technology can with stand temperature from - 40°C to 120 °C. The Printers shall be capable of printing various types of printing suitable for Cable marking, terminal marking and equipment marking. The printer should come with software that supports all types of printing used of marking. All software shall be loaded in separate operating station.

Marker Printers with High-speed UV hardening printer shall comply standards like DIN EN ISO 1043-4, DIN EN ISO 4892-2 AND DIN EN ISO 60068, DIN EN ISO 175, DIN 50018, DIN EN ISO 2409, IEC 60947-7-1/2, IEC 60068-2-11/52 and EN 60464-2:-2001 etc.

Accessories:

- i. Terminal marker card for 5mm, 6mm, 8mm & 10 mm Pitch (250 No. Each)
- ii. Wire Marker Card for wire diameter 1.9mm, 2.1mm, 2.9mm 3.1mm, 3.6mm,4.4mm, 4.9mm,5.6 mm 7.5mm and more than 7.5mm. (250 No. each)
- iii. Equipment Marking Card with carrier (200 No.).
- iv. Ink Cartridge for Printing above material (20 Nos.)"

63. All the calibration instruments shall have a common Lab WORK STATIONS and A3/A4 sized colored Laser jet printer cum scanner cum Copier along with complete software for calibration and report generation. Specification for WORK STATIONS and Printer shall be same as specified elsewhere in the specification, Vol. V, Part B, Chapter 3.

This should be universal calibration software complying to ISO17025 standards.

This should be able to communicate with compatible Test bench modules, should allow Automated planning and scheduling, suitable for use with multiple devices and instruments, allow Printing/emailing/storing certificates and reports, allow calibration labels layout design, calibration certificate design, should quickly generate procedures using templates, shall have built-in 1200+ pre-written test procedures included in the software and have feasibility to make more test procedures, should send calibration due reminders, e-mail reminder letters and lists, allow customizing reports and certificates, Create PDF reports and certificates, allow Universal instrument control, create uncertainty tables for laboratory & site uses.

The software shall have uncertainty calculations built-in for various calibration parameters and should also correlate the same with the

1200 test procedures and give pass/fail results for calibration performed.

The software shall also have following features :-

- i. Web-Certs, Online application enabling upload and retrieval of certificates and reports
- ii. Crystal Reports Software, Allows full modification of certificate, label, and report layouts.
- iii. Bar Code Reader

Universal ISO17025 is a standard calibration software, which can communicate to all modules featuring PC interface and be used to calculate uncertainties, print certificates, send reminders for due dates, store all data, and have internal procedures for calibration. This software shall also have data of numerous instruments as built-in which can be recalled and used while printing certificates to provide results in reference to the specifications of unit under calibration. There shall also be a procedure to add more instrument data as and when required. The software shall be closed loop software.

64. D.C. Regulated Power Supply

Bidder shall supply D.C. Regulated Power Supply designed with latest state of the art electronic and IC technology. D.C. Regulated power supply shall have the following features:

01. Voltage Range : 0 to +60V DC, 5 Amps. (Floating)
(Continuously adjustable)
02. Voltage/Current Range meters : 0-60V/0-10 A
03. Display : LCD
04. Meter Accuracy : +/- 2% FSD
05. Power Supply Connection : 240V AC, 50 Hz.
06. Output Impedance : 50 Ohm or less.
07. Load Regulation : 0.1% variation in voltage
0.2% variation in current
08. Drift in 8 Hours : 0.1% variation in voltage
0.2% variation in current
09. Ripple and Noise : Less than 1mV
10. Setting Resolution : 20mV / 20mA
11. Temperature Coefficient : 0.05% per Deg.c
12. Accessories : Test cords and clips are required.
13. Power supply shall be short circuit proof and crowbar protected.

65. Blank.

66. Overhead Interactive White Projection board

Two Nos. of overhead projection board (Interactive White Board) with complete accessories, software i.e one for conference room at service

building & one for training room shall be provided by bidder. These boards shall act as I/O device from/to the desktop computer or laptop computer.

These Interactive white boards shall be provided with following minimum features

- a. Two (2) nos. of USB port required for interfacing with PC/Laptop.
- b. Screen size 79" or better.
- c. Hand writing recognition with multi touch function
- d. Scroll down facility with wireless facility enabled.
- e. Remote conferencing enabled
- f. Should support OS: Windows, Mac and Linux
- g. Accessories as Stylus Pens & erasor including one spare set, VGA cable, wall mount brackets etc.
- h. Minimum 1 KVA industrial grade UPS with 60 minutes Ni Cd battery backup for each overhead projection board.

67. Optical time Domain reflectometer

- a. A recording optical time domain reflecto meter (OTDR) will be utilized to

test for end-to-end continuity and attenuation of each optical fiber. The OTDR shall be equipped with data storage (1 GB internal flash memory min.), printer, help feature, compare trace features and OTDR software. The data storage unit must include a built-in memory drive capable of storing a minimum of 100 test traces. Display shall be colored 6 inch TFT minimum. OTDR shall have built in power meter & visual fault locator.

Safety Class: - Class I FDA 21 CFR 1040.10 & 1040.11, IEC 60825-1:2007-03

Test Mode: - OTDR (Full auto, Expert Real Time), Auto test, OPM, OLS, VFL, DFS (Digital Fiber scope).

Application:-

- i. Automatic Pass/Fail Analysis (TIA/ISO/EN)
 - ii. Bi directionally measure loss and length of fiber links.
 - iii. Tier 1 & Tier 2 testing of networks.
- b. Data traces saved to disk shall include the following labels.
- i. Fiber Identification (ID) with a minimum of 10 characters.
 - ii. Cable ID with a minimum of 10 characters
 - iii. OTDR location with a minimum of 20 characters
 - iv. Far End location with a minimum of 20 characters.
 - v. Test operator initials with a minimum of 3 characters.

- c. The printer shall preferable be internal. The printer shall be able to print data traces within 30 seconds or less. The machine setting used to repeat tests at a later time shall include index, range, wavelength, average time, pulse width and scale settings. The test results (on printout) shall provide information including: loss, distance, reflectance, data and time.
- d. The requirements for the compare trace feature include the ability to recall two historical traces from a diskette and display them simultaneously for analysis and printing. The compare trace must compute and display a single graph representing any differences between two traces. The compare trace must be able to recall historical traces from a discrete and perform the same tests on connected live fibers. The compare trace shall perform a two point loss measurement test for any two particular fibers in a comparison analysis. The losses between the two points on the each fiber shall be displayed, and the differences between the two readings clearly shown.
- e. The OTDR must be equipped with software to support all of the required functions. The software shall provide for printing of whole set of traces (batch print) with minimal commands eliminating the time spent for printing traces individually.
- f. Bidder shall provide all mounting accessories, cables and connectors required to establish data communication.
- g. Power supply – Rechargeable batteries for 7 hours operation as per Telcordia (Bellcore). Universal type AC/DC Adaptor.
- h. Interfacing - USB ports, RJ-45 LAN ports, Fiber inspection probe connector port, Built in Bluetooth & wifi.
- i. Accessories – Fiber inspection probe, carrying case, USB mouse, USB keyboard, gloves, cable kits, software.

68. HUMIDITY CALIBRATOR –

Humidity Generator for calibrating a wide range of humidity sensors

RH: 3 to 95%RH with $\pm 1.5\%$ RH accuracy from 20-90%
Dew Point: -20°C to 40°C Dew Point with accuracy $\pm 0.2^{\circ}\text{C}$
Absolute Humidity: 0.7 to 35 grams / cubic meter
Stability of 0.2%RH
Port size: 5" diameter x 7" deep
Set point resolution: 0.1% RH, 0.1 $^{\circ}\text{C}$
Air cooled; orientation: any in 3 axes
Power Requirement: 240 V AC, 50 – 60 Hz
Padded carrying case shall be included
Serial computer control shall be included.

69. CONTINUITY TESTER

Continuity tester shall be electronic and battery operated. A hooter shall be provided which will sound when continuity detected. Tester

shall be supplied with battery charger, lead wires and probes. The tester shall be kept in a carrying case.

70. Digital Thermometer

A microprocessor driven thermometer with inbuilt sensor powered by rechargeable batteries shall be provided. Suitable charger (inbuilt / stand alone type) shall also be provided. This shall be able to display temperature and Maximum/Minimum memory for Temperature.

The Digital Thermometer shall meet as a minimum the following requirements:

Range	:	-20°C to + 100°C
Temperature Sensor	:	Thermistor
Resolution	:	0.1°C
Accuracy	:	Temp. $\pm 1^\circ\text{C}$

71. Blank

72. Decade Capacitance Box

The variable capacitance device shall provide an accurate capacitance source for different purposes.

The equipment shall meet the following requirement as a minimum.

(a) Range	:	100 pF to 10 Micro F in steps of 100 pF
(b) Residual capacitance max	:	20 pF
(c) Accuracy	:	$\pm 1\%$
(d) Operating voltage upto	:	100V dc

73. Decade Inductance Box

The variable inductance device shall provide an accurate Inductance source for various purposes as a minimum. It shall meet the following requirement as a minimum.

(a) Range	:	1 mH to 10 H
(b) Accuracy	:	$\pm 2\%$
(c) Residual Inductance	:	< 0.5 mH
(d) Operating Voltage	:	250 V

74. Clip-on AC Power Meter

This instrument is envisaged to measure true rms voltage, current and power without shutting down or disturbing running devices. The instrument shall meet the following requirement as a minimum.

a) Range	:	20-600 V rms, 0.2-20 A rms, 0.2-20 KW
b) Display	:	3.5 digit LCD
c) Power Source	:	Built in Batteries
d) Accuracy	:	(+1% of reading +0.5% of range)

- e) Accessories : Test leads, carrying case and other necessary accessories
Test leads, carrying case and other necessary accessories shall also be provided.

75. Portable High Speed Trend Recorder

- 75.1 The portable high speed trend recorder shall be provided for recording purpose during commissioning and for optimisation of various automatic control loops with high performance and high operating function along with high visibility TFT Color LCD display. Large-sized high visibility display with various display functions. Real time/Historical trend screen, Circular trend screen, Bar-graph screen, Data screen shall be selectable for various applications.

The trend recorder shall be flat bed desk top type with sharp touch panel display based on Human Engineering such as color, line, thickness, key position. Must adopt VGA (640X480) i.e. 4 times the resolution of conventional models. Data screen, Bar-graph screen, Real-time trend screen, Graphic screen shall be available to create custom display for each user .Pen writing, free writing by 16 colors, Circular trend screen, high-resolution color and easy to read curve shall be provided. Following features shall be provided as a minimum:

- a) Number of Channels : 6 independent channels for analog signals. 6 points/1 sec
- b) Input Signal Type : Universal with minimum Input
- types as below:
DC voltage: $\pm 13.8\text{mV}$, $\pm 200\text{mV}$, $\pm 500\text{mV}$, $\pm 2\text{V}$
Thermocouple: B, R, S, K, E, J, T, N, PtRh40, PtRh20
DC current: With external shunt resistor
Resistance thermometer: Pt100, JPt100
- Maximum Input Voltage : DC voltage input ($\pm 2\text{V}$ or less)
&
Thermocouple input (burnout enabled): $\pm 10\text{VDC}$
Resistance thermometer input: 6VDC
DC voltage input ($\pm 5\text{V}$ to $\pm 50\text{V}$): $\pm 60\text{VDC}$
- c) Recording : Continuous, different colour ink for each channel (Fiber tip recording shall be preferred).
Facilities of digital & analog

d)	Accuracy	:	Print-out shall be provided. ±0.5% of span
e)	Temperature Drift	:	0.05% of FS/Deg. C.
f)	Chart Speeds	:	60 cm/min. to 1 cm/Hr. switch Selectable in minimum 12, Sampling rate- 1s/12 points
g)	Recorder Electronics (dedicated)	:	Manual start/stop touch key operation) Schedule (designation for time of day and date) Trigger signal (alarm event, digital input
h)	Power Supply	:	100 to 240V AC (universal Power supply) 50/60Hz
i)	Power Supply Cable	:	At least 30 meters
j)	Trolley with Wheels	:	To be provided
k)	No. of Chart Rolls	:	Minimum 100 to be provided
l)	Ink Capsules of Each Colour	:	Minimum 20 for each colour to be provided
m)	Transparent Enclosure	:	To be provided.
n)	Standards	:	CE : EMC directive: EN61326 Class A EN61000-3-2 EN61000-3-3 Low voltage directive: EN61010-1, EN61010-2- 030 Protection: IP54

76 Bench Magnifier

It shall have low power, 'cool white' circular fluorescent tube for 240V, 50Hz operation and a double convex crown optical glass with approx. 300 mm focal length. Maximum height above bench shall be app. 600 mm or more. Max. reach (centre of lens to centre of base) shall be app. 500 mm or more. Base dimension shall be minimum 250mm x 150mm.

77. Laser based Shaft Alignment system

Applications	HT and LT Unidirectional Drives - Horizontal and vertical alignment, Machine train alignment, Alignment tolerance, Alignment target, Soft foot check, Visual inspection, chocking arrangement, Full template, Data base.
Measuring units	
Housing material	ABS plastic / Aluminum or better
Laser wave length	635 - 670 nm



Laser Safety Class	2
Laser Type	Red Diode laser
Maximum laser power	Upto 1 mW
Measuring Resolution	0.01 mm
Measuring Accuracy/error (Angular)	Maximum $\pm 1\%$
Distance between measuring	Minimum 33 feet / 10 mtrs.
Type of detectors	Two axis PSD.
Protection Class	Minimum IP65
Battery Type	Rechargeable batteries
Display unit:	
Housing material	ABS plastic or better.
Display size	Min. 7 inch diagonal.
Memory	Min. 1000 measurements
Battery type	Rechargeable type.
PC/OWS connection	USB
Displayed resolution	Min. 0.01 mm
Protection Class	Minimum IP65
System Features	
Bluetooth & Wireless Communication	Inbuilt
Ambient Light Protection Feature	Inbuilt
Thermal sensors	Inbuilt
Accelerometer	Inbuilt
PC/OWS/Laptop download	Plug in by USB socket
Softfoot check	Yes
Alignment tolerance check	Yes
Cables	As required with push/pull connectors.
User editable tolerances	Yes
Temperature range	0 - 50 °C

Operating humidity	< 90 %
Accessories	Display unit (batteries included) 2 Measuring units with spirit levels Mechanical shaft fixtures Magnetic V brackets (qty. as req.) Offset Brackets (qty. as req.) Locking chains with tightening pin (qty. as req.) USB cable (qty. as req.) Quick Start Guide Calibration certificate valid for 2 years CD/DVD with instructions for use and instructional video Tool box Carrying case, cleaning kit Measuring Tape 2 nos. Batteries set each for display unit and measuring units. 2 nos. Charger of each type. 4 Rods Any other item as required to meet the project site requirements.
Software	Complete software as required for alignment, analysis & diagnosis.

10.07.00 **Bill of Material for M&C:**

S. No.	Description of C&I Lab Instrument/Equipment.	Quantity (nos/set)
1.	Electronic Test Bench	2 set
2.	Pneumatic Test Bench	2 set
3.	Portable Calibrator for Vacuum	1 set
4.	Portable Digital Multimeter (4 ½ digit)	15 set
5.	Digital Multimeter (Table Mounting Type)	4 set (2 each for 5 ½ & 7 ½ digit)
6.1	U-Tube Manometer	2 no. of each range (total 4 nos.)
6.2	Inclined -Tube Manometer	2 no. of each range (Total 6 nos.) .
7.	Test Manometer	2 nos.
8.	Digital Manometer	2 nos.
9.1	Dead Weight Tester	1 no.
9.2	Vacuum Tester	1 no.
10.1	Standard Pressure Gauges	2 no. each type (Total 13

S. No.	Description of C&I Lab Instrument/Equipment.	Quantity (nos/set)
		nos.)
10.2	Hydraulic pressure gauge tester.	2 no.
11	Microprocessor based Fluidized Temperature Bath	1 no. .
11.1	Low, Medium & High temp Portable Dry block type Calibrator	2 no. each type (Total 6 nos.)
12	RCL Bridge/Analyser	2 set
13	In Circuit Tester	2 set
14	Function Generator	1 set
15	Digital Oscilloscope	1 set
16	Tachometer	1 set
17	Soldering iron 10 Watts 25 Watts 40 Watts	6 (2 no. of each type)
18	Solder Sucker	2 nos.
19	Soldering Desoldering station	2 nos.
20	Potentiometer/Rheostat	2A: 2 Nos. (5000 Ω) 5A: 2 No. (47 Ω) 2A: 2 No. (470 Ω) 10A: 2 No. (470 Ω) 2A: 2 No. (2200 Ω)
21	Blank	Blank
22	Mercury Thermometers	2 no. for each range i.e. total 26 nos.
23	Flow meter Calibrator 0 - 1000 mmwcl 0 - 6000 mmwcl 0 - 30000 mmwcl	3 nos. (1 no. for each range)
24	Stop Watch	2 nos.
25	Digital Thermograph/Hygrometer	1 nos.
26	Portable Flue gas Analyser	1 no. with each type of sensors.
27	Aneroid Barometer	1 no.
28	Miscellaneous Items	
	Tool maker clamp jaw	50 mm wide 1 100 mm wide 1

S. No.	Description of C&I Lab Instrument/Equipment.	Quantity (nos/set)
	Hand operated wire wrap tool	1
	Trimmer & Alignment Tool Kit	1
	Magnetic screw driver	2
	SS & copper tube cutter/blender	2
	Standard tool box	10 set
	Coil winding machine single phase motor driven to wind wires of dia0.001" to 0.036".	1
	Electrically operated wire wrap (0.2 mm to 1 mm)	1
	Panel Wiring Tool kit	10
29	mV Calibrator	4 no. (Portable) 1no.(Table mounted)
30	mA Calibrator	4 no. (Portable) 1no.(Table mounted)
31	Thermocouple Calibrator	2no. (Portable) 1no.(Table mounted)
32	RTD Calibrator	2no. (Portable) 1no.(Table mounted)
33	Pressure & Diff. Pressure Calibrator	2 no. (Portable) 1 no.(Table mounted) covering each range & Type
34	Vacuum Calibrator	1no.(Table mounted)
35	Multi Function Calibrator	1 set
36	Pressure & Vacuum Air Pump	1 set
37	Digital Insulation Tester	2 set
38	Sound Level Monitor	2 set
39	Air Set	2 set
40	Portable Electro-Pneumatic Calibrator 0 - 2 bar 0-10 bar 0 - 40 bar 0- 200 bar	4(1 no. each type)
41	Portable Analogue & Digital Vibration Meter	Analogue type - 2 Digital Type - 4

S. No.	Description of C&I Lab Instrument/Equipment.	Quantity (nos/set)
42	VIBRATION/ SHOCK PULSE ANALYSER cum Data Collector cum Balancer	2 set
43	Decade Resistance Box	3 nos. Analog type 3 nos. digital type
44	LAN/ Coaxial Cable Meter/ Tester	2 set
45	Portable Ultrasonic Flow meter	2 set
46	EARTH/Ground RESISTANCE TESTER	2 nos
47	PORTABLE INFRARED RADIATION THERMOGRAPH (IR Imaging device & Camera)	2 no.
48	Thermocouple Test Furnace	1 set
49	Microprocessor based Portable H2 Gas Analyser	1 set
50	Fiber Optic Testing Tool Set	2 set
51	Industrial portable Vacuum Cleaner	4 set
52.	Tong Tester	4 set
53.	Stroboscope	2 no.
54.	Test Temp Detector – Test RTD	1 No
55.1	Single Phase Auto Transformer	2No
55.2	Three Phase Auto Transformer	2 nos.
56	Redial Drilling Machine	1 no.
57	Portable multifunction counters	1 no.
58	Electronic Bench vice	1 no.
59	Fortin Barometer (Mercury)	1 no.
60	Phase Sequence Meter	1 no.
61	Portable pH Calibrator/Simulator	1 no.
62	Oil Condition Monitor	1 no.
63	Logic Probe	1 no.
64	Marker Printers	1 nos.
65.	Computer aided Calibration system with one no. OWS, Printer and Complete Software	1 set
66.	Blank	Blank
67	DC Regulated Power Supply	4 nos.
68.	Blank	blank

S. No.	Description of C&I Lab Instrument/Equipment.	Quantity (nos/set)
69.	Overhead projection Board (Interactive White Board)	2 nos.
70.	Optical time Domain reflectometer	2 nos.
71.	Humidity Calibrator	1 no.
72.	Continuity Tester	10 nos.
73.	Digital Thermometer	4 nos.
74.	Blank	Blank
75.	Decade capacitance box	1 no.
76.	Decade inductance box	1 no.
77.	Clip on AC power meter	1 no.
78.	Portable high speed trend recorder	1 no.
79.	Bench magnifier	2 nos.
80.	Laser based Shaft Alignment system.	1 no.
81.	All required accessories, interfacing cables, chargeable battery, carrying case, charger, software etc. shall be provided with each lab instrument/equipment as per requirement.	

CHAPTER – 11**CONTROL VALVES WITH ACTUATORS****11.01.00 CONTROL VALVES, ACTUATORS & ACCESSORIES****11.01.00 General Requirements**

11.01.01 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.

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

11.01.03 For special type of control valves such as combined pressure and temperature control valves for Aux PRDS application, separator drain control valves, also refer to the corresponding mechanical sections.

Control valve station shall be provided at the interconnection line between service air header and instrument air header before air dryer unit. When instrument air header pressure falls below set value, the control valve will start opening and maintain the instrument header pressure at specified level in line with plant requirement. Again when instrument air header pressure goes above specified level in line with plant requirement the control valve will fully close automatically. Complete system shall be in bidder scope.

11.02.00 CONTROL VALVE SIZING & CONSTRUCTION

11.02.01 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.

11.02.02 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 trim exit outlet velocity as defined in ISA handbook does not exceed 8 m/sec for liquid services, 150 m/sec. for steam services and 50% of sonic velocity for flashing services. Bidder shall furnish the sizing calculations clearly indicating the outlet velocity achieved with the valve size selected by him as well as noise calculations, which will be subject to Owner's approval during detailed engineering.

- 11.02.03 Control valves for steam and water applications shall be designed to prevent cavitation, wire drawing, flashing on the downstream side of valve and downstream piping. Thus for cavitation/flashing service, only valve with anti cavitations trim shall be provided. Detailed calculations to establish whether cavitation will occur or not for any given application shall be furnished.
- 11.02.04 Control valves for application such as Feed water control valve, HP & LP by pass spray control valves, APRDS control valves, Soot blower control valve, separator drain control valve, SH Spray Control, RH spray Control, Heavy Oil Heating, pressurizing and Control system, HP/LP heater Emergency level control, Emergency Make-up to condenser hotwell, GSC minimum flow, 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 minimum 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.
All SH/RH block valves, shut off valve of LDO & HFO and HP/LP bypass control valve shall have leakage class MSS-SP-61.
- 11.02.05 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.
- 11.02.06 The Liquid pressure recovery factor (FL) shall be 0.995 or better for severe flashing/cavitation services. Feed Water Control Valve, Super heater & Reheater Spray Water Control valves, LP/HP heater emergency & normal level control valve, HP /LP BP control valves, HP /LP BP spray control valves, Deaerator Overflow control valve and Separator Drain level control valve shall be considered for Severe Flashing/ cavitations service by bidder.
- 11.02.07 The Liquid pressure recovery factor (FL) shall be 0.985 or better for low flashing/cavitation services.
- 11.02.08 The valve travel time shall be less than 10 second for non critical services valves.
- 11.02.09 Rangeability should be 50 to 1 (min.) for non critical services valves.
- 11.02.10 Modulating Type Control Valve's Linearity, Hysteresis, Accuracy shall be $\leq \pm 1\%$ and Sensitivity shall be $\leq \pm 0.5\%$.
- 11.03.00 **VALVE CONSTRUCTION**
- 11.03.01 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.
- 11.03.02 Valves with high lift cage guided plugs & quick-change trims shall be supplied.
- 11.03.03 Cast Iron valves are not acceptable.

- 11.03.04 Bonnet joints for all control valves shall be of the flanged and bolted type or other construction acceptable to the Owner. Bonnet joints of the internal threaded or union type will not be acceptable.
- 11.03.05 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.
- 11.03.06 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)
- 11.03.07 Valve characteristic shall match with the process characteristics.
- 11.03.08 Extension bonnets shall be provided when the maximum temperature of flowing fluid is greater than 280 deg. C.
- 11.03.09 Flanged valves shall be rated at no less than ANSI press class of 300 lbs.
- 11.03.10 Each valve shall have an arrow permanently fixed on the valve body to indicate the correct direction of flow.
- 11.03.11 Each valve shall have a stainless steel name plate permanently fastened to the yoke which shall be visible when the valve is in service. The name plate shall include
- a. Tag No. and Valve Serial No.
 - b. Body material, size and pressure rating
 - c. Trim material, size characteristics
 - d. Action on air failure
 - e. Spring range
 - f. Stem travel
 - g. Valve action, etc.

11.04.00 **VALVE MATERIALS**

S. 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 fluid temperature below 275 Deg. C Alloy steel ASTM-A217Gr. WC9 for fluid temperature above 275 Deg. C and up to 550 deg. C. and for Aux. steam flow to Deaerator, CRH flow to Deaerator.	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	Alloy steel ASTM-A217 Gr. WC6	17-4 PH SS

S. No.	Service	Body material	Trim Material
	services		
4	DM water services	SS 316	316 SS/17-4 PH SS
5.	Main steam to Aux steam header, HP Bypass control valve.	SA182F92	Refer below cl. No. 11.04.01.
6.	LP Bypass Control Valve & Soot blower pressure control valve.	SA182F91	Refer below cl. No. 11.04.01.

- 11.04.01 **i.** Material of the HC PRV valve & Soot blower pressure control valve internals should be as under or better:-
- Guide : Inconel 718
Plug/stem : Inconel 718
Seat ring : SS 316 stellited
- ii. Material of LP Bypass steam conditioning valve internals should be as under or better:
- Guide : AISI616 or X20CrMoV111, whichever is better
Plug/stem : AISI616 or X20CrMoV111, whichever is better.
Seat ring : A-182 F91/C21 coating or X20CrMoV111, whichever is better.
- iii. Material of HP Bypass steam conditioning valve internals should be as under or better:
- Guide : X20CrMoV121.
Plug/stem : X20CrMoV121.
Seat ring : X20CrMoV121.

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

Cage material may be different from Trim/Plug material subject to superiority of cage material than trim/plug material.

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 Owner's consideration and approval.

11.05.00 **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 Owner’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.

11.06.00 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.

11.07.00 CONTROL VALVE ACCESSORY DEVICES

11.07.01 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.

11.07.02 Separate moisture separator unit for ensuring dryness of air entering I/P as well as the power cylinder is to be supplied with each control valve and control damper.

11.08.00 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 (Superimposed 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 with Die cast Aluminum/SS316 enclosure.
3	Software for Configuration and Diagnostics	Software	Windows based 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 (Pressure versus Valve travel and Travel versus 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	<=0.5 % of span.
		Ambient temp effect	<=0.01 %/ deg C or better.
11	EMC & CE compliance	Required to International Standard like EN/IEC.	EN50081-2 & EN 50082 or equivalent.
12	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 Vol-V C&I : Contract quantities of the specification).
		Pressure Gauge Block & Position Indicators.	For supply & output pressures, Air Filter Regulator, integral type position transmitter, in built mechanical position indicator 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.
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*** Note:**

- i. The HART signals shall be picked up from marshalling terminals of DDCMIS (SG/TG DDCMIS as well as BOP DDCMIS), as applicable. The details of the above mentioned HART management system specification are mentioned in HART system Vol-V, Part B, Chapter 3, DDCMIS, cl. no. 3.45.00. The positioners shall be monitored from this HART management system .To achieve this, Bidder shall provide the necessary software to achieve the functionalities described above under "Remote Configuration and Diagnostics", and this software shall be loaded in the HART management system.
- ii. Actuators shall have provision to be on fail safe condition in case of Air/power/hydraulic system failure.

11.09.00 FOR FOLLOWING CRITICAL APPLICATION SPECIAL CONTROL VALVES ARE REQUIRED:

1. HP & LP Bypass Valves and Control System
2. BFP – Minimum Re-circulation Valve
3. Feed Water Control Valve
4. SH & RH spray Control Valves
5. APRDS System
6. Soot Blower control valve
7. Separator level and Drain Control Valve.
8. Boiler startup recirculation control valve.

11.09.01 General Requirements for Critical Application Control Valves -

- i) The valve accessories shall include hand wheels, limit switches, smart valve positioner (4-20mA DC type), electro pneumatic converter, Air lock relay, Solenoid valve and all other items required for the completeness and the accessories shall be explosion proof type as per hazardous area classification wherever applicable.
- ii) Control valves shall be furnished with IBR certification, wherever required.
 1. **Noise:** The maximum allowable noise level shall be 85 dba or less at 1 m. distance from the downstream bare pipe surface. The specified noise level shall be attained without the use of orifices, mufflers, diffusers. No credit for thermal or acoustical insulations shall be taken.
 2. **Valve Trim:** Valve shall have quick change type trim utilizing top entry. No components shall be screwed or welded into the

body. The valve shall have equal pressure distribution around the plug to avoid chattering / vibration.

Trim of severe/critical service valve shall be of multi stage & multi path design with sufficient no. of discrete pressure drop stage to eliminate the chance of erosion, cavitations, noise, vibration through out the control range of valve.

3. **Leakage Class:** The valve shall have minimum class-V leakage for all steam applications including RH/SH, APRDS, Soot Blower control valve, HP/LP Bypass spray control valves, BFP minimum recirculation valve, Boiler startup recirculation control valve & Low Load feed water control valve.

In case of HP/LP Bypass control valve application, the leakage class should be MSS-SP 61 (block valve leakage).

4. **Actuator:** Actuator type should be pneumatic double acting piston/electro-Hydraulic. All the control valves, isolation, block valves and bypass valves with HP bypass and LP bypass system shall also be provided with electro-hydraulic actuators only.
5. Separate hydraulic power units shall be provided and sized to operate and control the HP Bypass steam conditioning valves, isolation valves & related spray water control valves and LP Bypass steam conditioning valves, isolation valves & related spray water control valves respectively. Each hydraulic unit shall be complete with 2x100% capacity motor driven pumps, valves, piping instrumentation, tubing, reservoir and accumulator(s), control cabinet with accessories all mounted on a common base. The motors shall be connected two (2) different power supplies. The hydraulic system shall have online filtration arrangement to keep hydraulic oil clean. The system shall have automatic temperature control device mounted on the tank to maintain hydraulic oil temperature below 60 deg. C.

11.10.00 **TEST AND EXAMINATION**

All valves shall be tested in accordance with the quality assurance program agreed between the Owner 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:

- 11.10.01 Non Destructive Test as per ANSI B-16.34.
- 11.10.02 Hydrostatic shell test in accordance with ANSI B 16.34 prior to seat leakage test.
- 11.10.03 Valve closure test and seat leakage test in accordance with ANSI-B 16.34 and as per the leakage class indicated above.

- 11.10.04 Functional Test: The fully assembled valves including actuators control devices and accessories shall be functionally tested to demonstrate times from open to close position.
- 11.10.05 CV Test: Please refer CI No. 13.00.00, Vol. V Part-B, Chapter : 13 (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 chapter has to be read in conjunction with other relevant chapter of this specification.

CHAPTER – 12

PLANT PERFORMANCE ANALYSIS, DIAGNOSIS AND OPTIMISATION SYSTEM

12.00.00 **PLANT PERFORMANCE ANALYSIS, DIAGNOSIS & OPTIMIZATION SYSTEM**

12.00.01 The Bidder shall provide OWS & server based On-line Plant Performance Analysis, Diagnosis & Optimization System (PADO) for the plant. The PADO shall incorporate the complete thermal design model of the Unit & Offsite packages/common auxiliaries. The system shall use the measured data from DDCMIS through appropriate redundant interface to be provided by the Bidder. PADO shall be connected to Station LAN of DDCMIS for two way communication i.e acquisition of measured data and dissemination of information to unit operators and other users on Station LAN. (Refer PADO drg # 114-01-0115-Rev-00).

12.00.02 The database shall be open and accessible through well-defined interface for any third party application.

12.00.03 All instruments exclusively required for implementation of PADO (including efficiency calculations of equipment) shall be in the scope of the bidder.

12.00.04 The PADO system shall provide the functions specified herein in a modular and seamlessly intergrated environment, using a common plant model and a dynamically shared data base. The database shall be open and accessible through well-defined interface for any third party application.

12.00.05 Industry standard operating system like UNIX/WINDOWS/OPEN-VMS etc shall be provided to ensure openness and connectivity to other systems in industry standard protocols. The system shall have user oriented programming languages & graphical user interface for any modification, addition of calculation formulas, equipment data fed into system, input & output parameters of what-if scenarios etc with proper access control. The system shall be user friendly and easy to operate.

Bidder shall clearly bring out in the bid any area where modifications will be restricted along with the reason thereof.

12.00.06 The Optimization Package will determine the optimum distribution of the load.

The Optimization Package will also identify if soot blowing is required in the SGs. If SGs are equipped with additional firing, the Optimization Package should also compute if additional firing is required.

The Optimization Package should monitor the actual operation of the entire process and should compare it continuously to its current optimum. Specifically, the operation of the steam turbine, the condenser and the feed water pre-heaters should be included in the Optimization Package evaluation. The impact of the relevant components on the economics of the current operation should be clearly identified. The operator should be informed whether any of the components is operating below its respective optimum value and how much this deviation costs in terms of additional fuel consumption.

- 12.01.00 **PERFORMANCE ANALYSIS AND MONITORING OF SYSTEMS AND COMPONENTS**
- 12.01.01 Calculate thermal performance status of the plant comprising SG, TG, condenser & associated items including CW pumps, ACW pumps, SCR, cooling towers and efficiency of generation using measured data.
- 12.01.02 Calculate all the key system performance indicators at system level such as heat rate, plant and equipment efficiency generator output and controllable losses.
- 12.01.03 Analyse the impact of individual component performance on overall losses or gains in total megawatt generation using first principle/empirical models as applicable (not output correction curves). All possible components/heads of losses shall be considered including piping losses (e.g. between boiler & turbine, heat loss to environment through pipes and equipments), gland and other leakages, drains, LP turbine exhaust losses etc. The references values for above computing should consider the effect of aging and performance degradation of the equipments.
- 12.01.04 Perform detailed analysis of each component including calculation of key performance indicators such as efficiency, heat transfer co-efficient, effectiveness for heat exchangers, TTD,DCA and fouling factor, Air Heater X ratio, Log. Mean Temperature Difference (LMTD) for condenser etc.
- 12.02.00 **EMISSION ANALYSIS AND MONITORING**
- 12.02.01 Monitor, tack and analyse plant emissions such as SO₂, Nox, Dust , Mecuiry CO & CO₂ in real time and correlate with major operating conditions of boiler, pin pointing the possible cause (s)
- 12.02.02 Monitor and analyse ESP and stack conditions such as temperature, humidity, gas flow rate and opacity.
- 12.02.03 Facilitate obtaining lowest emission while maintaining combustion efficiency.
- 12.02.04 Facility to set alarms to highlight conditions that violate predefined limits.
- 12.03.00 **SYSTEM AND PERFORMANCE DIAGNOSIS**
- 12.03.01 Continuous evaluation of system & component performance degradation to detect worn plant equipment. This will cover natural degradation based on a) Technical analysis of equipment data, material property etc and pointers from measured/computed values
- 12.03.02 Analysis of faults & abnormal operating conditions of all major equipments, auxiliaries and systems for quick identification of problem, pinpointing to the root cause of the problem.
- 12.03.03 Vibration measurement/analysis of major rotating machines & HT drives is performed separately under turbo supervisory instrumentation (TSI) system and vibration measurement system. The results from these systems shall be made available to PADO system through the DDCMIS network; so that the information related to these equipments health is available at one place.

12.04.00 SYSTEM AND PERFORMANCE OPTIMIZATION

Recommend to operator optimized operating ranges of controllable parameters to achieve minimum fuel cost within the system design and operating constraints for given process or activity at the current measured operating condition, using state of the art optimization techniques.

12.05.00 OTHER FUNCTIONS

In addition to the above functions, the PADO system shall possess the following analytical features:

- a. Verify the accuracy and provide the correct estimated value of the faulty or missing measurements. Perform data-reconciliation through mass and energy balance taking care of accuracy of individual measurements. For this purpose, the plant measurements shall be grouped in various accuracy classes, depending on which, weight age of a point in data reconciliation will be determined. It shall be possible to individually enable/disable data reconciliation for any point.

PADO results shall be tagged with its overall uncertainty, propagated through the uncertainties in the basic measurements, used in computing the results.

- b. Data created by one function shall be used to perform analysis using another set of functions without any processing or conditioning of the data.
- c. Simultaneous use of functions by one user on a single workstation or multiple users across multiple workstations.
- d. It shall be possible to perform what-if analysis at system & component level in a GUI based environment. This should be model based so that input conditions & output results can be added at site.
- e. Calculation of unaccounted losses as an aid in arresting systematic losses, and also for judging the need for updation of models.

12.06.00 OTHER REQUIREMENTS

The Plant Performance Analysis, Diagnosis & Optimization System (PADO), as described above, shall also include the following:-

- a. Boiler performance optimization packages including the optimized operation of soot Blowing System.
- b. Boiler stress condition analyzer.
- c. Interactive water and gas chemistry management system. This module shall access measured data, provide alarms and suggest correlation with process parameters indicating possible causes.
- d. Regenerative cycle performance optimization system. This module shall also access measured data, provide alarms and suggest correlation with process parameters indicating possible causes.
- e. Merit Order Rating Calculation and other related calculation

12.07.00 BOILER PERFORMANCE OPTIMIZATION SYSTEM

The bidder shall provide OWS based on line Boiler performance optimisation system (BPOS) for steam generator. The BPOS shall incorporate the complete thermal design model of the boiler capable of both forward and backward calculation of complete boiler thermal performance. The model shall be calibrated and made "site specific" based on series of field trails of thermal performance of the boiler during strat up and prior to trail operation. The input for the BPOS shall be based on accurate and continuous on line grid measurement of the following:

- a. Flue gas temperature at economizer inlet and outlet using acoustic pyrometer.
- b. Flue gas oxygen
- c. Other fluid temperature(s) entering and exiting various heat transfer banks.
- d. Coal characteristics (offline to be entered by the user)
- e. Unburnt carbon in Fly ash.
- f. Coal mass flow rate/Air fuel ratio in each PF pipe for each coal pulveriser.

The BPOS shall be capable for continuous on-line calculation of the thermal performance of the boiler for the operating conditions indicating performance prediction zonal absorption, metal temperature and shall have the following typical features.

- i. Fuel switching capability.
- ii. "WHAT IF" capability
- iii. Selective soot blowing of Furnace/Super heater based on trends of zonal absorption.
- iv. Expert system diagnostics for quick identification of the 'Root Cause' of deviations from the predicted parameters.

For this application, bidder may use boiler and other equipment model which has been used in some other plant as a reference model. However, this model has to be made "site specific" with project data during engineering stage and further tuned with information (parameter values as well as processed data) collected from actual installation.

12.08.00 HARDWARE REQUIREMENTS

12.08.01 The hardware shall include sets of hot redundant servers along with one workstation and A3 sized coloured LJP along with the complete networking in a 100 Mbps LAN Network. Refer Vol. V, part B, Ch. 3 for the specification of server and workstations. Processing capacity for PADO servers and workstations shall be sufficient to meet the functional requirements. System configuration drawing is attached. PADO system shall be time synchronized with station GPS based Master clock system.

12.08.02 The implementation of all associated hardware, networking and related work shall be the responsibility of the bidder in order to successfully operate the software.



12.09.00 DATA ACQUISITION & PROCESSING

The data acquisition, processing and dissemination of PADO results shall be done through two way links between PADO and main plant DDCMIS/station LAN system as follows:

- a. PADO system and station LAN switch/server (one number redundant link for total system)

The rate/frequency of acquisition and dissemination shall be commensurate with the application. For example: performance monitoring and longtime diagnostic type of applications, the frequency can be in minutes to ten minutes rate. However, for alarm and similar kind of applications, the rates shall be same as original HMIPIS scan cycle.

Data means process and complete/acquired parameters, current as well as historical.

PADO results shall be available as calculated data base points in station LAN data base (To be accessed by station LAN clients) as well as Unit HMI data base of DDCMIS through appropriate interface to be provided by the bidder for display and recording. Advisory messages/data shall be displayed on operator screens and other user screens using this interface.

The dissemination of these PADO results to other systems i.e. station LAN and unit HMI shall also be accomplished using the link mentioned at a above. The exact details of information to be disseminated and frequency shall be worked out during detail engineering.

All the communication i.e. acquisition of data and dissemination of information shall be through OPC protocol. For this purpose OPC UA servers on MIS/station LAN server shall be available.

Any other requirement for meeting the functionalities shall be clearly brought out by the bidder in his offer.

12.10.00 PADO System shall be based on Client-Server and expert system. The system shall operate on a commonly used hardware platform and network operating system. The system shall be suitable for simultaneous use by multiple users.

12.11.00 PADO system shall have suitable interface arrangement on station LAN, so that PADO parameters and mimics can be viewed at HPGCL Head quarter on real time data basis.

PADO system shall also have suitable interface arrangement for remote diagnostic support.

Bidder shall provide all necessary software, hardware & broad band internet connection for remote diagnostic support.

However to protect against unauthorized access to network, sufficient security arrangement in the form of firewall or any other suitable hardware / software keys etc., shall be provided by bidder. All hardware shall be of industrial grade only.

Complete system shall be commissioned & executed by bidder.

12.12.00 PADO System Implementation

System shall be delivered fully implemented & executed and shall be user tested at site. It is the bidder's responsibility to demonstrate the proper functioning of the system to HPGCL Personnel.

Following minimum activities shall be performed by bidder during site acceptance test.

- i. Demonstration of ON-line Optimization package on running plant.
- ii. Demonstration of data exchange between various modules.
- iii. Demonstration and verification of data exchange between optimization modules and plant DDCMIS.
- iv. Demonstration and verification of data exchange between optimization modules and MIS/Station LAN server and OWNER's HQ.

CHAPTER – 13**TYPE TEST REQUIREMENTS****13.00.00 General Requirements**

13.00.01 The Bidder 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 13.02.00 below, 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.

- (a) Out of the tests listed, the Bidder/ sub-vendor/ manufacturer is required to conduct certain type tests specifically for this contract (and witnessed by Owner or his authorized representative) even if the same had been conducted earlier, as clearly indicated subsequently against such tests.
- (b) For the rest, submission of type test results and certificate shall be acceptable provided.
 - i. The same has been carried out by the Bidder/ sub-vendor on exactly the same model /rating of equipment.
 - ii. There has been no change in the components from the offered equipment & tested equipment.
 - iii. The test has been carried out as per the latest standards along with amendments as on the date of Bid opening.
- (c) In case the approved equipment is different from the one on which the type test had been conducted earlier or any of the above grounds, then the tests have to be repeated and the cost of such tests shall be borne by the Bidder/ sub-vendor within the quoted price and no extra cost will be payable by the Owner on this account.

13.00.02 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 Owner.

13.00.03 The schedule of conduction of type tests/ submission of reports shall be submitted and finalized during pre-award discussion.

13.00.04 For the type tests to be conducted, Bidder shall submit detailed test procedure for approval by Owner. This shall clearly specify test setup, instruments to be used, procedure, acceptance norms (wherever applicable), recording of different parameters, interval of recording precautions to be taken etc. for the tests to be carried out.



13.00.05 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 Owner. If a test is waived off, then the cost shall not be payable.

13.01.00 SPECIAL REQUIREMENT FOR SOLID STATE EQUIPMENT/ SYSTEMS

13.01.01 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 61000-4-12 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.

13.02.00 TYPE TEST REQUIREMENT FOR C&I SYSTEMS

S. No.	Item COL2	Test Requirement COL3	Standard COL4	Test to be specifically conducted COL5	Approval required on Test certificate COL6
1	Elect. Metering instruments	As per Standard (col4)	IS-1248	No	Yes
2	Transducers	As per Standard (col4)	IEC-60688, IS-12784	No	Yes

S. No.	Item COL2	Test Requirement COL3	Standard COL4	Test to be specifically conducted COL5	Approval required on Test certificate COL6
3	Thermocouple	Degree Protection Test	IS-13947	No	No
4	RTD	As per Standard (col4)	IEC-60751	No	No
5	Electronic Transmitters	As per Standard (col4)	BS-6447/ IEC-60770	No	Yes
6	E/P converter	As per Standard (col4)	Mfr. standard	No	Yes
7	Dust emission monitor	Degree Protection Test	IS-13947	No	Yes
8	Instrumentation Cables Twisted & Shielded*				
	Conductor	Resistance	VDE-0815, IS-10810	No	Yes
		Diameter test	IS-10810	No	Yes
		Tin Coating test (per sulphate)	IS-8130/84	No	Yes
	Insulation	Loss of mass	VDE 0472, IS:5831/1984	No	Yes
		Ageing in air ovens**	VDE 0472, IS:5831/1984	No	Yes
		Tensile strength and elongation test before and after ageing**	VDE 0472, IS:5831/1984	No	Yes
		Heat shock	VDE 0472, IS:5831/1984	No	Yes
		Hot deformation	VDE 0472	No	Yes
		Shrinkage	VDE 0472, IS:5831/1984	No	Yes
		Bleeding and Blooming	IS-10810,	No	Yes

S. No.	Item COL2	Test Requirement COL3	Standard COL4	Test to be specifically conducted COL5	Approval required on Test certificate COL6
			IS:5831/1984		
		Cold bend test for PVC insulation.	IS:5831/1984		
		Insulation Resistance Test (Volume Resistivity method)	As per GTP		
	Inner sheath***	Loss of mass	VDE 0472, IS:5831/1984	No	Yes
		Heat shock	VDE 0472, IS:5831/1984	No	Yes
		Cold bend/ cold impact test	VDE 0472, IS:5831/1984	No	Yes
		Hot deformation	VDE 0472	No	Yes
		Shrinkage	VDE 0472, IS:5831/1984	No	Yes
	Outer sheath	Loss of mass	VDE 0472, IS:5831/1984	No	Yes
		Ageing in air ovens**	VDE 0472, IS:5831/1984	No	Yes
		Tensile strength and elongation test before and after ageing**	VDE 0472, IS:5831/1984	No	Yes
		Heat shock	VDE 0472, IS:5831/1984	No	Yes
		Hot deformation	VDE 0472	No	Yes
		Shrinkage	VDE	No	Yes

S. No.	Item COL2	Test Requirement COL3	Standard COL4	Test to be specifically conducted COL5	Approval required on Test certificate COL6
			0472, IS:5831/ 1984		
		Bleeding and Blooming	IS-10810, IS:5831/ 1984	No	Yes
		Colour fastness to water	IS-5831/1984	No	Yes
		Cold/bend cold impact test	VDE 0472, IS:5831/ 1984	No	Yes
		Oxygen index test	ASTMD-2863/77	No	Yes
		Smoke density test	ASTMD-2863, ASTM-D-2843/77	No	Yes
		Acid gas generation test	IEC-60754-1	No	Yes
	fillers				
		Oxygen index test	ASTMD-2863, IEC 60754-1	No	Yes
		Acid gas generation test	IEC-60754-1	No	Yes
	AL-MYLAR shield				
		Continuity Test	As per GTP	No	Yes
		Shield Thickness		No	Yes
		Overlap test		No	Yes
	Over all cable				
		Flammability Test	IEEE 383, IEEE-332 Part -3 (Categor	No	Yes

S. No.	Item COL2	Test Requirement COL3	Standard COL4	Test to be specifically conducted COL5	Approval required on Test certificate COL6
			y-B)		
		Swedish chimney test	SEN 4241475	No	Yes
		Noise interference	IEEE Transactions	No	Yes
		Dimensional checks	IS 10810	No	Yes
		Cross talk	VDE-0472	No	Yes
		Mutual capacitance	VDE-0472	No	Yes
		HV test	VDE-0815, As per GTP	No	Yes
		Drain wire continuity	VDE 0472	No	Yes

* 1.0 All cables to be supplied shall be of type tested quality. The Bidder shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last Ten years from the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

2.0 In case the Bidder is not able to submit report of the type test(s) conducted within last Ten years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Bidder shall conduct all such tests either in an independent laboratory or at manufacturer's works in presence of Owner's representative under this contract free of cost to the Owner and submit the reports for approval.

** These tests shall be carried out as per VDE0207 Part 6 & ASTM D-2116 for TEFLON insulated & outer sheathed cables

*** Applicable for armoured cables only

9	DC Power Supply System (Applicable for each model and rating)				
	1) The Type Test reports for offered rectifier module and the controller module irrespective of the rectifier bank shall be acceptable				
		Surge Withstand capability (SWC)	ANSI 37.90.1 IEEE-472, EN61000-4-12	No	Yes
		Dry Heat Test	IEC-68-	No	Yes



S. No.	Item COL2	Test Requirement COL3	Standard COL4	Test to be specifically conducted COL5	Approval required on Test certificate COL6
			2-2 or equivalent		
		Damp Heat test	IEC-68-2-3 or equivalent	No	Yes
		Vibration test	IEC-68-2-6 or equivalent	No	Yes
		Electrostatic discharge test	EN 61000-4-2 or equivalent	No	Yes
		Radio frequency immunity test	EN 61000-4-3 or equivalent	No	Yes
		Electromagnetic field immunity	EN 61000-4-3 or equivalent	No	Yes
		Degree of Protection	IS-13947 or equivalent	No	Yes
10	Battery##	As per stand col 4	IS-10918	No	Yes
11	UPS (Applicable for each model and rating)				
	1) Type Test reports of same series of UPS with similar PCB's cards and controllers as the target UPS system shall be acceptable.				
	2) For Dry heat, Damp heat and vibration, the tests conducted on individual PCB's shall be acceptable.				
		Surge Withstand capability (SWC)	ANSI 37.90.1 IEEE-472, EN61000-4-12	No	Yes
		Dry Heat Test	IEC-68-2-2 or equivalent	No	Yes

S. No.	Item COL2	Test Requirement COL3	Standard COL4	Test to be specifically conducted COL5	Approval required on Test certificate COL6
			nt		
		Damp Heat test	IEC-68-2-3 or equivalent	No	Yes
		Vibration test	IEC-68-2-6 or equivalent	No	Yes
		Electrostatic discharge test	EN 61000-4-2 or equivalent	No	Yes
		Radio frequency immunity test	EN 61000-4-3 or equivalent	No	Yes
		Electromagnetic field immunity	EN 61000-4-3 or equivalent	No	Yes
		Degree of Protection	IS-13947 or equivalent	No	Yes
		Fuse clearing capability	Approved procedure	No	Yes
		Short circuit current capability	IEC 60146-2	No	Yes
	Voltage stabilizers	Over Load Test	Approved procedure	No	Yes
		Temp rise test without redundant fans	Approved procedure	No	Yes
	LIE / LIR and Control Panels/Enclosures.	Degree of protection Test and Impact resistance test.	1. IP: IS/IEC 60529 or IS 13947	No	Yes

S. No.	Item COL2	Test Requirement COL3	Standard COL4	Test to be specifically conducted COL5	Approval required on Test certificate COL6
			2. IK: IEC 62262:2 002		
	Flue Gas Analysers	Degree of protection Test	IS-13947	No	Yes
	Mercury Analysers	Degree of protection Test	IS-13947	No	Yes
	AAQMS Analysers	Degree of protection Test	IS-13947	No	Yes
	Master clock	Functional test	As per Approve d procedur e	No	Yes
	CJC Box	Degree of protection Test and Impact resistance test.	1. IP: IS/IEC 60529 or IS 13947 2. IK: IEC 62262:2 002	No	Yes
	Junction Box	Degree of protection Test and Impact resistance test.	1. IP: IS/IEC 60529 or IS 13947 2. IK: IEC 62262:2 002	No	Yes
	OPC data access server Data exchange server and Historical data access server	OPC Compliance testing		No	Yes (Self certification is also acceptable)
	Conductivity type level switch	Degree of protection Test	IS-2147	No	No
	Local Gauges	Degree of protection Test	IS-2147	No	No
	Process actuated switches	Degree of protection Test	IS-2147	No	No
	Control Valves	CV Test	ISA 75.02	No	Yes

S. No.	Item COL2	Test Requirement COL3	Standard COL4	Test to be specifically conducted COL5	Approval required on Test certificate COL6
	PLCs	As per standard (col4) and cl. No. 13.03.00 below.	IEC 1131	No	No
	Flow Nozzle orifice plate	Calibration	ASME PTC BS 1042	No	Yes

The bidder shall submit for Owners approval the reports of all the type test as per latest IS-10918 carried out within last ten years from the date of Bid opening and the test(s) should have been either conducted at an independent laboratory or in presence / owners representative. The complete type test reports shall be for any rating of Battery in a particular group based on plate dimensions being manufactured by supplier.

Note: Type Tests are to be conducted only for the items, which are being supplied as a part of this Package.

13.03.00 TYPE TESTS for PLC

13.03.01 All equipments to be supplied shall be of type tested quality. The bidder shall submit for Owner's approval the reports of all the type testes as listed in this specification and carried out within last ten years from the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

However if the bidder is not able to submit report of the type tests(s) conducted within last ten years from the date of bid opening, or in case the type tests(s) are not found meeting the specification requirements, the Bidder shall conduct all such tests under this contract, at no additional cost to the owner either at third part lab or in presence of clients/owners representative and submit the reports for approval.

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

13.03.03 Following test reports shall be submitted for the equipment:

- a. Dry heat withstand test
- b. Variation of temperature immunity tests
- c. Variation immunity test
- d. Temperature cycle test
- e. Noise immunity test
- f. Dielectric test

- 13.03.04 Following tests shall be conducted under this contract as routine tests:
- a. Tests on internal and external wiring
 - b. Incoming power supply voltage and frequency variation test.
 - c. Test for verification of functional characteristics of I/Os
 - d. Task transition test (for each task, the bidder will list out the user accessible conditions which shall be used in the simulation of the task)
 - e. Functional testing of software and hardware in accordance with the approved block logic diagram with simulation of the system with switches, relay and solenoid valves etc. or equivalent loads.

CHAPTER – 14

PLANT AUXILIARY SYSTEM

- 14.00.00 CONTROL AND INSTRUMENTATION FOR PLANT AUXILIARY SYSTEMS**
- 14.00.01 Bidder shall provide complete Control and Instrumentation system with all accessories, auxiliaries and associated equipments and cables for the safe, efficient and reliable operation of the plant auxiliary systems as indicated under scope part at Part-A & Part B, Volume- V.
- 14.00.02 Bidder shall provide control system for safe, efficient and reliable operation of each of the plant auxiliary systems. The type of control system shall be as indicated under scope part at Part-A, Volume- V.
- 14.00.03 The control system 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 jeopardized. Control system shall be designed to prevent abnormal swings due to loss of Control System power supply, failure of any Control System component, open circuit/short circuit etc.
- 14.00.04 The Control system shall include on-line self-surveillance, monitoring and diagnostic facility giving the details of the fault on the Human Machine Interface System (HMIS) as per standard and proven practice of the bidder.
- For Fire Protection systems, the faults to be reported shall include fault in main & standby power supplies, sensor fault, Input/ Output card failure, Memory Status, Controller fault, failure of Communication/ Network links to PLCs, LAN etc. The diagnostic system shall ensure that the faults are detected before any significant change in any controller output has taken place.
- 14.00.05 The Control system shall generally operate in air conditioned area and shall be suitable for sustained operation for limited air conditioning failure.
- 14.00.06 PLC systems related to Fire Protection systems shall be interconnected with Fire Alarm panels also and redundant interface to DDCMIS from Fire Alarm panels is also envisaged. The alarm signals from PLC system & fire alarm system shall be provided to DDCMIS by interconnection of FAP at CER with DDCMIS. Hardwired signals shall be provided for interlock, protection & alarm from Fire alarm panels to main plant DDCMIS and respective off-site DDCMIS/PLC.
- 14.01.00 MICROPROCESSOR/ PROGRAMMABLE LOGIC BASED CONTROL SYSTEM**
- 14.01.01 Microprocessor/PLC PROCESSOR**

The processor unit shall be capable of executing the following functions:-

a	Receiving binary and analog signals from the field and providing command output to MCC/SWGR/Drive etc. through Input / Output modules and operator initiated commands from HMIS / control panel.
b	Implementing all logic functions for control, protection and annunciation of the equipment and systems.

c	Implementing modulating control function for certain application as specified elsewhere in the specification.
d	Providing supervisory information for alarm, various types of displays, status information, trending, historical storage of data etc.
e	Performing self-monitoring and diagnostic functions.

14.01.02 PLC system shall consist of two processors (Main processing unit & memories) one for normal operation and one as hot standby. In case of failure of working processor, there shall be an appropriate alarm and simultaneously the hot standby processor shall take over the complete process operation automatically. The transfer from main processor to standby processor shall be totally bump less and shall not cause any plant disturbance whatsoever. In the event of both processors failing, the system shall revert to fail safe mode. It shall be possible to keep any of the processors as master and other as standby. The standby processor shall be updated in line with the changes made in working processor.

Wherever multiple functional groups have been specified/ required, the above requirements are applicable for each functional group.

The memory unit of the CPU shall be field expandable. The memory capacity shall be sufficient (min. 16 MB per CPU) for system operation and shall have the capability for future expansion at least to the tune of 40%.

Programmed operating sequences and criteria shall be stored in non-volatile semi-conductor memories like EPROM. All dynamic memories shall be provided with buffer battery backup which shall be for at least 360 hours. The batteries shall be lithium or Ni-Cd type.

14.01.03 Priority of different commands shall be as follows:

Manual intervention shall be possible at any stage of operation. Protection commands shall have priority over manual commands and manual commands shall prevail over auto commands.

14.01.04 The latest proven PLC system shall be provided. Bidder to note that PLC system shall be from one manufacturer only. PLC system supplied & engineered through system house shall not be acceptable. It should be supplied & engineered from PLC manufacturer only. PLC should be sourced from original manufacturers. PLC system shall be complete with hot standby redundant CPU of word length of 64 bits minimum with floating point capability, Input / Output modules, dual serial link interface module for connecting Input / Output Modules, dual Communication Processors, dual Memory modules and redundant Power supply units. Power supply unit shall be hot redundant for each CPU & I/O rack. PLC system will be interfaced with main and respective DDCMIS through dual redundant interfacing (to be provided at PLC & DDCMIS end) for important process parameters. PLC shall confirm to IEC – 61131.

14.01.05 Redundant CPUs in hot standby mode shall operate on fault tolerant mode with continuous self and cross monitoring facility. Redundant CPU/controllers shall be placed separately and shall not share the same motherboard.

Failure of the active CPU shall not adversely affect the operation of the plant in any perceptible way. Failure of the active CPU will lead to transfer of the tasks

being performed to the other healthy CPU within fastest possible transfer time (i.e. ≤ 50 m sec.) without causing any output to drop during the Transfer period. In the Event of the both the CPU failure, the system shall revert to the Fail-safe mode. The CPUs shall not be loaded over 50% of the Individual capacity even under worst data loading conditions. It shall be possible to switch from the active to the back-up CPU and vice versa from Operating-station as well from the CPU front panel. (The worst data condition of PLC means all modules in active mode, printer in operation, OLCS & CLCS logics active and process in running condition). Data bus loading shall not be more than 50%. This configuration shall be applicable for each type of PLC based control system. Engineered solutions for redundancy in CPU & I/O cards are not acceptable.

The quantities of Hot standby redundant CPU/controllers for each PLC system shall be finalized during detailed engineering by owner depending upon CPU/controller's worst data loading conditions and CPU/controller's functional distribution.

14.01.06 **System Expandability**

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, hand/auto stations, push button stations, 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.

14.01.07 **On Line Maintenance**

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 jeopardise safety of plant and personnel.

14.01.08 **Fault Diagnostics**

The PLC 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/Engineering cum Programmer station. The failure/ malfunctions/faults to be reported shall include:

- (a) Module level faults of control system.
- (b) Failure of HMIPIS bus/unit LAN, system bus, Local/Remote communication 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 colour change on system status display and messages on programmer station/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 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/engineering. Work station/OWS.

14.01.09 **Fault Tolerance & Controllability**

14.01.09.01 The PLC 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 jeopardized. 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.

14.01.09.02 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.

14.01.09.03 No single failure either of equipment or power source shall be capable of rendering any part/system/sub-system of PLC 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.

14.01.09.04 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.

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.

- 14.01.09.05 The system design shall ensure that no single failure, whatsoever in any part of PLC 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.).
- 14.01.09.06 On power supply failure/PLC failure/communication failure etc. the output should be automatically switched over to the fail safe mode. In CPU, memory should exist where the sequence was aborted. Further in case of such failures, operating drives/ equipment shall be tripped or kept running as per a pre-determined programmable finalized during detailed engineering.
- 14.01.09.07 PLC shall meet all requirements stipulated under other Sub-sections/sections of the specification including Part A, Chapter 8, Vol II, (including the requirement Authorization to shipment test ATST) Quality assurance (Volume-II, Chapter 11) & General Technical Requirements (Volume- II, Chapter-5).

14.02.00 **HUMAN MACHINE INTERFACE SYSTEM (HMIS)**

- 14.02.01 Graphical Interface Unit (GIU) / Operator work station (OWS) shall perform control, monitoring and operation of all auxiliaries / drives interacting with PLC based / Microprocessor control system. It shall be possible to use the same as programming station of the PLC/ Control system and the Human Machine Interface System. In-case, the PC based OWS cannot be used as programming station of the PLC/ Control system and the Human Machine Interface System, then separate PC based programming station shall be provided (Refer Annexure A for details).
- 14.02.02 Operator shall be able to access all control/information related data under all operating conditions including a single processor/computer failure in the HMIS.
- 14.02.03 The operator functions for each OWS shall as a minimum include Control System operation (A/M selection, raise/lower, set point/bias change, on/off, open/close operation, mode/device selection, bypassing criteria, sequence auto, start/stop selection, drive auto selection, local-remote/other multi-position selection etc.); alarm acknowledge; call all kind of displays, logs, summaries, calculation results, etc.; printing of logs & reports; retrieval of historical data; and any other functions required for smooth operation, control & management of information as finalized during detailed engineering.
- 14.02.04 The display selection process shall be optimized so that the desired display can be selected with the minimum no. of operations. Navigation from one display to any other should be possible efficiently through paging soft keys as well as through targets defined on the displays. The display response shall be 1 sec maximum for control related displays. 2 to 3 sec for other displays.
- 14.02.05 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 as finalised by the Owner 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).

14.02.06 When any drive or sequence is being controlled from one OWS, the system shall inhibit control access of the same drive or sequence from other OWS or Local Control Panel.

14.02.07 Graphical Interface Unit shall meet the minimum functional requirements of monitoring, operating & controlling the process and displaying information related to process. GIU shall be provided with TFT active matrix display and keypad for operation. GIU shall be ruggedly designed to withstand hard environments like high temperature, shock and vibration.

14.03.00 **PROGRAMMING FUNCTIONALITIES**

Programming of the PLC/ Control system Processor / controller as well as programming of HMIS shall be user friendly with graphical user interface and shall not require knowledge of any specialized language. For example, the programming of PLC/ Control system shall use either of the following:-	
-	Flow-chart or block logic representing the instructions graphically.
-	Ladder diagrams.
The programming of HMIS (like development and modification of data base, mimics, logs / reports, HSR functionalities etc.) shall also be possible through user-friendly menus etc	
All programming functionalities shall be password protected to avoid unauthorized modification.	

14.04.00 **SOFTWARE REQUIREMENT**

14.04.01 All necessary software required for implementation of control logic, operator station displays / logs, storage & retrieval and other functional requirement shall be provided. The programs shall include high level languages as far as possible. The bidder shall provide sufficient documentation and program listing so that it is possible for the Owner to carry out modification at a later date.

14.04.02 The Bidder shall provide all software required by the system for meeting the intent and functional/parametric requirements of the specification.

14.04.03 Industry standard operating system like UNIX/WINDOWS (latest version) etc. to ensure openness and connectivity with other system in industry standard protocols (TCP-IP/ OPC etc.) shall be provided. The system shall have user friendly programming language & graphic user interface.

14.04.04 All system related software including Real Time Operating System, File management software, screen editor, database management software. On line diagnostics/debug software, peripheral drivers software and latest versions of standard PC-based software and latest WINDOWS based packages etc. and any other standard language offered shall be furnished as a minimum.



- 14.04.05 All application software for PLC/ Control system functioning like input scanning, acquisition, conditioning processing, control and communication and software for operator interface of monitors, displays, trends, curves, bar charts etc. Historical storage and retrieval utility, and alarm functions shall be provided.
- 14.04.06 The Bidder shall provide software locks and passwords to Owner's engineers at site for all operating & application software so that Owner's engineers can take backup of these software and are able to do modifications at site.
- 14.05.00 **INPUT/OUTPUT MODULES**
- 14.05.01 The PLC/ Control system should be designed according to the location of the input/output cabinets as specified.
- The max number of Input / Output points per card shall be 32 for digital and 16/8 for Analog / Thermocouple / RTD. No. of channels may also reduced to meet the I/O cards features specified in NIT. Individual input channels shall have galvanic isolation. Output points shall also have optical / galvanic isolation. Merely fusing of individual or a group of channels is not acceptable. The I/O cards shall be rack mounted. Failure of Analogue I/O cards, binary cards / modules shall also be displayed on the Engineering cum diagnostic station. Redundancy of I/O cards shall be as per design criteria & guidelines as specified elsewhere in the specification.
- 14.05.02 Input Output modules, as required in the Control System for all type of field input signals (4-20 mA, RTD, Thermocouple, non change over/change over type of contact inputs etc.) and outputs from the control system (non change-over/ change- over type of contact, 24 VDC output signals for energising interface relays, 4-20 mA output etc.) are to be provided by the Bidder as described in Volume- V, Part A.
- 14.05.03 Electrical isolation of 1.5KV with optical couplers between the plant input/output and controller shall be provided on the I/O cards. The isolation shall ensure that any inadvertent voltage or voltage spikes (as may be encountered in a plant of this nature) shall not damage or mal-operate the internal processing equipment. All I/O cards shall be provided with channel to channel isolation and self diagnostic features.
- 14.05.04 The Input/output system shall facilitate modular expansion in fixed stages.
- 14.05.05 Individually fused output circuits with the blower fuse indicator shall be provided. All input/output points shall be provided with status indicator. Input circuits shall be provided with fuses preferably for each input; alternatively suitable combination of inputs shall be done and provided with fuses such that for any fault, fuse failure shall affect the particular drive system only without affecting other systems. For Hydrogen Generation plant, Bidder's standard and proven practice in this regard shall also be taken into consideration.
- 14.05.06 All input/output cards shall have quick disconnect terminations allowing for card replacement without disconnection of external wiring and without switching of power supply.

- 14.05.07 The Bidder shall provide the following monitoring features:
- Power Supply monitoring
 - Contact bounce filtering
 - In case of power supply failure or hardware fault, the critical outputs shall be automatically switched to the fail-safe mode. The fail-safe mode shall be intimated to the successful Bidder during detailed engineering.
- 14.05.08 Binary Output modules shall be rated to switch ON/OFF coupling relays of approx. 3 VA at 24 VDC. and solenoid valves at 110 V AC The coupling relays shall be provided in LT/HT switchgears. Analog output modules shall be able to drive an load impedance of 500 Ohms minimum.
- 14.05.09 Output module shall be capable of switching ON/OFF inductive loads like solenoid valves, auxiliary relays etc. without any extra hardware.
- 14.05.10 Changeover contact or non changeover contact shall be provided in MCC for status feedback, control and interlock requirement as described in Volume- V, Part A, Table Drive I/O. Further multiplication, if required, shall be done by the bidder in PLC/ Control system.
- 14.05.11 All input field interrogation voltage shall be 24V DC.
- 14.05.12 I/O In case of loss of I/O communication link with the main processing unit, the shall be able to go to predetermined fail safe mode (to be decided during detailed engineering) with proper annunciation.
- 14.05.13 Any single sensor/transducer/ transmitter failure alarm shall be provided on programmer / Engineering station screens for all sensors / transducers / transmitters. Bidder shall provide remote Input/output modules Housed in free-standing cabinets/racks (with suitable redundant data link to the central PLC system) as specified. These Input/output modules shall meet the technical requirements as mentioned in the above clauses. Further these Input/output modules shall be designed to continuously work under the environment expected to be encountered in assigned areas without any air-conditioning support. Wherever the cable route distance of these I/O cabinets/racks exceeds a distance of 400 meters from the Central PLC, fiber optic data link has to be provided.
- 14.06.00 **SYSTEM SPARES CAPACITY**
- 14.06.01 Over and above the equipment and accessories required to meet the fully implemented system as per specification requirements, Control System shall have spare capacity and necessary hardware/ equipment/ accessories to meet following requirement for future expansion at site:
- 14.06.02 10% spare channels in each input/output modules fully wired up to cabinets TB.
- 14.06.03 Wired-in "usable" space for 10% modules in each of the system cabinets for mounting electronic modules wired up to corresponding spare terminals in system cabinets.

- 14.06.04 Each processor / controller shall have 40% spare functional capacity to implement additional function blocks, over and above implemented logic/ loops.
- 14.06.05 The Data communication system shall have the capacity to handle the additions mentioned above.
- 14.06.06 Twenty (20) percent spare relays of each type and rating mounted and wired in cabinets TB. All contacts of relays shall be terminated in terminal blocks of cabinets.
- 14.06.07 20% spare fully wired terminals of each type shall be provided in each cabinet.
- 14.07.00 **DATA COMMUNICATION SYSTEM (DCS)**
- 14.07.01 The Data Communication System shall include a redundant Main System Bus 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 DCS shall have the following minimum features :	
a	Redundant Communication controllers shall be provided to handle the communication between I/O Modules (including remote I/O) and PLC/ Control systems and between PLC/ Control systems and operator work station/HMI device.
b	The design shall be such as to minimize interruption of signals. It shall ensure that a single failure anywhere in the media shall cause no more than a single message to be disrupted and that message shall automatically be retransmitted. Any failure or physical removal of any station/module connected to the system bus shall not result in loss of any communication function to and from any other station/module.
c	Built-in diagnostics shall be provided for easy fault detection. Communication error detection and correction facility (ECC) shall be provided at all levels of communication. Failure of one bus and changeover to the standby system bus shall be automatic and completely bump less and the same shall be suitably alarmed/logged.
e	The design and installation of the system bus shall take care of the environmental conditions as applicable.
f	Data transmitting speed shall be sufficient to meet the responses of the system in terms of displays, control etc.
g	Passive coaxial cables or fibre optic cables shall be employed.
h	Communication links between CPU and individual Input & Output (I/O) modules rack shall be dual redundant with 10 Mbps speed and 16 bit CRC data protection feature. In no case failure of a link shall affect the control of the plant.
i	Each Network shall also be provided with external surge protection system and industrial firewall.
The Bidder shall furnish details regarding the communication system like communication protocol, bus utilization calculations etc.	

- 14.07.02 The PLC/ Control system shall be provided with necessary hardware and software for dual fiber optic connectivity & interconnection with station wide LAN (for scope of Station LAN refer Volume - Part-A) for transfer of signals for the purpose of information sharing. The plant information shall be made available through an Ethernet link following TCP/IP standard. The system shall be OPC compliant. The exact data structure shall be as decided during detailed engineering. All required plant data shall be transferred to/from through this ensuring complete security. The exact number of points to be transferred through the above communication link and the format of the data shall be finalised during detailed engineering. One additional Ethernet port shall be made available in PLC system for connectivity of wireless communication modem for future use. The Bidder shall provide all assistance to the BOP C&I System (for scope of BOP C&I System refer Volume - V, Part-A) Supplier including co-ordination and flow of required information etc. for display of all input points under alarm, connected to PLC/ Control system or generated by PLC/ Control system, on various operating stations on BOP C&I System (for scope of BOP C&I System refer Volume- V, Part-A) and various client PCs on station LAN.
- 14.08.00 **SYSTEM REACTION TIME**
- 14.08.01 The reaction time of the programmable control system from input signals at the input cards to output of the associated signals or commands of the output card inclusive of programmed logic processing, comprising a mixture of logic gates, arithmetic operations and other internal operations shall be less than 100 milli seconds under the most arduous control system operating conditions.
- 14.09.00 **OPERATOR INTERFACE DISPLAYS/LOGS/REPORTS**
- 14.09.01 Suitable Operator Interface Displays/Logs/Reports for control operation & monitoring shall be provided. The details shall be finalized during detailed Engineering. stage taking into account the bidders standard and proven practice.
- 14.10.00 **HISTORICAL STORAGE AND RETRIEVAL SYSTEM (HSRS)**
- 14.10.01 The data to be stored in the above system shall include alarm and event list, periodic plant data, selected logs/reports. The data/information to be stored & frequency of storage and retrieval shall be as finalised during detailed engineering. The system shall provide user-friendly operator functions to retrieve the data from historical storage. It shall be possible to retrieve the selected data on OWS or printer in form of trend/report by specifying date, time & period. Further, suitable index files/directories shall also be provided to facilitate the same. The logs/reports for at least last sixty (60) days shall be available on the disk. Memory capacity of hard disk shall be finalized accordingly.
- 14.10.02 In addition to above, the system shall also have facility to store & retrieve important plant data for a very long duration (plant life) on portable long term storage media). These data will include any data from the database as well as processed/computed data based an various calculations/transformation. The retrieved data from long term storage media should be possible to be presented in form of X-T display, X-Y display, logs, reports, etc.

14.11.00 **CONTROL & POWER SUPPLY SCHEME**

14.11.01 **General Requirements**

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

24 V DC power supply system shall be provided as below for all Offsite packages:-

(A) 24V DC power supply system for PLC based control system shall comprise of two sets, each set shall consist of 1 x 100% Chargers, 1 x 100% Nickel - Cadmium batteries for one (1) hour duty, 1 X 100% DC distribution board. For specification of power supply system refer Sub Section, Volume--V, Part B, chapter 7 of Specification.

(B) For CHP's off site packages, Parallel redundant 230 V AC to 24 V DC convertor with automatic 50% load sharing & 125 % capacity shall be provided for 24 V DC power supply in each cubicle separately as per requirements.

The UPS power supply shall be extended to Parallel redundant 230 V AC to 24 V DC convertor thru redundant UPS feeders.

AC to DC convertor shall be SMPS based and shall have wide range of AC/DC input voltage (85-264 V AC & 90-350 VDC). It shall have the necessary diagnostic functions like indications for DC OK, automatic overload monitoring etc. The MTBF for the power supplies shall not be less than 500,000 hours (in Accordance with (IEC - 1709) with operating temp. from -25deg. C to 70 deg. C.

There should not be Diode oring for switch over. There should be separate power supply (230 V AC to 24 V DC convertor) with parallel redundant features with automatic 50% load sharing and indication & alarm on 230 V AC to 24 V DC convertor failure.

Pot free contacts shall be provided for 230 V AC/24 V DC convertor Fail alarm, 24 V DC under voltage alarm, 24 V DC over voltage alarm etc.

(C) For PLC based off site packages, UPS System shall consist of 2 x 100% parallel redundant chargers and inverters with input isolation transformers, 1 x 100% Ni Cd battery bank for one (1) hour, Bypass line transformers & voltage stabilizer, static switch manual bypass switch, 2 x 100% ACDB, and other necessary protective devices and accessories. The UPS shall consist of complete hardware and software for remote management.

The specifications for this configuration shall be as per Cl. No. 7.06.00 to 7.10.00 as a minimum.

(D) All interconnection hardware including cables to be provided.

14.12.00 CONTROL CABINETS / PANELS/Desk

- 14.12.01 The cabinets shall be IP-32 protection class with a suitable canopy at the top to prevent ingress of dripping water. The Bidder 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. This shall be demonstrated to the Owner during the factory testing of the system. The Bidder shall ensure that the temperature rise is limited to 10 deg. C above ambient and is well within the safe limits for system components even under the worst condition as specified in Sub-section-basic Design criteria (Part-B, Volume- V) and specification requirements for remote I/O cabinets. Ventilation blowers shall be furnished as required by the equipment design and shall be sound proof to the maximum feasible extent. If blowers are required for satisfactory system operation, dual blowers 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.
- 14.12.02 The cabinets shall be designed for front access to system modules and rear access to wiring and shall be designed for bottom entry of the cables.
- 14.12.03 The cabinets shall be totally enclosed, free standing type and shall be constructed with design criteria specified in Volume- V, Part B, Chapter 6, 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 Owner and shall be furnished by the Bidder during detailed engineering.
- 14.12.04 Cabinet doors shall be hinged and shall have turned back edges and additional bracing where required ensuring rigidity. Hinges shall be of concealed type. Door latches shall be of three/four-point type to assure tight closing. Detachable lifting eyes or angles shall be furnished at the top of each separately shipped section and all necessary provisions shall be made to facilitate handling without damage. Front and rear doors shall be provided with locking arrangements with a master key for all cabinets. If width of a cabinet is more than 800 mm, double doors shall be provided.
- 14.12.05 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 colour 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. The detailed of panels/control desk and finish colours for exterior and interior surfaces shall be as per Volume-V, Part B, Chapter 6.
- 14.12.06 Paint films which show sags, checks or other imperfections shall not be acceptable.
- 14.12.07 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.
- 14.12.08 Refer Volume- V, Part B, and Chapter-1 for grounding requirements & panel protection class.
- 14.12.09 The mimic shall be configured on the OWS and it shall be possible to control, monitor and operate the plant from the same.

- 14.12.10 The technical specification covering panel fabrication details, wiring and termination details etc. shall be as described under Chapter 9, Volume- V, INST CABLE of this specification.
- 14.13.00 **ANNUNCIATION SYSTEM**
- 14.13.01 OWS based alarm system shall be provided with audio alarm facility (beep/tone generator). Hooters are to be provided.
- 14.13.02 The system shall display history of alarms in chronological order on any of the OWS. The system shall have all alarm functions and related function keys like alarm acknowledge, reset, paging, summaries etc. The alarm display/report format shall be as approved by the Owner.
- 14.13.03 Facility of audio annunciation shall be provided in OWS upon the occurrence OWS alarms irrespective of whether alarms are displayed or not. Facility to disable the audio annunciation shall be provided.
- 14.13.04 At least four levels of alarm priority shall be available which will be displayed in different Colour. It shall be possible to display & print alarms of any of the three levels.
- 14.13.05 Alarm boxes shall be provided in each display to alert the operator about an alarm when he is viewing some other picture. No of alarm boxes shall be finalised during detailed engineering for each process area & each priority therein.
- 14.13.06 Hardwired Annunciation system shall be provided for offsite packages as listed in Annexure A, Chapter 14, Part B, Volume- V.
- 14.14.00 **CONTROL DESK**
- 14.14.01 For off-site packages, Control desk shall be provided to keep the LED monitors at top and computers inside. Control desk shall consist of vertical, horizontal and base supports with their coverings for work surface, keyboard trays, mouse pads, monitor shelf and concealed cable and wire way management, perforated trays with covers in both horizontal and vertical directions. PA system handsets, telephone sets, any PB stations and lamps required shall be mounted on the control desk on mosaic grid structure and same shall be decided during detailed engineering. ASCII Keyboard shall be capable of being pulled out through a tray. NIT's GA drawings for control desk & printer tables shall be complied by bidder.
- 14.14.02 The cabling / wiring between OWS & CPU'S, power supply cables etc. shall be aesthetically routed and concealed from view.
- 14.15.00 **FURNITURE**
- Chairs – Industry standard revolving chairs with wheels and with provision for adjustment of height (hydraulically/gas lift) shall be provided for the operators, unit-in-charge & other personnel in control room area. These shall be designed for sitting for long duration such that these are comfortable for the back. Chair pedestal shall be made of 5mm thick MS plate covered with poly-propylene cladding. Arm-rests in one piece shall be of poly-urethane and twin wheel castor of glass filled nylon. The exact details shall be finalized & approved by Owner during detailed engineering.

14.16.00 **SOFTWARE DOCUMENTATION AND SOFTWARE LISTINGS**

14.16.01 All technical manuals, reference manuals, user's guide etc., in English required for modification/editing/addition/deletion of features in the software of the PLC/ Control system shall be furnished. The Bidder shall furnish a comprehensive list of all system/application software documentation after system finalization for Owner's review and approval.

14.16.02 All The software listings including source code for application software, All special - to-project data files etc. shall be submitted by the Bidder.

14.17.00 **SOFTWARE LICENCES**

The Bidder shall provide software license for all software being used in Bidder's System. The software licenses shall be provided for the project (e.g. organisation or site license) and shall not be hardware/machine-specific. That is, if any hardware/machine is upgraded or changed, the same license shall hold good and it shall not be necessary for Owner to seek a new license/renew license due to upgradation/change of hardware/machine in Bidder's System at site. All licenses shall be valid for the continuous service life of the plant.

As a customer support, the Bidder shall periodically inform the designated officer of the Owner about the software upgrades/new releases that would be taking place after the system is commissioned so that if required, same can be procured & implemented at site.

14.18.00 **(A) SPECIFICATIONS OF OWS**

The minimum requirement for OWS shall be as per Volume- V, Part B, Chapter 3.

UPS : 1 no. on-line Interactive UPS with 60 mins. battery backup on machine load (for OWS & its printer) with all accessories and software for remote monitoring facility for main off site Package.

Accessories : Required furniture for mounting of HMI peripherals shall be provided.

(B) GRAPHICAL INTERFACE UNIT

The minimum requirement of Graphical Interface Unit are as follows:

S. No.	Features	Description
1.	Power supply (Redundant)	230 V AC from UPS/24 V DC as per requirements thru redundant feeders.
2.	Display Size	10.4-15" minimum. (Industrial Grade) Actual size as per owner's approval.
3	Display Type	Coloured, TFT high resolution screens
4.	Protection class	IP-65 for extremely dust prone area, otherwise IP-55. Enclosure shall be IP 65 for extremely dust

S. No.	Features	Description
		prone area, otherwise IP-55
5	Keys	Function keys and numeric keys
6	Interfacing requirements	Interface with respective DDCMIS/PLC.
7	Functional requirements	Ability to do programming. Graphics display including alarms and operator guidance messages.
8.	Enclosures	Required as per site/process requirements.
9.	Other requirements	Industrial Grade, GIU shall be ruggedly designed to withstand hard environments like high temperature, shock and vibration.
10.	Interfacing with control system	Redundant
11.	Configuration	<p>On board Intel – Xeon quad core, 3.1 GHz latest processor or higher.</p> <ul style="list-style-type: none"> - 8 GB DDR3 RAM (min.) - 1 x 1000 GB IDE Hard Disc Drive of 7200 RPM or higher - 1024 MB Graphic Accelerator - System chipset: Intel Express - 2 x RS – 232 ports (1 no. general, 1 for service tool) - 3 nos. USB 3.0/2.0 - 2 x Ethernet (10 / 100 / 1000MB) cards (Industrial Grade) - 1 x windows 7/8/10 Professional or latest & proven version of Windows OS professional with Multimedia - Ethernet adapter - Third party operating system, graphical users interface and software, - 2 nos. graphic output cards - Minimum 2 nos Internal speakers - Redundant power supply (In built) - General MS Windows latest, Antii-virus software etc. <p>Application engineering & HMI software</p> <ul style="list-style-type: none"> - to suit project Specific requirement -Temperature- Operating +5 to +55 °C (+41 to +131 °F) Storage -40 to +70 °C (-40 to +158 °F) Temperature changes 3 °C/minutes according to IEC/EN 61131-2 -Altitude-2000 m according to IEC/EN 61131-2 -Pollution degree-Degree 2 according to IEC/EN 61131-2

S. No.	Features	Description
		<ul style="list-style-type: none"> -Corrosion protection-G3 compliant to ISA 71.04 -Vibration-10 < f < 50 Hz: 0.0375 mm amplitude, 50 < f < 150 Hz: 0.5 g acceleration, 5 < f < 500 Hz: 0.2 g acceleration -Emitted noise< 55 dB (A) -Shock, no package-150 m/s² in 11 ms, 20 g in 3 ms -Relative humidity- 5 to 95 %, non-condensing -Isolation voltage-Type test voltage: 500 V AC (corresponding to 700 V DC) <p>Certificates and Standards *</p> <ul style="list-style-type: none"> -CE*- marking: Meets EMC directive 2004/108/EC acc. to EN 61000-6-4, EN 61000-6-2 and Low Voltage Directive acc. to EN 61131-2 -Electrical Safety: EN 50178, IEC 61131-2, UL 508 -Hazardous location: UL 60079-15, cULus Class 1, Zone 2, AEx nA IIC T4, ExnA IIC T4Gc X -RoHS compliance: EN 50581:2012 -WEEE compliance: DIRECTIVE/2012/19/EU - Emission-Tested according to EN 61000-6-4 --EMC – Generic Emission Standard, Part 2 – Industrial Environment -Immunity-Tested according to EN 61000-6-2 EMC – Generic Immunity Standard, Part 2 – Industrial Environment -Shall be ISA secure certified

Note: Refer tabulated Annexure pertaining to Part-A for estimated quantities of GIU. (Quantified only for Bidding purpose, however, actual quantities shall be finalised during detailed Engineering).

14.19.00 PRINTER

14.19.01 Printers for Off-site packages shall be provided as indicated in Chapter 14, Annexure A as a part of the HMIS system. It shall print out all alarm/trip conditions and event changes in plant status along with date and time of occurrence.

The minimum requirement for printers & accessories shall be as per Volume- V, Part B, Chapter 3.



14.20.00 PLC Configuration:

The PLC configuration will have a hierarchy of industrial grade open system architecture for management information system (MIS) and closed system architecture for plant operation and control system.

The complete MIS system including hardware, software, cables etc, as required shall be provided. This shall acquire dynamic pre-configured points and mimics as required by Owner.

The closed system architecture for plant operation and control system is secure and deterministic system for real time operations of the plant.

Industrial grade managed type Ethernet switches shall be provided with features as same as specified at Vol V, Part B, Chapter 3.

PLC Network shall also be provided with external surge protection system and firewall.

"The Bus systems (like Profibus/ Modbus etc) or the Serial Port Systems (like RS-232/ RS-485 etc) shall be protected with suitable surge protection devices, confirming to the latest IEC-61643-21 guidelines. The surge handling capacity of device shall at least be 10 KA, 8/20 μ Sec between core-core and 20 KA, 8/20 μ Sec between core-ground. The device shall be pluggable & on-site testable".

All the operator stations will be 'work stations' as same as specified at cl. no. 4.03.03.04 and are required to reside on the main redundant bus running on IEEE 802.3, IEEE 802.4 or IEEE 802.5 to facilitate determinism.

PLC system shall have suitable software and hardware interface arrangement (thru MIS SERVER) so that pre-selected plant parameters and process mimics can be viewed at Owner's Head quarter on real time data basis.

PLC system shall have suitable interface arrangement for remote diagnostic support. Bidder shall provide all necessary software, hardware & broad band internet connection for remote diagnostic support.

However to protect against unauthorized access to network, sufficient security arrangement in the form of firewall or any other suitable hardware / software keys etc., shall be provided by bidder. All hardware shall be of industrial grade only.

Each PLC/Microprocessor based system/electrical system shall be time synchronized with master clock system

Complete system shall be commissioned & executed by bidder.

14.21.00 Visual Annunciation System**14.21.01 Functional Requirements**

The primary objective of the Visual Annunciation System shall be to draw operator's attention to abnormalities in plant status and parametric values enabling him to take corrective measures to avoid emergency/Plant trip out conditions or decrease in plant output.

Visual Annunciation System shall be on the lines of guidelines and stipulations given in:-

1. Specifications and guides for the use of general-purpose annunciators - ISA RP 19.1 - 1979.
2. Surge withstand capability tests - ANSI C 37.90a - 1974 and IEEE std. 472-1974.

The VAS system shall consist of single channel logic cards and facia windows with LEDs arranged in appropriate groups on backup control desk etc.

Logic cards shall be built around CMOS circuits or microprocessor based card. Logic cards shall be complete with contacts interrogation, contact bounce filtering with typically 15 ms duration and LED driver circuits. Drivers to LEDs shall be with current limiting feature and be provided with current regulation and short circuit protection.

Both NO/NC contacts shall be acceptable for annunciation. Change from NO to NC or vice versa shall be achieved through dip switch/jumper connections at cable level without any change in field wiring.

Logic cards shall be provided with optical isolation feature for all input signals.

In view of contact sharing between VAS and Plants monitoring system, interrogation voltage levels in the two systems shall be matched.

14.21.02 Sequence of annunciation for the control desk mounted facia windows shall be as below:

S No.	Condition	Visual	Audible
1.	Normal	OFF	OFF
2.	Alarm	Flash	ON
3.	Return To Normal		
a)	Before Acknowledge	ON	ON (Different tone)
b)	After Acknowledge	OFF	OFF
4.	Alarm Acknowledge		
a)	Before Return To Normal	Steady ON	OFF
b)	After Return To Normal	Slow Flashing	ON (Different tone)
5.	Reset	OFF	OFF
6.	Test	Flash	ON

Note: Pitch and volume of the tone generators for the audible alarms shall be adjustable. The hooters, buzzers, beacon lamps etc. shall also be provided above the same section. Each audible device shall be driven by separate tone generator.

14.21.03 **Specific Requirements**

The fascia window shall be translucent/plastic window with engraving with 16 nos. light emitting diodes with minimum average forward current - 50 mA, axial intensity 30 mcd at 25 mA and colour range 525 to 590 nanometers for red colour.

Size of Facia windows shall be 72(L) x 48 (H) mm.
The power supply to annunciator shall be monitored.

The VAS shall be designed for expansion capability upto 10% by more addition of requisite logic cards alone.

Inputs sizing group alarm facility, retransmission facia windows, power supplies and cabinets shall be designed in line.

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

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

14.21.04 Bidder shall provide Annunciation as integral part of PLC (driven with Digital Output from PLC). The number of Annunciation facia windows and Annunciation points shall be as required based. However minimum number of facia window shall be 30 Nos. for PLC operated main offsite packages. The facia window shall be mounted on desk / panel of control room.

Minimum number of facia window shall be 20 for Field mounted local control panels. However actual requirements shall be finalized during detailed engineering.

14.22.00 **Redundancy Criteria (For details also refer Volume- V, Part A)**

- i. Redundancy of components and systems shall be dictated by availability criteria to ensure the system availability target as well as safety considerations in critical applications.
- ii. Triple/Dual redundancy for sensors and transmitters will be used for critical and semi critical applications i.e for interlocks/trip/protection conditions (as decided by Owner).
- iii. The Wiring Scheme for inputs/outputs to/from PLC control system shall be as same specified at Volume- V, part A and Part B, Chapter 3 and as approved by owner.
- iv. All analog signals fed to the control system shall be acquired through analog card and validated.
- v. The CPU / Controllers, communication modules, data highway, power supply modules, etc for all PLCs shall be 100% hot standby redundant.
- vii. All input/output modules redundancy shall be as per Volume- V, Part A.

- viii. Drive control philosophy and Input/output sizing shall be same as specified for DDCMIS based main plant and off-site BOP packages.

14.23.00 **CONTROL PANEL AND OPERATOR INTERFACE (For details also refer Volume- V, chapter no. 6)**

- i. Operating console desks for OPERATING STATION's and KB shall be provided by bidder along with their printers in AC control room.
- ii. OPERATING STATION/KBD shall generally be used for control and monitoring.
- iii. Complete industrial grade Furniture for mounting Operating stations, Swivel Chairs, Printers, Keyboards, Computer etc. shall be furnished by bidder.
- iv. In the Control desk and relay based system following operator interface devices shall be provided as per Annexure A.
- 1) Control station (illuminated P.B. stations, control switches etc).
 - 2) Hardwired Annunciator
 - 3) Coloured Mimic with LEDs for Drive status (ON, OFF, & trip) and level (Low & High) of tanks.
 - 4) Process indicators & Ammeters as decided during detailed engineering.
- v. Control panels housing the control cards/equipment marshalling cabinets shall be located in a control room; and shall have IP 32 min. . degree of protection specified at Vol V, Part B, Chapter 1. Complete constructional details and features for control panels shall be as specified in Cl.6.10 of Vol V, Part B, Chapter 6 (Supervisory Control Panels, Supervisory control Desks, Equipment Panels)
- vi. Panels shall be furnished complete with requisite accessories such as transformers, regulators, switch-fuse units, MCB, MCCB and other power supply equipment to adopt the sources of power supply to requirements of panel mounted instruments and devices.
- vii. All panels, cabinets and enclosures shall be furnished, fully, wired with necessary provisions for convenience outlets, internal lighting, grounding, ventilation, space heating, and vibration isolation pads, double compression cable glands, integral piping and other accessories as per IS: 5039- 1969.
- viii. The sealing of panels/cabinets/enclosures bottom with bottom plate, Double compression cable glands and suitable sealing material to prevent entry of dust shall be in the Bidder's scope. Suitable arrangement for preventing fire propagation through cable entry points like fire seals etc. shall also be provided at cable entry points.
- xi. Fire/Smoke Detector, Neoprene/Polyurethane Gasket, Exhaust Fans with louvers & filters shall be provided in all consoles and panels.
- x. All the panels shall be equipped with Anti vibration pad of 15 mm size.

- xi. Bidder shall provide Ammeters on control panel/desk for all HT motor current and important LT motor ≥ 30 KW & other important drives and voltmeter for LT bus voltage.

14.24.00 RELAY BASED LOCAL CONTROL PANEL/DESK

Complete constructional details and features for Relay based local control panels shall be as specified in Cl.6.10 of Vol V, Part B, Chapter-6 in addition to the below technical details:

Panel shall be mounted on vibration dampers secured to steel frame on to the floor. Equipment and relays mounted on the panel shall be easily accessible. The panel shall be supplied completely wired upto terminal blocks for connecting external cables entering the panel from the bottom. Blank removable gland plate shall be provided with double compression type cable glands/conduits knockout along with the panel.

Terminal block shall be rated 650 volts grade, 10 Amps rated minimum made up of unbreakable polyamide 6.6 grade and shall have strap cage clamp type screw less terminals suitable for connection with 2x2.5 sq mm copper conductors on each side. Terminal block shall be provided with white marking strips. All metal parts shall be of non-ferrous material. The terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks. The minimum clearance between the first row of terminal blocks and the associated cable gland plate shall be 250 mm. Fuses shall not be mounted on terminal blocks. At least 20 percent spare unused terminals fully wired shall be provided on terminal block.

Contactors, Relays, timers and other devices mounted on the panel shall have clearly visible identification marking. Separate contactors shall be provided for start & stop command. Common contactor for start & stop command are not acceptable. All fuses shall be HRC semiconductor type of AC supply. HRC link & fuse shall be of removable type having 45 kA rupturing capacity (min) for protection of various circuits.

The panel shall be provided with a 25x6 mm tinned copper earthing strip running throughout the length of the panel at the bottom. Panel shall be provided with space heaters with isolating DPN MCB, and thermostats. LED based lamps illuminating lights, complete with door switches; and 1 no. 6 pin 6/16 amps sockets with DPN MCB.

Panel shall be provided with fluorescent illuminating lamps with door switch and 6 point 6/16A, 230V AC socket with switch for maintenance purposes. Panel shall have removable lifting eye bolts for safe lifting from top during handling. Control power supply shall be provided from dual redundant feeders with auto change over scheme, surge protection devices and Power/Volt/AM meter.

The panel shall be provided with push buttons, indicating lamps, annunciators, indicating instruments, interlock/ deinterlock switches etc., required for the complete system. General details as specified in Vol. V, chapter 6 shall be referred for engineering and design of relay panel/desk.

Coloured Mimic with 6/7 mm thickness sheet for respective plant lay out shall be provided as specified in Annexure A, control system philosophy.

20% spare relays of each type and rating shall be mounted and wired in relays control panel/Desk. All contacts of relays shall be terminated in terminal blocks of relay control panel/Desk, Additionally in the relay control panel/Desk, 20% spare wired terminal blocks shall be 'provided so that additional relays can be mounted and wired.

The annunciation system shall consist of panel mounted audio-visual windows of 50x75 mm provided with plug-in-type solid-state logic 16 nos. high intensity LEDs in parallel. EACH relay based control panel shall be provided with 30 nos min. facia windows. Initiating contacts may be either NO or NC; a jumper or switch shall be provided in each card to make it suitable for either type of contact. A set of acknowledge, reset and test push buttons shall be provided on the panel. All printed circuit boards shall be of epoxy fiber glass construction.

The sequence of annunciation shall be as follows:

	Condition	Visual	Audible
	Normal	OFF	OFF
	Alarm	Flashing	ON
	Acknowledge	Steady	OFF
	Return to Normal:		
a.	Before acknowledge	Flashing	ON
b.	After acknowledge	Steady	OFF
	Reset:		
a.	Alarm condition	No change	No change
b.	Return to normal	OFF	OFF

14.25.00 **LOCAL CONTROL PANEL**

Local control panel shall comply the features as specified in Vol. V, chapter-6 and above at Cl. No. 14.24.00.

CHAPTER 14/ANNEXURE – A
CONTROL SYSTEM FOR BOP/OFF-SITE PACAKGES

Control System for Major BOP/Off – Site/sub system Packages are as Follows:

S. No.	System /Package	Control System	Control From		Interface with Main Plant DDCMIS/ RIOs	Remarks	Control Scope
			Local Control	CCR			
1.	Main Ash Handling Plant & silo loading/unloading system.	DDCMIS based Main AHP DDCMIS	Yes Operation from OWS in AHP LCR	No	HW and SOFT LINK (Redundant bi-directional OPC link with Ethernet Based TCP/IP Protocol).	<p>Main AHP DDCMIS with two no. OWS, One no. Operating cum engineering station and Redundant hot standby processor with one no. A4 size color LJP & one no. DMP. In addition, Backup control desk with coloured Mimic, H.W. Annunciator, P.B. Ammeters, Indicators and indication Lamps, Ammeters shall also be provided.</p> <p>Remote I/O based local panel for bottom ash system to be provided.</p> <p>DCS based Ash water and ash slurry system RIO control panels with, One no. OWS, one no. Operating cum engineering station and Redundant hot standby processor with one no. DMP, redundant soft interface with AHP DDCMIS also to be provided.</p>	EPC Package Supplier Scope
2.	CHP Compressed Air System	Microprocessor & Main CHP DDCMIS based System.	Yes	No	HW and SOFT LINK (Redundant bi-directional OPC link with Ethernet Based TCP/IP Protocol).	The control & operation of Compressed air system for Coal handling system (part of Dust suppression system) shall be from Main CHP DDCMIS apart from its local microprocessor based Control Panels. Interfacing (Hardwired & soft link) of compressed air system microprocessor based control panel with MAIN CHP DDCMIS shall be same as specified for main plant compressor air system as below.	EPC Package Supplier Scope
3.	AHP Compressed Air System	Microprocessor & Main AHP DDCMIS based System.	Yes	No	HW and SOFT LINK (Redundant bi-directional OPC link with Ethernet Based TCP/IP Protocol).	The control & operation of Compressed air system for Fly /Coarse ash handling system shall be from MAIN AHP DDCMIS apart from its local microprocessor based Control Panels. Interfacing (Hardwired & soft link) of compressed air system microprocessor based control panel with MAIN AHP DDCMIS shall be same as specified for main plant compressor air system as below.	EPC Package Supplier Scope

S. No.	System /Package	Control System	Control From		Interface with Main Plant DDCMIS/ RIOs	Remarks	Control Scope
			Local Control	CCR			
4.	Air Conditioning System & Ventilation System	PLC based	Yes	No	HW and SOFT LINK (Redundant bi-directional OPC link with Ethernet Based TCP/IP Protocol)	PLC with Redundant hot standby processor & HW Annunciation windows, mimic, lamps & push buttons on desk.	EPC Package Supplier Scope
5.	Fire Detection Protection & Alarm System	Microprocessor based Fire detection, Protection & Alarm system., PLC based pump & Aux. controls and solid state annunciation	Yes	HW signals for equipment status/abnormal condition, Fire water pressure & Fire water tank level. Other non critical signals thru soft link for complete Monitoring shall be provided. Yes, for Fire Alarm, detection & Protection system.	H/W and soft link Interface of PLC with DDCMIS for monitoring only. Redundant Soft link. & Hardwired for Fire detection & Protection alarm system. Hardwired signals shall be provided for interlock, protection & alarm from Fire alarm panels to DDCMIS and respective PLC. (Redundant bi-directional OPC link with Ethernet Based TCP/IP Protocol for soft link interfacing)	a) PLC based pump controls and solid state Annunciation system. PLC shall be with Redundant hot standby processor & one no. OWS, one no. OEWS with A4 sized B/W LJP & A3 sized DMP. b) 100 % hot standby redundant Microprocessor based Fire protection, Detection and Alarm system shall be provided. Fire Alarm Panel shall be provided with 100% hot standby redundant Processor/controller. Repeater Panel shall be provided at different location in plant like each at fire station building, Cooling water pump house, Switchyard control room etc and at any other location as mentioned in the technical specification elsewhere. Two (2) nos. work stations shall be provided with A4 sized B/W LJP each (one set in CCR in TG building and other set in Fire station building) for Fire Detection, protection and Alarm system. Stand-alone floor mounted Fire Alarm panel shall be provided at different location in plant like each at CCR, ESP control room, CHP control room, AHP control room, WTP (DM plant control room), FO handling Plant control room etc. and at any other location as mentioned in the technical specification Vol-II.	EPC Package Supplier Scope

S. No.	System /Package	Control System	Control From		Interface with Main Plant DDCMIS/ RIOs	Remarks	Control Scope
			Local Control	CCR			
6.	Compressed Air System and Air Drying Plant	Microprocessor & Main plant DDCMIS System	Yes	Yes	H/W	<p>Microprocessor based control System for individual compressor and main plant DDCMIS shall be provided for overall monitoring, control & operation, loading, Unloading & auto standby start of compressors, Dryers, control valves, Solenoid valves, Field instruments etc.</p> <p>Each Compressor's Winding temp RTD signals, Bearing temp RTD signals and VMS signals shall be hardwired to Microprocessor field based control System and DDCMIS directly from field/VMS panel.</p> <p>DDCMIS shall have redundant soft interfacing (not in daisy serial link) with each individual compressor's microprocessor based control system, and HW signals required for command, status, local/remote operation, interlock & protection of complete compressor package.</p> <p>In Plant Compressor House – Remote I/O unit with redundant micro processor/controller of DDCMIS family is to be employed with one no. OWS & one no. A4 sized coloured LJP. Through redundant fiber optic cable, the bus is to be connected to DDCMIS of Central Control Room.</p>	EPC Package Supplier Scope
7.	Mill reject handling system	Main plant DDCMIS based	No	Yes	H/W	<p>Main Plant DDCMIS Control scope Local Control Panels with One (1) no. 15" TFT based touch screen (GIU) panel and Pneumatic panels with Hardwired interface with DDCMIS shall also be provided by bidder.</p> <p>The control & operation of Compressed air system for Mill Reject handling system shall be from main plant DDCMIS apart from its local Control Panels. Interfacing (Hardwired & soft link) of compressed air system's control panel and field instruments with DDCMIS shall be same as specified for main plant compressor air system in Vol. V, Part A.</p>	EPC Package Supplier Scope

S. No.	System /Package	Control System	Control From		Interface with Main Plant DDCMIS/ RIOs	Remarks	Control Scope
			Local Control	CCR			
8.	Pre-Treatment Plant including Filter Water Reservoir Pumps	DDCMIS based-DCS RIO in PT Plant LCR	Yes	No	H/W	In PT Plant LCR – DCS Remote I/O unit with redundant micro processor panel of Main DDCMIS family is to be employed. Through redundant fiber optic cable, the bus is to be connected to DDCMIS of Main DM Plant Control Room. Local control panel also shall be provided for annunciation & indications, Ammeter.	EPC Package Supplier Scope
9.	DM water plant System DM & Condensate Transfer Pumps, Hotwell Makeup Pumps, Boiler Fill Pumps, etc.	DDCMIS based-Main DM Plant DDCMIS in DM Plant Control Room	Yes	No	SOFT LINK (Redundant bi-directional OPC link with Ethernet Based TCP/IP Protocol).	DDCMIS with Two no. OWS, one no. Operating cum engineering station and Redundant hot standby processor with one no. A4 size Color LJP & one no. DMP. In addition Backup control desk with colored Mimic, H.W. Annunciator, indicators, Ammeters, P.B. and indication Lamps shall also be provided.	EPC Package Supplier Scope
10.	Raw Water system Including Ash Water Makeup System, Raw Water Chlorination System	DDCMIS based-DCS RIO in Raw Water Pump House LCR	Yes	No	H/W	In Raw Water Pump House LCR – DCS Remote I/O unit with redundant micro processor panel of Main DDCMIS family is to be employed. Through redundant fiber optic cable, the bus is to be connected to DDCMIS of Main DM Plant Control Room. Local control panel also shall be provided for annunciation & indications, Ammeter.	EPC Package DDCMIS Control scope
11.	CW Chlorination System	DDCMIS based-DCS RIO in CW Chlorination plant LCR	Yes Operation from Local control panel in CW Treatment Plant Building	No	H/W	In CW Chlorination plant LCR – DCS Remote I/O unit with redundant micro processor panel of Main DDCMIS family is to be employed. Through redundant fiber optic cable, the bus is to be connected to DDCMIS of Main DM Plant Control Room. Local control panel also shall be provided for annunciation & indications, Ammeter.	EPC Package Supplier Scope
12.	CW Pumps / ACW and CW make-up system	DDCMIS based	Yes	Yes	H/W	In Cooling Water Pump House – DCS Remote I/O unit with redundant micro processor panel of Main DDCMIS family is to be employed. Through redundant fiber optic cable, the bus is to be connected to DDCMIS of Central Control Room. Local control panel also shall be provided for annunciation & indications, Ammeter.	EPC Package DDCMIS Control scope

S. No.	System /Package	Control System	Control From		Interface with Main Plant DDCMIS/ RIOs	Remarks	Control Scope
			Local Control	CCR			
13.	DMCW System (SG & TG) & ACW booster pumps (SG)	DDCMIS based	Yes	Yes	H/W	DDCMIS/Nearby DCS RIO to be allocated during detailed Engg.	EPC Package DDCMIS Control scope
14.	TG Cycle (DM) Make-up Pump / Valve control and CST onwards monitoring and Boiler Fill Pump	DDCMIS based	Yes	Yes	H/W	DDCMIS/Nearby DCS RIO to be allocated during detailed Engg.	EPC Package DDCMIS Control scope
15.	Off-site packages for Coal Handling Plant	PLC based	Yes	No, Complete remote Monitoring shall be provided.	HW and SOFT LINK (Redundant bi-directional OPC link with Ethernet Based TCP/IP Protocol).	<p>a) PLC with Redundant hot standby processor based control system with Two (2) nos. OWS and one (1) no. Operating cum engineering work station (OEWS) and Local control Desk backed up by push button, switches, joy sticks etc & Annunciation windows separate for each stacker reclaim machine & reclaim machine. S/R/reclaimer control desk shall be provided in two parts, one part of the left side and the other part on the right side of the operator in the operator cabin. OWS shall be mounted in front of the operator so that he can control & operate the machine through keyboard/mouse. The other OWS, OEWS, PLC control panels, along with A4 sized colored LJP shall be housed in the MCC room on the S/R/reclaimer machine.</p> <p>Redundant wireless link or industrial grade redundant soft link (as approved by owner during detailed engineering) for monitoring & Hard wired interfacing for time critical, interlock, control & protection signals shall be provided between CHP DDCMIS & each Stacker reclaim PLC.</p> <p>b) PLC with Redundant hot standby processor based control system with One (1) no. OWS, One (1) no. Operating cum Engineering work station (OEWS) & A4 sized Color laser printer</p>	EPC Package Supplier Scope

S. No.	System /Package	Control System	Control From		Interface with Main Plant DDCMIS/ RIOs	Remarks	Control Scope
			Local Control	CCR			
						<p>and Local control pane/Desk backed up by push button, switches, HW annunciation etc. for Wagon Tippler system and Side Arm charger (SAC). Operator shall be able to control & operate the wagon tippler & Side Arm charger from control desk as well as from OWS. PLC shall be connected to main CHP DDCMIS via redundant soft link for monitoring and Hard wired interfacing for time critical, interlock, control & protection signals.</p> <p>c) The control & operation of Track Hopper system shall be from main CHP DDCMIS and local Control Panel/Desk backed up by push button and Annunciation window.</p> <p>d) PLC with Redundant hot standby processor based In motion weigh bridge system/Wagon Tippler Weigh Bridge System with One (1) no. OWES & A3 sized DMP. PLC shall be connected to main CHP DDCMIS via redundant soft link for monitoring and Hard wired interfacing for time critical, interlock, control & protection signals.</p>	
16.	Main Coal handling Plant including Dust Extraction system, Dust Suppression system, Service Water System, Potable Water System, etc.	Main CHP DDCMIS DDCMIS based	Yes Operation from OWS in Main CHP LCR	No, Complete remote Monitoring shall be provided.	HW and SOFT LINK (Redundant bi-directional OPC link with Ethernet Based TCP/IP Protocol).	Main CHP DDCMIS with two no. OWS, one no. Operating cum engineering station and Redundant hot standby processor with one no. A4 size color LJP & one no. DMP. In addition, Backup control desk with coloured Mimic, H.W. Annunciator, P.B. Ammeters, Indicators and indication Lamps, Ammeters shall also be provided.	EPC Package Supplier Scope

S. No.	System /Package	Control System	Control From		Interface with Main Plant DDCMIS/ RIOs	Remarks	Control Scope
			Local Control	CCR			
17.	CW Treatment plant	Relay based	Yes	No	N.A.	Relay based control desk with coloured Mimic, H.W. Annunciator, P.B. and indication Lamps shall be provided.	EPC Package Supplier Scope
18.	Fuel Oil Handling and unloading System	Main Plant DDCMIS based	Yes	Yes	H/W	Fuel Oil unloading Pump House – Remote I/O unit is to be employed with one no. GIU. Through redundant fiber optic cable, the bus is to be connected to DDCMIS panel located in FOPH Control Room.	EPC Package Supplier Scope
19.	H2 Gas Plant	PLC based	Yes HW signals for equipment status/abnormal condition, and critical process parameters etc. shall be provided to plant DDCMIS. Other non critical signals thru soft link for complete Monitoring shall be provided to Plant DDCMIS.	No, Complete remote Monitoring shall be provided.	HW and SOFT LINK (Redundant bi-directional OPC link with Ethernet Based TCP/IP Protocol).	a) PLC with Redundant Hot Standby Processor with one no. OEWS, one no. OWS & one no. B/W A4 sized LJP. H.W. Annunciation on Panel. b) GIU shall be provided with all major equipments & system. Actual Quantities shall be revised during detailed engineering.	EPC Package Supplier Scope
20.	Condenser Online Load Tube Cleaning System (COLTCS)	DDCMIS based	Yes	Yes	H/W	DDCMIS/Nearby DCS RIO to be allocated during detailed Engg.	EPC Package DDCMIS Control scope
21.	LP Dosing and O ₂ Dosing System	DDCMIS based	NO	Yes	H/W	DDCMIS/Nearby DCS RIO to be allocated during detailed Engg.	EPC Package DDCMIS Control scope

S. No.	System /Package	Control System	Control From		Interface with Main Plant DDCMIS/ RIOs	Remarks	Control Scope
			Local Control	CCR			
22.	Sewage water Treatment Plant	Relay Based	Yes	No	None	Relay based control desk with coloured Mimic, H.W. Annunciator, P.B. and indication Lamps shall be provided.	EPC Package Supplier Scope
23.	Effluent Treatment Plant plant misc sumps with pumps	PLC based	Yes	No	HW and SOFT LINK	Air conditioned panel mounted PLC with Redundant Hot Standby Processor with H.W. Annunciation on Panel. GIU shall be provided with all major equipment & system. Actual Quantities shall be revised during detailed engineering.	EPC Package Supplier Scope
24.	Cooling Tower	DDCMIS based	NO	Yes	H/W	DDCMIS/Nearby DCS RIO to be allocated during detailed Engg.	EPC Package DDCMIS Control scope
25.	FOPH (Fuel Oil Forwarding System)	DDCMIS based	Yes	Yes	H/W	In Fuel Oil Pump House – Remote I/O unit with redundant micro-processor panel of Main plant DDCMIS family is to be employed. Through redundant fiber optic cable, the bus is to be connected to DDCMIS of Central Control Room. Local control panel also shall be provided for annunciation & indications, Ammeter.	EPC Package DDCMIS Control scope
26.	FGD plant including Lime stone Handling, Gypsum handling, Flue gas System, Absorber System, Oxidation System, Process water distribution System, Dewatering System, Filtrate System, FGD bleed System	FGD DCS	Operation from EWS cum OWS in FGD LCR	Monitoring	SOFT LINK (Redundant bi-directional OPC link with Ethernet Based TCP/IP Protocol	1 No. EWS cum OWS + 2 No. OWS + 1 No. A3 Size LJP Colour + 1 No. LAPTOP + 2 Nos. LVS 1 No. OWS* in CCR + control desk and furniture for printers & OWS Location shall be FGD Local control Room and FGD DCS Remote I/Os,if any to be decided during detailed Engineering,	EPC Package DDCMIS Control scope

GENERAL

1. The specification provides a general guideline for Control & Instrumentations to be provided for the Plant auxiliary systems and Off Site Plants. Bidder shall provide functionally independent & geographically distributed DDCMIS/PLC (Programmable Logic Control) based control & Instrumentation system with all control equipment, instruments, accessories, cables and erection hardware for safe, efficient and reliable operation of the plant as specified in Vol. V, part A & B.
2. Each of the Plant Auxiliaries & off site systems shall be provided with annunciation system. It shall be an integral part of the control system. All the field contact for this purpose shall be acquired through control system. The annunciation sequence/logic shall conform to ISA sequence ISA-2A, subject to approval of owner during detail engineering based on the criticality of importance of BOP/Offsite package/sub system. The window lamps for the system shall be driven through digital output modules of the control system.
3. Remote Terminal Units (RTUs) have been envisaged for data acquisition function. Bidder shall provide necessary RTUs comprising of Input / Output modules, Processor etc. Configuration of the control system shall be as per the Volume VII of drawings section , signal cable for interface with PLC/DDCMIS panel, communication cables, and erection hardware's and other software & hardware for complete functioning of the off - site plants.
4. The instrumentation to be provided for each of the plant auxiliary & Off Site Plant systems shall be as per the technical specification document / drawings wherever provided for the respective systems as a minimum requirement for bidding purpose. However, for completeness of each of the plant auxiliary & Off Site system and its associated equipment, Bidder shall also provide all the necessary instruments to the process requirement even if it is not specifically indicated in the given technical Specification document / drawings.
5. The instrumentation, operation and control philosophy proposed is specific to the plant design. Any improvement over the proposed typical Control & Instrumentation scheme shall be accepted so long as it does not deviate from the basic intent and general philosophy enumerated herein and elsewhere in this specification.
6. Plant auxiliaries / Off Site Plants shall be operated from their respective local control panels or Operating work stations located in the local area air conditioned control rooms. Some of the auxiliaries will have operational facility from central control room as well as from local control panels. All the DDCMIS/ PLC's of CHP, FGD , Ash Handling plant, DM plant, PT plant , Service water pump house, Compressor Plant, Condensate polishing unit, Fire Water Pump house etc., shall have digital data communication connectivity with main plant DDCMIS already detailed in chapter 3&4. The control system for each of the Plant auxiliaries, Off Site Plant and their Man machine interface requirement and DDC MIS interfaces in the central control room shall be as follows:

- i. Considering the high ambient noise and electromagnetic interference prevailing in power plant, it is recommended that all links between off-site controls and plant DDC MIS shall be based on Dual Redundant Optical Fiber Communication (OFC) medium. Necessary ports / converters shall be provided at both ends. Spare capacity of 100% core of OFC link shall be insured.
 - ii. PLC and RTU shall be designed for operating in a non air-conditioned harsh environment also. Communication media shall be optical fiber cable with MODBUS / OPC protocol on hot redundant configuration between DDCMIS and PLC as per contract requirements. Optical cable, PLC end Modem/Converter and DDCMIS end Modem/Converter shall be supplied by bidder for both ends. Communication protocol between the Modems shall be RS485/Modbus and the maximum communication time for receipt of signal at DDCMIS end should not exceed 1-2 seconds. The Communication links shall be as per chapter 3.
 - iii. In addition Hardwired signal interfacing shall also be provided for any signal required for time critical, interlock, control & protection. Similarly cable for hard ware signal transfer between main plant DDCMIS and DDCMIS/PLC/relay system shall be supplied, laid terminated by the bidder including preparation of cable schedule. Quantum of hard wired signals for linking each PLC based system and DDCMIS shall be decided during detailed engineering. Spare cores/ pairs shall be provided based on the design requirements as per the contract requirements defined elsewhere in the specification.
 - iv. Above listed packages/control system indicated for interfacing with DDCMIS are minimum, and same shall be guaranteed by bidder. Any other package/control system specified anywhere in NIT/specification, or Any other package/control system required to be interfaced with DDCMIS as per owner requirements during detailed engineering, same shall also be complied by bidder.
7. Bidder will provide necessary separate industrial grade parallel redundant UPS power supply with 60 minutes battery backup for each PLC/DDCMIS, Operating station, printer, peripherals etc. Bidder shall have to provide necessary cabling for redundant power supply to UPS.
 8. Whenever control system is PLC/DDCMIS based, annunciation system shall be driven by PLC via Digital output. Mimic LED shall also be driven from PLC/DDCMIS digital output. For other relay based control systems, solid-state annunciation system shall be provided. Mimic acrylic sheet thickness shall be min 6-7 mm.
 9. For each PLC and Microprocessor based control system, without OEWS (Operating cum Engineering Work Station), Laptop along with software shall be provided for engineering. In addition, LAPTOPs shall be provided as per above Table in Annexure A.
 10. PLC system without OEWS (Operating & Engineering Work Station) shall have panel mounted push buttons, lamps, H.W. annunciation and MIMIC etc for operation & control purpose except specifically requirements of control desk mentioned for any package listed above.

11. All the PLC control system shall be of same make/model/family
12. All redundant OPC links shall be of latest version OPC AE (Alarm & Events), DA & UA protocol that support suitable for time stamped data transfer.
13. All cables terminated in the terminal block, Junction box end, power distribution scheme, instruments end etc shall be ferruled. Ferruling shall be double cross ferruling (i.e.) source and destination addresses shall be marked on both sides of the tube ferruling.
14. Any Package not listed above shall be PLC (redundant hot standby controllers) controlled with one no. OWS, one no. OEWS (Operating & Engineering Work Station) and one no. A4 colour LJP.
15. Bidder shall provide local panel for local start/ stop monitoring of auxiliaries and equipment as per requirement .The requirement shall be decided during detailed engineering. All local panel shall be NEMA 4X with canopy.
16. Bidder shall provide ammeters, voltmeters, PB, indicating lamp, mimic, electrical scheme, indicators, recorders and HW annunciations on the control desk/ panels as per requirement and shall be decided in detailed engineering.
17. PLC supplier shall prepare graphic for the complete plant with proper tag nos. for drives, binary inputs, analogue inputs, status of drives etc for the soft link for DDCMIS as per format of DDCMIS.
18. Each DDCMIS/PLC/Microprocessor based system/electrical system shall be redundant time synchronized with master clock system.
19. Each subsystem DDCMIS/PLC shall be provided with HW interfacing with main system DDCMIS/PLC for signals used for command, interlocks, protections and other important process parameters and shall be decided during detail engineering.
20. Control, operation & monitoring of electrical distribution system, namely PCC, Bus coupler, Incomer, breakers etc. for respective plant BOP/off-site package shall be controlled & operated from its respective DDCMIS/PLC operating station/ backup control desk as well as from respective switchgear unit. Control system for the same shall be implemented in the respective DDCMIS/PLC envisaged in the local control room. Bidder shall consider all transducers for monitoring of voltage, current, KWh, power factor at respective DDCMIS/PLC operating station and backup control desk. All signals shall be hardwired only.
21. The quantities of Hot standby redundant processors/CPU/controllers for each PLC system shall be finalized during detailed engineering by owner depending upon CPU/controller's worst data loading conditions and CPU/controller's functional distribution.

22. The technical particulars & requirements of PLC, OWS, Printers, LVS, GIU and all other related hardware/software shall be as per Vol. V, Part A & Vol. V, Part B, Chapter 3 & chapter 14.
23. The technical particulars & requirements of UPS & 24 V DC systems shall be as per Vol. V, Part A and Part B, Chapter 7.
24. In addition to interfacing defined in above table, any other interfacing required with station LAN, MIS server, End user's Head Quarter shall be provided as specified elsewhere in the specification.

CHAPTER – 15

ENVIRONMENT MONITORING SYSTEMS

15.00.00 ENVIRONMENT MONITORING SYSTEMS

Environment monitoring system provided by bidder shall consist of Boiler/stack emission monitoring system and Continuous ambient Air quality monitoring system. All the environmental parameters shall be monitored at respective location as detailed below and specified elsewhere in the specification. One no. DISPLAY BOARD shall be provided by bidder at plant main gate as per CPCB/SPCB requirement for monitoring the each & every environmental parameter.

15.01.00 Boiler/Stack emission monitoring system

15.01.01 Flue gas analyzers shall be provided for Boiler/stack continuous emission monitoring system (CEMS). Boiler/stack emission monitoring system comprising of carbon mono oxide, Sox /NOx, dust/opacity analyzer, Stack gas Flow & mercury Analyzer. All gas analyzer signals shall be connected to plant DDCMIS.

- i) All flue gas analyzers at stack shall be located at an elevation or as per pollution control board norms and shall be accessible for maintenance.
- ii) All output signals of all stack monitoring analyzers shall be hardwired and connected to plant DCS/ DDCSMIS as applicable for monitoring, archiving and report generation for environmental monitoring authorities. DDCMIS & CEMS OWS shall be equipped/loaded with necessary Boiler/Stack emission monitoring system's calculations and report generation software packages for generation of report for submission to environmental monitoring authorities. This is specific application software, being supplied by Boiler/Stack emission monitoring system's sub vendor under bidder scope.
- iii) Each analyser shall be independent and shall not share power supply processor etc. with other analyser except compressor for purging air. Separate compressor shall be provided as a part of CEMS.
- iv) In addition to continuous environment monitoring system, manual sampling provision for flue gas monitoring should be provided as per Emission latest Regulation of CPCB in each stack along with necessary provision of platform, lighting facility, safety rails and ladders etc. complete in all respect.
- v) Programmable Control Unit for CEMS

A programmable controller shall be provided for signal output, alarms, calibration cycle timers and measurement indication for each analyzer. The controller shall be panel or rack mounted and furnished with interconnecting cable to the field-mounted analyzer. Calibration cycle time shall be set over fixed internals and sequenced by the controller.

Isolated DPDT contacts shall be furnished for the following alarms:

- a) Two independently adjustable alarm levels for each constituent
 - Monitor range selection
 - Zero and span calibration
 - System faults

Bidder may use the control system with integral operating station in lieu of a programmable controller, provided the CEMS meets full certification criteria.

- vi) A dedicated Operating Station with calculations software, application software, report generation software packages, diagnostics and data logging features & B/W A4 sized LJP and laptop for site calibration shall be provided. The configuration of Operating station and Laptop shall be latest as specified in Volume V, Part B, chapter-3. Complete furniture as required for CEMS local control rooms shall also be provided by Bidder. Each Analyser shall be provided with RS232C/RS485/Ethernet TCP/IP output required to connect with CEMS operating work station, and port for calibration from Laptop.

Application software shall have the following minimum capabilities:-

- Visualization of acquired values of data from all analysers.
 - Average computation of data (programmable time like 30min, 1hour, 48 hours or 1 week).
 - Trend representation of raw, and averaged data (trend time period shall be freely selectable).
 - Archiving in simple formats like MS Excel etc.
 - Alarm setting and annunciation.
 - Calibration procedures.
 - Normalization of emission data.
 - Annual cumulative mass of pollution using flue gas flow and emission values.
 - Capabilities of comparison of data w.r.t. standard /threshold values.
 - Providing remote access to calibration and configuration.
 - Channel configuration for range, unit etc.
 - Data storage capacity.
 - Auto Report generation.
 - Diagnostics.
 - Data transmission.
 - All the necessary algorithms shall be provided to achieve system capability.
- vii) All the data shall also be available on DDCMIS for analysis and monitoring from CEMS OWS through redundant bus.
 - viii) Programmable digital display units/digital indicators shall be provided for each CEMS analyser in local CEMS room. Specification of digital display units/digital indicators shall be same as specified in Volume V, Part B, chapter 2, cl. No. 2.21.00.

- ix) The gas analyzers shall also follow the latest norms of Central Pollution Control Board. The measurement shall also conform to EPA, TUV, MCERTS or equivalents regulations.
- x) Power supply to CEMS shall be from plant UPS only.
- xi) Output of CO/Sox, Nox / CO₂/Dust monitors/Stack flow analyser shall be normalized for Temperature, Pressure, Water, vapour etc. This facility should be available in the respective gas analyzer.
- x) Weather protection against direct sunlight, rains etc for flow meter, local display/local indicators are required.

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

1. SO₂ / NO_x Analyser
2. CO analyser
3. CO₂ analyser
4. Flue gas Flow Meter
5. Flue gas temperature measurement
6. Stack Opacity Monitor
7. Mercury Analyser.

Quantities shall be as indicated in Volume V, Appendix I, Sr. no. G2, Part A.

The common requirements to be met for all types of analysers are as below. The specific requirements to be met by each type of analyser are detailed in the subsequent clauses.

15.01.03 **Common Requirements for all Analysers**

S. No.	Features	Essential/Minimum Requirements
1	Output signals	
	Analog	4-20mA DC galvanically isolated, if Analyzer provides superimposed HART signal on 4-20 mA DC output. It shall also be connected to OWS based HART station.
	Binary	2 NO + 2 NC for high alarm
2	Zero & span Adjustment	To be provided with range selection facility.
3	Ambient Temp.	50 °C
4	Indication	Digital Alphanumeric Display. Display of reading in engineering units shall be provided.
5	Enclosure Type/Material	Weather & Dust proof (IP 65) Die cast Aluminum/SS.
6	Type of Electronics	Microprocessor based with self diagnostic.

S. No.	Features	Essential/Minimum Requirements
7	Digital Signal transmission	HART/RS 485 Port Modbus Protocol/Ethernet TCP/IP protocol for communication of stack emission data to CEMS OWS to be provided by Bidder.
8	Calibration	Auto & Manual (from Remote)
9	Power Supply	To be arranged by Bidder subject to Owner's approval.
10.	Others	All interconnection tubing and cabling between probe and analyser / analyser panel and cabling from analyser/ analyser panel to DCS (in respective unit control room) & PC station are to be provided by Bidder.
		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	SO ₂ /NO _x /CO/CO ₂ -On stack at approximate elevation of 35 Mtrs. Stack Opacity & Flow measurement -On stack at approximate elevation of 88 Mtrs
		Mercury Analyser:- on stack at 35 Mtrs.
12	Location of the analysers (other than insitu type)/Analyser Panel.	AT 0' M near stack.
13	Compliance to standards	USEPA, TUV, MCERTS or equivalent standards
14	Type of Technology	SO ₂ /NO _x - Hot-extractive sampling type/Dilution Extractive/In-situ(Path) type CO- Hot-extractive sampling type/Dilution Extractive/In-situ (Cross-duct) type. (can be combined with SO ₂ /NO _x) CO ₂ - Hot-extractive sampling type/Dilution Extractive/In-situ (Cross-duct) type (can be combined with CO or SO ₂ /NO _x above). Stack Opacity- In situ (Path)type For Hot-extractive sampling type and Dilution extractive type systems, the entire system including analysers, sample handling/conditioning system etc offered shall be sourced from/assembled at Original Analyser manufacturer (OAM) works i.e., all components involved shall be imported or sourced from OAM only and no indigenous component shall

S. No.	Features	Essential/Minimum Requirements
		be used.
15	Contractual conditions for CEMS system	Availability of valid data:-AT least 90% of time during warranty and CMC period. For this purpose, Bidder may take necessary steps to ensure availability. Other conditions shall remain similar to Clause 3.39.00 & 3.40.00 of Volume V, Part B, Chapter 3.
16	System capability	<p>CEMS OWS station with application software shall be provided for the station. Application software shall have the following capabilities:</p> <ul style="list-style-type: none"> - Visualization of acquired values of data from all analysers - Average computation of data (programmable time like 30min, 1 hour, 24 hours, 48 Hours or 1 week) - Trend representation of raw, and averaged data (trend time period shall be freely selectable) - Archiving in simple formats like MS Excel etc. - Alarm setting and annunciation - Calibration procedures - Normalisation of emission data - Annual cumulative mass of pollutants using flue gas flow and emission values - Capabilities of comparison of data w.r.t. Standard/ threshold values. - Providing remote access to calibration and Configuration. - Channel configuration for range, unit etc. - Data storage capacity - Auto Report generation - Diagnostics - Data transmission - All the necessary algorithms shall be provided to achieve system capability. - Specification for OWS station shall be as per cl.no. 3.49.00, Volume V, Part B, Chapter 3

15.01.04 **Hot-extractive sampling type SO₂/NO_x, CO₂ & CO analyzers:-**

Specification Requirements system	SO ₂ Analyser and Nox Analyser cum monitor (combined)	CO ₂ Analyser	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/ 0-1500ppm Selectable	0 to 40% (fully selectable)	0-200 ppm to 0-1000ppm Programmable.
Accuracy	+/- 1% of F.S.	+/-2% of measured value	+/- 2 % of F.S.
Linearity	+/- 1% of F.S.	+/- 1% of F.S.	+/- 1% of F.S.
Repeatability	≤ 1% of Span	≤ 0.5% of Span	≤ 1% of Span
Response time (up to 90% of full scale)	< 5 seconds	< 5 seconds	< 5 seconds
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 Range	0-300 deg.C	0-300 deg.C	0-300 deg.C
Filter	Ceramic 3.5 Micron	Ceramic 3.5 Micron if extractive type	Ceramic 3.5 Micron
Accessories for purging system	Purging system (Auto Scavenging facility)	Purging system (Auto Scavenging facility)	Purging system (Auto Scavenging facility)
Temperature	Temperature of the sample shall be controlled before analyser.	Temperature of the sample shall be controlled before analyser.	Temperature of the sample shall be controlled before Analyser.

15.01.05 **Dilution Extractive type SO_x/NO_x/CO₂ & CO Analysers**

The design of the Dilution Extractive type system shall be satisfying the following requirements. The sampling system shall consist of Insitu 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.

- a) Modular Electronic Design.

- b) Heatless Air dryer with inlet filter, chemical scrubbers to remove traces of NO_x/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. The sample line has to be of PTFE.

Specification Requirements of Analysers	SO₂ Analyser	NO_x Analyser	CO₂ Analyser	CO Analyser
Principle	Pulsed/UV Fluorescence Technology.	Chemiluminescence Technology.	Gas Filter correlation	Gas Filter Correlation technology
Measurement Range	0-1500 ppm selectable	0-500ppm	0 to 40% (fully selectable)	0-200 ppm to 0-1000ppm Programmable.
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% F.S./Day)	(+/- 1% F.S./ Day)	(+/- 2% F.S./Day)	(+/- 1% F.S/ day)
Lower detection limit.	<= 1.0 ppb	<= 0.4 ppb	<=1 ppm	0.05ppm
Response time(up to 95% of full scale)	100 sec.	60 sec.	90 seconds	60 seconds
Accuracy/ Precision.	+/- 1%	+/- 1%	+/- 1%	+/- 1%
Linearity	(+/- 1% Full scale)	(+/- 1% Full scale)	(+/- 1.5% Full scale)	+/- 1% of F.S.
Operating Temp for analyser	5 deg.C - 40 deg.C	5 deg.C - 40 deg.C	5 deg.C - 40 deg.C	5 deg. - 40 deg.C

15.01.06 **Insitu (Path) type SO₂ / NO_x, CO₂ & CO analysers:**

Specification Requirements system	CO Analyser cum monitor	SO₂ / NO_x 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, programmable.	0-300 ppm/ 0-1500ppm Selectable.	0-40% (fully selectable)
Accuracy	+/- 5% of F.S.	<= 2% of measured value for SO ₂ and +/- 5% for NO ₂	
Linearity	+/-2% of F.S.	+/-1% of measurement range	+/-1% of measurement range
Repeatability	≤ 0.5% of Span		
Response time (up to 90% of full scale)	≤ 5 seconds		
a) Temperature Drift	Automatic temp compensation		
b) Zero Drift	<1% span/week		
c) Span Drift	< 1% measured value / week		
Operating Temperature Range	0-300 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	Automatic temperature control to be provided	Automatic temperature control to be provided	Automatic temperature control to be provided

15.01.07

ULTRASONIC FLOW METER FOR FLUE GAS FLOW IN STACK

Type	Transit time Ultrasonic meter
Mounting Style	Transducers on the duct/stack
Transducers	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 Bidder.
Output: Analog	Isolated 4-20mA linear outputs to DDCMIS.
Binary	RS485/ Ethernet communication link with MODBUS/OPC protocol to be connected to CEMS OWS station
Communication ports	Hand held terminal port
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, Weather protection against direct sunlight, rain etc. for Flow meter and suitable for Cooling water for Transducer
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.

15.01.08 **Dust density Stack Opacity monitor**

Specification Requirements system	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/m ³ , (Programmable)
Accuracy	2% of F.S.
Linearity	+/- 1% of F.S.
Repeatability	≤ 1% of Span
Response time (up to 90% of full scale)	≤ 5 secs
a) Temperature Drift	+/-1% in 24 hrs
b) Zero Drift	< 1% span/week
c) Span Drift	< 1% measured value/week
Operating Temperature Range	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	Yes. (Temperature measurement using thermocouple and transmitter with a 4-20mA flue gas temp signal to DDCMIS in addition to Opacity monitor)

Note:

01. 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. If the SO_x, NO_x, CO₂ & CO (if sampling/dilution type) analyzers do not meet the environmental conditions specified at cl. 1.07.00 of Volume V, Part- B, Ch.-01. Panel AC shall be provided in analyzer cabinets to meet the requirement.

15.01.09 **Continuous Online Mercury Analyser:**

Measurement	Elemental, Ionic & Total mercury
Measuring range	0–100 µg/Nm ³
Measuring principle	Cold Vapor Atomic Fluorescence
Flue gas temperature	0–250°C minimum. Probe material shall be as approved by owner.
Measuring outputs	2 x 0 / 4–20 mA, RS 232, RS 485 & Ethernet port
Digital outputs	4 relay outputs
Digital inputs	1 potential free outputs
Accuracy	< 1% of measuring range
Minimum Detectable limit	< 1 µg/Nm ³
Temporary change of sensitivity/Reference point drift	< ± 2% of measuring range per month
Temporary change of zero offset/Zero Point drift	< ± 1.4% of measuring range per month, zero correction (automatic)
Power supply	230 VAC, 50 Hz, from Plant UPS
Display	LCD display
Special Requirements	Non Interference with SO ₂ , NO _x , CO and any other chemical components.
Bus Protocol	MODBUS/TCP-IP protocol to be connected to CEMS OWS.
Accessories	Automatic purging system, Automatic dilution system, Automatic calibration system, filters etc. Panel shall be designed considering all requirements indicated in Volume V, Part B, Chapter 6.
Consumables	For one year operations in addition to mandatory spares.

15.02.00 **CONTINUOUS AMBIENT AIR QUALITY MONITORING SYSTEM (CAAQMS):**

15.02.01 AAQMS shall be provided to check upon the ambient air quality inside and around the power plant and capable of generating required reports for submission to relevant central & state regulatory agencies by owner. AAQMS's supplier shall have experience & PTR for installation, execution & commissioning of similar type of system in last 5 years in 2 nos. thermal power stations of capacity of 500 MW or more.

15.02.02 Ambient air quality shall be monitored for concentration levels of selected gaseous pollutants at different locations within the power station boundary

and adjoining areas as per the ambient air quality monitoring guidelines of central and state regulatory agencies like MOEF, central and state pollution control boards (PCBs) prevailing during contract execution phase.

- 15.02.03 AAQMS system including the analyzers being supplied shall meet all applicable requirements/ guidelines of relevant central & state regulatory agencies like MOEF, central and state pollution control boards (PCBs) etc or of US EPA in the absence of the same. It is the sole responsibility of the vendor to obtain the necessary approval. Owner has no liability towards the same. 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, Env. Canada, Env. Japan, EEC etc shall be furnished.
- 15.02.04 AAQMS shall include monitoring of the following pollutant gases/parameters. However, any other gases/parameters recommended by relevant central & state regulatory agencies during project implementation phase shall also be provided. Method of measurements & standards shall be as per CPCB and state pollution control boards (PCBs) norms. There shall not be any cost implication for the same to owner.
- a) Sulphur dioxide (SO₂)
 - b) Oxides of nitrogen (NO_x)
 - c) Carbon monoxide (CO)
 - d) Carbon Di-oxide (CO₂)
 - e) Suspended particulate matter (PM10)
 - f) Suspended particulate matter (PM2.5)-respiratory
 - g) Total Suspended particulate (TSP)
 - h) Ozone (O₃)
 - i) Mercury Analyser - at one location only
- 15.02.05 AAQMS for each plant location shall be fixed type, self contained 'station'. Total four (4) nos. such stations shall be provided at the min. one (1) no 'station' shall be located at the "Up wind" direction path. Balance three (3) no. 'stations' shall be located at different plant locations considering the factors like downwind direction, sensitive receptor, population etc. the exact location of the monitoring stations shall be decided in consultation with owner and regulatory agencies during project implementation phase. However, during the contract implementation stage, if additional number of such monitoring locations and hence AAQMS stations are required as per regulatory agencies requirement then the same shall be provided by the bidder at no extra cost implication to owner.
- 15.02.06 Ambient air quality monitoring for each plant location shall be suitable for continuous on line monitoring of different pollutant gases.
- AAQMS shall allow on line monitoring, on line logging of parameters values, on line archiving and on line report generation for environmental monitoring authorities (CPCB & SPCB) and plant management personnel. All required software & hardware shall be provided by bidder.
- 15.02.07 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.

- 15.02.08 The system must function properly in the weather and atmospheric conditions mentioned in Volume V, part B, chapter 1.
- 15.02.09 The system shall be supplied with all ancillaries and consumables necessary for trouble free operation during the Warranty period. In case the. Shelf life of any consumable is shorter, and then supplies to be done in suitable phases. Vendor shall give details of shelf-life, quantity of consumables required etc. to last the warranty period.
- 15.02.10 A Sampling System compatible with the Analysers / Monitors for Total Suspended Particulates (TSP), PM10, PH2.5, CO, O3, Mercury, NOx and SO2, CO2 shall be provided. The system, wherever applicable, shall also be compatible with Analysers for Pb (which the Owner may procure in future). The system, wherever applicable, shall have the facility for moisture removal.
- 15.02.11 Minimum requirements like input power, space, approach and any other associated facilities required for installation and commissioning of the AAQMS shall be specified by the vendor in the offer. Installation and commissioning of the AAQMS shall be done by the vendor at the site provided by HPGCL. Vendor shall obtain statutory and other clearances for purchase, commissioning and operation & maintenance of the AAQMS.
- 15.02.12 Vendor shall furnish, along with the bid documents, the details of calibration system provided with each Analyzer / Monitor.
- 15.02.13 AAQMS system shall include the following
- a) AAQMS stations -4 nos.
 - b) Centralized AAQMS data acquisition system.
- 15.02.14 Each AAQMS station shall include the following including analyzer, accessories, calibration facility, mounting racks/cabinets, furniture, and housing shelter, data acquisition system etc. but not limited to the same:
- a) Individual gas analyzers for the parameters specified.
 - b) Necessary sampling systems for AAQMS analysers
 - c) Multi gas calibration system
 - d) Zero air generators.
 - e) Hydrogen generator.
 - f) Calibration gas cylinders.
 - g) Mounting cabinet / rack for analyzers and accessories
 - h) Housing shelter for AAQMS equipment – environmentally conditioned, walk-in Type Shelter complete with lighting and convenience receptacles.

- i) UPS & lighting power supply complete with distribution facility.
- k) WORK STATIONS based data acquisition system for AAQMS station.
- l) Furniture like work station tables, industrial grade chairs, working tables etc.
- m) Interfacing the AAQMS analysers signals to the AAQMS work stations either by serial communication link or hardwired signals including suitable cables with accessories at both ends and cable carrier etc.

15.02.15

SPECIFICATIONS OF CONTINUOUS MONITORING AMBIENT AIR ANALYSERS

Description	NO-NO ₂ -Nox Analyser	SO ₂ Analyser	CO Analyser	Ozone Analyser	Mercury Analyser
Principle	Chemiluminescence	UV Fluorescence	NDIR Spectroscopy	UV Photometric/ Chemiluminescence	Atomic Absorption/ Atomic Fluorescence
Measurement	NO, NO ₂ , NOx in Ambient Air	Sulphur Dioxide Ambient Air	CO	O ₃	Hg
Display	LCD	LCD	LCD	LCD	LCD
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	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	0-1 PPM to 0-1,000 PPM selectable	0-100 ppb to 0-10 PPM	0.5 – 2000 ng/m ³ 5-1000 ng/m ³ selectable
Minimum detectable Limit	1 PPB	1 PPB	0.05 ppm	0.6 ppb (RMS)	-
Noise Level	0.5 PPB or less	0.5 PPB or less	-	-	-
Zero Drift Lowest Range	<1PPB in 24 Hours	<1 PPB in 24 Hours with automatic zero compensation	<0.1 ppm/day	<1.0 ppb	-
Span Drift at Lowest Range	+2% in 7 days of full scale	+2% in 7 days of full scale	<1% of reading per day	± 1% of measured value /week	-
Response time at Lowest range	<=100 sec	<=60 sec	<60 sec	20 Seconds	-
Linearity	+1% of full scale	+ 1% of full scale	1% of full scale	1% of full scale	-

Description	NO-NO ₂ -Nox Analyser	SO ₂ Analyser	CO Analyser	Ozone Analyser	Mercury Analyser
Calibration	Built – in calibration Facility	Built –in calibration facility	Built –in calibration facility	Built –in calibration facility	Built –in calibration facility
Consumables and spares	Recommended requirements of 3 Years of continuous operation	Recommended requirements of 3 Years of continuous operation	Recommended requirements of 3 Years of continuous operation	Recommended requirements of 3 Years of continuous operation	Recommended requirements of 3 Years of continuous operation
Digital Signal Transmission	RS 232 link. Analyser shall be capable to transfer all the data through RS 232/485 link to a PC/OWS based data logger.	RS 232 link. Analyser shall be capable to transfer all the data through RS 232/485 link to a PC/OWS based data logger.	RS 232 link. Analyser shall be capable to transfer all the data through RS 232/485 link to a PC/OWS based data logger.	RS 232 link. Analyser shall be capable to transfer all the data through RS 232/485 link to a PC/OWS based data logger.	RS 232 link. Analyser shall be capable to transfer all the data through RS 232/485 link to a PC/OWS based data logger.

15.02.16 **Continuous ambient air measurement of TSP, PM10 & PM 2.5.**

Principle:- 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. Each analyser shall 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

1.	Measurement	Continuous ambient air measurement of TSP, PM10 & PM 2.5
2	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.
3	Measurement Range	0-2000 microgram per cubic meter ($\mu\text{g}/\text{m}^3$) in programmable multi-ranges
4	Display	LCD
5	Resolution	1% of the concentration
6	Minimum Detectable Limit	2 micrograms/m ³
7	Filter material	glass fiber filter
8	Roll length	Approximately 30 meters
9	Measurement result	1 hour average of shorter
10	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.

15.02.17 **CO₂ analyser**

a) Principle	:	IR type with gas filter correction
b) Range	:	1 to 10000 ppm
c) Minimum detectable limits	:	0.04 ppb
d) Zero drift (24 hr. basis)	:	<0.1 ppm per day
e) Span drift (24 hr. basis)	:	± 1% per week
f) Response time	:	60 sec.
g) Accuracy	:	± 0.1 ppm
h) Linearity	:	± 1% of full scale reading
i) Operating temperature	:	20-30°C
j) Signal output	:	4-20 mA DC, RS 232 or RS 485 link
k) Power supply	:	230V AC(UPS)
l) Mounting	:	rack mounted
m) Digital Signal Transmission	:	RS 232 link. Analyser shall be capable to transfer all the data link to a logger. through RS 232/485 PC/OWS based data

15.02.18 **Multi-point calibration System**

To cross check the built-in-calibration facility of the Analysers/Monitors, a Multi- Gas Calibration System for each AAQMS station with fast response time shall be offered by the Vendor 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/4AB of Germany, Env. Canada, Env. Japan, EEC etc. requirements.

a) Flow measurement accuracy	± 1% of set point or ± 1% of full scale reading (ln 20-100%) whichever is less.
b) Repeatability of flow control	± 0.2 % of full scale reading
c) Linearity of mass flow Measurement	± 0.5 % of full scale reading
d) Calibration gas input ports	6 nos.
e) Response time	<60 sec. for 0-99 %
f) Temperature range	0-40°C
g) Power supply	230V AC (UPS)

15.02.19 Analyser gas sampling system shall be complete with sampling hood arrangement with SS hood, SS 316 manifold, moisture trap, air compressor of requisite capacity (minimum 10 LPM) and heat less type air dryer.

15.02.20 Zero air generators shall be with inbuilt catalytic converter.

15.02.21 The analysers should be complete with calibration system. Calibration gas cylinders for NOX, SO₂, CO, CO₂, O₃, Mercury Analyser, TSP, SPM-PM₁₀ & PM_{2.5} analysers as required of appropriate capacity suitable for minimum 6 months calibration with SS 316 regulator. All the calibration gases provided

along with the system must be NIST traceable. The analyser must have zero point internal calibration system. The calibration procedure shall be integrated into the software system for automatic calibration.

- 15.02.22 Hydrogen generator complete with fluid tank and all accessories –hydrogen purity of >99.99%.
- 15.02.23 All the Analyser shall be provided with dual range & auto ranging facility.
- 15.02.24 All consumables like Chemical reagents, filters, markers, papers etc shall be provided by bidder.
- 15.02.25 The analysers must function properly in Indian conditions without any defect between 0 to 50 deg C ambient temperature, 0 to 100% relative humidity and in high ambient dust level.
- 15.02.26 All Analysers, Monitors and Sensors shall be fully integrated in the Rack Cabinet which is installed in shelter and fully calibrated and tested before call for inspection. Total integrated analyser system along with shelter shall be functionally inspected by Owner at vendor's place prior to dispatch to site.
- 15.02.27 Analysers shall be provided with ears & handle (Retrofit).

15.03.00 Void.

15.04.00 **AAQMS analyser shelter**

15.04.01 **General requirement**

The analyser shelter shall be a completely assembled unit suitable for installation on a concrete pad or as a stand-alone unit. All internal piping and tubing shall terminate in bulkhead connections. Internal wiring will terminate in external junction boxes. All equipment including tubing, conduit fittings, junction boxes etc. shall be installed so as not to interface with the removal of analysers, sample handling systems and related equipment, accessibility for maintenance shall be the prime consideration. The minimum size of shelter shall be 3 x 4 mtr. to accommodate the panels, work stations, tables, revolving tilting chairs, cupboard, UPS, battery etc.

15.04.02 **Construction features**

- i. The analyser shelter shall consist of a self-framing exterior skin assembled on a rigid primed and painted steel superstructure. All materials used in the construction shall be non- combustible
- ii. Wall panels design to be completely weather resistant. The design shall allow for thermal expansion/contraction of the structure over the complete range of ambient temp. Applicable for the location without causing harmful buckling or opening of joints etc. materials of construction shall be 2 mm thick SS sheets for external walls and 18 gauge galvanized steel for internal walls with ribbed interlocking. The ribbed interlocking shall provide a strong column for the sheets on the side valves, where the "u" profile created at the edges, when interlocked with the second sheet, increases the section modules of ribbing.

- iii. The wall panels of the shelter shall be insulated and designed for the given ambient conditions by glass rock wool approx. 100 mm insulation thickness.
- iv. Roof panels design and construction to be completely weather resistant. The design shall allow for thermal expansion/contraction of the structure over the complete range of ambient temp. Applicable for the location without causing harmful buckling or opening of joints etc.
- v. The base structure of the shelter shall be constructed using ISMC (1501125) ISMB (100) welded property and adequately sized to ensure structural rigidity to prevent deformation during dragging, lifting, loading and unloading of the shelter.
- vi. The roof panels shall be provided with 80mm thick rock wool insulation.
- vii. All insulation materials are to be fire retarding.
- viii. The analyzer house shall have two doors, one as the main entrance and the other as the emergency of the shelter.
- ix. The doors are to be mounted on special hinges to ensure gas tight construction of the shelter.
- x. Doors shall be sturdy, double walled, insulated with rock wool and open to the outside. Each door shall have a window with transparent toughened safety glass.
- xi. The main entrance shall carry a plate indicating the plane area number and the tag-list of all the analyzers inside the shelter.
- xii. Analyzer shelters met the standards of the unknown building code with the following design loads:
 - i) Roof 20 lb / sq ft live load
 - ii) Wind 35 lb /sq ft at 0-30 ft above grade elevation
 - iii) Seismic zone as applicable
- xiii. All tubes and cable entries to the shelter shall be through multi-cable transit blocks – to ensure gas tightness of the shelter
- xiv. The floor is to be fabricated with anti-slip sheet and sealed continuously to ensure no loss of pressure.
- xv. Each shelter shall be provided with lightening protection system.

15.04.03

Painting

- a) Preliminary cleaning involving removing of grease, oil, paint and dirt, which prevent pickling acid from coming in contact with the scale or mist.
- b) Structural painting shall include scraping, chemical cleaning, one coat of each primer, one coat of epoxy zinc chromate red oxide primer and two coats of epoxy finish paint. The surface coating shall take sufficient care of removing all the containment thus ensuring against premature and

complete coating failure. Precautions to be taken to avoid air bubbles and uneven coat thickness.

- c) Internal sheet metal: the internal walls shall be powder coated.
- d) Painting for the shelter is completed in every respect before dispatch. No painting will be done at site except touch up of scratches made during site erection.

15.04.04 **Environmental conditioning**

Analyzer shelters shall be environmentally conditioned to keep the inside atmosphere of the shelter at a constant temperature of $24^{\circ}\text{C} \pm 3^{\circ}\text{C}$ to obtain repeatability and reliability of the analyzers and also a comfortable working environment for workmen. For this purpose either a skid mounted type air conditioning unit or 'split type' industrial grade air conditioner (1 working & 1 standby) to be provided. Air conditioner shall be able to work continuously under ambient worst conditions. A 300 mm single phase (230/240 V AC) exhaust fan with safety grills & flap type louver shall be provided in the shelter. Hygrometer shall be provided to measure & display the humidity inside the shelter. Similarly thermostat shall be provided to measure & display the Temperature inside the shelter. All Air conditioner shall be 5 star rated.

15.04.05 **Lighting**

- a) Illumination level in the shelters will be at a minimum of 300 lux at 750mm elevation inside the shelter. Maintenance factor shall be 0.65
- b) External dome type lighting shall be under the overhangs to provide sufficient illumination for maintenance work.
- c) Power switches for internal and external lighting will be provided near to the main entrance on the outside of the shelter.

15.04.06 **Fire detection & protection:**

Necessary fire & smoke detection devices, 2 nos. Fire Extinguishers, fire detection & protection measures for each analyzer shelter shall be provided as per regulatory requirement. Fire & smoke detection devices shall be provided with pot. free contact/suitable interfacing to connect with local work station for alarm purpose.

15.04.07 If UPS feeders cannot be provided from Plant UPS for the AAQMS 'station', then UPS of suitable capacity with all accessories like battery and battery charger shall be provided. Spec for UPS & battery shall be same as mentioned in Volume V, Part B, chapter 7, Cl. No. 7.01.05 (B) without BHMS.

15.05.00 **Power distribution board**

Power distribution board with external surge protection devices for distribution of UPS & 240/230 V AC power for all individual consumers as individual analyzers, auxiliary equipment inside and around the shelter, lighting receptacles shall be provided. Each of the main systems shall have an individual isolation circuit breaker 2 pole type mounted nest to the individual power users.

- 15.05.01 Telephone connection with telephone set and walki talkie set shall be provided for each AAQMS stations.
- 15.05.02 Air conditioner (condenser unit) and any other equipments installed outside the shelter shall be placed under proper sun/rain protection shade/canopy. Folding Aluminum ladder (height 180 cm) for roof access and mounting bracket for ladder shall be provided by bidder.
- 15.05.03 Analyser panels & furniture shall be provided with all features as specified in Volume V, Part B, chapter 1 & 6.
- 15.06.00 **WORK STATIONS based data acquisition system (DAS)/Data Logger System for AAQMS station**

The WORK STATIONS based DAS system for each AAQMS station shall collect, store and analyze real time air quality data from all instruments of the station through user friendly software and operate on the latest windows software system. Diagnostic features should be clearly indicated by the system and any unauthorized access should be protected by a password. PPB to microgram per cubic meter (ug/m³) conversion factors should be part of system. WORK STATIONS specification shall be same as specified in chapter 4. For these purpose all instruments shall be interfaced with local DAS system suitably either through a redundant serial link or by hardware. The application software shall have the following features:

- a) Calculation of arithmetic mean values, average values at different fixed intervals and user defined time periods like hourly/weekly/monthly/yearly etc.
- b) Calculation of pollution load and wind roses (by interfacing meteorological data wherever provided)
- c) Generation of reports for at different fixed intervals like daily, weekly, annual etc. and for user defined periods.
- d) Generation of reports in the form of line/column charts/tables/curves/graphics etc.
- e) Generation of reports for pollution load, wind rose, station etc.
- f) Comparison of data of various parameters for the same monitoring station.
- g) Generation of reports for real time data and based on archived data.
- h) Display of real time (on line momentary values) and archived values in tabular texts and graphic formats.
- i) Facility for calibration windows for analyser calibration.
- j) Real time monitoring of status of all analyses and sensors with diagnostics for maintenance personnel.
- k) Alarm annunciation of analyser/sensor abnormal conditions.
- l) 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). Diurnal variation, standard deviation, regression and other statistical parameter reporting possibilities with various available models.

- m) Control panel window for controls of each Analyser, including calibration.
- n) Real time multi-curves/graphs, historic multi-curves/graphs, tabular data over user selectable time period.
- o) Real time status and diagnostics for maintenance people.
- p) Possibility to export the data files in other formats.

15.06.01 **Data Communication System**

Redundant hardwired LAN connectivity or industrial grade UHF RF based redundant two way wireless communication link (as decided during detailed engineering depending upon the distance between individual AAQMS station and centralized AAQMS station) shall be provided for each AAQMS station for data communication with centralized AAQMS station.

Bidder shall determine the optimal antenna type required to achieve data transfer rate between all wireless access points. Bidder shall use for this purpose, approved and standard equipment like antenna and/or amplification devices etc. required to achieve the above and shall provide agreement of technical support and support availability.

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

15.07.00 **Central AAQMS monitoring**

15.07.01 Monitoring and report generation of AAQMS for the whole power station shall be carried out through a centralized WORK STATIONS based data acquisition system. For this purpose, all individual analyzer data from each AAQMS stations shall be collected in WORK STATIONS based centralized AAQMS DAS monitoring system with B&W A4 sized LJP. WORK STATIONS & printer specification shall be same as specified in Volume-V, Part-B, Chapter-3. Central AAQMS shall also be connected to Plant DDCMIS & MIS server for monitoring thru Station LAN for transfer of data. Necessary Software for the Purpose shall Be Loaded into DDCMIS.

15.07.02 Central AAQMS DAS system shall perform following functions:

- a) To collect all the data from individual AAQMS stations at prescribed time or on request.
- b) Ability to manage multiple remote AAQMS stations.
- c) Monitoring, analyze, report generation and archiving of data.
- d) To transmit the data to plant DDCMIS
- e) To transmit the data to Digital Display Board



- 15.07.03 Central AAQMS DAS system software shall have following features
- Data backup facilities should be available. Minimum, median, percentile, maximum, standard deviation frequency analysis and cumulative frequency analysis should be possible.
- a) Calculation of arithmetic mean values, average values at different fixed intervals and user defined time periods like hourly/weekly/monthly/yearly etc. for each remote station.
 - b) Calculation of pollution load and wind roses (by interfacing meteorological data)
 - c) Generation of reports for at different fixed intervals like daily, weekly, annual etc. and for user defined periods.
 - d) Generation of reports in the form of line/column charts/tables/curves/graphics etc.
 - e) Calculation of reports for pollution load, wind roses, station etc.
 - f) Comparison of data of various parameters for the same monitoring station.
 - g) Inter comparison of data between different monitoring stations.
 - h) Generation of reports for real time data and based on archived data.
 - i) Facility for calibration windows for analyzer calibration.
 - j) Real time monitoring of status of all analysers and sensors with diagnostics for maintenance personnel.
 - k) Alarm annunciation of analyser/sensor abnormal conditions.
 - l) Should have the facilities of the following chart types: like Line & column chart, Simple 3 D, line & column chart, Polar diagram and 3 D perspective column chart.
 - m) Should have the remote control facilities for calibrations (Zero & Span) and Measuring Range.
- 15.08.00 **Design, Functional & Performance Requirements**
- 15.08.01 AAQMS offered shall ensure operability, maintainability and reliability. This system offered shall be consistent with modern practices and shall be compliance with all applicable codes, standard guides, statutory regulations and safety requirements.
- 15.08.02 AAQMS shall be provided to check upon the ambient air quality inside and around the power plant and capable of generating required periodic reports for submission to relevant Central and State regulatory agencies by Owner.
- 15.08.03 Ambient air quality shall be monitored for concentration levels of specified gaseous pollutants at different locations within power station boundary and adjoining areas as per the ambient air quality monitoring guidelines of

National air quality standard & together with any specific guidelines of Central & State regulatory agencies like MOEF, Central and State Pollution Boards (PCBs) prevailing during project .

15.08.04 AAQMS system including the method of measurement and analysers being supplied shall meet all applicable requirements/guidelines of relevant Central & State regulatory agencies like MOEF, Central & State pollution Control Boards (PCBs) etc. or of US EPA in the absence of the same. It is the sole responsibility of the vendor to obtain the necessary approval from State PCB. Owner has no liability towards the same. A proof of approvals and certificates of the above compliance along with the copy of Test Report (in English) from internationally reputed agencies such as US EPA, TUV/UAB of Germany, EEC etc shall be furnished.

15.09.00 **Meteorological Monitoring System (MMS)**

15.09.01 A meteorological monitoring system (MMS) shall be provided in line with the recommendation of the EIA report. Meteorological data shall be monitored with in the Plant Premises at One (1) Location or as required by MOEFCC & State PCB. The Exact Location of the Monitoring Station(s) shall be decided in Consultation with Owner during Project Implementation Phase Based on the Central & State PCB Guidelines. The Following Parameters Shall Be Monitored:

- a) Wind Direction
- b) Wind Speed
- c) Ambient Temperature
- d) Ambient Pressure
- e) Solar Radiation
- f) Relative Humidity
- g) Rainfall

15.09.02 MMS shall be Continuous On-Line Type. MMS shall allow monitoring, Logging of parameter Values, Archiving and Report Generation for Environmental Monitoring Authorities and Plant Management Personnel. MMS sensors shall also be provided with auto calibration system.

The Meteorological **data acquisition system** / Data Logger shall be provided with at least 8 Analog and 24 Digital Inputs and internal memory for all collected parameters. The Data loggers shall have capability of connecting to all Analysers/ Monitors including any future optional Analysers and Sensors for meteorological parameters.

Functional Requirement of Data Logger

1. Calculate vector mean of wind direction and wind speed, generate reports of wind roses, pollution roses, alarm for all parameters.
2. 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). Diurnal variation, standard deviation, regression and other statistical parameter reporting possibilities with various available models.

3. Control panel window for controls of each Analyser, including calibration.
4. Real time multi-curves/graphs, historic multi-curves/graphs, tabular data over user selectable time period.
5. Real time status and diagnostics for maintenance people.
6. Possibility to export the data files in other formats.

15.09.03 MMS shall be complete with all the Necessary Measuring Equipment And Accessories And shall Be housed in A Walk-In Shelter, Environmentally Conditioned (If Required For Measuring Equipment), Complete With Lighting And Convenience Receptacles. For this Purpose MMS equipment can Be Housed In One AAQMS Station Shelter. Alternatively, A Separate Shelter For Housing MMS Equipment Shall Be provided with all features as specified for AAQMS shelter.

15.09.04 Output Signal of All Meteorological Monitoring Analysers shall be connected to the Central AAQMS monitoring station either through serial link or by hardwire signals for Monitoring, Archiving And Report Generation For Environmental Monitoring Authorities. Necessary Software for the purpose shall be loaded onto the Central AAQMS monitoring station.

15.09.05 **SPECIFICATIONS OF METEOROLOGICAL SENSORS**

Description	Wind Speed Sensor	Wind Direction Sensor	Air Temperature Sensor	Relative Humidity (Rh) Sensor	Solar Radiation Sensor (Solarimeter)
Principle	Frequency proportional to wind speed	Potentiometric type Sensor (Resistance proportional to Wind direction)	RTD (Platinum) Resistance proportional to temperature	Thin film capacitance type sensor	Thermopile/ Thermo-couple based with Appropriate Wind Shield
Range	0-60 m/ sec	0-360 deg	0-50 deg C	0-100% RH	0.3 to 60 microns Measurement range:- 0-1500 watt/m2
Accuracy	2 % of full scale	2 % of full scale	+ 0.2 deg C	3 % for range 10% to 90%	+ 3.5 %
Threshold	0.3 m/ sec	0.3 m/ sec		Sensitivity:- 0.2% RH	
Operating Temperature	0 to 50 deg C	0 to 50 deg C	0 to 50 deg C	0 to 50 deg C	0 to 50 deg C
Radiation shield			Non-aspirated Radiation Shield	Non-aspirated Radiation Shield	

15.09.06 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

15.09.07 Meteorological Mast

One Meteorological Mast of telescopic type and of specified height to be placed on an existing 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 for installation of the Sensors. Material of Construction of the Mast shall be metallic i.e. heavy grade aluminum and robust and shall be resistant to atmospheric corrosion. Wind load limit shall be more than 8.5 sq. ft at 50 mph.

15.10.00 CPCB is now insisting that all the Power plants should upload the environment parameters to CPCB's web server. One no of work station with necessary software (as recommended by CPCB) with modem & dedicated internet connection and necessary I/O cards to access the mA output from various analyzers, is to be supplied for uploading the parameters of CEMS & CAAQMS. (Minimum of 40 parameters are to be uploaded and actual no. will be discussed during detailed engineering).

15.11.00 Specification for Digital Display Board

1. Size of the display - 4' (H) X 8' (L) minimum.
2. Visibility Range - 80-100 mtr (Size of display shall be suitable to achieve the visibility range).
3. No of Display lines - 7 as following:
 - a. Name of company
 - b. Date and Day
 - c. Stack emission parameters with units
 - d. Ambient air quality parameters with units
 - e. Meteorological parameters
 - f. Provision for additional line

- | | | |
|-----|-----------------------------------|--|
| | | g. Provision for additional line |
| 4. | Display of colour elements | - Colour (RGY) |
| 5. | Minimum life span | - 5 years |
| 6. | Ambient Temperature | - Maximum 50°C |
| 7. | Humidity Range | - 0-99% |
| 8. | Language | - English only |
| 9. | Colour gradient | - Cluster LED based |
| 10. | Display casing | - Weather proof casing IP 65 with Canopy. |
| 11. | Type driven | - Microcontroller/Microprocessor |
| 12. | LED matrix | - 2X64X128 for above display size. |
| 13. | LED pitch | - 0.6" |
| 14. | Signal input to the display board | - (i) 10-Analog signals from stack Monitoring Device/DDCMIS.

(ii) Data communication through RS 232/ 485/Ethernet or suitable protocol from CEMS OWS for all parameters of Stack monitoring Device.

(iii) Data communication through RS 232/ 485/Ethernet or suitable protocol from CAAQMS station for all parameters of CAAQMS and Meteorological parameters. |
| 15. | Power Supply | - 230V AC from UPS. |

CHAPTER – 16**PLANT SECURITY AND SURVEILLANCE SYSTEM****16.00.00 PLANT SECURITY AND SURVEILLANCE SYSTEM****16.01.00 General Requirements**

- 16.01.01 The intent of the specification is to define the functional & design requirements for the CCTV System & Plant intruder detection system meant for gathering video information from the various areas of the power plant. The Bidder 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, conducts etc.) are also included in Bidder's scope.
- 16.01.02 The design and manufacture shall be such that equipment / components of same type and rating are interchangeable.
- 16.01.03 The number of camera units and their locations are listed at Appendix-1 to Part-A of technical specifications. The number of Camera management /Database Servers, Work Stations (with Monitor & Without monitor), Keyboard & Joystick, Network Switches, L-III switches(Router), Cables, Hardware & Software required for interfacing with LVS will be as on required basis & to ensure satisfactory performance of the system.
- 16.01.04 The system and all the equipment shall conform to the latest edition of India / International and CCITT standards as applicable. All the offered cameras and software must comply to ONVIF Profile G, T or latest version in order to ensure open architecture system and ease in future expansions, upgrades and maintenance. OEM of Camera and VMS Software shall be full member of ONVIF Committee. There should be no ONVIF membership restrictions on CCTV OEMs, this means that Camera OEMs can participate in ONVIF committees which include ONVIF new profile development and maintenance. Similarly, OEMs can use new ONVIF tools and software for camera testing. The bidder shall submit a declaration in this regard from the OEM. Also the offered camera and Software vendor must have the registered office in India with support and service facility. Repair and/replacement of the offered cameras/software shall be provided from this local office. Letter of declaration from OEM for the same shall be provided.
- 16.01.05 The Bidder shall guarantee satisfactory performance of the equipment under stipulated variations of voltage and frequency. The design and manufacture shall be such that equipments/components of same type and rating shall be interchangeable.
- 16.01.04 The design of the security & surveillance system shall take into account the potential security risks to the power plant. Plant security and surveillance system shall be an integrated system comprising the following systems/facilities:

- (a) Perimeter Intruder Detection System
- (b) CCTV Monitoring of Plant area/ equipment

16.02.00 **POWER SUPPLY ARRANGEMENT**

16.02.01 The complete System along with all its components i.e network switches, storage devices, servers, LAN switches, media converters, cameras etc. shall be powered from UPS system as detailed in Sub-section-Power Supply, Vol V, Part-B, Chapter 7. Bidder shall also provide local power distribution boxes (as detailed in Sub-section-Power Supply, Part-B, Chapter-7) as required for sub-distribution of UPS supply. Spec for UPS & battery shall be same as mentioned in Vol. V, Part B, chapter 7, Cl. No. 7.01.05.

16.02.02 Each camera shall be powered with UPS redundant power supply only with automatic change over circuitry at power distribution panel end.

Requirements of redundant mini smart UPS (in case main UPS power supply is not available) shall be decided during detailed engineering as per camera's locations. Bidder shall also provide local power distribution boxes as required for sub distribution of power supply from redundant mini-UPS to cameras. The power supply distribution box shall include automatic changeover circuitry, display, indicating LED/lamps, MCB's, terminal blocks etc suitable for application.

The location of mini-UPS & power distribution scheme shall be finalized by owner during detail engineering.

16.03.00 **DESIGN AND TECHNICAL REQUIREMENTS**

16.03.01 The CCTV system shall be able to provide surveillance of different locations the plant as listed at Appendix-1 to Part A of technical specifications. Bidder 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 with interface to station LAN network at one point. For more details refer Plant security & surveillance system, drg no. # 114-01-0122, Rev0. 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.265 or better compression technique. Joystick and mouse-keyboard controllers shall be used for Pan, Tilt, Zoom and other functions of desired cameras.

16.03.02 The complete system shall be divided into the following zones:-

- 1) One Zone for the Generating Unit.
- 2) One Zone for Common Plant System.
- 3) One Zone for Coal Handling Plant.
- 4) One Zone for distant plant (To be connected through Wireless).



- 16.03.03 The camera server and hot redundant 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 suitably 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.
- 16.03.04 System shall ensure that once recorded, video cannot be altered. Recorded video shall be encrypted using industry standard 1024 bit encryption. System shall also be configured to raise the alarm in case any video files within the recording media is deleted by any manual action.
- 16.03.05 Camera server shall be provided with sufficient storage space to store recordings of all cameras at 25 FPS,4CIF 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.
- 16.03.06 It shall be possible to export selected portion of recording to Portable Media. The exported clip shall be in commonly used movie file formats e.g MPEG, AVI, WMV and no special software shall be used to view same. The system should be capable for attaching a digital signature for authentication of exported video clips in WMV/AVI format.
- 16.03.07 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 Bidder 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.
- 16.03.08 The system shall be able to accept potential free contacts from other system and use the same for predefined actions (like zoom/pan/tilt of cameras, bringing out pre-defined views on predefined monitors etc.) This feature shall be extensively used for linking fire related signals. For implementation of the same, 30 nos. potential free contacts for unit, 30 nos. potential free contacts for CHP and 25/30 Nos. potential free contacts for common plant area shall be provided for interfacing with CCTV system panels. This functionality can be provided as a part of camera or through separate network compatible alarm panel.
- 16.03.09 For the purpose of perimeter detection and CCTV monitoring, a security room shall be provided (location of security room shall be as finalized during detailed engineering). This room will house servers, OS, Network controllers/switches, Video recorders, monitors, PTZ units/controllers and other associated accessories. CCTV control room & redundant data base video management server & camera server room shall be air-conditioned room.

All IP based cameras for perimeter detection system and CCTV system shall be connected to suitably located Field Network switches (Layer-2 Managed Switch) in groups through single/ multi mode armored Fiber Optic cable or UTP cables for transferring camera video signals. Field Network Switches will then be connected to Core network controllers/Switches which will sit on the separate CCTV specific plant LAN (IEEE 802.3).

Field Network Switches shall be suitable for accepting different types of field devices e.g. fixed cameras, dome cameras, CMOS camera etc.

All camera images shall be continuously recorded. System offered shall allow to record and hold camera images for a minimum period of 90 days @ 1280 x 720 @ 24 x 7 @ high motion continuous recording. But, system shall allow to increase the recording resolution to 1920 x 1080 Full HD 25FPS in case of alarm. Facility for transferring camera images to separate recorders/ data storage devices like SAN (Storage Area Network)/NAS (Network Attached Storage) and play back facility of the same shall be provided. Bidder shall also provide additional data storage devices to store the backup data for one year.

Camera image monitoring and viewing facility shall be provided at security room, CHP control room, AHP control room, WTP/DM plant control room, FGD Building, central fire station building control room, Chief Engineer/General Manager's room, O&M Incharge's room, Erection Incharge's room, Plant main Gate/entry's room and at CCR. While from CCR, AHP control room, WTP/DM plant control room, central fire station building control room, Chief Engineer/General Manager's room, O&M Incharge's room, Erection Incharge's room, Plant main Gate/entry's room and CHP control room, only CCTV monitoring will be carried out, both perimeter detection and CCTV viewing shall be possible from security room.

Alarm & Display monitors shall be provided as follows:

- (a) 1 nos Operating Stations (OS) with A4 sized coloured LJP each (total 2 sets) & PTZ controllers for Perimeter Monitoring & CCTV package respectively at Security room respectively.
- (b) 1 no Operating Station (OS) and 1 no. ≥ 55 " diagonal sized full HD LED TV each of latest version with advanced features & PTZ controller at CCR for CCTV monitoring for unit and one more complete set for common area.
- (c) 1 no. Operating station and 1 no. ≥ 55 " diagonal sized full HD LED TV each of latest version with advanced features & PTZ controller at CHP control room for CCTV monitoring of CHP area
- (d) 1 no. ≥ 55 " diagonal sized full HD LED TV each (total 2 nos.) of latest version with advanced features at main security office to show the real time images for CCTV system & perimeter intruder detection system respectively.
- (e) 1 no. Operating station and & PTZ controller at AHP control room for CCTV monitoring.
- (f) 1 no. Operating station and PTZ controller at WTP/DM control room for CCTV monitoring.
- (g) 1 no. Operating station and PTZ controller at Central Fire Station building's control room for CCTV monitoring.
- (h) 1 no. Operating station and PTZ controller at Chief Engineer/General Manager's room for CCTV monitoring for unit.

- (i) 1 no. Operating station and PTZ controller at O&M Incharge's room for CCTV monitoring.
- (j) 1 no. Operating station and PTZ controller at Erection Incharge's room for CCTV monitoring for unit.
- (k) 1 no. Operating station and PTZ controller at Plant main gate/entry's room for CCTV monitoring.
- (l) 1 no. Operating station and PTZ controller at FGD Building for CCTV monitoring.

16.04.00 **Perimeter Intruder Detection System**

16.04.01 Perimeter intruder detection system shall meet following requirements:

- a) The detection system shall be installed along the entire length of fence/ boundary of the power plant and all entry & exit gates on the boundary. The system shall be capable of providing 24 hour continuous surveillance by means of a network of video cameras.
- b) The intruder detection system shall be based on video motion detection technology.
- c) The system shall be able to identify and distinguish between whether the intruder is a human being or an animal.
- d) Upon detection of intrusion, suitable alarms to be raised to security guards and corresponding camera image shall be displayed on a high resolution dedicated alarm screen.
- e) The system shall allow for the adjusting the sensitivity to reduce false alarms.
- f) When there is no intrusion, the camera images shall be displayed and recorded on a multiplexed basis.
- g) As many cameras as required for proper coverage of total perimeter length shall be provided. However, individual camera coverage shall not exceed 100 meter distance along the perimeter length.
- h) The hot Redundant Digital Video Management Server System for perimeter intruder system shall be similar to the same hardware and operating system configuration of database server envisaged for CCTV package.
- i) Spec for UPS & battery shall be same as mentioned in Vol. V, Part B, chapter 7, Cl. No. 7.01.05.

16.04.02 The Perimeter intruder detection system and CCTV system shall be able to provide surveillance of different locations the plant. The different areas to be viewed are indicated at the end of this clause and the controls for each units are to be provided in the Control Room. Bidder to note that the locations indicated in this sub-section are tentative only. The exact locations shall be decided during detailed engineering for the various operational areas of the power plant.

16.04.03 The system shall comprise of Redundant Video Management Server System capable of controlling all the Cameras for Zoom, Pan/Tilt, Multiple preposition and auxiliaries, suitable number of camera servers for common areas for controlling both manually and automatic and all other accessories required to provide best quality video with controls for making the system complete. The Redundant Digital Video Management Server System for perimeter intruder system shall be similar to the same hardware and operating system configuration of database server envisaged for CCTV package.

16.04.04 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 Thermal power plant environment.

16.04.05 The system shall have the following facilities:

- (a) Zooming
- (b) Pan control
- (c) Tilt control
- (d) Computer interface
- (e) Logging printer part
- (f) Multiple prepositions
- (g) Programmability
- (h) Alarm interface

The Bidder shall indicate details of the video and controls in his proposal.

16.04.06 The system supplied shall be complete in all respects for reliable performance. The Bidder shall submit the details block schematic, video, signal & power wiring diagram, describing the connections between the Camera's, streamers, digital video management server & camera server. Programming required shall be done by the Bidder for satisfactory operation

16.05.00 **DESCRIPTION OF THE SYSTEM COMPONENTS:**

The CCTV system and Perimeter intruder detection system shall have digital video recording facility as well as data management facility at suitable independent location. Bidder shall provide suitable digital video recording & management system (DVRMS) for this purpose.

System shall provide the Prioritized Failover and Redundant recording facility. System shall be configured with N+1 or N+N configuration to meet below capabilities.

- i) Standby recording server/servers shall take over (Failover) the recording of cameras in case any one of the primary recording server fails.
- ii) In case more than one primary recording server fails then standby server shall take over the recording of high priority cameras from all the failed servers limited to its maximum capacity.
- iii) Apart from above Failover functionality, this standby server shall parallel (Redundant) record at least 20% most critical cameras from each server or overall cameras of Plant and Perimeter irrespective of its primary recording server status (i.e. working or failed). If prioritized failover is supported then bidder shall offer N+N failover.
- iv) System shall also provide Failover Database to avoid single point of failure.

- 16.05.01 **Application Software for Video Monitoring, Recording & Management.**
- 16.05.02 The application software shall be used to display, store, control & manage the entire surveillance system. The software shall be capable of handling 20 % additional cameras over and above the number of cameras specified in each zone. It shall support flexible 1/2/4 windows split screen display mode or scroll mode on the monitors for live video.
- 16.05.03 It shall be possible to define priority based camera control rights for each camera or a group of cameras with unified log-in throughout the system. There should be a configurable hierarchy 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 from any location/client to any camera/recording and if all permissive met can be able to control/view the same. The system administrator shall have rights to add/delete/configure users with rights.
- 16.05.04 The software shall be programmable with facility of sequences that can run independently of each other in either forward or reverse direction.
- 16.05.05 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 search and replay the recorded video date, time, camera, event wise.
- The system shall include dual authentication feature. This feature is to restrict all users in a surveillance system to perform Playback operation. While performing playback operation at least two people from different roles should authenticate. For an Administrator, user authentication is not required and can do any playback operation. For an operator user, a popup is displayed and an Administrator user or any other User with different role needs to authenticate to perform playback operation.
- The system shall have smart Motion Search allows operator to search motion of an object in a recorded clip. This feature overcomes the traditional way of searching for an object in recorded clips. It enables you to filter the search in a recorded clip based on Year, Month, Day, Hours, Minutes and Seconds. Operator can view the recordings of before and after the existence of an object. Operator need to configure a region of the object in the recorded clip and then define the date and time range to search for the motion of the selected object.
- The Incident Mode feature helps in creating a story line of a particular incident that is captured using the video recorded from one or more surveillance cameras. Operator can create a clip for the incident that is triggered and view it as a story line. Operator can save the clip with digital signature and send it for further evidence. Operator can create a story line from a maximum of 16 cameras at a time.
- 16.05.06 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, acknowledgment 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 remote monitor feature helps to remotely control the digital monitors of operators from administrator workstation. This feature is particularly useful for controlling the display of video of operator's monitors. With remote monitor mode, administrator can perform following features:

- Selecting the cameras from which video is displayed
- Video layouts Selection
- Creating Video Layouts
- Starting the recording of video

The system shall include operator messaging. Same is a feature that enables administrator/super user to send video displayed in one or more panels or the whole video layout to other operators and digital monitors. The digital monitors are connected to the VMS client workstations. Super user/administrator can include comments in the message and send it to operators and to yourself. This feature is useful when super user /administrator notice an event in the video and want to communicate it to others. The other operators can view the video and watch the event super user noticed.

- Sending the Message to other operators and Digital Monitors
- Forwarding a Received Message
- Sending the whole video layout super user/administrator is viewing as a Message
- Viewing Live Video from received message
- Viewing Video and Comments in a Message

- 16.05.07 The system shall have alarm interface capability. When an alarm occurs in the Security or Control System 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. 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.
- 16.05.08 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 1,2,4,9,16,25,36 etc.
- 16.05.09 The system shall support video analytics (Configurable) in respect of Video motion Detection, Intrusion Detection (fixed camera), Object tracking, Object classification & Tracking etc It shall be possible to activate recordings automatically based on events generated logged and suitably alarmed by video analytics.
- 16.05.10 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.
- There should be dynamic on-screen icons for programming, controlling and monitoring of all the system functions & showing real time status of the system

being controlled.

Software shall also provide the ability to monitor system status events. Systems alarms, switching functions, sequence events, keyboard actions, and video loss & Network Loss information & Alarm with Complete system diagnostic.

Other features:

A. The System shall have web-based client for a map-based user interface designed to improve situational awareness. The graphical user interface is a high-resolution interactive map with a deep zoom capability allowing easy navigation of the facility to find issues or to review areas of interest. Large-scale individual maps are linked with simple navigation to seamlessly access maps at national, local and site levels with building details and individual internal floorplans.

- System should support configuring image-based maps (.jpg, .png, .bmp)
- System should support configuring online GIS maps and should leverage Open Street maps through supplementary license.
- System should support importing the maps directly from CAD files.

B. The web client should have feature of video salvo view and device management

- System should allow configuring video salvos view in web client. Support salvo layouts include but not limited to 1x2, 2x2, 3x3.
- System should support displaying live and playback, controlling PTZ in the web client
- Intelligent Command web client should support modern web browser like Chrome, Mozilla Firefox and Safari to view cameras configured with codecs H.264 and H.265

Device Management & Maintenance Console: Device management console enables managing cameras by allowing system administrator to maintain a firmware inventory, view current firmware version vs installed version and initiate firmware upgrade simultaneously for all or selected cameras. In addition to firmware upgrades, system lets administrators to easily comply with password management policies for peripheral devices by allowing to change camera password simultaneously for all or selected cameras.

16.05.11 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 such as: Interventions such as manual recording and configuration setting changes Cameras controlled, Video accessed/Stored.

This log must also contain a history of the status e.g. failure of all the system components. This log shall be maintained for a minimum period of ten (10) days.

16.05.12 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.

16.05.13 All functionalities of CCTV clients can be on any PC connected to station LAN, by installation of suitable client. Software licenses for the same shall be supplied.

16.06.00 **Cameras:**

- i. The cameras shall be rugged high speed PTZ dome digital IP cameras with inbuilt PTZ driver unit & RS 485 receiver unit and Fixed cameras as per BOQ, 1/4 inch ,1/2.8 or 1/3 inch or bigger image format fully performance color CCD/CMOS dome cameras. These cameras should provide 1920 x 1080 HD high resolution and high sensitivity suitable for operation in a power plant, both in natural and artificial sighted areas.
- ii. The cameras should have features as mentioned below:
 - a. Suitable for night-time surveillance.
 - b. Manual or Automatic colour/infra-red switching.
 - c. Automatic picture enhancement/3D Noise reduction to give a balanced picture where there is too little/too much light.
 - d. Remote camera setup, with on screen menu display.
 - e. Back light composition
 - f. Automatic white balance, with mode selection options
 - g. Contour correction and contrast compression control.
 - h. Synchronization selection for Gen lock, external V-lock, mains lock and internal free-running.
 - j. PTZ Cameras provided with auto IRIS motorized lens, low lux density (0.005 lux) suitable for functioning in darkness (night shot & vision capability) and Infra-red illuminator (150 Meter IR distance).

iii. Detailed technical specifications are as under:

(Fixed cameras shall have same specifications except all the Pan/Tilt/Zoom related functions.)

- a. Imager Supply Interline transfer CCD/CMOS, 1/2.8" or 1/3" or bigger image format or better with 3 D noise reduction.
- b. Picture resolution for PTZ: 1920 x 1080.Sensitivity 301 RE
Picture Resolution for Fixed: 2592 x 1520
- c. Sensitivity 30 IRE
Colour: 0.08 lux
Monochrome: 0.005 lux
- d. IR range for Fixed Camera: 100 meters
IR range for PTZ Camera: 150 meters
- e. Signal-to-noise: >48dB.
- f. Pattern for PTZ cameras: 4 pattern, 240 s memory
- g. Optical Zoom for PTZ cameras 25X 4.7-5.3mm to 125mm and 8-50mm Varifocal HD Auto Iris IR corrected lens for fixed cameras
- h. Digital Zoom 10 X
- i. Power: 230V A C (From Bidder's UPS)
- j. Network Interface: Ethernet 100/1000 Mbps
- k. Dual H.265 Streaming: Stream 1 @ 1920 x 1080 @ 25FPS and Stream 2 @ D1 @ 25FPS simultaneously. Fixed camera shall have Minimum 2592 x 1520 resolution@ 25 FPS on Stream 1
- l. Range: 150 mtrs. with optical zoom for PTZ cameras and 100 mtrs

- for fixed cameras
- m. Audio: Two way Audio IN/Out port
 - n. Alarm I/O: At least one potential free In and One Out
 - o. Defog: On/Off (Required)
 - p. ONVIF Compliance: ONVIF Profile S, G, and T (ONVIF approved certificate / ONVIF conformant devices listed on the ONVIF global website. The CCTV OEM shall be full member of ONVIF Committee. There should be no ONVIF membership restrictions on CCTV OEMs, this means that Camera OEMs can participate in ONVIF committees which include ONVIF new profile development and maintenance. Similarly, OEMs can use new ONVIF tools and software for camera testing. The bidder shall submit a declaration
Cyber Security Compliance: Multiple user access levels should be available with enhanced password policy, Data Security Standard compliance, Digest authentication, IP Filtering, AES 256-bit Encryption, IEEE 802.1x.
 - q. The cameras offered must be cyber security certified with NDAA/UL Cyber security certificate/NIST/ TPM/ Cybersecurity Chipset/ Any other cyber security certificate from Indian Government body for mitigating cyber security risk/ration in this regard from the OEM.
 - r. The CCTV OEM should be an official HEVC licensee for using the genuine legal H.265 compression. Documentary proof shall be submitted in this regard.

iv. Camera Housing

- (a) All the cameras and accessories are to be housed in Weather Proof environmental housing made of aluminum. The housing with heater and blower or equivalent mechanism installed should provide protection for camera/lens assemblies in the ambient temperature range of (-) 10 deg. C to 60 deg C. The cameras for fuel oil pump house, oil handling systems and oil tank area shall be explosion proof type and for complete coal handling plant, cameras shall be flame proof type only. For other areas where a potential flammable atmosphere may exist and are classified in accordance with the provisions of latest version of relevant IS, only certified equipment shall be used in such designated hazardous areas, which further shall be finalised during detailed engineering.
- (b) The housing of fixed camera should also have thermostatically controlled heater kit, continuous duty blower kit available within the housing. Bidder shall also consider equivalent mechanism of heater & blower to meet the requirement of above ambient temperature range.
- (c) The minimum protection standard for cameras shall be IP 67.
- (d) The camera for FOPH and Fuel oil tank area, Ammonia unloading & handling area, H₂ Area, O₂ Area shall be explosion proof type and for CHP area, camera shall be flame proof type only. All Explosion proof and flame proof cameras shall have Factory fitted integrated housing of same make as camera. Weatherproof cameras with separate explosion proof and flame proof housing shall not be acceptable. All FLP & EXP cameras shall be IECex/ATEX & CCOE certified. Quoted Make & Model/Series of FLP camera should have been

supplied/installed in CHP area of Power Plant of equivalent/more capacity.

(e) Camera mounting Height shall not be more than 6 mtrs.

16.07.00 The Digital Video Recording & Management System shall include:

- i. Hot Redundant Database Servers
- ii. Camera Servers (N+1 or N + N configuration)
- iii. Security Control Systems
- iv. Operator Stations
- v. Network connected digital IP cameras
- vi. Network infrastructure
- vii. Time Synchronization from Master clock system. (Complete hardware & software required to achieve time synchronization from master clock system shall be provided by bidder).

16.07.01 Hot Redundant/Failover Database Servers

16.07.01.01 The Database Server contains a database of all network-connected cameras and their configuration.

16.07.01.02 The Database Server shall:

- a. Manage the system database, containing details including
 - i. System configuration
 - ii. Camera configuration and settings
 - iii. Recording configuration and settings
 - iv. Configuration of Quad Views and Sequences
 - v. Details of recordings
 - vi. Schedules
 - vii. Operator security details
 - viii. Configuration of Surveillance and Alarm Monitors
 - ix. Configuration of Video Analytics
- b. Manage communication between the Operator Stations and the Camera Servers
- c. Video Motion Detection
- d. Allow alarms/events in the CCTV Security System or Control System to initiate recordings
- e. Report any camera failures or recording failures to the integrated Control system or Security system
- f. Provide a full audit log of all system status (camera, server availability) and operator actions.
- g. it 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 sequence shall also support camera prepositions for each camera on each sequence step.

16.07.01.03 The Database Server shall be able to be use in a hot redundant/failover configuration, using two separate Database Servers. The backup Database Server shall be continuously synchronized with the master Database Server to ensure that it is always up-to-date and ready for a fail-over, when required.

16.07.01.04 The DVRMS must be capable of running a pair of similarly configured computers in a hot backup configuration where at any point in time, one is the acting

Primary and the other is acting as the Hot Backup. An on-line database synchronization mechanism must be supported.

16.07.01.05 Simply having each Database Server scan each Camera Sever, or requiring the Camera Servers send all updates to both Database Servers is not acceptable. The database duplication must be performed on a per-transaction basis for two reasons:

- i. To ensure that the duplicated Backup database is consistent at all times with the Primary database
- ii. To avoid unnecessary loading of Camera Servers caused by duplicate polling.
- iii. It must be possible to remove one of the redundant systems for maintenance without interrupting operation, and upon its reinstatement, re-synchronize the databases, again without interruption to system operation.

16.07.01.06 The Database Server (RAID 5 grade) shall be able to operate with no performance degradation using the following hardware and operating system configuration:

- i. Intel Xeon Sixteen (16) Core 64 bit Processor /36T capable 3.6 GHz with 24.75M cache memory per processor 2.20 GHz , Dual independent 2666 MHz system bus (2 way SMF) or better.
- ii. 2x16 GB, 3200 SDRAM
- iii. Hard Disk storage of 2TB min. or higher as per system requirements.
- iv. Dual 100/1000/10000 Mbps NIC for network connection to the other components of the DVRMS
- v. Graphics card supporting 24-bit colour and with 512 MB video RAM if the Database Server is also used as a client station
- vi. Windows 2022 Server (SP1), Windows 2000 Server (SP4), Windows 8/7/XP Professional (SP2) or Windows 2000 Professional (SP4), Window 2012 server or higher as per the latest proven version.
- vii. Microsoft SQL express 2008 or better
- viii. Microsoft Internet Explorer 8.0 with Service Pack 1 or higher
- ix. Application software
- x. Dual hot plug power supplies
- xi. Dual Hot plug fans.
- xii. RAID5 configured disks for video storage sufficient for recording @ 25FPS @ 1280 x 720 @ 90 days @ 24 x 7 @ full motion continuous recording. System shall allow to increase the recording to 1920 x 1080 Full HD 25FPS in case of alarm.
- xiii. 40" LED Monitors with 1920 x 1080 pixel resolutions & 178 deg V/H viewing angle.

16.07.02 Camera Servers

16.07.02.01 The Camera Server(s) must be capable of supporting a large amount of disk space for online video storage and access to high capacity archiving mechanisms for the removal of stored video to off-line media.

16.07.02.02 The Camera Server shall:



1. Manage live video from camera -
2. Transmit live video to Operator Stations
3. Receive camera control commands from Operator Stations and then send the commands to cameras
4. Store live video to hard disk
5. Transmit previously stored video to Operator Stations
6. Archive previously stored video to off-line storage media
7. Retrieve archived video from off-line storage media
8. Provide Video Analytics including:
9. Video Motion Detection and camera tampering.
10. Export the recordings into MPEG format so that it can be viewed using standard tools including Microsoft's Video Player.

The Camera Servers shall communicate with Database Server for all camera database information. But, camera server shall still be capable to continue basic functions like Recording, Playback, PTZ control etc. even in case of failure of communication with database server. Proprietary hardware platforms are not acceptable.

16.07.02.03 The Camera Server shall be able to operate with no performance degradation with the same configuration of hardware, softwares and operating system specified for database server including RAID1 for OS & applications and RAID5 for video storage.

16.07.03 **CONFIGURATION**

- i. Configuration of Operating stations shall be same as specified at Vol. V, Chapter 3 with 40" sized LED monitors.
- ii. Memory of database & camera server is minimum as specified above, memory shall be suitable to have 3 month recording @1280 x 720 @ 24 x7 @ high motion continuous in server. Further DVD/Memory storage device shall be provided by bidder for taking backup of past data storage of minimum one year for retrieval.
- iii. All software & operating system shall be latest & proven at the time of supply.
- iv. Server shall be rack mounted.
- v. The server/OWS processor shall be latest and got approved from owner at the time of supply.

16.07.04 **PTZ /Joystick Controller:**

Joystick Controller shall have full function used for system control and programming for selection of various camera functions including pan, tilt and zoom lens controls and shall be ergonomically designed.

16.08.00 **Communication Network:**

All the network switches shall be industrial grade with diagnostic features and sized to meet the functional requirements as specified. All the network switches shall be provided with thirty percent (30%) spare ports.

Communication Network shall be industrial grade and shall be provided with industrial grade managed Ethernet switches, industrial grade media convertor, industrial grade communication hardware, external surge protection



system/devices and industrial firewall etc.

16.09.00 **CABLES:**

16.09.01 **Network Cabling**

A full duplex Local Area Network (LAN) shall be provided for communication between the system elements. All interfaces to the LAN shall be a minimum of 100BaseTX Ethernet. The LAN may use additional technologies within the backbone for greater speed or distance. Acceptable types are:

- a. FDDI
- b. 100BaseFX
- c. 1000BaseSX or 1000BaseLX Gigabit Ethernet
- d. Asynchronous Transfer Mode (ATM)

The LAN shall use standard network cables. Acceptable cable types are:

1. Optical Fiber
2. Category 5e or Category 6 Unshielded Twisted Pair (UTP)

The LAN shall be logically and/or physically separate from any existing LAN infrastructure. Interconnection to other LANs shall be through one of the following:

1. A router
2. A Layer 3 capable network switch
3. As an additional VLAN to the existing LAN equipment. Where required to interconnect VLANs, a router or Layer 3 capable switch shall be provided

The network shall be designed in a manner such that failure of a individual switch shall not hamper the failure of the entire system.

Special Requirements :- In addition to above requirements, The design of the plant security & surveillance system's LAN shall also meet the technical requirements stipulated for Station LAN at Chapter 3, Vol. V.

16.09.02 **VIDEO CABLING**

Where standard CCTV cameras are used (allowed only in case of Explosion proof), Cat-6 cable or optical fiber shall be used to connect the camera. In a new installation it is not acceptable to install a star topology video cabling system with all cabling coming back to a single location.

It is not acceptable for video cables to be run back to the Camera Server. All communications with the Camera Server shall be via the LAN.

Each network digital IP camera shall have a single network interface to be used for video and Pan/Tilt/Zoom communications.

16.09.03 Cables should be suitable for installation as follows:

- (a) Above ground in open-air location (tray/ducts) in tropical, humid and corrosive atmosphere prevalent in thermal power plant.

- (b) Direct buried in underground trenches conduits with uncontrolled back fill and possibility of flooding by water and chemicals.
- (c) Laid underground in RCC lined cable trenches with possibility of flooding by water.
- (d) Site condition for cables laid above/underground shall be specified in the BOM. If not specifically mentioned therein, the design ambient air temperature of 75 deg. C ground temperature of 40 deg. C, thermal resistivity of soil at 150 deg. C cm/watt and altitude more than 1000 meter, above main sea level shall be considered.
- (e) Cables of reputed make with approval of Purchaser/consultant shall be tested at works as well s site after installation as per applicable standards.
- (f) All the required cables shall be supplied on as required basis. Further, 500 meters of each type of cables shall be provided as spare.
- (g) Fiber optic cables are to be provided whenever the cable runs length/ signal loop length is more than 100 meters or as per standard technical requirements without any distortion of the video & audio signals. Fiber optic cables shall be provided meeting requirements specified in the NIT, Vol. V, chapter 9.
- h. All the cables are to be provided by the Bidder on as required basis.
- i. All the cables shall be laid thru GI conduit pipes or suitable grade permanently lubricated HDPE protection pipe as per IS 4984, IS 12235 & TEC.G/CDS-08/01 of suitable size @53% fill factor.
- j. To avoid any type of external signal interference with CCTV system signals, all type of protection & hardware shall be provided by bidder.

16.10.00 **OPERATIONAL REQUIREMENTS:**

The CCTV system should comply to the following operational requirement.

- i. From the master control panel (keyboard) it shall be possible to select any camera and display the picture on any of the monitors.
- ii. Commands from the video server is sent via a onsite receiver/drive unit to the camera which in turn controls the pan/tilt zoom etc., functions.
- iii. Operator shall be able to control all the cameras, pan / tilt and zoom functions automatically.
- iv. The Camera Server shall record the activities of all the places where alarm have been alerted. The recording time shall be as per the hard capacity as mentioned in the camera server specifications.
- v. It should be possible to export selected portion of recording to DVD/memory storage device. The exported clip shall be in commonly used movie file formats e.g. MPEG, AVI, WMV and no special software shall be used to view same.
- vii. The software for clients shall preferably work on a Browser/Application based system. This will allow any authorized user to display any video (live/recorded) of any camera on the monitor with associated controls.

16.11.00 **Video Motion Detection**

The DVRMS system must be able to support video motion detection algorithms, which can be executed by the video camera or the Camera Server. The enabling of Video Motion Detection shall be either:



- i. on a continuous basis
- ii. Scheduled for particular times, dates, days, months etc
- iii. The Camera Server-based algorithm must be able to provide the following functionality:
 - a. Detect and track objects
 - b. Learn the scene
 - c. Adapt to a changing outdoor environment
 - d. Ignore environmental changes including rain, hail, wind, swaying trees and gradual light changes

The operator shall be able to configure the following parameters for each camera:

1. Detection Type: Continuous or scheduled
2. Actions to Perform When Motion is detected: When motion is detected, the following actions shall be performed automatically:
Generate an alarm in the Security System, Building Control System or Industrial Control System of configurable priority (journal, low, medium, high)
3. Start a recording, with the following configurable settings
 - a) Pre-Record Duration: The amount of pre-recorded video, allowing the Camera Server to capture video prior to the detection of motion, as well as after the detection of motion. Shall be selectable from a list of values ranging between 0 seconds and 5 minutes.
 - b) Post Record Duration: Motion detection activated recordings will terminate after this period. Shall be selectable from a list of values ranging between 0 seconds and 5 minutes or until motion has stopped.
 - c) Frame Rate. Video quality required for motion detection activated recordings. Shall be selectable from the entire range of frame rates supported for the camera/streamer. For MPEG encoding, support shall be provided to record only the Index frames, or a subset of the Index/ complete frames.
 - d) Retention period. The default period that motion detection activated recordings will be retained by the Camera Server before being deleted. The retention period of individual recordings shall be able to be changed as necessary. Shall be selectable from a list of values ranging between one hour and 365 days.
 - e) Send video to an operator station or alarm monitor: Automatically switch an operator station or alarm monitor to view the camera which has motion detected.
4. Motion Finished Time: The amount of time where no motion (inactivity) is detected before the previous motion is classified as completed. This

shall be used for allowing recordings to continue until motion has finished.

The DVRMS must provide a means of automatic and manual tuning of the Video Motion Detection for each camera. Incorporated within this tuning are the following:

1. Selection of the frame rate used for detection
2. Optimization for directions of movement In any direction
3. Across the camera view
4. Area wise Configuration for camera
5. Sensitivity level to fine tune the motion detection algorithm
6. Specification of a minimum object size to allow noise filtering in the system to reduce false detections and alarms.

The DVRMS must also provide the ability to only detect motion in particular regions of the camera view. The ability to graphically select these regions using the mouse must be provided, with an unlimited number of regions permitted per camera. The regions of interest will be multi-vertices shapes with a minimum of 6 vertices to allow the region to be properly matched to the scene being detected. It shall be possible to add and remove vertices from the defined region of interest as needed. Solutions providing only rectangular regions of interest will not be accepted.

Each region must be able to be individually tuned and have separate tuning parameters. This method of tuning must also provide a live tuning window whereby these settings and regions can be altered and tested prior to being used. This live tuning window shall show the live video as well as the regions of interest. During the time that motion is detected within a region, the border of the region shall change to a different color. In this way, tuning can be performed to achieve the desired performance. Text shall also be provided in the window to alert the user that motion has been detected.

16.12.00 **CONTRACT QUANTITIES:**

Refer Appendix-I to Part-A, Vol.-V of Technical Specifications. Quantities indicated are the minimum requirements, however each & every item shall be provided as per system requirements.

CHAPTER – 17**QUALITY ASSURANCE AND TESTING AND GUARANTEES****17.01.00 GENERAL REQUIREMENT**

17.01.01 All equipment furnished under this specification shall be subject to test by authorized quality assurance personnel of the Bidder, representatives of the Owner during manufacture, erection and on completion. Bidder's quality assurance personnel for these shop and site tests shall be identified in advance and shall be acceptable to the Owner. The approval of the Owner or passing of such inspection of tests will not, however, prejudice the right of the owner to reject the equipment if it does not comply with the specifications when erected or fails to give complete satisfaction in service.

17.01.02 The Bidder shall furnish details of shop and site tests proposed to be conducted by him at various stages to meet the specification requirements for each type of instrument/system along with his proposal. Bidder shall also furnish details of his proposed shop and site quality assurance organization for this contract

17.01.03 All equipment and systems furnished under this specification shall be subjected to shop & site tests in accordance with the Quality Assurance Program approved by the Owner and shall be adequate to ensure full compliance with these specification, all applicable codes & standards and detailed engineering drawings and documents approved by the Owner.

17.01.04 The Bidder shall provide all required test equipment and simulation devices for performing all shop and site tests. All tests equipment shall be of reputed make, required accuracy class and shall be recently calibrated. The record of calibration of test equipment shall be made available to the Owner on demand.

17.01.05 The cost of all tests as per the requirements of this specification and approved quality assurance programme shall be included in Bidder's lump sum price for this package and no extra price shall be payable by the Owner for conducting any test as per the intent and requirements of this specification.

17.01.06 All approval/Inspection are to be carried out by Owner or owner appointed agency only.

17.01.07 Bidder shall also refer Vol. II and Chapter-13, Part-B Vol. V for any other additional details/information/data.

17.02.00 SHOP TESTS**17.02.01 General Requirement**

17.02.01.01 Shop tests shall include all tests to be carried out at Bidder's works at of this sub-bidder and at works where raw materials used for manufacture of equipment is produced.

Individual components, instruments and devices furnished in accordance with specification sheets, and I&C device list enclosed with these specifications shall be shop tested by manufacturer prior to shipment. The manufacturer shall conduct these tests for certifying compliance with published specifications for the equipment and provide test results to the Owner in writing. These tests and test certificates shall be in accordance with the agreed 'QA' programme for major systems/equipments. However, manufacturer's standard methods shall be followed if details of tests for any equipment are not covered under this agreed 'QA Programme'.

17.02.01.02 Whenever tested quality material is specified and wherever called upon by Indian Boilers Regulations or by the design code, the test pieces are to be prepared and tested to Owner's satisfaction.

17.02.02 **Material Tests**

17.02.02.01 Whenever tested quality material specified and whenever called upon by Indian Boilers Regulations or by design code, the test pieces, are to be prepared and tested to Owner's satisfaction.

17.02.02.02 In the event of Owner being furnished with certified particulars of tests, which have been carried out by the suppliers of material, the Owner may, at his discretion, dispense with these tests.

17.02.03 **Test at Manufacturer's Works**

17.02.03.01 Works tests are to include electrical, mechanical performance and hydraulic tests in accordance with relevant IS, IBR or any other approved standard or any other tests called for by the Owner under these specifications to ensure that the equipment being supplied fulfills the requirements of these specifications. For equipments not covered by any IS or other approved standards, the tests to be carried out shall be in accordance with Bidders' quality assurance programme approved by the Owner.

17.02.03.02 Control systems, monitoring systems, control panels instrument enclosures, and power supply systems shall be shop tested according to unique requirements specified in the applicable section of these specifications for each item and quality assurance program approved by the owner.

17.02.03.03 All shop tests shall be performed prior to shipment and the Owner shall be given the opportunity to witness these tests. The Bidder shall notify the Owner regarding readiness for shop test at least 10 days before the scheduled date if the tests to be conducted within Indian and at least 60 days before the schedule date if the test is to be conducted abroad.

17.02.04 **Factory Tests**

17.02.04.01 Automatic Control and Monitoring system (DDCMIS, PLC & any other microprocessor based control system) including alarm annunciation system furnished as per this specification shall be subject to shop and site tests as per the requirements of this specification, applicable codes and Owner approved Quantity Assurance Program so as to demonstrate to the Owner that the equipment furnished by the Bidder meets the intent and requirement of this specification. These tests shall include but shall not be limited to the tests indicated in the subsequent clauses.

17.02.04.02 Surge Protection Test for Solid State Equipment

All solid state equipment shall be able to withstand the electrical noise and surge as encountered in actual service conditions and inherent in a Power plant, and shall meet the requirements of surge protection as defined in ANSI/IEEE C37.90.1 – 2002/2012, IEC – 60255-151, IEC-60255-27, EN/IEC 61000-4-2/3/4/5/6/12.

Complete details of the features incorporated in electronic system to meet this requirement, the relevant test carried out, and the test certificates shall be submitted by the bidder.

17.02.04.03 Burn-in and Elevated Temperature Test

All solid state electronic equipment shall be tested as a complete system/equipment with all devices connected for a minimum of 168 hours continuously under energized conditions prior to shipment from manufacturer's works, as per the following cycle :-

During the first 48 hours of testing the ambient temperature shall be maintained at 50 deg.C and relative humidity at 95%. The equipment shall be interconnected with all devices, which will cause it to repeatedly perform all operations; it is supposed to perform in actual service, with load on various components being equal to those, which will be experienced in actual service.

The 48 hours tests period shall be continuous but shall be divided into four 12 hours segments. The input voltage during each 12-hour segment shall be nominal voltage for 11 hours, followed by 110% of normal voltage for 30 minutes followed by 90 percent of nominal voltage for 30 minutes.

The 48 hours elevated temp test shall be followed by 120 hours of burn in test as specified in the above paragraphs except that the temperature is reduced to ambient temperature prevalent at that time. Alternatively copy of type test certificate for burn-in test shall be submitted.

17.02.04.04 The Bidder shall furnish full details regarding shop tests and site tests, as per good engineering practices. The Owner shall approve all such tests and the supplier shall conduct all such tests without calling for additional price.

The tests shall cover factory tests, burn-in and elevated temperature tests, simulation and functional tests, insulation tests as applicable, the rating of the contact devices and components, surge withstand capability test, conformity of interconnection cables, testing and checking of other conditions deemed to be necessary with the system/equipment items.

17.02.04.05 All instruments and control equipment supplied against this contract shall be factory calibrated at least at five (5) points through out the range and checked for their functional/performance requirements. The instruments shall also be calibrated at site prior to commissioning.

17.02.04.06 All panels, instruments enclosures, junction boxes, etc. shall be type tested for degree of protection and applicable in accordance with IS: 13947.

- 17.02.04.07 Type, routine and acceptance testing of all equipments, supplied under this contract, shall be in accordance with relevant NEEA/IS/IEC/ANSI/BS/ISA standards, in addition to the requirements of Owner approved Quality Plans. Six (6) copies of test reports shall be submitted to the Owner for approval prior to dispatch of respective equipment
- 17.02.04.08 The representative of Owner shall be given opportunity to witness the factory tests which shall be mutually finalized during the progress of the contract.
- 17.02.04.09 All control systems to be furnished for this project shall be factory tested for circuit continuity and direction of response. The Components to be tested shall include all controllers, HAND/AUTO station, other system modules, alarm contactors and multi-conductor interconnecting cables. The tests shall be performed with all of the system components supplied by the Bidder connected to form a complete system with the sole exception of transmitters. The tests shall include a means of confirming the mathematical design response of the control system by simulating changes in system input. The tests shall be a qualitative functional test of each component of control system, which simulates dynamic inputs and monitors system outputs.
- 17.02.04.10 Certain control loops shall be factory tested using closed loop mathematical simulation techniques. Control loops to be tested by closed loop methods are broadly as under. However, owner has discretion to test and all control loops during simulation testing.
- i) Firing rate control (fuel and air flow control)
 - ii) Furnace draft control
 - iii) Boiler separator level control
 - iv) Response time for Turbine Control System.
- The input simulation equipment shall be designed to produce effects from control system outputs based on mathematical model of the predicted performance and process dynamics of the main unit equipment. The control constants of various control loop components shall be adjusted to produce a stable and optimum control adjusted to produce a stable and optimum control when connected to the simulation equipment.
- 17.02.04.11 Simulation data including factory adjustment of control system constants, and simulation equations shall be tabulated and shall be made available by the Bidder for customer's use during field check out and the start up of the control system.
- 17.02.04.12 Availability of a simulated type test for automatic control loops specified with a detailed description of testing methods utilized shall be indicated.
- 17.02.04.13 The availability of facilities for carrying out the model test for the control systems shall be indicated by the bidder. Also details of test procedures and copies of test results conducted for a similar fossil fuel fired unit shall be furnished. The data required from Boiler and Turbo generator supplies shall also be furnished by the Bidder.
- 17.02.04.14 Brief description of all tests proposed to be conducted on each control system components during various stages of manufacture, installation and commissioning shall be furnished. Copies of test data accumulated during the tests shall be submitted to the mutually agreed formats.

17.02.04.15 The owner shall witness the factory tests which shall be performed at a time mutually agreeable to the Bidder and the owner.

17.02.04.16 Factory Acceptance Tests for DDCMIS & DCS

GENERAL	1	FACTORY ACCEPTENCE TEST (FAT): REF NOTE-1	✓
	2	FACTORY ACCEPTENCE TEST (FAT) PROCEDURE: REF.NOTE -2	✓
TEST REQUIR MENTS	3	TEST SHALL BE PERFORMED WITH THE COMPLETELY ASSEMBLED SYSTEM AND ALSO WITH COMPLETE I&C SOFTWARE AND PERFORMING ALL FUNCTIONS EXPECTED OUT WHILE IN ACTUAL SERVICE AND WITH STSTEM CONFIGURATION AS FINALISED AND PERFORMING.	✓
	4	PROCESS INPUT/OUTPUT CONDITIONS AND OTHER LOAD ON THE SYSTEM TO BE STIMULATED	✓
	5	EITHER BY HARDWARE/SOFTWARE.	✓
	6	ALL SYSTEM SOFTWARE and APPLICATION SOFTWARE TO BE LOADED AND OPERATIONAL ON THE	✓
	7	SYSTEM PRIOR TO FAT	✓
	8	FAT TO BE CONDUCTED AT ELEVATED TEMP. OF 45 DEG C FOR MINIMUM 48 HOURS	✓
	9	FAT UNDER FOUR CYLES OF VOLTAGE FLUCATIONS VIZ NOMINAL AT 110 % OF RATED VOLTAGE	✓
	10	PERFORMANCE TEST:	✓
	11	-	
	12	-	
TEST DOCUME NTS DRAWIN GS	13	TOTAL SYSTEM CONFIGARATION DRAWINGS	
	14	FAT PROCEDURE CONSITING OF:	
	15	(i) TEST EQUIPMENT	
	16	(ii) TEST ENVIRONMENT	
	17	(iii) TEST CONFIGURATION	✓
	18	(iv) TEST PROCEDURE	
	19	(v) TEST SCHEDULE	
	20	(vi) TEST VENUE	
	21	(vii) TEST REPORTS- SPECIMEN COPIES	
	22	FUNCTION DESIGN SPECIFICATION FOR EACH EQUIPMENT / SYSTEM	
	23	-	
	24	-	
PRELIMI NARY CHECKS	25	GENERAL APPEARENCE CHECK and BILL OF MATERIALS CHECK	✓
	26	CONSTRUCTION CHECK AS PER OVER ALL GENERAL ARRANGEMENT DRAWINGS	✓
	27	DIMENSIONAL CHECK	✓
	28	LABELLING, TERMINAL ARRANGEMENT AND EQUIPMENT IDENTIFICATION CHECK	✓
	29	POWER SUPPLY VOLTAGE LEVEL CHECK and POWER 'LEDs -ON CHECK	✓
	30	COOLING FAN OPERATION CHECK	✓
	31	GROUNDING NETWORK CHECK	✓

SYSTEM CHECKS	1	POWER SUPPLY UNDER VOLTAGE AND OVER VOLTAGE CHECK ($\pm 10\%$).	✓
	2	PROCESSOR and MAIN DATA BUS NETWORK REDUNDANCY CHECK.	✓
	3	COMMUNICATION COUPLER REDUNDANCY CHECK.	✓
	4	COMMUNICATION MODULE OF THE CONTROLLER TO NETWORK REDUNDANCY CHECK.	✓
	5	POWER SUPPLY REDUNDANCY CHECK.	✓
	6	HARDWARE ON-LINE MAINTAINABILITY CHECK.	✓
	7	-	✓
	8	-	✓
CONTROLLER ENGINEER	9	CLOSED LOOP CONTROL SIMULATION CHECK	✓
	10	OPEN LOOP CONTROL SIMULATION CHECK	✓
	11	CONTROL LOOP RESPONSE CHECK	✓
	12	BUMPLESS AUTO MANUAL TRANSFER CHECK	✓
	13	OPERATING STATION - GRAPHIC OVERVIEW CHECK	✓
	14	OPERATING STATION- TREND CHECK	✓
	15	OPERATING STATION- REAL TIME TREND CHECK	✓
	16	OPERATING STATION- MIMICS CHECK	✓
	17	OPERATING STATION- CHECK FOR OPERATING CONTROL DIRECTLY FROM MIMICS	✓
	18	OPERATING STATION- FUNCTION KEYS CHECK	✓
	19	OPERATING STATION- TOUCH SCREEN FUNCTION CHECK	✓
	20	OPERATING STATION- ANALOG CONTROL DISPLAY CHECK	✓
	21	OPERATING STATION- SEQUENCE CONTROL DISPLAY CHECK	✓
	22	OPERATING STATION- OPERATOR GUIDENCE MESSAGE CHECK	✓
	23	OPERATING STATION- ALARM MANAGEMENT FUNCTION CHECK	✓
	24	OPERATING STATION LOGGING FUNCTION CHECK	✓
	25	OPERATING STATION / RESPONSE / UPDATING CHECK	✓
	26	KEYBOARD LOCK FUNCTION CHECK	✓
	27	OPERATING STATION INTERCHANGEABILITY and ASSIGNABILITY CHECK	✓
	28	PRINTER ASSIGNABILITY and BACK-UP FUNCTION CHECK	✓
	29	FLOPPY DISK/ STD / OPTICAL DISK UNIT STORAGE and RETRIEVAL CHECK	✓
	30	OPERATING STATION ASSIGNABILITY CHECK FOR HARD COPIER FUNCTION	✓
	31	PLANT PERFORMANCE CALCULATION CHECK	✓
	32	COMMUNICATION INTERFACE TO OTHER'S SYSTEM SIMULATION CHECK	✓
	33	-	✓
	34	DATA BUS DISTANCE BUILDING CHECK (REFER NOTE- 3)	✓
	35	GRAPHIC DISPLAY BUILDING FUNCTION CHECK	✓

MAINTENANCE	36	CLOSED LOOP CONTROL SYSTEM MODIFICATION CHECK	✓
	37	OPEN LOOP CONTROL SYSTEM MODIFICATION CHECK	✓
	38	ALARM DISPLAY PRIORITISATION CHECK	✓
	39	SYSTEM SECURITY CHECK	✓
	40	SYSTEM ALARM CHECK	✓
	41	SYSTEM DIAGNOSTIC FUNCTION CHECK	✓
	42	POINT DETAIL CONFIGURATION CHECK	✓
	43	CONTROL LOOP TUNING CHECK	✓
	44	SYSTEM SELF DOCUMENTATION CHECK	✓
NOTES	<p>1. THE INTENT OF THE FAT IS TO DEMONSTRATE AND ENSURE THAT THE I&C SYSTEM MEETS ALL THE FUNCTIONAL REQUIREMENTS AS INTENDED IN THE SPECIFICATION / CONTRACT. A COMPLETED INTEGRATED TEST OF THE SYSTEM SHALL BE CARRIED OUT AT VENDOR'S WORKS IN THE PRESENCE OF OWNER, ON COMPLETION OF INTEGRATION/MANUFACTURING OF THE SYSTEM. THE SHIPMENT OF I&C EQUIPMENT TO SITE WILL BE EFFECTED ONLY AFTER THE FAT HAS BEEN ACCEPTED BY THE OWNER.</p> <p>2. FAT PROCEDURE SHALL BE PREPARED BY VENDOR AND TO BE SUBMITTED FOR OWNER'S APPROVAL WELL IN ADVANCE PRIOR TO THE COMMENCEMENT OF FAT.</p> <p>3. FAT SHALL BE CONDUCTED WITH THE DISTANCE BETWEEN THE PROCESSOR AND OTHER SUPPORTING PERIPHERIALS AS PER THE FINAL LAYOUT IN THE CONTROL ROOM.</p> <p>4. ALL THE RELEVANT APPROVED DOCUMENTS REQUIRED FOR FAT SHALL BE SUBMITTED BY THE BIDDER IN ADVANCE PRIOR TO COMMENCEMENT OF FAT.</p>		

17.02.04.17 Tests to be performed during FAT of PLC system

Following minimum tests shall be performed during FAT at manufacturer's place of PLC system:

- 1) Hardware Inspection of PLC Sub System
 - i) Heat run test
 - ii) Hardware check / physical software package check
 - iii) I/O loading specification
 - iv) PLC start-up and power fail restart
 - v) PLC processor back-up function
 - vi) Communication redundancy
- 2) Application Inspection for Logic Functions
 - i) Ladder logic functional check and graphic screen check
- 3) Application Inspection for PLC Panels
 - i) General arrangement
 - ii) Appearance and construction
 - iii) Panel wiring
 - iv) Panel functional check
 - v) Power supply redundancy check

- 4) PLC System Checks
- i) PLC Scan time functional test
 - ii) PLC/IO panel/Engineering station functions
 - iii) Diagnostic and process alarm test
 - iv) Controller redundancy test
 - v. I/O cards redundancy test.
 - vi) Controller loading test
 - iv) Online replacement of Module

In addition to above test, Bidder shall also perform other tests as per approved QAP & FAT procedure. Also bidder shall submit "Type Test" report as per IEC – 61131.2 along with FAT report for PLC.

- 17.02.04.18 The Factory Acceptance test for Safety Instrumented Systems (SIS) shall be conforming to IEC-61511-1-Cl. No. 13.

Installation, Commissioning, verification, Pre-startup test at site for Safety Instrumented Systems (SIS) shall be as per ISA 84.01.

- 17.02.04.19 **FACTORY ACCEPTANCE TEST FOR SIMULATOR**

Factory Acceptance Test (FAT) shall include all required tests to fully demonstrate to Owner's satisfaction that each equipment/sub-system/system software modules etc. furnished as per this specification, as well as Simulator as a whole, fully meets the functional, parametric and other requirements of this specification and Owner's approved drawings/documents under all operating regimes.

Bidder to note that FAT procedure given below in subsequent clauses are only indicative in order to help the Bidder in understanding the requirements and help him in submitting a detailed procedure based on these guidelines meeting all the specification requirements.

The Bidder shall also carry out the tests included in subsequent clause as pre FAT and submit its results before inviting Owner for FAT.

The Factory Acceptance Test (FAT) shall include all reasonable exercises, which the combination of equipment and software can be expected to perform. These tests shall be divided into, as a minimum, but not limited to the following categories:

- i. Pre power on checks
- ii. Power on check
- iii. Hardware tests
- iv. Functional tests
- v. Parametric tests
- vi. Specific tests on Electronic hardware

The major Functional Tests shall include but not limited to the following:

- a) Verification of individual modules in line with approved documents.
- b) Verification of adherence to parameters for various plant configurations at different initial conditions.
- c) **Functional test for C&I Model**
Verification of proper realization of Control and Logic functions as per input documents and approved functional design specification (FDS).
- d) **Functional tests for HMIPIS**
- i. Verification of all types of displays, logs including their formats, bar graphs, X-Y plots etc. Verification of all function keys on keyboards and availability of all operator functions.
- ii. Verification of event generation and handling capabilities of HMIPIS processors by simulating various types of events / data and observing associated event sequence display and alarm signaling boxes.
- iii. Calculations:
All calculations shall be tested to demonstrate that these are in accordance with the specification and I/O schedule. The Bidder shall prepare all tests cases for calculations (3 for each calculation at low, mid and upper ranges of inputs) and submit them for the owner's approval. Test cases shall include performance calculations, flow and level calculations, pressure and temperature compensations, etc.
- iv. Checking historical storage and retrieval functions including long-term storage.
- v. Checking healthiness of processor, main memory. Testing of initialization and loading of configuration data, etc.
- vi. Verification of all programmers' stations functions for HMIPIS and Control System, as well as for documentation facility as specified.
- vii. Various display response time / System accuracy etc.
- viii. Display update time on OWS
- e) Functional test for networking & communication devices
- i. Verification of various features as per approved documents.
- ii. Verification of throughput after creating high communication traffic.
- f) Instructor's workstation Functions
Verification of all features of instructor functions like malfunction, initial conditions, snap shots, trainee exercises etc. in line with specification & approved documentation.
- g) Programming and Documentation functions

- i. Verification of all programming function like, modification of application software, database, administrator's function etc. in line with specification and approved documents.
- ii. Verification of all documentation functions in line with specification and approved documents.

17.02.04.19.2 FAT Procedure

The Bidder shall submit a detailed FAT procedure for owner's approval during detailed engineering stage based on the above guidelines. The FAT procedure to be submitted by the Bidder shall be detailed and exhaustive enough such that owner is satisfied that all the Simulator System specification requirements and features are being tested and the system meets these requirements.

17.02.04.20 Tests to be performed during FAT of Peripherals & other control system

1. Colour Graphic Video Display Unit (OWS)
 - i. Functional tests (As per FAT procedure. Note-1)
 - ii. Test for capabilities of OWS including error detection for the Complete system (Both hardware & software) simulating worst conditions
 - iii. Noise test
 - iv. Surge withstanding capacity as per IEEE or equivalent
 - v. Quality assurance as governed by BS 5750 or equivalent
 - vi. Design, construction, components, finishes and testing of electronic equipment as per EES-1980 (General specification of electronic equipment) or equivalent
2. Keyboard
 - i. Test for satisfactory operation of keyboard controls, push buttons and all associated functions (As per FAT procedure. Note-1)
 - ii. Quality assurance as governed by BS 5750 or equivalent for functional test for the complete system simulating worst conditions
 - iii. Design, construction, components, finishes and testing of electronic equipment as per EES-1980 (General specification of electronic equipment) or equivalent
3. Printers
 - i. Noise level test for the printer
 - ii. Test of interlock performance and error detection feature.
 - iii. Quality assurance as governed by BS 5750 or equivalent
 - iv. Design, construction, components, finishes and testing of electronic equipment as per EES-1980 (General specification of electronic equipment) or equivalent

4. Floppy / Tape Drive Unit / Bulk Memory Unit / DVD, CD drive Unit / DAT Drive
 - i. Noise test
 - ii. Surge withstanding capacity as per IEEE or equivalent
 - iii. Quality assurance as governed by BS 5750 or equivalent
 - iv. Design, construction, components, finishes and testing of electronic equipment as per EES-1980 (General specification of electronic equipment) or equivalent
 - v. Test of Control unit and drive for all features, date checking Features.
5. Vibration Monitoring & Analysis System
 - i. Simulated functional test (Note-1)
 - ii. Tests for server, LED monitor, Printer, Keyboard
6. PADO (Performance & Optimization System)
 - i. Simulated functional test (Note-1)
 - ii. Tests for server, LED monitor, Printer, Keyboard
 - iii. Testing of various models operation and its result validation.
 - iv. Performance verification of various calculations.
 - v. System data base results verifications.
7. HMS System
 - i. Simulated functional test (Note-1)
 - ii. Tests for server, LED monitor, Printer, Keyboard
8. MIS System
 - i. Simulated functional test (Note-1)
 - ii. Tests for server, LED monitor, Printer, Keyboard

Note-: Test shall be witnessed by Owner or Owner's representative.

9. PSSS System
 - i. Simulated functional test (Note-1)
 - ii. Tests for server, LED monitor, Printer, Keyboard

Note-1: Test to be witnessed by Owner.

10. CAAQMS and MMS System
 - i. Simulated functional test (Note-1)
 - ii. Tests for server, LED monitor, Printer, Keyboard

Note-1: Test to be witnessed by Owner.

11. Video Conferencing System
 - i. Simulated functional test (Note-1)
 - ii. Tests for server, LED monitor, Printer, Keyboard

Note-1: Test to be witnessed by Owner.

NOTES:

1. The intent of the FAT is to demonstrate and ensure that the I&C system meets all the functional requirements as intended in the specification / contract. A completed integrated test of the system shall be carried out at vendor's works in the presence of Owner or Owner's representative, on completion of integration / manufacturing of the system. The shipment of I&C equipment to site will be effected only after the FAT has been accepted by Owner.
2. FAT procedure shall be prepared by vendor and to be submitted for Owners approval well in advance prior to the commencement of FAT.

17.02.04.21 Calibration of Instruments

The Bidder shall carry out the calibration of instruments as indicated below by submitting the test procedure and quality assurance plan for the Owner's approval. Bidder shall also prepare detailed checklist/calibration sheets for each of the systems/equipment clearly indicating the step-by-step procedures to be carried out for calibration pre commissioning, loop checking, powering and commissioning.

The calibration of all instruments shall be checked and calibration records prepared for the Owner's use. If the instruments require recalibration, Bidder shall recalibrate the instruments and revise the calibration records and submit to the Owner.

TESTS TO BE PERFORMED FOR FIELD INSTRUMENTS & EQUIPMENT

1.	Pressure Gauges
	Calibration, Accuracy Test, Hydro test (1.5 times max. pr.)
2.	Pressure switches
	Calibration test / Hydro test / Contact rating test / Accuracy test / Repeatability test
3.	Pressure Transmitter
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
4.	Differential Pressure Gauges
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
5.	Differential Pressure Switches

	Calibration test / Hydro test / Contact rating test / Leak test / Accuracy test / Repeatability test.
6.	Differential pressure transmitter
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
7.	Thermometers
	Calibration / Material test / Accuracy test / Bore concentricity: $\pm 5\%$ of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
8.	Temperature switch
	Calibration / Material test / Accuracy test / Bore concentricity: 1.5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.) / Contact rating test.
9.	Resistance temperature detector assembly.
	Calibration / Material test / Bore concentricity test / Insulation test ($\leq 500 \text{ M}\Omega$ at 500V DC) as per ISA, Hydro test for TW. Bore concentricity: $\pm 5\%$ of wall thickness, Accuracy test.
10.	Thermocouple assembly
	Calibration / Material test, Insulation test ($\leq 500 \Omega$ at 500 V, DC) as per ISA, Hydro static test (1.5 times max. pr.), Bore concentricity: $\pm 5\%$ of wall thickness.
11.	Temperature Transmitter
	Calibration test / Accuracy test / Ambient temperature error test
12.	Thermowells
	Material test / Bore concentricity: $\pm 5\%$ of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
13	Interposing Relay
	Functional Test/temperature rise test/high voltage test/limits of operation test/insulation.
14.	Level Gauges
	Hydrostatic test / Material test / Seat leakage test / Ball check test.
15.	Level switches (Magnetic)
	Material test / Contact rating test / Hydro test / Calibration test.
16.	Level gauge (prope)
	Material test/contact rating test/Hydro test/Calibration test
17.	Flow Switch
	Material test / Hydro static test (1.5 times max. pr.) / functional test.
18.	Flow glasses
	Material test / Hydrostatic test (1.5 times max. pr.) / functional test.
19.	Variable area flow meters

	Calibration test / Material test / Hydrostatic test (1.5 times max. pr.)
20.	Flow element
	100% Radiography test / Hydro test / Calibration test, IBR Certificate.
	Calibration test for flow element shall be witnessed by Owner/Consultant.
21.	Control valves/Pneumatic block valve/Pressure regulating valve –Refer Vol-V Part-B chapter 11.
22.	Pneumatic Block Valves
	<ul style="list-style-type: none"> a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test j) Also refer Vol-V Part-B chapter 11 for further details.
23.	Pressure Regulating Valve
	<ul style="list-style-type: none"> a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test j) Also refer Vol-V Part-B chapter 11 for further details.
24.	Position transmitters
	Calibration / hysteresis and Accuracy test
25.	Electro Pneumatic Convertors
	Calibration test / Accuracy test
26.	Solenoid valves
	Hydrotest / Seat leakage test / CV test / Coil insulation test
27.	Air filter regulators

	Calibration test / Accuracy test
28.	Junction Boxes
	Test for degree of protection / Material test
29.	Transmitter Racks :
	Hydro test, air leak test for piping / tubing and fittings. IBR certification as required for tubing / piping and fittings.
30.	Tests for terminal blocks
	Test for moulding for flame resistant, Non-hygroscopic and Decarbonised / Insulation test between terminals / Insulation between terminal block and frame.
31.	Thermocouple extension cable & Instrumentation Cables and Fiber Optical Cables
	Thermo-emf characteristic / Continuity test / Measurement on capacitance, inductance and loop resistance / Insulation resistance / High voltage test as per latest IS / Tensile and elongation test / Oxygen index test / Any other test applicable. (Also refer Vol-V Part-B chapter 9 for further details). For Details of type and acceptance tests for Instrumentation Cables refer Vol-V Part-B chapter 9. For Details of tests for Fiber Optical Cables refer Vol-V Part-B chapter 9.
32.	Mass flow meter
	Performance test / Calibration test / Hydrostatic test.
33.	Boiler Level Gauge
	Hydrostatic test / Material test / Seat leakage test / IBR Certificate
34.	pH/Conductivity measurement / Silica / Dissolved oxygen analysers:
	Calibration test, Accuracy test
35.	Sample cooler :
	Hydro test, IBR Certificate
36.	Sampling racks :
	Hydro test, IBR Certificate for tubes and fittings.
37.	S02 / Nox analyser / SPM analyser:
	Calibration test, accuracy test
38.	Interposing relay
	Functional test, temperature rise test, H.V test, Insulation test
39.	Local Panels : Visual inspection, wiring & continuity check, H.V. and I.R. tests on panels, checking of bill of materials, functional tests.
40	Wiring Termination & Accessories
	Routine test: Conductor resistance test/High voltage test/Impulse dielectric test/insulation test/Humidity test/Temperature rise test on power circuits/short time current test on power circuits.

	Type test: Annealing test/Test for insulation and sheath/ Flame retardance test - a) Oxygen index, b) Flammability / Test for acid gas generation/test for water absorption/wet dielectric test
41	Marshalling/System cabinets
	Verification of degree of protection/Electrical tests as detailed under wiring Termination & accessories/Type test and routine test as per relevant Indian standards.
	Notes:
	1. Test Certificates in addition to inspection at manufacturer's works shall be furnished for all the instruments for Owner / Consultant's review.
	2. Above Test to be witnessed shall be finalized by Owner.
	3. In addition to above test, test as per approved QAP shall also be witnessed by owner.
	4. Accuracy test, Calibration test, Overload/Over range protection test, IR test, Hydro test & Leakage test as applicable for measuring instruments are covered under the routine test. The test certificates/reports shall be furnished by bidder to owner for approval.

QUALITY PLAN SUBMISSION PROGRAMME FOR THE BIDDERS

In addition to above requirements, The Quality Assurance Plans as conceived for the project are also enclosed in Volume II. Bidders to follow the NIT specification in totality i.e both Volume II & Volume V to submit QAP for Approval.

17.02.05

Testing at Site [Prior to commercial operation]

- a. All equipment shall be checked thoroughly in respect of the following:
 - i. Visual and mechanical testing
 - ii. Complete system configuration loading functions; system diagnostics; system proper operation specified power supply specifications.
 - iii. Checking of loop configuration & OS displays; correct functioning of all keyboards; correct change-over of redundant devices; proper functioning of printer, sample printing of all types of log reports, shutdown reports and MIS reports; shutdown system.
 - iv. Loading of user's programme and checking out of results.

Repeating any or all such tests (as necessary) as performed at works.
- b. **Modulating Control Loop Test**

Loop test performed after calibration of all instruments and leak test of signal lines to check the functional performance of all elements of loop. Control loop testing shall be generally by simulation of process

conditions and shall fix points namely 0%, 25%, 50%, 75% and 100% of full scale inputs. The field/receiver pressure switches shall be simulated for abnormality by disconnecting the wires of terminals and checking the function of all associated systems. Performance of individual loops may be accepted for an overall accuracy of $\pm 0.5\%$. After the loop test is complete, the bidder shall connect back any terminations and connections removed for loop check.

c. Protection, Interlocking Sequence Control Loop Checking

- i. Loop check shall be carried out for checking the interconnection, configuration and overall system functioning. It includes termination of field cables in control room, checking of interconnection between equipment, ferruling, tagging of interconnecting cables & ferruling of field cables in control room and performing overall loop performance check from field instruments/equipment to DDCMIS and back; and all associated loop interconnections.
- ii. Loop checking ensures proper configuration, functioning and interconnection.
- iii. All readings shall be recorded on an approved format covering the following:
 - All loop components shall be checked for proper functioning.
 - For field switches and other initiating devices, abnormalities shall be simulated by disconnecting the wires at the field instruments end.
 - Alarm cards shall be checked for different settings on both increasing and decreasing signals. Shutdown schemes shall be checked for proper functioning, configuration and actuation.
 - Signal from shutdown scheme to shutdown values shall be checked at the respective values. The stroke checking as well as time of operation checking of shutdown values with its logging also forms a part of loop checking.

17.02.06 Commissioning Tests

The Bidder shall perform commissioning tests for all their offered instrumentation and control devices, loops, sub-systems and systems. Commissioning tests for instrumentation and controls shall include but not be limited to –

- Test on devices and loops
- Functional tests on subsystems and systems
- Performance tests on systems to demonstrate that it meets all guarantees as proposed by the bidder
- Fine tuning of control systems

17.02.07 Authorization to Ship Test

Authorization to ship test procedures shall be prepared by the Bidder and shall be submitted to the Owner/Engineer for approval of at least 7 days prior to commencement of these tests. The Authorisation to ship test shall test all functions of the system. These tests shall include all of the features of the operational tests. Every input point will be tested. The following tests shall also be included:

- i) Simulation of Inputs – to verify conversion accuracies, scans rates, operator’s panel functions, and correctness of calculations.
- ii) Operational Test – to verify that the system performs all required functions and meets the specification requirement.
- iii) Diagnostic Test – to test working and bulk memory locations, instruction complements, functioning of outputs and peripheral devices, functioning of system check modules, etc.
- iv) Power Consumption Test – to verify KW consumption.
- v) Power Failure Test – to observe the consequences of a total power failure.
- vi) Accuracy and Repeatability Test – accuracy and repeatability for analog inputs shall be demonstrated by statistical analysis using the point values read every scan cycle for a consecutive 8 hour period for a total of 10 per cent of all analog inputs. The specified noise rejection capabilities shall be demonstrated using the same test and analysis, by the application of at least 135 V RMS common mode and 25 RMS differential mode to the inputs. The noise rejection test shall be a second 8-hour test. Inputs to be used will be randomly selected by the Owner prior to the test. The test shall be carried out during the Authorisation-to-Ship Tests,
- vii) Functions – all computer functions shall be tested to demonstrate they are in accordance with the specification.
- viii) Format – All computer print – outs & OWS display formats shall be checked to demonstrate that they are in accordance to the specification.
- ix) Calculations – all computer calculations shall be tested to demonstrate they are in accordance with the specification and computer I/O schedule. The Bidder shall prepare all test cases for calculations (three for each calculation at low, mid and upper ranges of inputs) and submit them for the Owner’s review in accordance with contract schedule. Test cases shall include performance calculations, flow and level calculations.
- x) Demonstration of the manual and auto switchover from master to standby controller.
- xi) Demonstration of automatic switchover from the main to redundant data highway.
- xii) System and sub-system response time tests.
- xiii) All test as specified in FAT procedures mentioned above.
- xiv) All test as specified in Vol. II.

The Bidder shall provide a complete factory test of the system hardware and software. All diagnostic and software debug tests shall be performed at the factory in presence of the Owner/Engineer’s representatives. Test shall be performed with the computer system assembled and all parts interconnected together with simulated analog and digital inputs.

Solid-state logic system shall be tested as complete assemblies. Testing of individual components or modules will not be acceptable.

The authorization-to-ship tests shall include all reasonable exercises, which the combination of equipment and software can be expected to perform. The test shall include, but not be limited to the following:-

Thorough exercising of each device.

Demonstration of required spare system capacity point by point exercising of each input and output.

Demonstration of all man/machine functions.

Demonstration of the proper functioning of all software.

One month to the start of the factory test, the Bidder shall submit his testing procedures for approval. A representative of the Owner will witness factory tests. The Bidder shall notify the Owner at least 2 weeks prior to factory testing. Following the test if, in the opinion of the Owner, the system has not been adequately manufactured, programmed, tested, or debugged, the test shall be re-run. The system shall not be shipped without the approval of the Owner. The results of all the factory tests shall be documented and submitted to the Owner.

Upon successful completion of the authorisation-to-ship tests the Owner/Engineer will provide the Bidder with a written authorisation for shipment of the system equipment to the site.

17.03.00 **ON-SITE TESTS**

All the site activities including unloading, storage cum insurance of equipment and materials on arrival to site, installation, commissioning and carrying out all the tests at site shall be performed by the Bidder at no cost to the Owner in presence of Owner/Consultant's representatives and with the permission of owner as and when required.

The Bidder shall furnish the necessary manpower and the services of technical representative(s), who shall provide technical guidance and advice for the installation of the equipment and placing the system in operation. The services of the technical representative(s) shall be available for the period from arrival of the equipment on site until the equipment is finally accepted by the owner. The on-site tests shall include the following tests in the sequence given:-

A) **Inspection of Equipment on Arrival**

The Bidder's field representative(s) shall inspect all supplied equipment upon arrival on-site. All observed damage to equipment shall be reported to the Owner/Consultant.

B) **Preliminary On-site Checks and Tests**

After field installation and before equipment energisation and connection of field inputs, the Bidder shall carefully inspect all

equipment and shall check all Bidder supplied wiring and cable to assure correctness of corrections and proper equipment installation. After these checks, the Bidder's representative shall power the system and perform a standard diagnostic test to assure that the system is working. The field inputs and outputs will then be connected by Bidder.

C) Start-up / Initial Operation

On completion of erection of the equipment and before start-up, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the owner and the Bidder for correctness and completeness of installation and acceptability for start-up, leading to initial pre-commissioning tests at site. The list of pre-commissioning tests to be performed shall be as mutually agreed and included in the Bidder's quality assurance program.

The Bidder's commissioning/start-up engineers, specifically identified as far as possible, shall be responsible for carrying out all the pre-commissioning tests. On completion of inspection, checking and after pre-commissioning tests are satisfactorily over, the complete equipment shall be placed on initial operation during which period the complete equipment shall be operated integrally with sub-systems and supporting equipment as a complete plant.

The Bidder shall intimate his clearance for taking unit in service after completion of routine / performance tests.

D) Trial Operation

After taking the unit in service and taking full loading of the same, the plant shall then be taken on trial operation during which period all necessary adjustments shall be made while operating, over the full load range enabling the plant to be made ready for performance and guarantee tests.

The duration of Trial operation of the complete equipment shall be 7 days out of which at least 72 hours shall be continuous operation on full load or any other duration as may be agreed to between the owner and the Bidder. The Trial Operation shall be considered successful, provided that each item of the equipment has operated continuously at the specified operating characteristics, for the period of Trial Operation.

For the period of Trial Operation, the time of operation with any load shall be counted. Minor interruptions not exceeding 30 minutes at a time caused during the continuous operation shall not affect the total duration of Trial Operation. However, if in the opinion of the Owner, the interruption is longer, the Trial Operation shall be prolonged for the period of interruption.

A trial operation report comprising observations and recordings of various parameters to be measured in respect to the above described Trial Operation shall be prepared by the Bidder. This report, besides recording the details of the various observations during trial run, shall also include the dates of start and finish of the trial operation and

shall be signed by the representatives of both the parties. The report shall record all the details of interruptions, adjustments made and any minor repairs done during the Trial Operation. Based on the observations, necessary modifications/repairs to the system shall be carried out by the Bidder to the full satisfaction of the Owner to enable the latter to accord permission to carry out performance and Guarantee tests on the plant. However, minor defects which do not endanger the safe operation of the equipment shall not be considered as reasons for withholding the aforesaid permission.

The system shall be completely tested in the field by the Bidder's service representatives in the presence of the Owner's representative. All diagnostic and software debug tests performed at the factory shall also be performed in the field. These tests shall include a full demonstration of all operating software programs operating in the real time environment. The results of all field tests shall be documented and submitted to the owner.

E) System Documentation Check

Upon successful completion of the preliminary On-site checks and tests the owner's and the Bidder's representative shall check that all required system documentation, in its final form was delivered to the Owner. All error and inefficiencies in the system documentation (manuals, drawings, software) shall be corrected by the Bidder before the Owner accepts the system. Duly corrected system documentation shall be furnished to the Owner.

- 17.04.00 **PERFORMANCE AND GUARANTEE TEST AND ACCEPTANCE OF THE SYSTEM BY OWNER**
- 17.04.01 After successful trial operation the final test as to the performance and guarantees shall be conducted at site, by the Owner. The Bidder's commissioning and start-up engineers shall make the unit ready for such tests, assist the owner in conducting such tests free of cost. Such tests will be commenced within a period of one month or less after the successful completion of Trial Operations. Any extension of time beyond the above-specified period shall be mutually agreed upon. Such test shall be for operation of 7 days out of which at least 72 hours shall be continuous operation on full load.
- 17.04.02 These tests shall be binding on both the parties of the Bidder to determine compliance of the equipment and the performance guarantees.
- 17.04.03 Any special equipment, tools and tackle required for the successful completion of the performance and Guarantee Tests shall be provided by the Bidder, free of cost.
- 17.04.04 The guaranteed performance figures of the equipment/systems shall be provided by the Bidder as per this specification. Should the results of these tests show any decrease from the guaranteed values, the Bidder shall modify the equipment as required to enable it to meet the guarantees. In such case, Performance and Guarantee Tests shall be repeated within one month from the date of equipment is ready for retest, and all cost for modifications

including labour, materials and the cost of additional testing to prove that the equipment meets the guarantees shall be borne by the Bidder. If the Vendor is unable to meet the guarantees, even after the adjustments/calibration, the Owner retains the option to reject the Equipment, and in the case of such option of rejection being exercised, the Vendor shall replace the entire equipment with the one, which shall meet the guaranteed values.

The above guarantees will be inclusive of the final control element responses. The bidder has the responsibility to commission the control loop inclusive of the final control element, some of which are supplied by others/Owner.

17.04.05 These tests shall be sufficiently detailed so as to fully satisfy the Owner that the equipment/systems furnished by the Bidder meet all requirements of this specification as well as the published specifications of the respective manufacturers.

17.04.06 **Measurement System**

The Bidder shall guarantee the proper functioning of all the measurement system equipment as specified in enclosed data sheets.

The test of long-term stability of analog inputs calibration shall be demonstrated by the comparison of the results of the 8-hour stability test run at the field, using precision test voltage, with no calibration allowed during the test (no manual recalibration allowed for the time of the eight-hour field stability test. The bidder will have access to the records at all times and the test will be conducted in a manner as to satisfy the bidder that the specified operating conditions have been maintained. A complete copy of the test data will be furnished to the Bidder. In case of failure to pass the test, the bidder shall change or replace the equipment furnished so that the test can be performed successfully.

17.04.07 **Control System**

17.04.07.01 The distributed control system/DDCMIS shall provide automatic control of the plant for full applicable operating range of the unit and shall provide a unit operating turndown ratio of not less than six to one. The requirement is based upon the unit maximum load resulting in readings for steam flow, feed water flow, air flow, fuel flow and steam pressure that are at a maximum of 90 per cent of the range span. If the readings are less than 90 per cent, the turn down requirement will be adjusted for each affected system.

17.04.07.02 The control system shall permit the performance of the dynamic load tests (ramp test, steady state test & step tests) while maintaining safe furnace conditions, major process parameters and without endangering other equipments. All tests will be performed with the system in automatic mode:

- a) Drop 30 per cent of maximum load capability from approximately full load at a rate of 10% per minute
- b) Drop load from full rated output to the lowest load runback limit, at a rate corresponding to the fastest runback rate.
- c) Pick up 50 per cent of the maximum load capability from approximately 50 per cent load at a rate of 10 % per minute.

During transient conditions causing deviation of process variables, the control system furnished under this specification shall not permit deviations which exceed those permitted by the manufactures of the controlled process equipment, for load demand changes as indicated above.

SG and its auxiliaries along with its control system (SG C&I), TG and its auxiliaries along with its control system (TG C&I) when integrated with Unit C&I systems shall meet the permissible limits for important parameters, under various operating conditions specified. The tentative parameters to be monitored for this test are given in the table no. 4.1, chapter 4 and The exact parameters shall be as finalised by the boiler and turbine suppliers with owner's approval. The control loops shall perform to return the controlled variable to the set point in a stable manner with out cycling in the shortest possible time and without any loop interactions or cycling of generation when generation matches unit load demand.

17.04.07.03 The balance of plant (BOP) control loops shall also be designed to maintain the controlled variable to set values within permissible limits (as per clause 17.04.07.02) under varying load conditions. The control loops shall perform to demonstrate proper control action following load changes indicated in clause 17.04.07.02, shall limit the transient disturbances within permissible range and return the controlled variable to the set point in a stable manner without cycling in the shortest possible time.

17.04.07.04 The bidder shall also guarantee that the control system provided by him will be responsive and stable and will maintain the deviation of controlled variables from set point within the limits, so that the equipment being controlled will operate below over the range required. The controls shall operate automatically, with no assistance from the operator. The bidder shall successfully demonstrate the performance of automatic control systems before acceptance and taking over of this system by the Owner.

The control systems including furnace draft & firing rate control shall also comply with all relevant requirements of NFPA code no. 85 "Standard for prevention of furnace explosion in Pulveriser Fired Utility stations" and all other applicable codes regarding safety.

17.04.07.05 All runback conditions listed below shall be proved by the bidder without any oil support.

- i. FD/ID/PA fan trip
- ii. BFP/CEP trip.
- iii. One mill and two mill trip.
- iv. Any other condition decided during detailed engineering.

17.04.07.06 The following parametric tests shall also be conducted under worst case loading conditions as defined in Annexure – 1 to this chapter – (details of which shall be as approved by owner during detailed engineering.)

- a) For control system
CPU loading, cycle time/controller reaction time and memory spare capacity.

- b) For MMIPIS
CPU loading, spare duty cycle, spare memory capacity
- c) Spare duty cycle for system bus
- d) Various display response time
- e) System accuracy
- f) OWS display update time

17.04.07.07 For the parametric test, the following requirements shall be met

- i) Processor spare duty cycle (free time)

Under worst case loading of MMIPIS and system bus each MMIPIS processor shall have 40% free time when measured over any two second period and 50% free time when measured over any one minute period.

Under worst case loading conditions of control system processor shall have 20% free time when measured over any one minute period.

Under worst case loading conditions of control system, control system processor/controller shall have 20% free time when measured over any one minute period.

The bidder shall furnish all necessary data to fully satisfy the owner that the processor/controller spare duty cycle figures quoted by the bidder are realistic and based on configuration and computation capability of the offered system and these shall be actually achieved in the fully implemented system as commissioned at project site.

- ii) System bus spare duty cycle (free time)

The system bus shall have min. 50% free time during the worst case loading conditions of control system, MMIPIS and the system bus, measured over any 2 seconds interval.

The Bidder shall furnish all necessary data to fully satisfy the owner that the system bus spare duty cycle figures quoted by the Bidder are realistic and based on configuration and computation capability of the offered system and these shall be achieved in the fully implemented system as commissioned at project site.

- iii) Display response time

The system shall acknowledge all operator requests in one of the following manners within one second of pressing of the last button:
Commencement of the request display

OR

Acknowledgement of operator request in a suitable manner.

The display response time as defined above, under the worst case loading conditions shall not be worse than the following:

All control related displays	1sec.
Point details display	1-2sec.

(Single point)	
Bar chart display (20point, current data)	1-2sec.
Operator guide / plant start-up Guide message display (full Screen of alphanumeric Information and a maximum Of ten numbers of dynamic Data items)	1-2sec
Plant mimic display of fair Complexity with a minimum of 120 numbers of dynamic data Items e.g., values, macros, Line segment, etc.	2-3sec.
Group review display (current Values of twenty points)	2-3sec.
X-Y plot display (2 X-Y-plots And a single display requiring Both historical as well as Current data)	3-4sec.
X-T plot display (trend of 6 Analog points and a single Display requiring both historical As well as current data)	3-4sec.
Plant summary display (e.g., Bad point summary, limit check Removed point summary. Assume The whole data base search is Required and the summary display Contains ten points only).	3-4sec.

The response time for screen update, after the execution of the control command from the time the command is issued (for example command to start a motor to the time the screen is updated) shall be within two seconds (excluding the drive actuation time).

iv) System accuracy requirements

The overall system accuracy from signal input terminals to output presentation on LED display and printers for the least accurate input range and maximum scan rate shall be not worse than +/-0.1% of full scale of the engineering process range +/- ½ LSB for 4-20 mA input. For this purpose, the number of decimal places on display for testing purpose shall be sufficient to cover 0.01% of full scale range. For temperature input modules, the sensor range as per relevant ASME/DIN standard or equivalent shall be used in place of process range.

v) OWS update rates

All OWS display shall be updated at least every one-two seconds.

17.04.07.08 The system shall be accepted by the owner after satisfactory completion of pre-commissioning test, trial operation and performance guarantee test, contingent upon satisfactory computation of 180 days availability guarantee tests.

All expenses connected with performance guarantee test for acceptance of the system and all operating & test personnel shall be borne by the bidder. The system acceptance will consist of a written statement by the owner that all system documentation are received in the proper form and quantity, and that all on site operational and acceptance tests are successfully completed.

17.05.00 **AVAILABILITY GUARANTEE TEST**

17.05.01 **AVAILABILITY GUARANTEE**

The Bidder shall guarantee 99.7 per cent system availability for a continuous period of 180 days. An availability guarantee test shall be conducted to assure this level of availability. If the accrued downtime exceeds 0.3 per cent of 180 days, during a loss of availability, a new 180 days run shall start at the time when the system becomes available again. Loss of availability (unavailable system) shall be defined as the loss of the system's guaranteed accuracy and repeatability or of any system function; except, however, that the loss of a function for not more than five per cent of the points shall not be considered loss of availability. Loss of a function for not more than five per cent of the points shall be treated as partial unavailability and the corresponding outage time shall be weighed with respect to function and percentage of the points for which the function and percentage of the points for which the function is unavailable. Loss of each function shall have one weighing factor and unavailability of each equipment, peripheral device or process I/O card etc. shall have another weighing factor. The system shall be considered unavailable upon loss of functions or equipment such as loss of two control OWSs, all control room printers, all control room displays, control room operator keyboard, all alarming capability more than 5 percent of inputs or accuracy of more than 5 per cent of inputs, etc. The guaranteed accuracy and repeatability and system parametric requirements specified in clauses on system parametric requirements shall be maintained for the entire 180 days run without manual recalibration or any other changes made to the DDCMIS/DCS.

Downtime shall start upon loss of a system function and shall end upon restoration of all system functions. A minimum of one hour's down time shall be charged for each loss of availability in determining system availability.

If availability is lost due to reasons not attributed to the bidder/bidder's system or due to force majeure, then downtime shall not accrue & interrupted test resulting from the same shall be extended by an amount of time equal to the length of interruptions.

The bidder shall submit the availability test procedure to Owner's approval. The details regarding outage time, weighing factors for various system functions equipments to calculate the down time, test duration etc., shall be discussed and finalized during detailed engineering. After conductance of

availability test, bidder shall prepare reports covering the methods followed, observations and submit to Owner.

Test Dates

The availability test shall commence after the performance guarantee and acceptance tests .

Test Duration and Definition

The availability test duration shall be 180 days of accumulated test duration time. Such duration time shall be continuous from the start of test except as defined hereinafter. The test shall be conducted for a specified duration of time as mutually agreed between owner and bidder.

The availability shall be expressed by a percentage, which shall be calculated as:

100 (Test duration time – Accumulated system outage time)

Test Duration Time

The accumulated system outage time shall be a total of time in which all Bidders supplied systems and system functions are not available. A weighing factor shall be used to determine the amount of outage/time assesses due to partial failures. System outage time shall be calculated as:

(Outage time) x (Weighing Factors)

System outage time shall be accumulated over the test duration and shall be the accumulated system outage time.

Outage Time and Weighing Factors

Outage time will be assessed for the length of time in which all or any part of each of the following functions are not either continuously available or available when requested by operator action. The outage time shall be weighed by each function’s associated weighing factor as listed in below:

<u>System Element</u>	<u>Weighting Factor</u>
Data acquisition and Validation	1.00
Control Function	1.00
Historical Storage Function	0.30
Operator guides (OWS)	0.50
<u>System Element</u>	<u>Weighting Factor</u>
System summaries	0.30
Alarming, displays and logs	0.90
Other displays	0.30
Logs (except SOE)	0.30
Report	0.30
Sequence of events log	0.30
OWS Graphic	0.30
Each Bulk Memory	0.50
Each utility OWS and alarm OWS	0.33
Display / KBD	
Each Control OWS	0.50
Each Keyboard	0.50



Each printer	0.30
Cartridge Tape	0.40
Data Highway	0.75
Each Programmer's OWS/KBD	0.30
Engineer's Workstation	0.30
5% I/O Points	1.00
5% Controllers	1.00

Weighting factors for other system elements shall be defined and agreed upon after contract award.

The loss of functions based on the weighting factors above shall be limited to 1.00 maximum.

Conditions

Upon loss of any function as listed previously the Owner shall notify the Bidder. Downtime shall start at the time of notification exclusive of actual travel time required by the Bidder but not in excess of 8 hours.

Any degradation of functions shall accrue outage time regardless of processor configuration.

During a period of system outage, the Owner shall use operable functions of the system provided that such use does not interfere with maintenance of the inoperable functions or hardware as determined by the Bidder.

Should the Bidder determine that partial use of the system by the Owner will interfere with the Bidder's maintenance procedures, system outage time shall accumulate with a weighing factor of 1.0 since no functions are available to the Owner? This shall include off-line servicing.

Outage time for each function shall stop at the time the Bidder returns each of the functions as listed in clause on "outage time and weighing factors" to full service and relinquishes full use of the system to the Owner.

Outage of system functions due to the failure of equipment not supplied by the Bidder shall not be used to calculate system availability. The time required to initialize the Bidder's system following such outages shall not be used to calculate system availability provided that initialization time does not exceed 10 minutes. Time required for initialization of the Bidder's system for any reason, in excess of 10 minutes shall accumulate as system outage time. All costs associated with maintaining 99.7 percent availability for a continuous period of 180 days shall be borne by the Bidder. This includes hardware, software, spares and services.

The 99.7 per cent availability shall exclude downtime required for scheduled maintenance and service. The Bidder's proposal shall list maintenance and service requirement for all applicable equipment. If these requirements are not listed, it shall be understood that no downtime is required.

17.05.02 In case, bidder is not able to meet above specified availability guarantee requirements, then bidder shall make necessary modification and/or replacement to rectify the shortfall for achieving the system guarantee, and

the issue shall be dealt in line with the Category – III guarantee under Vol. II, Chapter 8.

17.06.00 **Training**

Bidder will be responsible for providing training to Owner's personnel on offered systems at Bidder's Works/Bidder's Associate's Works. It shall include training operators in the use of system, in the programming and hardware maintenance of the equipment to the extent that the Owner's personnel can make corrections and changes to the systems programs and maintain the system's hardware. . "Such training shall be as specified under General Technical Requirements in Volume-II of Specification".

17.07.00 **Warranty**

The Bidder shall provide an unlimited warranty on all equipments, systems and software during the defect liability period. This warranty shall include repair, replacement or correction of identified software or hardware discrepancies at no cost to OWNER.

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

The Bidder shall provide warranty spares and an exhaustive list of warranty spares including components for system hardware and instrumentation and peripherals based on (and keeping adequate margin over) normally experienced failure rate shall be submitted by the Bidder for Owner's review regarding adequacy of the same. The Bidder must furnish the list before inviting OWNER personnel for ATS test. The warranty spares as per the list mentioned above will be dispatched by the Bidder along with the main equipment consignment. The Bidder shall also provide expendable items for the warranty period. This shall include printer ribbon, ink/toner cartridge print head etc. Excluding floppy disk, M.O. Disk, tape cartridge and paper. Unused spare/consumable shall be bidder's property and taken back.

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

After six months of DDCMIS operation the Bidder shall provide the list of parts and expendables utilized for the period. The same information will be provided at the conclusion of the warranty.

In order to discharge the warranty responsibility, the bidder shall include in his proposal lumpsum price for the provisions of a team of service personnel at Site who will be fully qualified to perform the required duties throughout the warranty period of one year. The Bidder shall deploy at least one

engineer, two supervisors and four technicians in the team. The Owner shall approve the exact nos. & composition of team members. In case, the team is unable to rectify hardware or software problems, the Bidder shall depute and/or station additional specialist to rectify the problem to ensure 99.7% availability of system. The availability of system shall be calculated as per Vol. II, Chapter 8.

17.08.00 **Remote Service Centre for DDCMIS/DCS/PLC/PADO**

Bidder shall provide the necessary hardware & software required for connecting the DDCMIS/DCS/PLC/PADO system to Bidder's remote service centres, through which the remote diagnostics & fault analysis of the DDCMIS/DCS/PLC/PADO system can be carried out. 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. Bidder may also offer remote diagnostic & analysis facility at respective system level. Bidder shall provide all the necessary hardware & software accordingly. For remote service centre connectivity, the fixed cost (e.g. service provider charges & its equipments etc.) and running cost till warranty shall be included in the quoted price.

ANNEXURE – 1

1.00.00 Worst Case loading Condition for Control System

The worst case loading conditions shall include the following tasks as a minimum:

- 1.01.00 All process inputs coming to Control System including SOE/annunciation input being scanned, acquired, conditioned and processes.
- 1.02.00 All closed loop controls are in operation during a disturbed (non-steady) state of the process.
- 1.03.00 All open loop controls of DDCMIS are in operation during a distributed (non-steady) state.
- 1.04.00 All data being transferred between control system, system bus and MMIPIS.
- 1.05.00 Three (3) alarms are being generated per second from each of the functional groups of control System.
- 1.06.00 Twelve control commands from MMIPIS are being executed in one minute.
- 1.07.00 All processors (including hot standby) health being monitored.
- 1.08.00 All standby processors status being updated.

2.00.00 MMIPIS Worst Case Loading Conditions (See Note below)

The worst case loading conditions shall include the following tasks as a minimum:

- 2.01.00 Continuous data transfer between System Bus & MMIPIS.
- 2.02.00 All calculations including performance calculations being performed at the specified rates.
- 2.03.00 Alarms being reported at the rate of three (3) alarms per second for each of the Control System functional groups.
- 2.04.00 Two control operator commands for control/information within a base period of one minute from OWS & each LVS.
- 2.05.00 Data collection for all logs/reports in progress.
- 2.06.00 OWS/LVS displays are in operation as follows:
 - LVS- 1,4 - Sequence chain display with maximum number of dynamic data items.
 - LVS- 2, - Individual display with maximum number of dynamic data items.
 - LVS-3,5 - Plant mimic display with one hundred and twenty (120) numbers of dynamic data items.
 - OWS-1 - Overview display with max. no. Of dynamic data items.

- OWS-2 - Group display (twenty points, current data)
- OWS-3 - Alarm display of twenty (20) points.
- OWS-4 - 4 nos. Windows each running current trend.

Unit Incharge - Plant Overview display

OWS

All PC stations X-T plots are displayed & updated.

On Station WAN

And unit LAN

- 2.07.00 All printers connected to MMIPIS are in operation at rated speed.
- 2.08.00 MMIPIS processors and all peripherals health being monitored.
- 2.09.00 Data collection for trend function and historical data storage in progress.
- 2.10.00 Four Alarm acknowledgments within a base period of one minute from each OWS & LVS.
- 2.11.00 Calculations for long term storage of data being performed.
- 2.12.00 SOE printing in progress.
- 2.13.00 Data transfer with other DDCMIS sub-systems, all PLCs and SG/TG C&I Systems in progress for controls (commands) as well as for information.

3.00.00 **The Worst Case Loading Condition For System Bus**

The worst case loading condition shall mean continuous data transfer between the distributed modules (Control System/MMIPIS), at their individual worst case loading conditions defined at 1.00.00 & 2.00.00 above respectively.

Note : This clause is generally for the unified DDCMIS. This shall be suitably modified for other DDCMIS/DCS subsection depending on actual configuration.

CHAPTER – 18**CONTROL PHILOSOPHIES FOR BOP PACKAGES**

18.01.00 This chapter provides general guideline for control and operation for BOP Packages. This does not relieve bidder from the overall responsibility to comply with other detailed chapters of this Technical specification / Contract. Bidder shall also be responsible to provide all necessary equipments, all control equipment, instruments, and accessories, all Instrumentation cables including laying and termination of cables, erection hardware for safe, efficient and reliable operation of the plant.

18.01.01 **GENERAL DESCRIPTION**

Bidder to provide the DDCMIS based control system/Relay based control system/ Microprocessor & PLC based control System for different BOP/Off-site packages and number of Operating Work Stations , Operating cum Engineering Work stations ,LVS, Type of Printers, Laptop etc. for each package shall be as per Vol. V, Part A and Part B, chapter 3 & chapter 14, Annexure-A.

Control Desk shall be provided with Push buttons, indicating lamps, MIMICS, Indicators, ammeters, voltmeters, electrical scheme, chartless recorders and HW annunciations etc. as per Vol. V, chapter 3 and chapter 14.

Each DDCMIS based control system, PLC /Microprocessor based system shall be time synchronized with master clock system.

DDCMIS based control system offered for BOP/Offsite packages shall be provided with same features, functionality and design criteria as same envisaged for main plant DDCMIS.

Bidder shall provide redundant data communication connectivity (H/W and Software as indicated in chapter 14, Annexure-A) with DDCMIS/PLC for monitoring purpose as per chapter 14 (Annexure – A).

Hard wired signal interfacing shall also be provided for any signal required for time critical, interlock, control & protection. Similarly cable for hard ware signal transfer between main plant DDCMIS and DDCMIS/PLC/relay system shall be supplied, laid terminated by the bidder including preparation of cable schedule. Quantum of hard wired signals for linking each PLC/DDCMIS based system and main plant DDCMIS shall be decided during detailed engineering.

18.02.00 **CONTROL PHILOSOPHY OF COAL HANDLING PLANT**

The control & instrumentation shall be through standalone DDCMIS based control system with Hot Redundant Standby Processor system for Coal handling plant (Detailed in cl no. 18.02.01) covering the total functional requirement of sequence control, interlock and protection, monitoring, alarm, data logging etc.

The design of the control system and related equipment shall adhere to the principle of Fail safe operation of all system levels i.e the failure of signal, failure of power or failure of any component should not cause a hazardous

condition and at the same time prevent occurrence of false trips and provide reliable and efficient operation of the plant under dynamic conditions.

The system shall provide an integrated control & monitoring of coal handling plant equipment from a Main CHP Control Room. The control Room operator shall be provided with color graphic displays of the Coal handling plant and with sufficient details to allow proper control and monitoring of the plant function.

18.02.01 The entire Coal handling plant will be controlled from the following control points as per Vol. V, Part A and Part B, Chapter 14, Annexure-A.

- i. Main CHP DDCMIS with Redundant Hot standby functionally distributed processors and Back up control desk shall be provided which shall be located in the main CHP Control Room.

Connectivity: This CHP DDCMIS shall have dual redundant bidirectional OPC link connectivity with Ethernet based TCP/IP protocol with main plant DDCMIS for monitoring purpose. (as per main plant DDCMIS format)

Two no. Large Video Screens shall be provided for control and monitoring purpose.

- ii. Wagon tippler PLC with Redundant Hot standby processor and its dedicated control desk shall be provided which shall be located in the Wagon tippler control Room.

Connectivity: This PLC shall have redundant data communication connectivity (Softlink) with main CHP DDCMIS for monitoring purpose. All time critical, interlock, control & protection signals will be hardwired to Main CHP DDCMIS which shall be decided during detailed Engineering.

- iii. Separate Stacker Reclaimer PLC with Redundant Hot standby processor and its dedicated control desk shall be provided with each stacker reclaimer machine & reclaimer machine.

Connectivity: This PLC shall have redundant data communication connectivity (Soft link) or redundant industrial grade WIRELESS link (as approved by owner during detailed engineering) with main CHP DDCMIS for monitoring purpose. All time critical, interlock, control & protection signals will be hardwired to Main CHP DDCMIS which shall be decided during detailed Engineering.

- iv. In motion weigh bridge system PLC with Redundant Hot standby processor which shall be located in the designated control room.

Connectivity: This PLC shall have redundant data communication connectivity (Softlink) with main CHP DDCMIS for monitoring purpose. All time critical, interlock, control & protection signals will be hardwired to Main CHP DDCMIS which shall be decided during detailed Engineering.

18.02.02 Number of Operating Work Stations, Engineering Work stations, Type of Printers for CHP DDCMIS and for each PLC shall be as per Vol. V, Part A and Part B, chapter 14, Annexure-A along with its accessories like monitor, keyboard etc.

The main switchgear will be housed in the main control room building for CHP, the I/O cards, and the relays for drives and the equipments which are around the crusher house shall be mounted in the system cabinets which are located in the main CHP control room building.

18.02.03 The control panel for CHP (located in CHP control room) shall have coloured Mimic, Ammeters, parameters Indicators, recorders and totaliser etc. and the alarm Annunciation facia windows at the top.

Following Equipment will generally come under sequential interlock scheme and can be started / stopped from operating stations and backup control desk cum mimic panel in the main CHP control room with indication on operating station and backup control desk cum mimic panel with fault annunciation facility.

- i. All belt conveyors.
- ii. Vibrating Grizzly feeders.
- iii. Belt Feeders
- iv. Crushers
- v. Flap Gates.
- vi. Dry Fog Dust Suppression System
- vii. Apron Feeder with dribble conveyor
- viii. Belt Weigher
- ix. Metal Detector
- x. In Line Magnetic Separator
- xi. Hydraulic Scoop Coupling.
- xii. Coal Sampling unit.
- xiii. Air Conditioning & ventilation system for CHP
- xiv Track Hopper
- xv. Service water system, Cooling water system and Potable water system.
- xvi. Compressed Air System for CHP.

The sequential control system shall provide stream selection from underground conveyor of track hopper, from crusher conveyor to stacking yard conveyor, from stacker –re claimer to staking yard conveyor during reclaim mode etc.

However, all the above-mentioned equipments will have their own local control panels/ station for start / stop with push buttons, indicating lamps, HW annunciators etc. and /or any other function required with suitable lockable type local / remote selector switch shall be housed in local panel and placed near drives. The feedback for the same shall be H/W with main CHP DDCMIS.

- 18.02.04 Following Local control Panels shall be provided in the field, which shall have H/W status indication and alarms on mimic at control panel in main CHP control room.
These equipments will not generally come under interlock scheme and can be started / stopped / controlled from its local control panels with the feedback to main CHP control room to provide status indication /alarms.
- i. Travelling tripper
 - ii. Rotary Plough Discharge Machine
 - iii. Diverter Gates
 - iv. Side Arm Charger
 - v. Coal Scooper
 - vi. Plain Water Dust suppression System.
 - vii. Sump Pumps
- 18.02.05 Following equipment will be operated from its local panels without any indication in CHP main control desk and mimic.
- i. Electric Hoist.
 - ii. EOT Cranes.
 - iii. Passenger cum Goods Elevator.
- 18.02.06 Local Control Panels (referred at cl no. 18.02.04 above) shall be hard wired interfaced with main CHP DDCMIS to monitor status indication /alarms and time critical, interlock, control & protection signals. This may be done through remote I/O cards located in remote I/O panel in the local room or can be H/W directly to main CHP DDCMIS and local area PLC as approved by owner. The system cabinets shall be suitable for protection class IP-66/ NEMA 4x.
- 18.02.07 Similarly Coal unloading operation for wagon rakes near track hopper area shall be controlled from CHP DDCMIS based control panel located in the control room with in building near track hopper. The Rotary Plough Discharge Machine shall be operated & controlled from THC DDCMIS GIU panel apart from its local Control Panels. Similarly the control & operation of Compressed air system for track hopper complex shall be from THC DDCMIS panel apart from its local Control Panels. Interfacing (Hardwired & soft link) of THC compressed air system control panel with THC DDCMIS panel shall be same as specified for main plant compressor air system in Vol. V, chapter 14, Annexure A. The control room in this building shall be provided with glass panel to have full view of rakes unloading operation.
- 18.02.08 One (1) no. Integral Weighbridge below each Wagon Tippler Platform for measurement of gross weight for measurement of gross weight for each wagon shall be provided for the wagon tippler hopper complex. Each weighing bridge shall have built in diagnostic and weight measurements software loaded on Operating work Station. All cabling shall be sheathed and braided stainless steel to protect against corrosion and gnawing rodents.
- Bidder shall provide redundant software link with "ON line in motion bridge" PLC system & other belt weighing system with CHP DDCMIS System to calculate coal flow to indicate following status :-
- (a) Daily and cumulative coal unloading by track hopper.

- (b) Daily and cumulative coal sent to stockpile.
(c) Daily and cumulative coal sent to Boiler bunker.
(d) Amount of coal available in stockpile.
- 18.02.09. Safety switches like pull cord, belt sway switches, zero speed switches (quantities to be decided during detail Engineering) shall be provided as per the technical Specifications mentioned in Vol. V, Chapter-3. Safety Switches voltage level should be 24 V DC only.
Emergency stop PB for conveyers, other limit switch, cable glands etc. of CHP which produces spark shall be provided with dust and flame proof enclosure conforming to IS-2148. The cable (rope) operated emergency stop device designed to meet the requirement of EN 418 (Safety of machinery – emergency Stop equipment).
- 18.02.10 Remote indication in plant main control room (DDCMIS) for no of wagons unloaded in 24 hours and the total coal unloaded in 24 hours should be provided.
- 18.02.11 Anemometer shall be provided on the stacker & re-claimer to measure the wind velocity and direction of wind. Instrument shall comprise of sensors, control unit and display unit. Interface with CHP DDCMIS shall be furnished for alarm.
- 18.02.12 Void.
- 18.02.13 For measuring coal stock pile's level & volume, 3D Acoustic type level Transmitters with local indicators shall be provided and indication shall be available on stacker-reclaimer PLC & main CHP DDCMIS. Quantities of 3 D sensors in one system shall be finalized during detailed engineering considering + 1% accuracy and depending upon sensor capability and stock pile volumetric area (Length x width & height) with 20% extra margin. .
- 18.02.14 Temperature measurement for winding of all HT drives crushers motors; conveyors etc shall be provided with 6 no. each duplex type RTDs or 12 no. simplex type RTDs. and 4 No. Duplex type RTD or 8 no. simplex type RTDS for bearing Temperature on both (DE & NDE) for each HT Motor and driven equipment.
Vibration measurement of all HT drives shall be as per details in Vol. V, part A and part B, Chapter- 2.
- 18.02.15 Level switches (Low & high) in Dust suppression System water Tanks and other water sumps shall be provided as per Technical specifications Vol. V, chapter-2.
- 18.02.16 Power supply system required for Control and instrumentation system including parallel redundant (2 x 100%) UPS system, Batteries and 24 V DC chargers systems shall be provided as per Vol. V chapter-7.
- Bidder to provide all control equipment, instruments (As per Technical specification in Vol. V chapter-2), accessories, all Instrumentation cables (As per Technical Specifications, Vol. V chapter-9) including laying and termination of cables, erection hardware for safe, efficient and reliable operation of the plant. (As per Technical specification in Vol. V, chapter-9)

- 18.02.17 Refer Vol. V, Part A, and Vol. V, Part B – Chapter 3, Chapter 14 (Annexure-A), and System configuration drawing in Vol. VII for details of control and operation of CHP.
- 18.02.18 Control & monitoring of electrical distribution system, namely PCC, Bus coupler, Incomer, etc. for this plant shall be controlled from its monitoring station as well as from respective switchgear unit. Control system for the same shall be implemented in the CHP DDCMIS envisaged in the CHP control room. Bidder shall consider all transducers for monitoring of voltage, current, Kwh, power factor at respective CHP DDCMIS monitor station.
- 18.02.19 VHF Communication facility with complete hardware & software between CHP control room and all strategic working area such as wagon tippler control room, stacker-Reclaimer control cabin, bunker floor etc. shall be provided by bidder. VHF communication facility with complete hardware & software shall also be provided between engine driver and operation personnel in WT/Track hopper control room.
- 18.02.20 **System operation**
- 18.02.20.01 Operation philosophy of the plant, In general, shall be as elaborated below, details shall be finalized during detailed engineering by owner.
- (a) Coal flow path selection shall be done from OWS/Keyboard to select any one of the following conveying paths.
- (1) Track hopper to boiler bunker
 - (2) Track hopper to stock yard
 - (3) Stock yard to boiler bunkers
 - (4) Wagon tippler to boiler bunker
 - (5) Wagon tippler to stock yard
 - (6) Combination of above

The coal handling system operator will select any one of the above paths from OWS located on the main control desk. The flow stream path is then selected by positioning different flap gates/movable discharge pulley at desired positions by means of keyboard available at the central control desk. Once the system is in the operation, the gates/movable discharge pulley can be not be moved from their position and path. Flap gates which do not come in the stream in which coal flow is taking place can be operated at any time. However , for the flap gates in bunker area conveyors is in operation and feeding coal using interlock bypass facility, provided that sequential permissive are available.

The control system will be designed for "Auto" & "manual" operation of the conveyors in the selected path. Auto/manual Selection shall be done from keyboard.

Auto Mode: In the "Auto" mode, the conveyors and related equipment will start sequentially when the "system start" is activated. During stopping, when the "System stop" is activated, all conveyors will also stop sequentially (in the reverse sequence) allowing time delays for clearing the belts.

Manual : In manual mode, the operator will start the conveyor system, in the same sequence as Input Auto mode from keyboard. The operator will also stop the conveyor system, by pressing "system stop" or individual "stop" push buttons/command from keyboard in the reverse sequence.

During "Sequence start" in both Auto and manual modes, first the required number of hooters (3 phase induction motor type) will be energized simultaneously for a preset time of 1 minute or so (adjustable at site) as per the program. After the preset time, the hooters will stop and a preset time of two minutes (adjustable at site) as per the program will be allowed for the movement of the personnel and for the permissive of the conveyor system operation. This condition will be indicated on the panel by lowing of lamp. "Coal Handling Sequence start". The starting permissive will be available for a period of 5 minutes (Preprogrammed and adjustable in the field). In the event the last conveyor/equipment not started within the preset time of 5 minutes, the start command for equipment not started will be withdrawn. The system cannot be started again unless the "Sequence Start" push button is again pressed and the hooters sound again, as described before. Those conveyors and equipment, which have already started will continue to run.

The status indication in the graphic display against all conveyors and equipment in the selected path/stream will start slow flickering. However, all status indications against all flap gates/movable discharge pulley in the selected path will glow steadily. Therefore, from the selected flow stream path of the flap gates/movable discharge pulley, the operator will come to know the conveyors are equipment to be started for the selected path/stream. After a conveyor/equipment is started, the status indications against the conveyor/equipment will change to steady glow indicating that is running.

Graphic display status indicators associated with a particular motor/equipment shall flicker fast in case of fault/trip.

In addition, emergency stop push button on the control desk for immediate shut down of complete plant shall be provided.

For changeover of feed from one row of bunkers to another row of bunker without stopping of the CHP, provision shall be made for interlock bypass on the control desk for flap gates of all conveyors in boiler area or a preset period. If the changeover, in above specified time, is not completed then the entire CHP shall stop.

- (i) Lamp test facility will be provided for the annunciation and mimic lamps.

18.02.21 Conveyor system

- (a) Normally the movement of the paddle feeders feeding coal from the track hopper to the reclaim conveyor shall be controlled from the paddle feeder itself based on instruction from main control room. The operation of the apron feeders feeding coal from the wagon tippler hopper to the reclaim conveyor shall be controlled from wagon tippler control room.

- (b) The paddle feeder carriages shall move continuously to and fro along their tracks. Suitable limit switches and anti-collision devices (both mechanical limit switch operated and infra-red type) shall be provided to enable them to change direction of movement as soon as they come within a specified distance of each other and at the end of travel in one direction.
- (c) The operation and stoppage of the paddle feeders shall be signaled in the main control room of the coal handling plant. It shall be possible to stop the paddle feeder from main control room. It shall be possible to stop the track hopper conveyor from respective paddle feeder.
- (d) Approach of a railway wagon rake to the plant shall be signaled (visual and audible) in the track hopper or wagon tippler control room as well as to the main coal handling plant control room. As soon as the rake come within 100 m distances from the track hopper or wagon tippler. Provision shall be made for the same by the contactor in control desk.
- (e) Each conveyor shall be protected against damage to the edge of the belt due to excessive sideways movement by providing an adequate number of belt sway switches. In addition, each conveyor shall be provided with one (1) No. speed detection device (zero speed switch). The zero speed switch shall be designed to sense belt speed. In case of speed of belt goes below 85% of rated speed, it shall trip the conveyor.
- (f) All the conveyors shall be protected from the reverse running due to power failure by providing mechanical or electrical locking system.
- (g) The starting sequence of the conveyors shall follow a direction opposite to that of flow of material. i.e.
- (1) In case of direct conveying of coal to boiler bunkers, start from bunker conveyor and end up with reclaim conveyors below track hopper/wagon tippler
 - (2) In case of stacking of coal in stock yard, start from yard conveyor and end up with reclaim conveyor below track hopper/wagon tippler hopper. However for yard conveyor to start, the stacker cum reclaimers shall be in operation.
 - (3) In case of reclamation of coal from stock yard, start from bunker conveyors and end up with yard conveyor along with stacker/Reclaimer.
 - (4) The starting of paddle feeder shall be interlocked with operation of the reclaim conveyors below track hopper.
 - (5) The starting of apron feeders and wagon tipplers shall be interlocked with operation of the reclaim conveyors below wagon tippler hopper.

The starting of mobile trippers shall be interlocked with operation of the bunker bay conveyors.

- (h) Inter locking of yard conveyor with stacker cum reclaimer boom conveyor shall be provided.
- (i) Any individual equipment (belt conveyor etc.) should not be allowed to start unless the equipment immediately following the same in the direction of flow of material already in operation.
- (j) Stop/tripping of any equipment from running condition shall trip all preceding equipment in the system, except crushers but shall not effect succeeding ones which shall continue to operate.
- (k) Adequate number of pull-cord switches shall be provided at suitable intervals along the length of each belt conveyor, which shall enable the respective conveyor to be stopped immediately. Each pull chord switch shall be identified by a specific number on HMI in the main control room. Each belt sway switch shall also be identified by a specific number on HMI in control room.
- (l) Means shall be provided the pre-warm personnel working nearby when starting any conveyor, stacker-cum-reclaimer, wagon tippler and mobile tippler.
- (m) Interlocking of various conveyors shall be achieved with flap gate, discharge pulleys, Rack & pinion gate, limit switches and zero speed switches.
- (n) Suitable Indication for paddle wheel rpm shall be provided on the local panels. Manual facility to control the cutting rate of paddle feeder shall also be provided.
- (o) Motors shall start only when the brake/rail camp if provoked, is "not applied" condition. This signal shall be obtained from limit switch provided for that purpose.
- (p) Ring granulators shall be provided with speed and vibration monitoring instruments. Ring granulators shall trip in case speed/vibration is going beyond tolerable limits of design. Temperature sensing devices shall be installed on all bearings of each of the ring granulator to trip the rings granulator in case of temperature goes beyond limit. Audio visual annunciation shall be provided in main control room and locally also.
- (q) Once a conveyor trips, flap gate directing coal from this conveyor shall change over its position with a time delay and shall come back to the original position again. This is to prevent jamming of gate.
- (r) Tripping of the respective conveyor shall be provided in case any of paddle feeders and mobile trippers starts running along with the conveyor belt at speed higher than their rated speed by providing an over speed sensing device on the equipment.
- (s) It shall be possible to trip track hopper conveyor, bunker conveyor and yard conveyor from paddle feeder, mobile tripper and stacker/reclaimer.

- (t) Where ever scoop type coupling provided for HT motors, the coastline time of respective conveyors, thruster brake, actuator selection and the chute size shall be so selected such that there is no spillage of coal from any down stream conveyor during next start.
- (u) Whenever the conveyor/belt feeder is provided with the movable discharge pulleys in place of flap gates, the starting of the conveyor/belt feeder will be interlocked with the position of the movable discharge pulley.

18.02.22 Interlocking

- (a) The following conveyors/ equipments will come under interlock scheme:-
 - (1) All conveyors
 - (2) All flap gates
 - (3) All movable belt feeders/pulleys
 - (4) Rack and Pinion gates
 - (5) Metal detectors
 - (6) Magnetic separators and suspended Magnet
 - (7) Crushers
 - (8) Paddle feeders
 - (9) Belt Scale
 - (10) Mobile trippers
 - (11) Stacker/Reclaimer
 - (12) Wagon tipplers
 - (13) Apron feeders and dribble conveyors
 - (14) Belt feeder
- (b) The following equipment will not come under interlock of the conveyor scheme
 - (1) All dust suppression systems and service water system
 - (2) Ventilation system
- (c) All conveyors and equipments will have local push button stations each consisting of:
 - (1) Pos -I, Pos-II & stop button for flap gate and R&P gate.
 - (2) Emergency stop push button (Red) for other equipment
- (d) Belt scale shall be started when relevant conveyors are started.
- (e) The dust suppression system will be energized as soon as the conveyors are energized.
- (f) Coal handling plant shall be tripped in case of detection of fire.
- (g) Interlock for H.T. Motor

H.T. motors used will continue to run on no load by disengaging the fluid coupling in case of failure of any process interlock. The HT. motor will however be tripped in case of any motor fault like O/L, high motor

winding temperature etc. In addition, In case of normal stop command, after running of the system, motors will stop.

- (h) The following are the various safety interlocks for the conveyors and other equipment, This LIST is indicative only and the bidder shall develop a comprehensive interlocking scheme.

Conveyors

- a. Pull chord switch – not operated
- b. Belt sway switch – not operated
- c. Under speed switch – closed at 90% speed of the conveyor within designed accelerating time.
- d. Motor protection - not tripped
- e. Local stop PB – reset
- f. Chute block switch – not operated
- g. Brakes for conveyors – not operated
- h. Trips circuit healthy.
- i. Temp. of fluid coupling oil – not high

Paddle feeders

- a. Motor O/L – not tripped
- b. Local E-Stop PB – reset
- c. Stop PB in main CHP control room – reset
- d. All limit switches – reset
- e. Over speed limit switch – not tripped

Travelling Tripper

- a. Stop PB in local control station – reset
- b. Motor O/L not tripped
- c. Over Travel limit switches – not tripped

Magnetic separator/Metal detectors/Suspended magnets

- a. O/L/fault relay – not tripped
- b. Stop PB (Local and remote) reset
- c. Metal detector reset
- d. Oil temperature – not high

Flap Gates/R & P Gates

- a. End of travel limit switches – reset
- b. Torques limit switches- reset
- c. Local Stop – rest

Ring Granulator

- a. Zero speed – not operated
- b. Temperature of fluid coupling oil – not high
- c. Local stop push button reset
- d. Temperature of bearings – not high
- e. Cooling water flow switch – reset

Wagon tippler

- a. Motor O/L – not tripped
- b. Local E shop PB –reset
- c. Shop PB in main CHP Control Room reset
- d. All limit switches – reset
- e. All limit switches – not tripped.

Apron Feeder

- a. Motor O/L – not tripped
- b. Local PB – reset
- c. Dribble conveyor - not tripped

18.02.23 The list of indication and audio visual annunciation given in subsequent clauses are indicative only and the same shall be finalised during detailed engineering.

18.02.23.01 **Status Indication in Large Video Screen**

Following Individual status indications shall be provided in LVS with individual ON/OFF/TRIP indications on OWS.

- a. Conveyor "ON"
- b. Flap gate/ Rack and Pinion
- c. Belt scale flow rate indication and totalizer.
- d. Belt sway switch operated for each conveyor (individual switch indication on OWS)
- e. Pull cord switch operated for each conveyor (individual switch indication on OWS)
- f. Zero speed switch operated for each conveyor
- g. Paddle Feeder 'ON'
- h. Travelling tripper position.
- i. Crusher ON
- j. MD/ILMS/SM/CSU ON
- k. DS/SW/PW/CW/DE/Vent ON (System wise)
- l. Stacker-cum –Reclaimer ON (Any travel position)
- m. Unit wise MW indication, total coal flow & bunker level
- n. Wagon tippler – ON
- o. Apron Feeder – ON

Further Mimic lamps for HT and LT SLDs shall be provided on the control desk.

18.02.23.02 **Annunciation System:**

DDCMIS/ Control Desk shall be provided with adequate number of facia type annunciation windows operating through DDCMIS for the following audio – visual fault annunciation purposes. Wherever group annunciation is provided, alarm status is provided, alarm status of individual equipment shall be provided on OWS.

- a. 3.3 Kv Breaker Trip (Group wise for each board)
- b. 415 V MCC Breaker Trip (MCC wise)

- c. Bus under Voltage for each LT MCC & HT switchgear buses.
- d. Following group wise annunciation shall be provided for transformers:
 - (1) Buchholz alarm
 - (2) Winding/oil temperature high alarm
 - (3) Oil level low alarm
 - (4) Buchholz trip
 - (5) Winding/ Oil temperature high trip
- e. A.C. Control supply failure
- f. D.C. Control supply failure
- g. Annunciation Supply Failure
- h. Both CPU AIL
- i. Stand by CPU in service
- j. HT motor overload alarms (individual)
- k. HT motor bearing/winding temp. high alarm (group) and trip (group)
- l. HT motor trip on electrical fault (Group)
- m. LT motor overload tripped (Group)
- n. Crusher vibration monitor alarm (Group)
- o. Belt sway switch operated (Group)
- p. Pull cord switch operated (Group)
- q. Zero speed switch operated (Group)
- r. Chute plugged (Group)
- s. Wagon rake arrived
 - (t) Paddle feeder over speed tripped (group)
 - (u) Tripper over speed tripped (group)
 - (v) Stacker-reclaimer tripped group.
 - (w) Magnetic separator fault and cleaning belt trip.
 - (x) (i) Metal Detector fault (group)
(ii) Metal Detected/MD not reset (group)
 - (y) Belt scale fault (group)
 - (z) Sampling system faults and trips (group)
 - (ab) Dust suppression/service water system faults and trips (system wise)
 - (ac) water level low in tanks (group)
 - (ad) Oil temperature of fluid coupling high.
 - (ae) Crusher low speed & crusher bearing temperature -high
 - (af) wagon tippler tripped
 - (ag) Apron feeder tripped
 - (ah) 20% spare window

For identification of the fault for a particular conveyor or equipment, status indication against that conveyor/equipment in the MIMIC will start fast flickering and the annunciation window will be blinking against that particular fault. In addition, a buzzer (alarm) will start sounding. After acknowledgement of the fault, the buzzer will stop, but the fast flickering on the MIMIC and the steady glow on the annunciation window will continue until the fault is cleared and the reset push button is pressed. When the fault is cleared and the reset push button is pressed the status indication of that conveyor/equipment on the MIMIC will start slow blinking if it is on selected path otherwise it will go off and the steady glow in the annunciation window will go off. However, pressing of the reset push button before clearance of the fault, will have no effect on the lamps.

At the time of fault, the faulty conveyor/equipment as well as the preceding conveyors/equipment in the interlock sequence, will stop except H.T. motor will trip but the succeeding conveyors/equipment will continue to run. The

status indication against the preceding conveyors/equipment will start slow blinking while the faulty conveyor/equipment will be fast blinking.

Start command shall not be initiated unless reset button is pressed after clearance fault.

The sequence of operation of the annunciation system shall be as follows:

Condition		Status
Normal	Annunciation Window	Off
	Status Indication	Steady glow
	Buzzer	Off
Fault	Ann. Window	Blinking
	Status Indication	Fast blinking
	Buzzer	Sounding
Press Accept P.B.	Annunciation Window	Steady Glow
	Status Indication	Fast blinking
	Buzzer	Off
Press Reset P.B. (when fault is cleared)	Annunciation	off
	Status indication	Steady blinking (if on selected path) Off (if no path)
	Buzzer	off

18.02.24 **Dust suppression system.**

(a) Conveyors/Equipments

- (1) It shall be possible to operate the dry fog system on to coal stream only when Corresponding conveyors/equipment are running coal with material at spray application points.
- (2) If a running pump trips stand -by pump shall start automatically. It shall be possible to select any of the pumps as auto standby from main CHP Control room.
- (3) Pumps/pumps shall trip with a time delay, if discharge valves fail to open. Suitable pressure/flow switch shall be provided to sense this condition.
- (4) Pumps shall trip in case of level of water in tank.

- (5) All feeding pumps to tank shall trip in case of high pressure and no flow by pressure switch.
- (6) Motorized inlet valve to dust suppression tanks shall close in case of high-High level & open in case of low level.
- (7) Pumps shall be started manually or from DDCMIS. If any of the pumps/pumps trips, stand-by pumps/pumps shall start automatically . It shall be possible to select any of the pumps as auto stand-by
- (8) Following annunciation shall be provided at local control panel.
 - (i) Motor Electrical protection Operated (group)
 - (ii) Discharge water pressure low(group)
 - (iii) Water Level low in tank
- (9) Following individual indications shall be provided at local control panel.
 - (i) Motor ON/OFFF/Trip
 - (ii) Discharge pressure healthy
 - (iii) Water level high in tank.

(b). Wagon unloading (At Track Hopper & wagon Tippler Hopper)

- (1) System shall be operated from local control panel. However, the controls shall be through DDCMIS.
- (2) Dust suppression system shall be provided to cover the track hopper in minimum one & maximum twenty sections. Push button for each section shall be located on each side of the track hopper at convenient location. Dust suppression shall be provided to cover Wagon Tippler hopper. Push Button shall be located at convenient location.
- (3) Pumps shall be started manually or from DDCMIS. If any of the pump/pumps trip, stand-By /pumps shall start automatically. It shall be possible to select any of the pumps as auto-stand-by.
- (4) Pumps shall trip in case of low level of water in tank.
- (5) Following annunciations shall be provided at local control panel.
 - (i) Motor electrical protection at local control panel.
 - (ii) Discharge water pressure low (group)
 - (iii) Water level low in tank (Individual)
- (6) Following individual indications shall be provided at local control panel.
 - (i) Motor ON/OFF/TRIP
 - (ii) Discharge pressure healthy
 - (iii) Water Level high in Tank

(c). Stockyard Dust Suppression.

- (1) Water supply pumps shall be started in manual mode from Main CHP control room. Control shall be from DDCMIS>
- (2) If any of the running pump/pumps trip, standby pump/pumps shall start automatically (pressure switch signal shall not be used for this purpose).
- (3) Pumps shall trip in case of low level of water in tank.
- (4) All feeding pumps to tank shall trip in case of high level in tank.

(d). Paddle Feeder Dust Suppression System

Trolley mounted dust suppression system arrangement shall be provided as described elsewhere in the specification and shall be controlled from the local control panel. Rest of the system to supply ground storage tanks and ring header etc. Shall be connected from Main CHP control room.

- (e) Following individual inputs shall be provided to DDCMIS system from all the above dust suppression systems (except trolley mounted system for paddle feeders) for alarms/indications.
 - (i) Motor ON/OFF/TRIP
 - (ii) Water Level Low in Tank.
 - (iii) Water Level High in Tank
 - (iv) Discharge Pressure low

18.02.25 Metal Detectors

- (a) It shall be possible to start the conveyors only after energizing the metal detector and metal detector reset condition. Once the metal is detected corresponding conveyor shall trip.

It shall be possible to restart the conveyors, after local resetting of the metal detector and pulling back the marker bag in position. Metal detector ON/OFF push button shall be provided in main control also.

- (b) In case of tripping of conveyor system, metal detector shall get de-energized after a time lag.
- (c) Following individual indications shall be provided on local control panel
 - (1) Metal detector 'ON'
 - (2) Metal Detected
 - (3) Metal Detector 'reset'
 - (4) Metal detector faulty

18.02.26 Sump Pumps

- (a) Sump Pumps shall start and stop by the level switches. in the sump automatically. Further manual override start/stop push button shall be provided locally on ground level.
- (b) Any of the pumps can be selected as auto-standby

- (c). If the sump level continues to be high even after the first pump is under operation second pump shall start automatically.
- (d) The following indications for sump pumps shall be provided on local control Panel.
 - (1) Water Level High
 - (2) Motor ON/OFF/TRIP

18.02.27 Coal sampling System

- (a) Coal sampling Unit shall be controlled through main coal handling plant DDCMIS. Controls and interlocks for proper material flow shall be provided similar to conveyor system. MIMIC shall be provided in the operator work station (OWS) at main CHP control room.
- (b) Only one start/stop push button along with selector switches for various modes of operation of coal sampling system shall be provided for automatic operation of complete coal sampling system. This control facility shall be provided at main CHP control desk as well as locally. In any case, local push button stations shall be provided for all individual equipment of coal sampling system near the equipment.
- (c) All necessary automatic controls shall be provided for meeting the requirements of ASTM-D-2234.
- (d) Following indications shall be provided on local control Panel.
 - (1) System ON/OFF/TRIP
 - (2) Primary Cutter stuck up between parking positions.
- (e) In case of primary cutter getting stuck between parking positions, preceding conveyor shall trip and annunciation shall appear at main CHP Control room.
- (f) There shall be protection in the primary coal sampler to trip the conveyor belt in case primary sampler falls on running conveyor due to coupling due to coupling failure etc.
- (g) Individual Motor ON/OFF/TRIP indications shall be provided at main CHP control room.

18.02.28 Paddle Feeders

Paddle feeders shall be controlled from local control panel suitably mounted on the Unit. Requirements of operation as described elsewhere in the specification shall be complied with. Following indications shall also be provided on the local control Panel:

- (a) Motor ON/OFF
- (b) Motor O/L protection Operated
- (c) Brakes applied (if provide)
- (d) "Digital pressure indications of hydraulic power pack including those of hydraulic pump discharge, return (leakage) traverse pump discharge (forward and reverse) oil line.
- (e) Coal flow rate.

Main hydraulic pressure of paddle feeder wheel drive system to be reduced to minimum though its control circuit during each tripping of main drive motor.

18.02.29 Travelling Trippers

- (a) Mobile tripper unit shall be locally controlled from the operating platform suitably located with the unit as per instructions given from main CHP control room.
- (b) End travel limit switches shall also be provided.
- (c) Travel drive motor shall start only when brake and rail clamps are in disengaged condition.
- (d) It shall be possible to trip the bunker conveyors from tripper.
- (e) When the last bunker is full, it shall not be possible to change over the tripper flap gate from bunker feeding position to last bunker feeding position.
- (f) As soon as the bunker conveyor trips, tripper flap gate change over its position after a time lag.
- (g) Two nos. emergency stop button one on each side shall be provided on tripper to stop the machine at any position. The control unit on tripper shall be provided with Start/Stop push button and indication lamp for travel/gate. The tripper brakes and rail clamps shall be energized (and released) when the tripper motors are ON and the brakes will be applied when the travel motors are OFF. Two travel limit switches shall be provided at either end of tripper carriage for limiting the travel drive between two ends of the track. The first one shall be normal limit and the second one for over travel limit. In addition to above, position indications for bunker position of tripper will be provided in main control room. Necessary position encoders/limit switches shall be provided.
- (h) Following individual indications shall be provided on local control panel.
 - (1) Motor ON/OFF/TRIP
 - (2) Brakes applied
 - (3) Rail Clamps applied
 - (4) Flap Gate Position
- (i) Indication of tripper flap gate positions shall be given in the main CHP control room.
- (j) It shall be possible for operator to manually trip the coal feeding equipment viz. paddle feeders or stacker/reclaimers from the tripper.
- (k) Chute Blockage switch shall be provided at each leg of chute and shall trip the tripper conveyor in case of blockage.

18.02.30 Flap Gates/R&P gates

All Flap Gates/R&P gates shall be motorised with remote controlled from the main Control desk. Their position shall be indicated on the MIMIC of main Control Room.

18.02.31 Belt Weighers

Each belt scale shall give output to DDCMIS for display of flow rate indicator and totaliser on LED and print out at CHP control Room. 4 nos. rate flow rate indicators, one for each paddle shall also be furnished to display the instantaneous TPH on respective paddle feeder using the output of belt scale on conveyors. Each Belt scale shall also have rate flow indicator and totaliser mounted near the Unit. Belt weighers shall also be provided on stacker/Reclaimer mounted near the Unit. Belt weighers shall also be provided on stacker reclaimer as described elsewhere in the specification.

18.02.32 Magnetic separator/suspended magnet

It shall be possible to start the conveyor only after energising the magnet of IIMS or SM. Further if conveyor system trips magnetic separators shall get de-energised after a time lag and suspended magnet will remain energised and can be de-energised locally. Also if drive motor of cleated belt of ILMS trips, magnetic separator shall not get-De-energised, but conveyor system shall trip and audio-visual annunciation shall appear at CHP Control room.

Following individual indications shall be provided on local control Panel.

- (a) Magnetic separator ON.
- (b) Incoming supply ON.
- (c) Under current relay operated.
- (d) Cleated belt motor ON/OFF/TRIP
- (e) Oil temperature high

18.02.33 Service water, cooling water and potable water pumps.

- (a) These pumps shall be started from main CHP control room.
- (b) Pump shall trip in case of low water level in tank.
- (c) Water Level Low in tank.
- (d) Water Level high in tank.
- (e) Following individual inputs shall also be provided to DDCMIS system for alarms/Indications.

- (1) Motor ON/OFF/TIP
- (2) Discharge water Pressure Low
- (3) Water Level Low in Tank.
- (4) Water Level High in tank

18.02.34 Stacker/Reclaimer

- (a) The stacker reclaimer shall be controlled from the operator's cabin in the machine through PLC system of stacker cum reclaimer.
- (b) Slew speed shall be controlled through power transducers on Bucket wheel drive motor for uniform feeding. Setting of power transducer shall be done from operators cabin.
- (c) Slew reversal shall be automatic through
 - (1) Power transducers on Bucket wheel and/or
 - (2) Extreme end limit switches and/or
 - (3) Manual command
- (d) At the end of the slew pass stacker-cum-reclaimer drive shall advance automatically to required depth of cut depth of cut shall be controlled through the setting of power transducer on bucket wheel. It shall also be possible to set the depth of cut through separate setting knob in operator cabin.
- (e) All controls shall be based on feedback signals from field equipment.
- (f) All electronic circuitry shall have self-diagnostic features.
- (g) Operator's cabin shall maintain horizontal level automatically as per boom conveyor position.
- (h) For all drives, zero speed shall be ensured before affecting reversal, by providing suitable speed sensing device.

- (i) Motors shall start on when the brake and or rail/clamp, is in "Not Applied condition" This signal shall be obtained from limit switch provided for that purpose.
- (j) If wind velocity is high, it shall cut off power supply to stacker Cum Reclaimer with a delay, after giving sufficient time to operator to bring the boom in minimum wind pressure direction/position.
- (k) All sequential interlocks for proper material flow shall be provided.
- (l) It shall be possible to operate the lubrication system from operator's cabin.

(m) Manual-Local

With the selector switch in this position all drives functions on the stacker cum reclaimer can be operated by push buttons local to the drives. All other operation initiating shall be locked out.

(n) Manual-Remote

Manual Controls facility shall also be provided in control desk and keyboard (operator's cabin) as below:

- (1) Individual Controls shall be provided for each equipment
 - (2) Manual Slew speed variation and depth of cut setting facilities shall be provided.
- (o) Following minimum audio-visual annunciation shall be provided through integral type annunciation system in operators cabin in stacker-reclaimer. Annunciation system shall meet the requirements specified in the relevant electrical sections.
- (1) Wind velocity high
 - (2) Lubrication system trouble for slew drive
 - (3) Lubrication system trouble for bucket wheel drive
 - (4) Hoisting system trouble
 - (5) Chute plugged
 - (6) Coal flow rate high
 - (7) Belt sway switch operated
 - (8) Zero speed switch operated.
 - (9) Pull chord switch operated
 - (10) Motor electrical protection operated (individual)
 - (11) For L.T. Transformer wind temp high alarm and trip.
 - (12) LT Breaker tripped.
 - (13) HT switch tripped.
 - (14) 20% spare windows
 - (15) Rail clamps of stacker reclaimer not engaged.
- (p) Following individual indications shall be provided in operator's cabin and OWS
- (1) Motor ON/OFF/TRIP
 - (2) Control supply healthy
 - (3) All necessary position/motion/level indications.
- (q) Ammeters shall be provided in control desk for all the motors.
- (r) Wind velocity indication shall be provided in operator's cabin
- (s) Bidder shall provide a comprehensive interlock and protection scheme and include a block logic diagram and write up on the scheme

proposed. The final scheme shall be subject to approval of employer. Sequential interlocking as applicable shall be provided. This shall be a part of main interlock scheme/write-up for the entire Coal Handling Plant.

- (t) Boom conveyor shall be interlocked in such a way that it cannot start in reclaiming mode unless yard conveyor is running. In addition, yard conveyor would not start unless boom conveyor is running in stacking mode (with CHP in stacking mode) Following indications shall also be provided in operator's cabin.
- (1) Boom conveyor Stacking
 - (2) Boom conveyor Reclaiming.

For indications/interlocks indicated above, and for communication system between stacker/reclaimer and main control room, bidder shall provide all necessary control cables.

- (u). It shall be possible to trip stacker/reclaimer from main CHP control room also.
- (v) A push button shall be provided in operator's cabin to trip the yard conveyor.

18.02.35 **Wagon Tippler**

Wagon tippler shall be connected from the local control Panel suitably placed. Requirement of operation as described elsewhere in the specifications shall be complied with. Following indications shall also be provided on local control Panel.

- a) Motor ON/OFF
- b) Motor O/L Protection Operated
- c) Brakes applied (if provide)
- d) Hydraulic power pack indications as applicable
- e) Dribble conveyor

Main hydraulic pressure of champing drive system to be reduced to minimum though its control circuit during each tripping of main drive motor.

18.02.36 **Summary of control philosophy**

Bidder shall furnish summary of control philosophy indicating permissive, trip and interlock conditions for each drive/equipment. It shall clearly list all permissive conditions (conditions required to start the drive), all the trip/protection conditions and each auto start/open and auto stop/close conditions for each drive/equipment.

The sequential start-up and shut-down steps for a group of drive/equipments shall also be described clearly.

The above summary conditions shall be comprehensive to include all process conditions and shall be elaborated in clear and unambiguous way, and shall include tag number of devices and equipments.

18.02.37 Unidirectional Stacker/Reclaimer Control

The entire control & operation of stacker Reclaimer machine shall be from the operators cabin on the machine itself. Flat LED monitor shall be provided at the control desk of the operators' caption.

18.02.38 **Wagon tippler control room**

The entire control and operation of wagon tippers, apron feeders and side arm charger shall be from the wagon tippler control room.

18.02.39 In addition to the remote control of various equipment, local stop push button station shall be provided for all equipment.

18.03.00 **CONTROL PHILOSOPHY OF ASH HANDLING SYSTEM.**

The control & instrumentation shall be through AHP DDCMIS (Details in cl no. 18.03.01) with Hot Redundant Standby Processor system for entire Ash handling plant covering the total functional requirement of sequence control, interlock and protection, monitoring, alarm, data logging etc.

The design of the control system and related equipment shall adhere to the principle of Fail safe operation of all system levels i.e. the failure of signal, failure of power or failure of any component should not cause a hazardous condition and at the same time prevent occurrence of false trips and provide reliable and efficient operation of the plant under dynamic conditions.

The system shall provide an integrated control and data acquisition system for providing control & monitoring of Ash handling plant from a Main AHP Control Room. The control room operator shall be provided with colour graphic displays of the Ash handling plant and with sufficient details to allow proper control & monitoring of the plant function.

18.03.01 The entire Ash handling plant will be controlled from the following control points as indicated in Vol. V, Part-A and Part B, Chapter 14, Annexure-A.

- i. Fly Ash, Coarse Ash and Bottom Ash water and ash slurry shall be DDCMIS system with Redundant hot standby processor which is to be located in the AHP control Room.

Connectivity: This AHP DDCMIS shall have dual redundant bidirectional OPC link connectivity with Ethernet based TCP/IP protocol with main plant DDCMIS for monitoring purpose (as per DDCMIS format).

Two nos. Large Video Screen shall be provided for control and monitoring purpose.

18.03.02 Number of Operating Work Stations, Operating cum Engineering Work stations , Type of Printers for AHP DDCMIS shall be as per Vol. V, Part -A along with its accessories like monitor ,keyboard etc.

18.03.03 AHP Central Control Room will house system cabinets in addition to control desk.

Following Equipment will come under interlock scheme and can be started / stopped from operating work stations with indication/mimics on operating work station with fault annunciation facility.

- i. All Pumps/Blowers and Compressors.
- ii. Bottom Ash system.
- iii. Fly ash system, comprising of ash extraction from ESP's & duct hopper to buffer hopper located near ESP's and fly ash transportation system from buffer hopper to storage silos.
- iv. Ash slurry disposal system.
- v. Bottom ash over flow system comprising of bottom ash over flow water storage tanks, settling tank, ash over flow water pumps, sludge pumps etc.
- vi. Silo system.
- vii. All Motorized valves
- viii. All pneumatic operated valves.

18.03.04 Following Local control Panels shall be provided which shall have status indication and alarms on mimic at control panel in main AHP control room.

Connectivity: These Local Control Panel shall have HW interfacing with AHP DDCMIS in AHP control Room.

- i. Bottom Ash Local Control Panel (This panel shall provide control for clinker grinders, bottom ash discharge valves, jet pumps for ash slurry transport etc.)
- ii. Silo Unloading Control Panel with 1 no. OWS (This Panel shall be provided in MCC room near silo area for fly ash collection system. The panel shall be provided for control of dry pneumatic ash extraction transportation and unloading system)
- iii. Coarse Ash Local control Panel
- iv. Fly Ash remote Area Utility Panel

18.03.05 The various local control panels envisaged will be located/installed in different areas for ease of operation of different sub systems. Suitable alarm/annunciation system will be provided to warn of any mal-functioning of the ash handling system.

The system cabinet associated with various local controls shall be located near the local control panels. These cabinets shall accommodate I/O cards, relays, interfacing equipments etc. To provide status indication/ alarms etc. for various drives/ valves /equipments in main AHP control room.

The control panel shall be provided with GIU for monitoring and audio-visual summary fault annunciation purpose.

- 18.03.06 All instruments like vacuum/pressure switches, pressure gauges, transmitter, level controllers, level switches/indicators, level probes, flow indicators and any other special instruments for remote measurements in the main control room shall be provided by the bidder as per the Technical Specifications mentioned in Vol. V Chapter-3.
- 18.03.07 Temperature measurement for winding of all HT drives crushers motors, conveyors etc shall be provided with 6 no. each duplex type RTDs or 12 no. simplex type RTDs. and 4 Nos. Duplex type RTD or 8 no. simplex type RTDS for bearing Temperature on both (DE & NDE) for each HT drive and driven equipment.
- Vibration measurement of all HT drives shall be as per details in Vol. V Chapter- 4
- 18.03.08 Power supply system required for Control and instrumentation system including parallel redundant (2 x 100%) UPS system, Batteries and 24 V DC chargers systems shall be provided as per Vol. V, Part B, chapter-7.
- 18.03.09 Bidder to provide all control equipment, instruments (As per Technical specification in Vol. V, Part B, chapter- 2 & 3), accessories & all Instrumentation cables (As per Technical Specifications mentioned in Vol. V, Part B, chapter-9) including laying and termination of cables, erection hardware for safe, efficient and reliable operation of the plant (As per Technical specification in Vol. V, chapter-8 & Chapter 23).
- Refer Vol. V, Part A, and Vol. V, Part B, Chapter 3, Chapter 14, Annexure-A, and System configuration drawing in Vol. VII for detail of control and operation of AHP.
- 18.03.10 Local override operation knob to be provided on the solenoid valves.
- 18.03.11 Control & monitoring of electrical distribution system, namely PCC, Bus coupler, Incomer, etc. for this plant shall be controlled from its monitoring station as well as from respective switchgear unit. Control system for the same shall be implemented in the AHP DDCMIS envisaged in the AHP control room. Bidder shall consider all transducers for monitoring of voltage, current, Kwh, power factor at AHP DDCMIS monitor station.
- 18.03.12 The control & operation of Compressed air system for Ash handling system shall be from AHP DDCMIS apart from its local Control Panels. Interfacing (Hardwired & soft link) of compressed air system control panel with DDCMIS panel shall be same as specified for main plant compressor air system in Vol. V, Annexure A.
- 18.04.00 **CONTROL PHILOSOPHY OF PLANT WATER SYSTEM**
- The control & instrumentation shall be through water system DDCMIS with Hot Redundant standby Processor system as indicated in Vol. V, Part -A which shall cover the total functional requirement of sequence control, interlock and protection, monitoring, alarm, data logging etc.

The following Plant water system will be controlled from the control points as indicated in Vol. V, Part -A and Part B, Chapter 14, Annexure-A.

- i. DM Water plant System including DM storage tanks, DM Neutralization pit, DM regeneration System, degasser system, Acid/alkali storage system, DM transfer pumps, DM regeneration pumps up to condensate storage tank, Air conditioning of water system control room.
- ii. Raw Water intake system, Raw water system, AHP pumps, Pre-Treatment plant, Clarifier water Plant includes control of APH/ESP wash water pumps, Service water pumps, AHP seal water make-up pumps, DM feed pumps, FGD makeup water pumps (if provided).
- iii. Effluent Treatment Plant CMB sump & Pumps system.
- iv. CW Chlorination System
- v. CW Treatment plant
- vi. Main Plant DDCMIS controlled (CW Pumps / ACW pumps, self-leanng strainer and CW make-up system, DMCW System (SG & TG) & ACW pumps (SG), TG Cycle (DM) Make-up Pump / Valve control and CST onwards monitoring and Boiler Fill Pump).
- vii. Sewage Water Treatment Plant.
- viii. ETP Misc. sumps with pumps.

18.04.01 Temperature measurement for winding of all HT drives crushers motors, conveyors etc shall be provided with 6 no. each duplex type RTDs or 12 no. simplex type RTDs. and 4 No. Duplex type RTD or 8 no. simplex type RTDS for bearing Temperature on both (DE & NDE) for each HT drive and Driven equipment.

Vibration measurement of all HT drives shall be as per details in Vol. V Chapter- 4

18.04.02 Power supply system required for Control and instrumentation system including parallel redundant (2 x 100%) UPS system, Batteries and 24 V DC chargers systems shall be provided as per Vol. V, Part A and Part B, chapter-7 for each system.

18.04.03 Bidder to provide all control equipment, instruments (As per Technical specification in Vol. V chapter-2), accessories, all Instrumentation cables (As per Technical Specifications mentioned in Vol. V chapter-9) including laying and termination of cables, erection hardware for safe, efficient and reliable operation of the plant. (As per Technical specification in Vol. V chapter-8)

18.04.04 Refer Vol. V, Part -A for detail control and operation of plant water system.

18.04.05 **DM WATER PLANT SYSTEM**

18.04.05.01 The operation and control of Dematerializing Plant shall be through plant water system DDCMIS with redundant hot standby processor. This plant water system DDCMIS shall have dual redundant bidirectional OPC link connectivity with Ethernet based TCP/IP protocol with main plant DDCMIS for monitoring purpose (as per DDCMIS format)

Three nos. Large Video Screen shall be provided for control and monitoring purpose.

However, there shall be provision of changeover to manual operation. The control operation philosophy shall include sequential control like semi-auto/remote-manual/manual, facility like step numbering, step time elapsed time, hold/release push button through work station, flow of control logic (sequence of various steps) for smooth operation of the entire plant.

Number of Operating Work Stations , operating cum Engineering Work stations , Type of Printers for Plant Water DDCMIS shall be as per Vol. V, Part -A along with its accessories like monitor ,keyboard etc.

- 18.04.05.02 DM plant control system shall be designed so that complete Operation, Control & monitoring, interlocks, logic etc. from D M Plant control room. Bidder shall also provide GIU and remote I/O panels as per requirements and as indicated in Vol. V, Part A.
- 18.04.05.03 The operator will initiate the operation of regeneration/rinsing/backwashing of a particular ion-exchange unit/filter based on the criteria described below, but the change from one step of the sequence to the next will be automatic. The system will employ a logical system, which will link the various steps such as closing/opening of different valves, starting/stopping of various pumps, which make a sequence.
- 18.04.05.04 Filters / Ion exchange units will be automatically isolated from the system as follows:
- a. Pressure Sand Filter: On passing predetermined volume of water or high Differential pressure across the filter bed.
 - b. Activated Carbon Filter: On passing predetermined volume of water or on reaching preset residual chlorine level of high Differential pressure across the filter bed.
 - c. Cation: On reaching high sodium leakage or on passing of predetermined volume of filtered water whichever Occurs first.
 - d. Anion Unit: On reaching higher conductivity & Silica at Outlet or on passing of predetermined volume of De cationised water, whichever occurs first.
 - e. Mixed Bed Unit: On reaching higher conductivity, pH at outlet or On passing of predetermined volume of deionised Water or on reaching preset silica level, whichever occurs first.
- 18.04.05.05 As state above, the isolation of the exchanger unit from the system will be displayed on monitor. The operator will then select the particular vessel to be regenerated through option and selected for regeneration. On selecting the option the regeneration cycle shall start automatically. During regeneration, the progress of different sequence/sub-process shall be displayed to the operator in the form of step number as well as step description which is in progress, the set time for that.

- 18.04.05.06 The progress of the sequence shall be displayed to the operator through suitable means. The system will incorporate the necessary safety systems, locking systems and manual emergency system. On failure of logic system, in between, the failure shall be annunciated to the operator and all the valves corresponding to that unit, being regenerated shall close automatically.
- 18.04.05.07 A graphic depicting the complete plant process operations shall be designed properly and be available on MONITOR. The graphic shall indicate the different filters, exchanger units, measuring tanks, opening/closing of valves (motorized and solenoid operated), ON / OFF of different pumps and blowers etc. Color-coding shall be used to differentiate lines for different services such as normal water lines, backwash lines, Acid / Alkali lines etc.
- 18.04.05.08 Separate conductivity measurement, silica measurement and pH measurements shall be employed for ensuring the various parameters in the effluent and in the rinse line of caution, anion and mixed bed exchanger units for normal and rinsing operation (As per the technical specification mentioned in Vol-III). The conductivity cell in the rinsing line shall be automatically isolated during the first half of the rinsing cycle and shall be connected automatically during the second half of rinsing cycle when the conductivity is less than 100 micromhos/cm excess over the rinse water conductivity.
- 18.04.05.09 Discharge valves of all pumps of the entire plant, connected with semi-auto/remote manual operation shall be pneumatically operated: and all pumps, pneumatically operated valves, drive motors of all the other equipment and other accessories, pneumatic on-off valves, etc. shall be completely suitable for remote manual operation from operating console/panel. All drive motor shall also be provided with arrangement of local stopping. Tripping of drive motors from local panel shall be permissible irrespective of the position of local-remote selection option. Local stop push-button shall be locked after tripping the motor from local.
- 18.04.06 Although the basic demineralising process is semi-automatic in nature, following operations shall be performed manually.
- 18.04.06.01 Unloading and Transfer of Acid.
- i. Hydrochloric acid will be unloaded from the road tank-cars by operating any one of the acid unloading pumps. Operation shall be controlled from local panel.
 - ii. Hydrochloric acid, stored in over ground tanks, will be led remote manually by gravity to the acid measuring tanks for cation, mixed bed units to fill up to the desired level. Subsequent transfer of acid from the measuring tanks to the ion-exchanger units as required in regeneration operation is however automatic.
- 18.04.06.02 Unloading, Preparation and Transfer of Alkali.
- i. Caustic solution will be unloaded from the road tank-cars by operating any one of the Caustic unloading pumps. Operation shall be controlled manually from local panel.

- ii. Caustic solution, stored in over ground tanks, will be led remote manually by gravity to the caustic measuring tanks for anion, mixed bed units to fill up to the desired level. Subsequent transfer of caustic from the measuring tanks to the ion-exchanger units as required in regeneration operation is however automatic.
- iii. All operations in items (a) and (b) will be controlled manually from the local panel.
- iv. Transfer of alkali to the respective measuring tanks for anion and mixed bed exchanger units will be done remote manually. However, subsequent transfer of alkali to respective ion exchanger units will be automatic.

18.04.06.03 Neutralization of Waste from DM Plant.

- i. After completion of regeneration of one cation and one anion exchanger, the waste generated during regenerations will be thoroughly recirculated in the neutralizing pit and if necessary, acid/alkali solution will be added to make the waste slightly alkaline.
- ii. When required pH of waste solution has been reached, the waste solution will be pumped to the effluent treatment plant area and the effluent shall conform to IS-2490. The pump will automatically be tripped when the level in neutralization pit reaches very low.
- iii. Priming of pumps operating under suction lift and operations as in (a) and (b) will be done manually. All pump operation shall be controlled from the local panel.

18.04.07 **PRE-TREATMENT PLANT**

The operation and control of PT plant shall also be done through plant water system DDCMIS with Redundant hot standby processors.

The control operation philosophy shall include sequential control like semi-auto/remote-manual/manual, facility like step numbering, step time elapsed time, hold/release push button through work station, flow of control logic (sequence of various steps) for smooth operation of the entire plant.

The Operating stations and Engineering stations, printers etc. for control and operation of plant water system DDCMIS shall be provided as per Vol. V, part -A along with its accessories like monitor, keyboard etc.

18.04.07.01 The chemical dosing is envisaged only in manual mode from local. The Dosing pumps, Tank agitator, Sludge pumps and clarifloculator bridge pumps shall be operated from remote as well as local control panel of chemical house.

18.04.07.02 Drives on the clarifier bridge i.e. rake mechanism drive motor and flocculator agitator motor shall be operated from local start/stop push buttons to be located near it.

18.04.07.03 The clarified water storage sump level is controlled by raw water inlet control valve with respect to the level in the clarified water sump.

- 18.04.07.04 All the chemical dosing/solution tank shall be provided with local level indicator and low level switch ,which shall be interlocked with respective dosing pumps i.e the pump shall trip in case of the low level in the respective tank.
- 18.04.07.05 The sludge sump shall be provided with necessary Level switches which shall be used for Auto start /stop of Sludge pumps.
- 18.04.07.06 Bidder shall provide flow transmitter/meter to measure total Raw Water flow for indication totalisation in plant water system DDCMIS..

18.04.08 **Sewage water TREATMENT PLANT**

The operation and control philosophy of sewage water Treatment Plant shall be done through Relay based control system. Relay based control desk shall be provided with coloured Mimic, H.W. Annunciator, P.B., Indicators, indication Lamps and Ammeters)

18.04.09 **CW CHLORINATION PLANT CONTROLS.**

The control & instrumentation shall be through plant water system DDCMIS with Hot Redundant Standby Processor system for CW Chlorination Plant covering the total functional requirement of sequence control, interlock and protection, monitoring, alarm, data logging etc.

The design of the control system and related equipment shall adhere to the principle of Fail safe operation of all system levels i.e. the failure of signal, failure of power or failure of any component should not cause a hazardous condition and at the same time prevent occurrence of false trips and provide reliable and efficient operation of the plant under dynamic conditions.

The Operating stations and Engineering stations, printers etc. for control and operation of plant water system DDCMIS shall be provided as per Vol. V, Part -A along with its accessories like monitor, keyboard etc.

- 18.04.09.01 Each pump shall be provided with Start/Stop push Buttons in back up control panels with Stop/Stop/Trip indication. A window based annunciation system shall be provided on the Back up control Panel for all major alarms/trip conditions. The annunciation system shall also include alarms for abnormal level conditions in caustic solutions preparation cum recirculation tanks,
- 18.04.09.02 The chlorination of potable water system shall be separately carried out through chlorine cylinder. This arrangement is located nearby DM plant building .The operation & control is similar to above and operated through a local control panel located there.
- 18.04.09.03 On line chlorine analyzer shall be provided for measurement of residual chlorine.

18.04.10 **CW TREATMENT PLANT CONTROL**

The operation and control philosophy of circulating water/cooling water treatment plant shall through plant water system DDCMIS with Hot Redundant Standby Processor system provided for CW Chlorination Plant.

- 18.04.10.01 Sulphuric acid shall be unloaded by two no. unloading pumps into over ground acid storage tanks. Acid shall be subsequently transferred to acid dosing tanks by using above unloading pumps.
- 18.04.10.02 The sulphuric acid dosing pumps operation shall be auto and manual from local control panel. In the auto mode, the rate of acid dosing shall be controlled by auto adjusting of the stroke of the pumps by sensing of pH of circulating water. However the starting and tripping of the dosing pumps shall be controlled by the level switches of the dosing tanks.
- 18.04.10.03 During normal operation sulphuric acid dosing pumps shall operate in the auto mode and inject sulphuric acid to maintain the pH of circulating water at desired level so that alkalinity remains within desired limits.
- 18.04.10.04 The operation of other chemical dosing pumps like anti scalant dosing pumps, anti corrosion dosing pumps and biocide dosing shall be manual from local control panel operation of the pumps shall be guided through the level of the respective tanks.
- 18.04.11 Control & monitoring of electrical distribution system, namely PCC, Bus coupler, Incomer, etc. for water system shall be controlled from plant water system DDCMIS based monitoring station, as well as from respective switchgear unit. Control system for the same shall be implemented in the plant water system DDCMIS envisaged in the water system control room. Bidder shall consider all transducers for monitoring of voltage, current, Kwh, power factor at plant water system DDCMIS monitor station/relay based local control panel.

18.05.00 **CONTROL PHILOSOPHY OF FUEL OIL HANDLING & UNLOADING SYSTEM**

The control & instrumentation shall be through main plant DDCMIS with Hot Redundant Standby Processor system for Fuel Oil Handling and unloading System covering the total functional requirement of sequence control, interlock and protection, monitoring, alarm, data logging etc.

The design of the control system and related equipment shall adhere to the principle of Fail safe operation of all system levels i.e the failure of signal, failure of power or failure of any component should not cause a hazardous condition and at the same time prevent occurrence of false trips and provide reliable and efficient operation of the plant under dynamic conditions.

The control Room operator shall be provided with color graphic displays of the Fuel Oil Handling and unloading plant and with sufficient details to allow proper control and monitoring of the plant function.

- 18.05.01 Number of Operating Work Stations, operating cum Engineering Work stations, Type of Printers for DDCMIS shall be as per Vol. V, Part -A along with its accessories like monitor, keyboard etc.
- 18.05.02 Temperature measurement for winding of all HT drives crushers motors, conveyors etc. shall be provided with 6 no. each duplex type RTDs or 12 no. simplex type RTDs. and 4 Nos. Duplex type RTD or 8 no. simplex type RTDS for bearing Temperature on both (DE & NDE) for each HT drive and driven equipment.

Vibration measurement of all HT drives shall be as per details in Vol. V Chapter-2.

- 18.05.03 Power supply system required for Control and instrumentation system including parallel redundant (2 x 100%) UPS system, Batteries and 24 V DC chargers systems shall be provided as per Vol. V Part A, and Part B, chapter-7 for each system.
- 18.05.04 Bidder to provide all control equipment, instruments (As per Technical specification in Vol. V, Part B, chapter- 2 & 3), accessories & all Instrumentation cables (As per Technical Specifications mentioned in Vol. V, Part B, chapter-9) including laying and termination of cables, erection hardware for safe, efficient and reliable operation of the plant (As per Technical specification in Vol. V, Part B, chapter-8 & Chapter 23).
- 18.05.05 Refer Vol. V, Part A, and Vol. V, Part B, Chapter 3, Chapter 14, Annexure-A, and System configuration drawing in Vol. VII for detail of control and operation of Fuel Oil handling system.
- 18.05.06 All the instruments shall be supplied as required with all necessary accessories for safe and efficient running of the plant. All primary instruments shall be flame proof (IEC-60079).
- 18.06.00 **CONTROL PHILOSOPHY FOR COMPRESSED AIR SYSTEM.**

Microprocessor based control System for individual compressor and main plant DDCMIS with Hot redundant processors shall be provided for overall monitoring, control & operation, loading, Unloading & auto standby start of compressors, Dryers, control valves, Solenoid valves, Field instruments etc.

Each Compressor's Winding temp RTD signals, Bearing temp RTD signals and VMS signals shall be hardwired to Microprocessor based control System and main plant DDCMIS directly from field/VMS panel.

Main plant DDCMIS shall have redundant interfacing (not in daisy serial link) with each individual compressor's microprocessor based control system, and HW signals required for command, status, local/remote operation, interlock & protection of complete compressor package.

- 18.06.01 Number of Operating Work Stations , Operating cum Engineering Work stations , Type of Printers for main plant DDCMIS shall be as per Vol. V, Part -A along with its accessories like monitor ,keyboard etc.
- 18.06.02 Power supply system required for Control and instrumentation system including parallel redundant (2 x 100%) UPS system, Batteries and 24 V DC chargers systems shall be provided as per Vol. V chapter-7 for each system.
- 18.06.03 Bidder to provide all control equipment, instruments (As per Technical specification in Vo V chapter-2), accessories, all Instrumentation cables (As per Technical Specifications mentioned in Vol. V chapter-9) including laying and termination of cables, erection hardware for safe, efficient and reliable operation of the plant. (As per Technical specification in Vol. V chapter-8)

- 18.06.04 All the instruments & control valves shall be supplied as required with all necessary accessories for safe and efficient running of the plant.
- 18.07.00 **CONTROL PHILOSOPHY FOR FIRE ALARM, DETECTION & PROTECTION SYSTEM.**
- The control & instrumentation for Fire Alarm, Detection & protection system shall be done through dual redundant Microprocessor based detection and PLC based pump controls along with the solid state annunciations.
- Number of Operating Work Stations , Operating Engineering Work stations , Type of Printers for each PLC shall be as per Vol. V, Chapter 14, Annexure-A along with its accessories like monitor ,keyboard etc.
- Connectivity: This PLC & microprocessor based control system shall have redundant data communication connectivity (Softlink) with DDCMIS for monitoring purpose. (as per DDCMIS format). All time critical, interlock, control & protection signals will be hardwired to DDCMIS and respective PLC, which shall be decided during detailed Engineering.
- 18.07.01 PLC based pump controls and solid state Annunciation system. PLC shall be with redundant hot standby processor
- 18.07.02 100 % hot standby Redundant Microprocessor based Fire Detection and Alarm system shall be provided. Fire Alarm Panel shall be provided with 100% hot standby redundant Processor/controller.
- 18.07.03 Repeater Panels shall be provided.
- 18.07.04 Two (2) nos. Operating work stations shall be provided (one in DDCMIS CCR and another one No. in Fire station) with A4 sized B/W LJP each for Fire Detection and Alarm system.
- 18.07.05 Fire Alarm panel shall be provided at different location in plant like each at CCR, Fire station, ESP, CHP, AHP, WTP, FO Plant, FGD etc.
- 18.07.06 Power supply system required for Control and instrumentation system including parallel redundant (2 x 100%) UPS system, Batteries and 24 V DC chargers systems shall be provided as per Vol V chapter-7 & chapter 14 for each system.
- 18.07.07 Temperature measurement for winding of all HT drives crushers motors, conveyors etc shall be provided with 6 no. each duplex type RTDs or 12 no. simplex type RTDs. and 4 NoS. Duplex type RTD or 8 no. simplex type RTDS for bearing Temperature on both (DE & NDE) for each HT drive and driven equipment.
- Vibration measurement of all HT drives shall be as per details in Vol V Chapter- 2
- 18.07.08 Bidder to provide all control equipment, instruments (As per Technical specification in Vol V chapter-2), accessories, all Instrumentation cables (As per Technical Specifications mentioned in Vol. V chapter-9) including laying and termination of cables, erection hardware for safe, efficient and reliable operation of the plant. (As per Technical specification in Vol. V chapter-8)

- 18.07.09 All the instruments shall be supplied as required with all necessary accessories for safe and efficient running of the plant. All primary instruments shall be flame proof (IEC-60079).
- 18.08.00 **CONTROL PHILOSOPHY FOR AIR CONDITIONING SYSTEM AND VENTILATION SYSTEM.**
- The control & instrumentation for Air condition System and Ventilation System of main plant TG building and ESP building shall be done through with Hot Redundant Standby Processor based plant DDCMIS system covering the total functional requirement of sequence control, interlock and protection, monitoring, alarm, data logging etc.
- The control & instrumentation for Air condition System and Ventilation System of service building and Administration building shall be done through with Hot Redundant Standby Processor based PLC system covering the total functional requirement of sequence control, interlock and protection, monitoring, alarm, data logging etc.
- The control & instrumentation for Air condition System and Ventilation System of respective BOP package shall be done through with Hot Redundant Standby Processor based respective BOP DDCMIS system covering the total functional requirement of sequence control, interlock and protection, monitoring, alarm, data logging etc.
- The design of the control system and related equipment shall adhere to the principle of Fail safe operation of all system levels i.e the failure of signal, failure of power or failure of any component should not cause a hazardous condition and at the same time prevent occurrence of false trips and provide reliable and efficient operation of the plant under dynamic conditions.
- Number of Operating Work Stations , GIU, Engineering Work stations , Type of Printers for each DDCMIS shall be as per Vol. V, Part -A along with its accessories like monitor ,keyboard etc.
- The control Room operator shall be provided with color graphic displays of the Complete plant and with sufficient details to allow proper control and monitoring of the plant function. H.W. Annunciation, etc. shall be provided on the PLC control panel.
- Number of Operating Work Stations , GIU, Engineering Work stations , Type of Printers for each PLC shall be as per chapter 14, Annexure-A along with its accessories like monitor ,keyboard etc.
- 18.08.01 Power supply system required for Control and instrumentation system including parallel redundant (2 x 100%) UPS system, Batteries and 24 V DC chargers systems shall be provided as per Vol. V, Part A and Part B, chapter 14 and chapter-7 for each system.
- 18.08.02 Bidder to provide all control equipment, instruments (As per Technical specification in Vol. V chapter-2), accessories, all Instrumentation cables (As per Technical Specifications mentioned in Vol. V chapter-9) including laying and termination of cables, erection hardware for safe, efficient and reliable operation of the plant. (As per Technical specification in Vol. V chapter-8).

18.08.03 All the instruments shall be supplied as required with all necessary accessories for safe and efficient running of the plant.

Note: In case of any ambiguity in this chapter w.r.t the technical Specifications (Detailed Chapters), bidder to follow the detailed chapters of these NIT specifications.

CHAPTER – 19

OPERATOR TRAINING SIMULATOR

19.00.00 This specification covers the system design, engineering, manufacturing, supply, assembly, packing, transportation, warehousing, field construction, erection, wiring, cabling, shop and site tests, putting them into successful commissioning as per instructions of Owner's personnel and all other services as specified in relevant sections in accordance with the intent and requirements of this specification of Operator Training Simulator.

The equipment furnished to this specification shall conform exactly to the requirements herein, unless modified by the respective Data Sheet of the equipment.

19.01.00 The design, material, construction features, manufacture, inspection and testing of Operator Training Simulator shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable standards. Nothing in this specification shall be construed to relieve the Bidder of this responsibility.

19.02.00 **Technical Requirement**

19.02.01 **Operator Training Process Plant Simulator**

The Operator Training process plant simulator system shall be provided based on the design of the super critical power plant projects. The Simulator Design shall include equipments, Instrumentation and controls that will enable operator to function in all modes of the specified coal fired power plant operation including normal, abnormal or emergency operating conditions except as specifically noted otherwise. The response of the simulator resulting from operator action, automatic plant controls and inherent operating characteristics shall be realistic to the extent that an experienced operator shall not observe a difference, within the limits of the performance criteria, between the HMI indications of the simulator and the reference plant. The simulator shall calculate plant system parameters corresponding to particular operating conditions, display these parameters on the appropriate displays, and provide proper alarm and/or protective system action. The Operator Training Simulator shall be designed with same features & design criteria as envisaged for DDCMIS/DCS/DEH/TSSS control system and as per ANSI/ISA-77.20-1993 (R2005) - Fossil Fuel Power Plant Simulators - Functional Requirements.

19.03.00 **Qualifying Requirements**

The Simulator's vendor should be a Simulator manufacturer and a graphical user interface (GUI) based simulation modeling tool developer for coal fired thermal power plant and should have designed engineered, supplied, erected & commissioned full scope replica Training Simulator for a coal fired station having unit size 800 MW in **India**, which is in successful operation for a period of not less than one (1) year as on the date of bid opening.

19.04.00 **Features of Process Plant Simulator**

- a) The simulator offered shall be capable of simulating continuously, automatically, reliably, and in real time all operations of the real plant as specified. A simulator of high fidelity and integrated behavior is called for to provide the realistic simulation of the plant system and equipment and control and instrumentation.
- b) The modeling shall be such that each plant system accurately simulates all functions as detailed in the drawings / documents supplied by the bidder to simulator bidder. The combination of all systems shall provide a realistic overall plant simulation. Any details or information of systems and equipment described in this specification are for bidding purpose. Generally, modeling for each system and component shall be done for each operable mode i.e. Automatic, Semi-Automatic, Manual, etc. where the system / equipment is capable of being operated in more than one mode.
- c) The simulator design shall provide for adequate flexibility to allow expansion or modification of the hardware and software to reflect advances in design and technology and to upgrade the simulator systems, equipment and responses to actual plant operating conditions.
- d) The simulator models of the plant dynamics shall represent the responses of the respective base projects in a realistic manner to the operator-trainee on the HMI. The design shall include, where required, special phases of operation of certain plant functions operable from outside the unit control room during normal and abnormal simulated plant operations. These functions shall be operable from the instructor's stations, the instructor acting as a remote operator.
- e) The information that will be required for the development of mathematical models and database along with the schedule there of shall be clearly brought out in the bid proposals in details.
- f) After plant startup, actual plant operating data shall be used by the bidder in retuning of the models and database.
- g) Simulator fine tuning shall cover all modifications required to correct the modeling inaccuracies; changes to accommodate any change in design data and drawings from data freeze date to fine tuning data freeze date due to design modifications, changes made during installations and commissioning and any other reason as well as data based on actual operation of the plant.

19.04.01 The computational cycle time for each system module shall be such that simulated plant transients shall have the same time dependence as when observed in the reference plant. Transient responses shall reflect plant like trends.

19.04.02 The simulator shall be capable of performing in the following manner:

- a) The coal fired plant simulation shall provide the transient responses such as caused by, but not limited to, changes in various pressures, flows, temperature, density, heating value, moisture content, feeder position and coal air mixture proportion changes, coal quality variations,



change in positions of all valves, dampers and vanes in all plant systems etc. Ambient temperature variation should be an instructor operation particularly for the cooling water temperature variations for its variation to be felt into the system efficiency.

- b) The simulator shall be capable of simulating continuously in real time and selectively in fast time a hot or cold startup to full load condition, load modulation (both manual and automatic) and a shutdown to hot or cold condition.
- c) In the absence of operating power plant performance data, the simulation shall be based on predicted plant design data. The simulator shall use parameters corresponding to the particular operating conditions display these parameters, and provide the proper alarm are approached or exceeded.
- d) In case the basic plant / equipment data is not available for a few plant areas, then artificial intelligence based modeling shall be required to be provided.
- e) The simulator shall permit the operator-trainee to complete any part of the pre-start-up procedures conducted at the Operating Work Station (OWS). These pre-start up preparations shall include verification of trip and alarm settings and operational checkout of critical systems or equipment.
- f) The effect of any malfunction or a combination of malfunction shall be reflected in all plant parameters just as it would be in the real plant. At the time of occurrence of malfunctions, no parameter shall show unrealistic value.
- g) All graphics, protections, interlocks, logics and controls of the real plant shall be incorporated in the simulation model.
- h) Selected local operator actions as specified, Remote functions shall also be incorporated in the model.
- i) The systems and descriptions specified in the specification should not be taken as the total simulation requirements but are meant only as a guide for bid purpose to define the minimum scope of simulation that is required. The model requirements mentioned in this specification are only indicative and not exhaustive. The Bidder shall describe in the proposal the details of proposed mathematical modelling and give explanations to satisfy model requirements for the reference plant. The Bidder has to model the actual plant for which the data shall be furnished during detailed engineering.

19.04.03 Wherever a quantity of certain functions are specified, e.g. Malfunction, initial conditions etc. it is intended to mean the number of such functions to be implemented. The system shall be capable of adding more quantities at any stage & configuration should in no way be restricting such expansion. Limitation, if any, in the offered system, shall be brought out clearly in the bid.

19.04.04 The scope of simulation shall be limited to the controls of systems operated from the Central Control Room generally for the equipment and systems



located in main plant as well as a few equipment and systems those are not in main plant but controlled from main plant like CW system, etc.

19.04.05 Bidder will furnish all the data/details related to various plant and equipment which are to be simulated during detailed engineering stage like P&IDs, Heat Balance Diagrams, Main equipment data sheets and drawings, material specification, characteristic curves etc. for the process modeling to their sub vendor.

Similarly for the C&I model and HMI implementation, Bidder will also furnish to their sub vendor other data/details like plant I/O list, logic and loop diagrams, HMI displays, log / HSR assignments, calculation etc. during detailed engineering as well brief functionalities of the DDCMIS system including control system and HMI functionalities to be emulated. However, the functionalities of the C&I system as given elsewhere in the specification shall also be provided by bidder to their sub vendor to give an idea about the level of simulation expected for various C&I systems also.

19.05.00 **Other Requirements of Process Plant Simulator**

- a) The plant simulator offered shall be suitable for training plant operators to hand on operation of the actual plant under simulated environment. The system shall be from the latest proven range from reputed manufacturer meeting the qualifying requirements with established expertise in power plant simulation business.
- b) System shall be microprocessor based using latest but standard software platform with same features & design criteria as envisaged for DDCMIS/DCS control system.
- c) In appearance, the simulator operator's console shall be exactly identical to plant control room, including the LVS and operator's printers.
- d) The entire plant operating parameters and dynamics shall be programmed in the form of mathematical models and shall be stored in the simulator server.
- e) The process logic, sequence etc shall be stored in another plant management system server.
- f) The instructor functions like simulated process setup routines shall be stored in the instructor server.
- g) All the servers shall be redundant. One being main and the other being back up unit, so that no data is lost in case of a server crash.
- h) The servers shall be seamlessly networked in a redundant Network.
- i) Simulator shall permit the session to start from any plant condition based on initial condition set up. At least 200 such present initial conditions shall be offered.
- j) All simulated function dynamics shall match real plant conditions as if the events are happening in "real time". The instructor, however, shall have the discretion to deviate from real time if he finds it beneficial for training and saving in training time. In fast time mode, certain plant processes like turbine metal heating, vacuum pulling shall occur at ten times faster than normal speed. This facility shall allow study and analysis of transient conditions etc.

In slow time mode, the entire plant operation and response shall get slowed down to a rate ten times slower than normal. This facility shall allow study and analysis of transient conditions etc.

In step time mode, the entire plant operation and response shall get stepped down to a rate thirty two times than normal. This facility is particularly useful in the study and analysis of sudden fluctuations in parameters, unit trip sequence etc.

- k) As the trainees carry out operations on the simulator, the OWS shall constantly record the same. At any moment of time, a record of the past four hours operation at the interval of 2 minutes shall be available to the operator. The instructor shall, with the backtrack facility be able to take the simulator back in time to any past condition up to the last 4 hour to analyse trainee's performance.
- l) In the event, the trainee desires that some functions are performed locally, the same shall be simulated from the trainer's console.
- m) Instructor shall be able to freeze the process at any point he desires to stop and explain certain situations to the trainee.
- n) The instructor shall inject process malfunctions from his terminal. The action of the operator viz. how fast he suspects some abnormality, how quickly he succeeds in tracing the root cause, what remedial measures he takes and how much effect it has on the plant, can be noted and assessed. At least 500 malfunction conditions shall be available. A malfunction shall be introduced with a percentage of severity and delay& ramp time for delay in operation of malfunction.
- o) Malfunctions shall be inserted either from Sim diagram or from malfunction index. Malfunction summary shall display how many malfunctions have been inserted. A minimum of 500 malfunctions shall be possible to configure.
- p) Replay function, similar to the Backtrack function, shall permit the operator to review simulator behavior with a specific backtrack condition. By this function the instructor shall demonstrate the trainee's action during any emergency situation to assess the trainee's performance during transient conditions, sudden fluctuations in parameters etc. A minimum of 150 backtrack conditions shall be provided.
- q) A total of at least 32 event triggers shall trigger a predefined automatic response, or set of responses, on the occurrence of a simulation event. An inserted malfunctions or override, which is assigned a trigger, will become active automatically when the plant condition described by the event trigger functions are not done.
- r) Through a set of automated plant procedure the instructor shall create standard exercises, to test the ability and reflexes of the trainee during operation of the plant. The automated plant procedure summary shall dynamically display the current execution status of every command in the APP. The current command shall be highlighted in blue and all previous commands shall be highlighted in green and command, which has been skipped, highlighted in yellow.
- s) Monitored parameter shall allow the monitoring and plotting of constants and variables in the database.
- t) The trainee performance review function shall effectively produce a printed report that logs, organizes and interprets the actions that have taken place during a specific of a scenario so that an instructor can

review trainee performance easily. This shall include monitoring the values of selected parameters relative to selected value ranges and all operator and instructor actions.

The simulator system shall also have a lesson management system for creation, storage, updating and printing of lesson document as an aid to training.

- u) The system shall have its in-built diagnostic system like Daily Operational Readiness Test to verify the correct operation of all hardware. This shall allow the identification of faulty components
- v) All servers, Operating stations, Operating cum Engineering work station, LVS and printers shall be provided with same features/accessories as specified for DDCMIS/DCS.
- w) Process Model and emulated control system shall have a cycle time less than 100 msec.
- x) Facility to interface with third party application through OPC or any other open protocol.
- y) The Simulator system shall be an emulation of DDCMIS & DCS covering the scope of simulation. Functionalities of DDCMIS & DCS system has been specified, from which Bidder shall get an idea about the functionalities of DDCMIS & DCS system, both control system which is to be emulated and HMI which shall be totally replicated by emulation.

19.06.00 **INSTRUCTOR FUNCTIONS**

The instructor shall be able to interfere with the model in various ways outlined below. For doing this, different modes like menu mode, mimic mode, expert mode etc. shall be provided.

19.06.01 **Malfunctions**

- 19.06.01.1 The simulator shall be capable of simulating the malfunctions given in the "List of Malfunctions" Specified in Table – 19.1 with provision to accommodate a total of at least 500 malfunctions. The remaining malfunctions and their method of initiation shall be determined by the Simulator Manufacturer in consultation with Owner.
- 19.06.01.2 All of the malfunctions shall simulate conditions as they would occur in the plant. Also the system must simulate conditions that might be introduced by operator errors during a malfunction. Plant response to the malfunction shall be carried out a reasonable and stable operating condition as determined by owner, by analysis of the training value of each malfunction. Models of malfunctions must include responses for no corrective action, improper action, and operator recovery cases.
- 19.06.01.3 An adjustable time delay shall be included in the malfunction software to permit the instructor to insert separate initiation times for selected malfunctions. Any number of malfunctions shall be capable of being initiated simultaneously or within a delay time selected by the instructor. This time delay shall be variable up to 2 hours.
- 19.06.01.4 The discernible transient response of certain malfunctions shall be simulated and accurately displayed on HMI. For example, if the inserted malfunction should cause a gradual increase in a pressure, then the concurrent changes in other parameters must be simulated through the level of advance alarm setting



and up to the trip setting. If the operator does not take suitable corrective action upon noting the conditions or upon receiving the advance alarm the trip setting will be reached, and appropriate trip events, including unit trip shall be initiated. All malfunctions shall be simulated to persist until corrected by the operator or terminated by the instructor. It will be possible to select a degree of degradation in the system (0-100 percent with increments of 1%) for applicable malfunctions.

19.06.01.5 Some pre-selected malfunctions are non-recoverable, that is, those malfunctions where the operator trainee is not expected to bring the plant back to normal operation, for example, a furnace explosion. With such malfunctions the bidder shall provide a description of the expected "hand off" response. The description shall include a list of affected displays, showing change in process parameters, and alarm activated. In addition, the bidder shall specify the appropriate operator responses to recoverable malfunctions.

19.06.01.6 The instructor shall be able to accomplish the following malfunction operations.

1. Time delay malfunctions by setting a problem time for malfunction activation.
2. Initiate up to 20 malfunctions at the same time.
3. Make a variable malfunction become progressively larger without clearing the malfunction.
4. Determine which malfunctions are active.
5. Select which component of redundant components is to fail when identified in the malfunction list
6. Select in which manner (high, low or fail) an instrument is to behave when identified in Malfunctions list.
7. If a malfunction summary tableau is utilized, a brief malfunction description shall be displayed for each selected malfunction.
8. Clearing the malfunction.
9. Initiation of malfunctions with variable severity shall be varied by numerical quantity rather than percentage, e.g. loss of pump capacity or pump loads shall be given in absolute value rather than a percentage of rated flow.
10. Others as finalized during detailed engineering.

19.06.02 **Initialization**

19.06.02.1 The instructor shall have the capability of initializing the simulator to any one of the fifty (50) initial operation conditions. Selection of initialization conditions shall be done by the instructor. Actuation shall cause the necessary plant parameters to change to correspond with the desired initialization conditions. No changes in programming/ software and making new settings shall be necessary to accomplish these changes. Initialization shall automatically remove all conditions and malfunctions present in the previous simulator operation. The instructor shall be able to initialize to any of 50 initialization conditions, 20 pre-selected conditions and 30 snapshot conditions. The pre-selected conditions specified at clause 8.2.2 below shall meet and shall be chosen by the owner during detailed engineering. After any initialization condition is selected the system shall perform a switch check function to ensure that all parameters are at the expected value and only then it will run either



automatically or after instructor's intervention. Facility to override switch check shall be provided as an instructor function.

19.06.02.2 The simulator shall be capable of having initialization conditions added or deleted at anytime in the future. However, the pre-selected initial conditions shall be password protected. A partial list of some typical initialization points is as follows:

- 1) **Cold start** - All equipments are stopped and all process temperatures are at 21 Deg.C. All piping, heaters, hot wells, Deaerator storage tank and condensate tank an auxiliary boiler filled or at normal levels. The boiler is drained. Fuel oil is available. Electrical start-up system shall be de-energized.
- 2) Same as (1) above, except with the electrical startup system energized.
- 3) **Partial cold start** - Auxiliary boiler on, supplying steam seals, vacuum is established, the boiler is fired and all necessary auxiliaries are operating. Process conditions will be the same as for a cold start except those affected by this level of operation.
- 4) **Bypass**- The unit is operating with the turbine bypass valve almost fully open and essentially no steam to the turbine. All process conditions are reflected by this level of operation
- 5) **Hot start** - same as mode 1, except that all process temperatures are at their value for 75 percent load. Air compressors service water pumps, and turbine oil pumps are running as required.
- 6) **Hot restart after unit trip** - The boiler is operating at effectively normal pressure and temperature and the turbine bypass valve is open.
- 7) **Cold Turbine – Generator Rolling** – The unit is just on turning gear and ready for acceleration. Process conditions will be appropriate for this level of operation.
- 8) **Hot Turbine – Generator Rolling** – The unit is effectively in same condition as in 7 above except turbine metal and associated equipment is at a higher temperature.
- 9) **Half load** – Unit is at normal conditions for 50% load.
- 10) **Full Load** – Unit is at normal conditions for 100% load.
- 11) **Cold start** – Ignition preparation state.
- 12) **Cold start** – Condenser vacuum up preparation state.
- 13) **Cold start** – Turbine start up preparation state
- 14) **Cold start** – Synchronizing preparation state.
- 15-49) (spares) for future expansions and/or special snapshot conditions.
- 50) **Replay** – Initiate a replay to any prior simulator dynamic conditions recorded for up to 2 hours (just prior to freeze initialization). Replay of



a prior dynamics state should be similar in operation to initializing the simulator in all respects.

19.06.03 **Back Track and Replay/Record**

19.06.03.1 **Back-Track**

The simulator shall have back-track backward and back-track forward capability. The simulator backtracks capability shall meet the following minimum requirements:-

- a. The backtrack program shall continuously record the initialization data pool in one minute interval on the disk in a wrap round manner for a period of 60 minutes. Thus at any time, 60 minute data set shall be available covering preceding 60 minutes.
- b. The desired backtrack record shall be directly obtainable by the instructor either selecting the problem time of the record or by having the program automatically step backwards in time either manually or automatically as selected.
- c. The instructor may initialize the simulator at a specific backtrack time. However, if the backtrack time is not specified, then it will default to one minute.

19.06.03.2 **REPLAY/RECORD**

- a. The record program shall initially store the current status of all parameters at the same rate at which the simulation module of highest interaction rate is running.
- b. The reply/record system shall be able to record eight hours of simulator operation.
- c. The instructor shall have the ability to replay any recorded tape to review the exercise and while this tape is being played all the parameters are available in the HMI.

19.06.04 **REMOTE FUNCTIONS**

19.06.04.1 Functions (such as operation of manual valves etc.) that is not envisaged to be controlled from the control room (CR) and functions (such as tank levels, temperatures, differential pressures, etc.) which will be varied to change the operational conditions and procedures are required for simulation fidelity and diversity of operation and shall be designated as remote functions. The instructor's control of these functions should require minimum operations to change a particular function. Certain continuous type functions (such as manual valve positions, throttle valve positions, tank levels, temperatures, differential pressures, etc.) shall be simulated so as to provide the instructor with variable quantities through a specified range. This will, for instance, allow the instructor to vary the rate of increase/decrease of parameter (oil, water etc.) in a tank by throttling the flow of a parameter through a pipe, utilize automatic pump/value control logic by varying input parameters, etc.

19.06.04.2 Even through the method of simulation may take need multiple settings to control one functions, it will be counted as one remote function only.



19.06.05 TIME SCALING

- 19.06.05.1 The simulator shall be capable of operating in three modes namely, fast time, real time and slow time.
- 19.06.05.2 Fast time (also called Real-Time Compression) shall provide the capability to accelerate the dynamic simulation in order to observe slow transients or shorten certain time consuming activities, such as obtaining adequate turbine heat up, boiler heat up, raising of condenser vacuum etc. which are characterized by long time- constant. The fast time interaction rate shall be supplied by the Manufacturer for final review and acceptance by Owner. Real time compression shall be provided at ten (10) times real time simulation.
- 19.06.05.3 Real time simulation shall be the normal simulation mode of operation and shall apply to all systems. All system dynamic models shall have sufficient iteration rate to ensure specified tolerance / fidelity and the real plant response.
- 19.06.05.4 Slow time (also called Real Time simulator expansion) that gives an apparent increase in the time interval shall be provided to slow down dynamic simulation in order to observe fast transients and trip situation, loss of component, accidents etc. that is characterized by short time-constant.

19.06.06 CRY WOLF ALARM

The instructor shall have the capability to initiate cry wolf alarms. These alarms will appear to the trainee as real events although no effects on dynamic simulation models will occur. These alarms will be clearly distinguished from malfunctions and will not be included as any part of the number of spare malfunctions required by this specification.

19.06.07 INSTRUCTOR INTERVENTION

The instructor shall have the capability of overriding any parameter without affecting the corresponding mathematical model computer process variable value. This override shall continue until reset by the instructor or by an exercise program. Override capability shall be provided on all inputs/output alarms and not on just a few, because in real life any instrument or alarm can fail leading to a false alarm.

19.06.08 TRAINEE PERFORMANCE PROGRAM

- 19.06.08.1 Trainee performance shall be continuously monitored during a training drill. All operators' action shall be retained in memory with the name of the device manipulated, and the time of the actions. At the termination of the drill, the trainee performance program shall generate a summary of relevant data, including trainee's (or trainees') and instructor's names, date, nature of the training drill, name of variable, critical parameters, high and low deviations from reference values, total amount of units generated during exercise, etc.
- 19.06.08.2 The termination of the drill may be accomplished by the instructor at any time or it may be terminated by a pre-programmed time interval selectable by the instructor.

19.06.09 TRAINEE EXERCISE PROGRAM

A computerized exercise program shall be provided that will automatically step the trainee through a series of simulator drills and exercises plus a number of operational problems. This program shall be developed so as to eliminate / minimize manual control manipulations by the instructor. There shall be minimum of 30 exercises in trainee exercise program. These exercises shall be submitted to the Owner for approval.

19.06.10 SIMULATOR EXERCISE GUIDE

19.06.10.1 The Bidder shall provide a suggested guide that will contain a series of simulator drills and exercises (minimum 50) arranged in logical sequence and according to difficulty of the task to be learned, subject to acceptance by Owner. The guide shall also contain a number of operational problems that the trainee will be required to solve at the simulator. The guide shall assist the instructor by outlining training objectives and specifying the practice sessions required to accomplish performance goals.

19.06.11 OTHER REQUIRED FUNCTIONS

The instructor shall be able to monitor the following functions:-

- a. Manipulate external parameters, which are not modeled, but which affect the simulated plant. These include external load, frequency and /voltage, power factor, and inlet temperature of cooling water etc.
- b. Monitor the actual value of up to 200 specified intermediate calculated variables in the plant models with proper physical units for example, enthalpy, entropy, mass, volume etc.

19.06.12 FREEZE / RUN

It will be possible to freeze the dynamic simulations by the instructor. All the parameters & functionalities shall hold the current value / states till the intervention of the instructor. This can be stored to be used for a future initializing point. It will be possible to continue the programs at that point itself and run the system.

19.06.13 SNAPSHOT

A selectable snapshot capability shall be provided to allow the instructor to store the particular conditions that exist at any instant during a training session, for future recall, as an additional initialization condition. This feature shall supplement the backtrack feature by allowing the instructor to recreate a particular training condition either within or beyond the periods covered by the backtrack mode. The snapshot feature shall have no effect on other initialization conditions discussed previously.

It shall be possible to store the full set of parameters at any instant during simulation by taking a snapshot without freeze. These snapshots also can be used as initialization points in future.

19.07.00 SYSTEM HARDWARE DESIGN AND GENERAL REQUIREMENTS

The simulator system shall consist of simulation Servers, simulator programmer station, instructor's station and total HMI system (consisting of servers, workstation programmer station, LED monitors, Printers, etc. Simulator & HMI network components & communication devices, interconnecting cables etc. However it may be noted that any additional equipment / software shall also be provided by the bidder to meet the functional requirement of the specification.

The schematic diagram showing the basic structure of the system is shown in drawing (enclosed herewith drg. no. 114-01-0117).

The Simulator system as specified shall be based on latest state of the art Workstations and Servers and technology suitable for industrial application & power plant environment.

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. The exact system configuration and sizing shall be as approved by owner.

The Servers / Workstation employed for Simulator system shall be based on industry standard hardware and software which will ensure easy connectivity with other systems and portability of owner developed and third party software.

Communication channel between the MMI and simulator system (as well between other devices / sets as detailed out in various modes of operation) including controllers, memory etc. shall be sufficient to handle all the communication system throughput including video information to meet the parametric requirement of simulator as well as HMI under worst case data flow.

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

All the peripherals shall conform to the minimum requirement specified herein the specification. But the exact make & model shall be as approved by owner during detailed engineering. The LAN to be provided shall support TCP/IP protocol (Ethernet connectivity) for interface with other systems wherever applicable and shall have data communication speed of min. 1000 MBPS. All network components of LAN and Servers/ Workstations shall be compatible to the LAN, without degrading its performance.

19.07.01 Simulator major Hardware functional requirement:**19.07.01.1 Simulation Servers**

Simulation servers along with their associate devices shall run the main simulation software, which include the basic Operating System, simulation environment, application programs & associated routines for process models & control system models. These servers shall also be capable of a running multiple simulator software for simultaneous access to the simulator from both HMIPIS locations. These servers should also be able to double as additional simulation programmer station tools.

19.07.01.2 Simulator Programming/Engineering Station

Simulator Programming Station is intended for development, modification & documentation of simulator software. All necessary tools like GUI based modeling tools, Data base management tool, necessary compilers/ interpreters for high level language used for any application development etc. shall be provided. Further, all the functionalities and relevant features of DDCMIS programming station including documentation facility shall be provided.

19.07.01.3 Instructor Station

Instructor Station shall be used for instructor's integration with the model for training purpose. This station shall be able to perform all instructors' functions specified in cl no. **19.06.00**. It shall also be possible to develop some combination of instructor's activity (e.g. certain combination of malfunctions & remote operation etc.) and tools necessary for the same may be provided.

19.07.01.4 HMI Servers / Workstations

The work stations shall be used for holding the total HMI data base for all operator functions as well as for other HMI applications like Historical storage, logs, calculations, displays, command processing etc. in a manner similar to the reference plant. It shall also be possible for this server to be switched to the real plant as well as some other station as the case may be.

19.07.01.5 LVS & Operator Work Stations

LVS & Operator Work Stations are meant for trainee operator's interaction with the simulator.

19.07.01.6 Network Connection

The function of the network connection is for interconnection between simulator system HMI, remote terminals, real life plant DDCMIS & DCS system etc. The design of this system shall be sufficient to take care of all functionalities and parametric requirement including speed, bandwidth, response time etc.

Networking (LAN) components including switches, Firewall, fibre optics cable, other cable as required, jack panel with wire manager, patch cord, coupler, rack with all accessories, connectors, port, etc. shall be supplied.

19.07.01.7 Simulator major Hardware Specification:

All servers, Operating stations, Operating cum Engineering work station, LVS, printers and network components shall be provided with same features/accessories as specified for DDCMIS/DCS.

19.07.01.8 Projector with Projector screen (white marker board)

One no. projector with white marker board size of 80" shall be provided by bidder for concurrent classroom lectures. The projector shall have following minimum features:-

DLP/LCD based technology, Minimum 3000 lumens, minimum contrast ratio 400:1, uniformity of minimum 90%, with wireless adapter, USB port, with in-built speaker, able to provide Full HD view, motorized zoom & focusing, Optional lense in built for short & long throw, auto image feature depending

upon input, with universal inputs like VGA, S video input, Composite video, IR, Audio, etc and Network capability.

19.07.01.9 Hardware to be provided with Simulator (minimum requirements)

The following hardware shall be operating in a networked environment to form an integrated system. All the components required to achieve this requirement shall be included. Specification of each hardware shall be same as specified in Vol. V, Part B, and chapter 3.

- (i) Operator Stations (5 nos.)- Implemented on similar family of workstation hardware and software as in the main DDCMIS & DCS
- (ii) Large Video Screen 2 no. with display controller and own work station each.
- (iii) Instructor's OWS: 2 no.
- (iv) Redundant Simulation Servers for running the simulation software : (qty as required)
- (v) Redundant HMI Servers for running the HMI software: (qty as required)
- (vi) HMI Programming/Engineering Station : 1 no.
- (vii) Simulation Programming/Engineering Station : 1 no.
- (viii) Cabinets, Almira, lockers & Other accessories : (qty as required)
- (ix) Projector and projector screen (White Marker Board) for concurrent classroom lectures (1 set)
- (x) Industrial Grade managed type Network components such as switches, routers, network cables etc.
- (xi) Industrial Grade Furniture to install the above (similar to main control room)
- (xii) A4 sized colored printers (2 nos.) and A3 sized colored printer (1 no)
- (xiii) Additional 10 no. industrial grade chairs for Trainees.

19.08.00 SIMULATOR WORK STATION SOFTWARE

19.08.01 General Software Requirements

The Simulator Manufacturer shall use graphical packages for development of the models so that future modifications are very easily possible. For any specific customized application commonly used standard high-level languages shall be used. This applies to programs, which simulate power plant processes and equipments. The Manufacturer shall not employ direct machine / assembly level programs for development of application software. Programming techniques shall ensure that the applications are structured and modular and easily understood, maintained and/or modified by programmers having average knowledge of the languages used, without the need of very special training.

The Simulator Computer Software shall include the following:

- i. Operating system software, including Utility and debug software as well as Diagnostic and test software



The Simulator Manufacturer shall utilize the computer vendor supplied operating system software. This operating system shall have the following characteristics as minimum.

- a. Real time multiprogramming operating system supporting multiple concurrently executing programs.
 - b. Multiple software priority levels
 - c. Dynamic memory allocation and deal location
 - d. Program overlay support
 - e. Memory resident sub routine library support
 - f. Inter-process and shared memory support
 - g. Control & servicing of standard peripherals devices.
 - h. System procedure for task activation, schedule
 - i. file management services support
 - j. Global memory support
 - k. Re-entrant executive services
 - l. On line watchdog routine
 - m. Automatic power fail and restart capability
 - n. Re-entrant program generation
 - o. Mass storage editing programs
 - p. Real time I/O and interrupt handling capability
- ii. Plant simulation software (Process model, C&I model and HMI to meet total functional requirements)
 - iii. Instructor station software (To carry out various instructor's functions including invoking of malfunctions, remote functions etc., trainee exercises and other activities)

19.09.00 HMI SERVER / WORKSTATION SOFTWARE

- 19.09.01 The Bidder shall provide all software required by the system for meeting the intent and functional/parametric requirements of the specification.
- 19.09.02 Industry standard operating system like WINDOWS (latest version)/OPEN-VMS etc. to ensure openness and connectivity with other system in industry standard protocols (TCP-IP etc.) shall be provided for HMIOWS. The system shall have user oriented programming language & graphic user interface.
- 19.09.03 All system related software including Real Time Operating System, File management software, screen editor, database management software, On line diagnostics/debug software, peripheral drivers software shall be provided. Latest versions of standard OWS-based software for database handling, word-processing, spreadsheet, etc. and latest WINDOWS based packages etc. and any other standard language offered shall be furnished as a minimum. Systems having program development environments like Programmer's stations, Station LAN Server shall have high level programming support like Microsoft visual studio, Oracle RDBMS, etc.
- 19.09.04 All application software for control system functioning like input scanning, acquisition, conditioning, processing & control along with communication among various Control System functional blocks, HMIOWS and system bus, HMIPIS software for operator interface of monitors, displays, trends, curves,



bar charts etc., performance calculations (with Steam properties routines utilities), Historical storage and retrieval utility, sequence of events recording, system functions shall be provided.

19.09.05 The Bidder shall provide software locks and passwords to the owner at site for all operating & application software in order to prevent unauthorized access and only owner's authorized engineers be able to do modifications at site.

19.09.06 Three (3) sets of backup software on non-write able media shall be provided.

19.10.00 Power cables with necessary sizing shall be supplied & laid by bidder from main plant UPS ACDB1 and UPS ACDB2 to simulator room at a centralized location in simulator room and from there the required distribution board with UPS redundant feeders including 20 % spare feeders shall be provided for distribution purpose inside the simulator room. Required MCB's & fuses and LED lamp indication shall be provided at distribution board.

19.11.00 **SIMULATOR PERFORMANCE TESTING**

The Performance criteria for following conditions to be included:

- a. Steady state performance w.r.t. accuracy of critical and calculated parameters at steady state 25-100% full load range and other loads.
- b. Transient condition performance.

19.11.01 **Performance Criteria:**

The following table lists the functional performance parameters

Steady State Performance: The simulator shall meet the requirements for the accuracy of critical parameters as below :-

Steady state 25-100% of full load range +/-1 % full scale.
Steady state other loads +/-2% of full scale.

- a) Generator Output
- b) Input to the boiler
- c) Main Steam Pressure
- d) Main Steam Flow
- e) Turbine Valve Position
- f) Reheat Steam Pressure
- g) Furnace Pressure
- h) Primary air flow
- i) Secondary Air flow
- j) Furnace Temperature
- k) Separator outlet temperature
- l) Reheat inlet and outlet temperatures
- m) Final Superheater inlet and outlet steam temperature
- n) Mill coal flows and temperatures
- o) Feedwater flow and enthalpy p) Steam enthalpy

Other calculated parameters than these shall be within the following range

Steady state operation 100% full load +/-2% of full scale

Steady state operation 25 -100% full load +/-5% of full scale

Steady state operation other loads +/-10% of full scale.

Item	Guaranteed Performance
Cycle time of process models & Control Logic Emulation	< 100 ms (Execution of one cycle of Control logics and Process Models shall be completed in 100 ms or less)
Hard disk capacity spare	> 60%
Worst-case CPU loading	< 60%

19.12.00 **TRAINING**

The Bidder shall include training for 30 man days on the supplied simulator system in the following areas:

- a. System design structure and basis of design
- b. Hardware components and their configuration
- c. System Software and Simulation Software Tools
- d. Plant process modelling and DCS emulation
- e. Project specific application development, configuration and modifications including equipment modelling and interconnections of models, graphics development , configuring equations etc,
- f. Maintenance and troubleshooting of hardware and software components

19.13.00 **FAT (Factory Acceptance test)**

The FAT of the supplied Simulator system shall take place at Bidder's location in an integrated manner with all components connected and functioning (For details refer Vol. V part-B, Chapter 17).

19.14.00 **COMMISSIONING**

The Simulator shall be commissioned at site sufficiently in advance to enable testing of control logics and providing training to operator ahead of commissioning of the 800 MW unit. The Simulator supplier's own specialist shall participate in the commissioning and validation of the simulator at site.

It is the responsibility of the Bidder to provide the necessary data to their simulator supplier for the plant at different operating conditions including different loads, transients, and abnormal conditions. Such data collection shall be carried out during plant commissioning stage itself so as to avoid requirement of setting up of plant conditions separately for validation of Simulator only.



The necessary plant and design data shall be given to the Simulator's supplier by bidder. Bidder shall be responsible for conversion to other formats, if required, by the Simulator's supplier.

19.15.00 **SAT (Site Acceptance Test)**

Subsequent to tuning and commissioning at site, a detailed SAT shall be conducted to confirm the performance of the system under all steady state and transient conditions. The bidder shall update the simulator to reflect the plant condition based on the plant operating experience till the unit commercial operation is completed.

19.16.00 **DELIVERY**

The Simulator system shall be delivered at site, after satisfactory integrated testing at factory, prior to delivery of the DDCMIS & DCS system.

19.17.00 **SERVICES**

The offer shall include the services for configuration, model development, testing, FAT, training, installation supervision and commissioning and warranty.

Table – 19.1**LIST OF MALFUNCTIONS**

S. No.	MALFUNCTION	CAUSE
1.	Coal pulveriser (A-N) choking or loading up	Coal moisture content increases from the design valve of 12% to an instruction variable amount 12-25%
2.	Coal FDR (A-N) trip	Motor overload
3.	Pulveriser (A-N) trip	Motor overload
4.	Pulveriser reduced capacity (A-N)	Rise of mill temp. due to hot air
5.	Pulveriser reduced capacity (A-N)	Change in coal quality causing the grinding ability index to decrease a Variable amount (0-100%)
6.	Coal FDR (A-N) fails to deliver coal	An accumulation of wet coal sticking to the sides of the coal feeder discharge . Causing a reduction of pipe diameter at 5% MIN.
7.	Water wall tube leak (Each different zones)	Erosion caused by soot blowing has worn the tube metal thin enough to cause a tube leak at an instr. Variable rate of zero to 100%
8.	ID fan (A) or (B) Trip	Phase to phase fault causes circuit breaker to open.
9.	FD fan (A) or (B) Trip	Oil pressure switch fails closed.
10.	PA fan (A) or (B) Trip	PA Fan outboard bearing temp. indication from (A) side fan or (B) side fan fails high.
11.	ID fan (A) or (B) outboard brg. Temp. high	Wiped bearing.
12.	FD fan (A) or (B) outboard bearing temp. high	Wiped bearing
13.	PA fan (A) or (B) outboard bearing vibration high	Instructor variable 0-100 microns above normal levels
14.	ID fan (A) or (B) outboard bearing vibration high	Instructor variable 0-100 microns above normal levels
15.	Flame scanner shows flame continually (for each Oil / Coal elevation)	Instructor induced malfunction
16.	Fuel flow runback to less than demand	Spurious electrical malfunction in auto combustion control causing fuel flow to drop by 20% and then revert to manual.
17.	RH tube leak	Tube failure
18.	Secondary SH tube leak	External erosion causes an instructor variable peak from 0 to 100%
19.	Electrometric safety valve. Fails open	Steam pres. Transmitter fails high

S. No.	MALFUNCTION	CAUSE
20.	Primary air out of air heater damper fails closed	The linkage connecting the damper to the actuator fails allowing the (A) side dampers to go closed.
21.	Pulveriser (A-N) tempering air damper froze	Binding in linkage.
22.	Plugged air heater (Both for primary and secondary)	Build up of fly ASH on air heater elements
23.	Aux. Air damper adjacent to coal elev. Faulty modulating	Control malfunction giving 20% less out put than required
24.	BMS DC supply failure	BMS cabinet fuse blown
25.	A or B FD fan discharge Damper fails closed	Broken linkage allowing the damper to close
26.	Aux. Air damper not modulating	AB Aux. Air damper stuck
27.	Left side furnace pres. Transmitter false reading	Plugging of left side furnace pres. With ash
28.	Burner tilts fail high	Controller malfunction
29.	HO header pres. Low	Slow response from the header pres. Regulator as the first set of oil gun valves are opened.
30.	HO trip valve. Fails closed	Broken air line to the valve actuator
31.	HO temp. low	Temperature controller fails high and causes the steam flow regulating valve to the 2 HO heater to close.
32.	HO supply header pres. Low	HO discharge strainers begin plugging up at 2% per minute until they have completely plugged.
33.	Aux. PRDS valves fail closed	Auto controller malfunction
34.	(A) or (B) air heater main drive motor trip (Both on sec)	Motor overload causes the circ. Breaker to open
35.	Firing rate limited	Poor coal quality
36.	Air flow runback to less than demand	Instructor variable 30 to 100%
37.	ID fans (A or B) inlet vanes froze	Air failure to the E/P converters
38.	High SH tube metal temp.	Partial plugging of the final SH section causes elevated tube metal temp. on the clean side
39.	Boiler water /steam silica concentration high	Silica analyzer fails high
40.	Throttle pres. Transmitter failure	Electrical malfunction causes transmitter output to fail low
41.	Loss of seal air to pulveriser (A-N)	Seal air damper fails closed

S. No.	MALFUNCTION	CAUSE
42.	Air flow less than 30%	Air flow controller minimum set point offset to 28% air flow
43.	Air flow more than 40% during startup	Minimum air flow set point offset 10% high
44.	All pulveriser trip	Spurious elec. Signal from BMS hot primary air L0 L0 pressure switch lasting one second.
45.	Boiler purge timer failure	Timer fails to reset and gives the purge complete indication as soon as all the purge permissive have been met.
46.	Flame scanner failure	Instructor induced malfunction
47.	Igniter pair 1 and 3 elevation (AB, CD, EF, GH, JK or MN) fail off	IFM failure due to soot deposits.
48.	Elevation AB oil gun 1 scavenging valve sticks open	Operating solenoid stuck
49.	No start permissible pulveriser (A-N)	Pulveriser Disc. Gate limit switch failure
50.	Pulveriser (A-N) primary air flow temp. comp. Thermo-couple fails	Broken wire on thermocouple
51.	Pulveriser hot air gate fails closed (A-N)	Spurious electrical signal causes the hot air gate to close
52.	Pulveriser (A-N) motor stator temp. high	Partial blockage of motor ventilation
53.	Pulveriser Air flow feedback offset 25% high (A-N)	Tapping point used for air flow measurement becomes partially plugged and gives false air flow signal
54.	Pulveriser (A-N) fails to start	Shaft seizure
55.	Loss of coal feeder flow rate indication (A-N)	Both FDR flow transmitter fail low
56.	Furnace walls badly slagged	Poor pulveriser performance causes ASH to accumulate at 10 time the normal rate
57.	Abnormal ASH buildup on reheater pendant	Change in ASH characteristics of coal being burned causes ASH to accumulate on the reheater tube surfaces at 20 times the normal rate
58.	ASH buildup in the economiser	Poor coal quality causing ASH to accumulate at 10 times the normal rate
59.	Primary air pres. Control malfunction	PA fan inlet vane position freezes regardless of controller output.
60.	Furnace pres. Controller malfunction (A or B) side	Controller electrical malfunction causes the associated ID fans inlet vanes to go wide open

S. No.	MALFUNCTION	CAUSE
61.	Purge ready condition can not be met	Pulveriser hot air gate not proven closed
62.	Air heater fire (A or B) (both for primary and secondary)	Accumulation of unburned fuel particles
63.	Auxiliary air damper control power failure	Control maintenance personnel mistakenly turn off the electrical power serving the auxiliary air damper control
64.	Burner tilt position difference	Binding linkage on corner no. 1
65.	Stator cooling water tube leak	Broken hose supplying the stator winding being measured causes a leakage rate of 4 lit. per minutes
66.	Hydrogen cooler tube leak	Tube rupture caused by corrosion produces a leakage rate of 1 litre per minute
67.	Loss of H2 seal oil pressure	Seal oil filter beings plugging up at 2% per minute
68.	Generator hydrogen leak	Leaking pipe flange, instructor variable 0 to 100%
69.	Generator gas temperature high	H2 coolers heat exchange surfaces become fouled and impede heat transfer by 30%
70.	Low stator cooling water flow	Stator cooling water filter begins plugging at 2% per minute
71.	Loss of outside power to buses 1A & 1B	Reserve station supply breakers fail to close on unit trip
72.	Generator trip	Phase to phase electrical fault
73.	Generator auto voltage regulator failure	Pulse amplifier fails
74.	Electrical transmission network being fed by the generator drops down to 49.5 Hz	Overloaded transmission system
75.	System voltage drops low	High demand for reactive power causing main bus voltage to drop 5%
76.	Loss of Generator excitation	Load on rectifier transformer
77.	Unequal generator phase loading	Imbalance on the main 400 kV bus
78.	Loss of 24 V DC bus to FSSS	Electrical fault on the bus opens the feeder breaker
79.	Loss of 415 VAS bus	Electrical fault of the bus opens the feeder breaker
80.	Loss of normal feed BKR to the AC/ emergency Bus section	Elect. Fault causing incoming BKR to trip
81.	Megawatt transducer fails	Blown fuse in the transmitter

S. No.	MALFUNCTION	CAUSE
82.	Low stator water resistance	Deionizer capacity exhausted and high conductivity water leaking into the system from the makeup line.
83.	Loss of one hydrogen cooler	Air locking in H2 cooler
84.	Generator bearing 1 babbit temp. high	Restriction of oil flow to bearing
85.	High stator cooling water temp.	Clarified cooling water passing through the stator water cooler in inadvertently throttle to a point where heat removal capacity is reduced by 50%
86.	Seal oil leakage into the generator	Seal oil drain port on turbine end becomes restricted
87.	Auto synchronizer rails	Running frequency input is lost
88.	Generator seal oil temperature high	Cooling water flow to the seal oil cooler is lost
89.	Main power transformer oil temperature high	Loss of cooling system
90.	(A or B) unit aux. XFMR failure	Differential relay operates on electrical fault
91.	Loss of emergency supply power	Diesel generator fails to start on loss of normal essential service feed
92.	Generator auto voltage regulator oscillating	Control malfunction
93.	DC seal oil pump fails to start	Loss of power supply to the pump
94.	Stator cooling water pump (A-B) trips	Motor overloaded
95.	220V DC bus fuse blown	Main bus fault
96.	Loss of condenser circ. Water pump (1-3)	Phase to phase fault causes the circuit breaker to open
97.	Ext. STM shutoff valve. to 6 H.P. FW HTR fails closed	Spurious electrical signal
98.	LP heater 3 tube leak	Tube failure causes a leakage rate of 100 T/HR
99.	FW heater tube leak	Tube failure causes a leakage rate of 100% instrument air
100.	(A-C) BFP high brg. Vibration	Mech. Seal failure causing vibration. To increase at a rate sufficient to trip the pump on high vibration after 10 min.
101.	Loss of BFP suction (A-C)	Plugging of suction filter
102.	Condenser tube leak	Cross sectional break in the left side tubes causing disturbance in condenser vacuum. Variable rate of leakage into the Hotwell of 0 to 100%.

S. No.	MALFUNCTION	CAUSE
103.	Condenser air leakage	Mechanical failure of the condenser structure causing an instructor variable leakage rate of 0-100%
104.	A or B condensate pump trip	Electrical fault
105.	Ext. steam valve to LP FW heater fails closed	Spurious electrical malfunction
106.	FW heater tube leak	Tube failure causes a leakage rate of 100% instrument air
107.	BFP (A / B / C) high brg. Vibration	Mech. Seal failure causing vibration. To increase at a rate sufficient to trip the pump on high vibration after 10 min.
108.	Loss of BFP suction (A/B/C)	Plugging of suction filter
109.	Condensate recirculation Valve fails open	Spurious electrical malfunction causes SV to de-energize
110.	Condensate pump A / B / C trip	Electrical fault
111.	Ext. steam valve to LP FW heater fails closed	Spurious electrical malfunction.
112.	BFP (A/B/C) Hydraulic coupling oil temperature high	Hydraulic Coupling oil cooler becomes plugged up at 10% a min.
113.	Condenser circ. Water differential pressure high	Large pieces of debris restrict circ. Water flow by 0-25% operator variable
114.	HP FW HTR ext. steam. Block valve fail to go closed on demand	Mechanical binding
115.	Loss of station air pressure	Break in station air header
116.	Loss of instrument air pressure	Leakage flange
117.	Loss of aux. Steam	Aux. Steam header cross tie valve to aux. Boiler steam supply header valve Fails/ closed.
118.	Stuck water wall soot blower (A-B)	Fully retracted limit switch fails to make up after soot blower has done blowing
119.	AH cold end temperature low (A or B)	Condensate backs up into the steam coil air preheaters (A or B)
120.	Loss of gland steam vapor extractors	Thermal overload opens the circuit breaker
121.	Loss of turbine lube oil vapor extractor	Motor overload circuit breaker opens
122.	Scanner air fan (A or B) trips	Motor overloaded
123.	UPS supply failure	Electrical malfunction



S. No.	MALFUNCTION	CAUSE
124.	Loss of soot blowing steam	Soot blowing steam regulating valve fails closed
125.	Retractable soot blower failure	Broken steam valve actuating steam
126.	Air heater air motor fails to auto start (A or B)	Electrical malfunction
127.	Hydrazine feed pump fails (A-B)	Pump mechanical failure causes hydrazine injection to cease
128.	A or B turbine aux. Oil pump trips	Motor overload
129.	Low sec. Oil pres. To the intercept control valve	Leaking secondary oil piping after follow up piston
130.	Gland steam condenser tube leak	Ruptured tubes causing leakage at a rate of 100T/HR
131.	Loss of turbine gland sealing steam	Steam seal supply valve losses its control signal and fails closed.
132.	Gland steam pressure high	Gland leak off control valve losses its negative voltage input and goes closed
133.	Emergency stop valves fails closed	Spurious electrical malfunction of the test solenoid
134.	Intercept stop valves fails closed	Spurious electrical malfunction of the test solenoid
135.	Turbine control valve malfunction	Governing system malfunction causes the control valves to fail to an instructor variable position 0 to 100%
136.	Loss of exhaust hood sprays	Spurious electrical malfunction causes the hood spray valve to close
137.	Turbine main pump failure	Broken impeller
138.	Low turbine lube oil reservoir level	Corroded cooling water tube causing a leak of oil into the cooling water at a rate which causes the turbine oil reservoir level to drop at 25 mm per min.
139.	High turbine bearing vibration	When this malfunction is inserted, the vibration on all turbine bearing will increase an instructor variable amount (0-100) microns over the normal level
140.	ATRS subgroup sequence control turbine system failure	Control coordinator card failure
141.	ATRS sub loop control turbine drains failure	Electrical fault
142.	Loss of turbine TSI power	Turbo supervisory cabinet power supply fuse blown
143.	Broken last stage turbine blade	Metal fatigue causing a small piece of metal to break off from one of the blades

S. No.	MALFUNCTION	CAUSE
144.	Main turbine EHG control fails high	Spurious electrical malfunction
145.	Turbine axial shift high	Thrust bearing pad failure
146.	Main turbine lube oil cooler cooling capacity reduced	Biological fouling of heat transfer surfaces
147.	Barring gear valve stuck closed	Mechanical binding
148.	High turbine back pressure	Fouled condenser instructor variable 0-100%
149.	Turbine thrust BRG trip device faulty	Return oil line plugged
150.	Emergency stop valve before seat drain valve will not open	Mechanical binding
151.	Loss of control power to turbine EHC system	Ground fault in main cont. circuit
152.	Turbine HP bypass spray valve fails closed	Remote operator inadvertently closes
153.	LP bypass desuperheater. Valves fail closed	Loss of control oil pressure
154.	Water in the turbine inlet steam	Emergency stop valve before and after seal drain line plugged, allowing condensate to form in the main steam line.
155.	Wall stress analyzer failure	Electrical malfunction
156.	Turbine LP bypass fails	Electro hydraulic converter follow up piston sticks.
157.	Turbine HP bypasses valves (1/2) fails to open on demand	Steam temp. Thermocouple down steam of the HP bypass valve failed high
158.	Turbine lube oil temp. Control failure	Temperature transmitter being used for control, develops and offset 10 C lower than actual.
159.	Turbine low lube oil pressure trip device faulty	Pressure switch failure
160.	ATRS control power failure	Ground fault on field wiring
161.	ATRS sub group oil system failure	Control coordinator card failure
162.	Low VAC trip device fails to function	Piston valve in the low vacuum trip device sticks in the upper position.
163	PA A or B fan IGV Position Feed Back faulty	Loss of position feed back
164	ID fan IGV Position Feed Back faulty	Loss of position feed back
165	FD fan IGV Position Feed Back faulty	Loss of position feed back

S. No.	MALFUNCTION	CAUSE
166	Malfunctioning of Air Pre Heater rotor	Mechanical fault
167	Post purge trip	
168	AB elevation one corner HO MIV closed	Spurious close
169	Low O2 level in Flue gas path	
170	Generator cold gas temperature high	
171	APH Stoppage alarm	
172 to 500	Various failures / errors related to C&I systems starting from field instruments, actuators, instrument air supply, cables, control system modules like I/O modules, controllers, DC and UPS power supplies, impulse pipes/ tubes, fittings, analyzers, HMI system components, data base and other software, System bus and other communication devices etc.	TO BE ELABORATED DURING DETAILED ENGINEERING STAGE.

CHAPTER – 20**DOCUMENTATION MANAGEMENT SYSTEM**

- 20.00.00 This chapter covers the system design, engineering, manufacturing, supply, assembly, packing, transportation, erection, wiring, cabling, shop and site tests, putting them into successful commissioning as per instructions of Owner's personnel and all other services as specified in accordance with the intent and requirement of this specification of Documentation Management System.
- 20.01.00 **General:**
- Bidder shall provide project documentation system for complete plant pertaining to all the disciplines viz. Civil, Mechanical, Electrical, Control & Instrumentation, Quality Assurance etc. including As-Built documentation for the same through use of high standard State-of-the-art Documentation Management system.
- 20.02.00 **Scope of supply:**
- A complete Integrated & Engineered Documentation system consisting of hardware, customizable documentation software, UPS, furniture, associated networking with all interfacing components, system-documentation, user-manuals, training, up-gradation & maintenance of software required for successful implementation of Documentation Management system at Owner's Office.
- 20.02.01 Bidder shall be required to arrive at the methodology, based on globally acceptable standards and best practices, suitable for Industrial/ Power plants. System shall be used to manage, track and store the electronic documents of paper-based information captured through the mediums like Document scanners, Mailboxes, Websites, Office tools, Integration tools, etc. System shall support Image Fusion, to meet the needs of safe archival as well as quick digital access.
- 20.02.03 The Bidder's involvement needs to be spread across a period of 120 months from the date of Letter of Intent (LOI) and implementation at all the locations. Bidder's service support shall be required during business hours (9:00AM to 6:00PM) and working days as defined by the Central Govt. holiday calendar. Bidder shall ensure availability of expert and sufficient expert support staff across their service centers or remote service locations.
- 20.03.00 **Provenness of offered system:**
1. Bidder shall submit the documentary evidence for supplying the Documentation Management system for at least two industrial plants/power projects, who have been using the software for a minimum period of two years as on date of opening of bid.
 2. The Documentation Management system must have been running satisfactorily for a period of minimum One year. The user certificate of satisfactory performance to be furnished as a proof, in the bid offer.
 3. The Document Management software shall be able to control, track, store,

organize documents and maintain workflow, document repositories, output systems and information retrieval systems.

4. File searching shall be possible by file name, key words, author of the file, and hierarchical position of the author, date created, date modified, priority set and status.
5. The solution shall be easy to configure and implement, so as to integrate into existing infrastructure and applications. It shall also archive records in a non-proprietary format that can be read on any operating system, without special software or any viewers, into the foreseeable future. Documents stored in the system shall retain its original format and run in its native application when retrieved. The system shall duly allow for easy transfer of database and images to any other system.
6. The solution shall offer a comprehensive range of cost-effective services for Document Management System as under:
 - a) Accessing data from anywhere & anytime.
 - b) Ability to work in web browser without download source files.
 - c) Restricted access rights & control with ability to auto-update/ assign the current status of each document across all descendants throughout the hierarchy, incase if any status updates will be devised by Master-users/ administrators over the management information systems network.
 - d) Working in collaborated environment with various stakeholders in project.
 - e) Managing documentation of all disciplines & functions.
 - f) Upload & download document at one go.
 - g) Document Scanning.
 - h) Data conversion (TIFF to RTF, PDF, HTML, XML etc.)
This solution shall include conversion of image files like JPEG, TIFF, PDF, etc to XML PDF, HTML etc.
7. Automated Workflow system shall allow collection of information along the hierarchy or from outside the system including reviewing, commenting and approving by various users in the hierarchy. The system shall support movement of information across and within departments, thereby seeking opinions/approvals from relevant department user.
8. System Workflow shall meet below criterion as minimum, however as the system further needs to be integrated with Cloud based and existing documentation applications, hence same shall not be limited to below:
 - a) Document Uploading- Uploading prepared document & assignment of approved workflow.
 - b) Document check, review and approval- Internal documents Red-lining, commenting, review and approval.

- c) Transmittal Creation (In & Out) - Export & import documents between the associated departments.
- d) Comments Resolution sheet generation – Cloud, IP & Mobile based.
- e) Projects dashboard- Review of reports and dashboard for project monitoring and control.

20.04.00 **General Technical Instruction:**

20.04.01 It is not the intent to specify here all the details of "Complete plant Documentation Management System Design". However, system shall conform in all respects to high standards of design, engineering and workmanship and shall be capable of performing the required duties.

20.04.02 Notwithstanding what is specified in this document, it shall be the Bidder's responsibility to configure the total solution so that Documentation Management system performs satisfactorily.

20.04.03 Bidder shall be responsible for the complete application engineering of the Documentation Management system. Any modification or revision necessary because of as-built documentation shall be carried out by the Bidder.

20.04.04 LAN version and Cloud Version of System software to be installed for concurrent working of multiple users. Quantum of users and the permissions with privileges to be granted or assigned shall be decided during detailed Engineering stage. Bidder to consider minimum 30 Users at Owner's office.

20.04.05 All necessary technical literature/documentary evidence, wherever needed, shall be submitted to show that the supplies are in line with technical specifications.

20.05.00 **Documentation Management System functional requirements:**

20.05.01 The documentation system shall store complete plant drawings and documents for all the plant packages. Bidder shall indicate the capability of their offered system and shall engineer the same as per Owner's requirement.

20.05.02 The System shall be in the form of customizable software. The editable software for project shall be accessible by plant personnel with user name and password.

20.05.03 **Architecture and Scalability :**

- a) System shall support open, scalable, Multi-tier architecture with each tier fully independent with support for clustering.
- b) The system shall provide interface with any other system that Owner will implement in future eg. Workflow management system (Business Process Management) solution.
- c) Support distributed Document Repositories for document upload and access at local level, which can be replicated with central repository at scheduled intervals.

- d) System shall be platform independent and support complete Windows prototypes on client side i.e it shall support all Windows based browsers on client side.

20.05.04 **Storage & Archival of Documents:**

Bidder shall provide central server with storage devices, system software along-with in-built cloud-based document management software to collaborate, store and manage all documents on one central platform thereby enhancing efficiency and productivity. Bidder shall also provide communication, networking equipment and bandwidth for implementing the DMS, storage and retrieval of data and shall furnish the process & details of archiving the documents and retrieval from archive as & when required. The storage system shall provide long-term and reliable storage for documents and shall accommodate changing documents, growing volumes and advancing technology.

Following facilities shall be provided by the DMS in this regard –

- a) Categorization of documents in folders-subfolders. There shall not be any limit on the number of folder and levels of sub folders.
- b) Document Version Management with Check Out / Check In facility.
- c) Extensive document and folder level operation such as move / copy, email, download, delete, metadata association etc.
- d) Repository shall be format agnostic.
- e) Indexing of the documents on user defined parameters. The index system shall create an organized document filing system and make retrieval simple and efficient.
- f) Association of the key words with the documents.
- g) Support archival of PDF/A format documents.

20.05.05 **DMS Administration :**

- a) System shall provide web-based administration module.
- b) Adequate administrative controls and security features with ability to set access Controls at multiple levels.
- c) The system is supposed to provide separate digital signature for each department in-charge.
- d) It shall support multiple level of access rights like read, create, modify, delete etc. on documents and folders.
- e) Roles and Privileges: Super/Master User, Administrator Login, Group Manager and user profiles.
- f) The system shall support extensive reporting facility at document, folder and user level.

- g) It shall empower to manage audit trails and exporting reports.
- h) The system shall have the capability for exception reporting, based on specified rules eg. No. of documents accessed in specified period of time etc. The system shall have an ability to generate automatic alerts in case of such Exceptions.
- i) The DMS shall Support various Meta Data Types like Numeric, Float, text etc.
- j) System shall have inbuilt health and monitoring tool for proactive monitoring of application and services.

20.05.06 Retrieval:

A retrieval system shall retrieve right documents fast and easy. Documents shall be stored in html, xml or pdf format etc.

- a) Extensive search facility to retrieve documents or folders/files.
- b) Support saving of search queries and search results.
- c) Search for documents/folders using user-defined indexes and document classes. i.e. Application number, Institute name, address, date etc.
- d) Full text search on image and electronic documents.
- e) Support for wildcard character based search.
- f) Extensive search facility to retrieve documents or folders/files.

20.05.07 Document View & Reporting:

Document viewing shall be readily available to those who need it, with the flexibility to control access rights to the system and shall be accessible in the office or at different locations over the Intranet, or over the Internet.

- a) Server based Inbuilt Document Image Viewer for displaying image document without native viewer.
- b) Client shall be platform independent and support all standard browsers on client side.
- c) Support comprehensive annotation features like highlighting, marking text, underlining putting sticky notes on documents, and support for text and image stamps etc.
- d) Automatic stamping of annotations with user name, date and time of putting Annotations.
- e) Securing annotations for selective users.
- f) Built in Support for rendering and viewing PDF/A document format with support of applying annotation.
- g) Proposed DMS shall provide Web Content Management capabilities for providing Web based access to Institutes and students over internet.

20.05.08 **Scanning:**

A reputed scanning system for putting paper files into Server/ Computer. The paper size will be A0, A3, A4 including Blueprints for documents/ drawings etc. The minimum scanning resolution shall be as per the latest industrial standards. Bidder to ensure proper readability of output image.

The DMS shall have following features –

- a) Support for Bulk Scanning
- b) Support for Web Scanning / Distributed Scanning
- c) Support platform independent scanning
- d) Image Assisted Indexing of Scanned Documents
- e) Direct upload of Scanned Document to DMS
- f) System shall be provided with built-in Document Quality Analyzer (DQA) for automatic correction of parameters like improper resolution, format/ compression not proper, skew, wrong orientation, error in automatic cropping, punch hole marks etc. during scanning.
- g) Provide Image processing libraries that support image enhancements such as
Changing contrast, zoom in/out, cleaning etc. and other imaging features like compression and extraction etc.
- h) Facility to upload scanned batches from different field offices with Auto Folder/Subfolder creation document filing & indexing on user defined fields.
- i) System ability to provide Compression of scanned image files.

20.05.09 **Audit Trails**

- a) Support Extensive Audit-trails at user (User Activity, File Movement Records)
- b) Facility to generate Audit trails on separate actions
- c) Log all the actions done by individual users with user name

20.06.00 The solution shall include Work Flow management besides the following features:

I. Inward Receipt:

- a) Complete solution for inward receipts at all locations

II. File Creation shall provide fully functional:

- a) Unique Numbering of File
- b) Stores File Name, Subject, Creators Notes
- c) Priority Indication (Immediate/Normal/Later)
- d) Nature Indication (Confidential/Normal)
- e) Files shall be Version Numbered
- f) Metadata Capturing ability for input whenever applicable/possible for fast search

- III. Work Flow Creation & Assignment shall support:**
- Multiple Work Flows
 - Create a New Work Flow at Run-Time
 - Create Inter-Departmental & Intra-Departmental Work Flows (Assignments)
- IV. Action on File shall print:**
- Pending File Reminders
 - Receipt Acknowledgement
 - Noting
 - Attachments - Any type of Attachment (incl. PDF, HTML, JPEG, Docs, Excel Sheets, Audio/Video files etc. in correct and recoverable format)
 - Add/Update/Delete/View (Linked File) References facility
 - Tasks Assignments
- V. File Approval shall generate:**
- Outgoing Draft Reply Letter Generation and outgoing reply by email, letter SMS etc.
 - Reply – E-Mail, Letter, SMS etc.
- VI. Outward Generation & Dispatch shall provide:**
- Auto Disposal by Different Disposal Modes
 - Outward Entry module shall generate Two Copies – Fair Copy and Office Copy and send it to the Dispatch Section for delivery to the intended users/senders
 - Carry Forward of Non-Disposed Files
- VII. Query / Views on following shall provide:**
- Text Based, Keyword based, Wild Cards based search options
 - Subject-wise Generalized Summery
 - Inward number v/s. Outward number
- VIII. User Creation & Other Security Features**
- History of Positions held with Timeline
 - Security Features like Password Complexity & Encryption, Audit Trails
 - Database Triggers to Stop Direct Updatons
- IX. Reporting Module**
- Register Printing

2.07.00 **Indexing Documents**

The indexing methodologies used, shall be easy to use and understood by the user who retrieve the documents, as well as those who file them.

Shall organize documents as given below:

a) Index Fields

An imaging system shall allow users to customize index templates, create multiple templates and have different types of index field data within each template, such as date, number and alphanumeric characters. Index fields shall be used to categorize documents, track creation or retention dates, or record subject matter, among other uses. In addition, an imaging system shall allow pull down boxes to speed index field entry and have tools available to help automate entering index information.

b) Folder/File Structure

An imaging system shall provide a visual method of finding documents. An Imaging system shall have the ability to electronically re-create this filing system through multiple levels of nested folders.

c) Retrieving Documents

Whatever the method, document retrieval shall be simple and user-friendly. The system shall provide easy, fast and efficient retrieval of relevant documents.

d) Controlling Access

The system shall provide appropriate levels of access to HPGCL data, without compromising confidentiality or security.

e) Broad Availability

The system shall provide a client-based user interface that enables the scanning, indexing & retrieval of documents. Users shall be able to search, retrieve and view documents with any web browser.

f) Comprehensive Security

The system shall allow the system administrator to control what folders and documents users can see, and what actions they can perform on those documents (edit, copy, delete, etc.) The system shall control access to folders, documents and even redacted images and text in a simple and complete manner. It shall be possible to add/delete/modify any attribute, data specification, parameter etc. from the system with proper protection. Password security for protection of database of Documentation system from unauthorized use, must be provided. Provision of transferring/accessing information to/from MS Access/Excel formats from/to other workstations on the network shall be provided.

20.08.00 **The Documentation Management system Configuration:**

20.08.01 Bidder shall be responsible to supply completely engineered documentation system including necessary hardware of proper size and the software necessary to meet the requirements of the project. The relational database shall be generated by the Bidder to display and print out all plant documentation by the system.

- 20.08.02 The Documentation Management system at Owner's head office and project site shall run on a dedicated server each along with the accessories like LED monitor, DVD read/writer and A3 sized coloured laser printer cum scanner respectively.
- 20.08.03 All software provided shall necessarily include the cost for perpetual license(s) for use on all the machines and an Annual Maintenance Contract (AMC) which shall include software upgrades as & when released by the software agency for a period of ten (10) years from date of receipt of LOI (Letter Of Intent).
- 20.08.04 All documentation can be archived on HDD attached to System & bulk storage.
- 20.08.05 Any information shall be accessible for the system in a menu driven program only.
- 20.08.06 Bidder shall obtain and load all documentation data as available from sub packagers/ sub vendors and shall be responsible for uploading all modification or revision necessary because of As-built documentation of each plant package.
- 20.09.00 **Hardware requirement of Documentation Management system:**
- Bidder to ensure, that all the requirement as specified above are fully complied by the offered "Documentation Management system". In addition, following hardware requirement and connectivity requirement shall also be complied:
- 20.09.01 One no. (1) Server with One no.(1) work-station and bulk storage (min 10TB), One no.(1) Industrial grade Color laser printer cum scanner (of paper handling capacity upto A3 size) with printer cartridges, papers, accessories along-with four sets of print cartridges and eight ream of papers , One no.(1) A0 size colored plotter of latest hybrid configuration available in market inline with the latest industrial standards with complete accessories & standalone machine software with in-built cloud-based documents management software module etc. The size of monitors for both Server and Workstation shall be as per Vol. V, Part B, Chapter 3.
- 20.09.02 The Documentation System server, work stations, printers, scanner, plotter and the related accessories shall meet the technical requirements as indicated in Vol. V, Part B, Chapter 3 as minimum, however latest configuration for complete Hardware including machine and cloud management software shall be finalized during detailed engineering. Bidder shall also provide expandable items for entire warranty period. This shall include printer ribbon, ink/toner cartridge print head etc. shall also be provided with printer.
- 20.09.03 The Documentation System shall work as a stand-alone system. Suitable hardware and software firewall for interfacing with the other applicable processes and applications shall also be provided. All network hardware like routers, bridges, switches etc. shall be managed type industrial grade only.
- 20.09.05 DMS provided at project site shall be kept at documentation room as a dedicated Documentation Node and shall be connected to station LAN/MIS server/DDCMIS.
- 20.09.06 The system shall have facility to store bulk data for 15 years duration with facility for retrieval of the same. Memory size of servers shall be designed & provided by Bidder accordingly. The system shall have facility to share all the

data in the hard disk/back up media and provide user-friendly utilities to retrieve and analyze stored data.

- 20.09.07 The system shall be provided with UPS power supply. The power supply provision shall be such that on failure of normal power supply the UPS power supply shall cater to the requirement of the equipment so as never to hinder the functioning of the system in any manner due to power supply failure.

Minimum 2 KVA intelligent online UPS with 60 minutes battery backup for DMS server, Workstation with Printer/plotter.	Three nos. at Owner's Office each for Work station , Server , Printer/plotter
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- 20.09.10 Industrial grade furniture shall be provided for Documentation Management system as explained in chapter 6.

20.10.00 **Documentation Management system Planning and Implementation**

System implementation shall take into account after the commissioning of subject plant. System shall be delivered fully implemented and shall be user tested at site. It is the Bidder's responsibility to demonstrate the proper functioning of the system to user personnel abiding following:

- (i) Complete installation along with Plotters and Printers of the DMS System should be within 30 days from the date of LOI.
- (ii) Engagement of Operating personnel will be in Bidder's scope till FTO.
- (iii) All consumables till FTO for plotter i.e paper of A0 size, Refilling / procuring of cartridges would be in Bidder's scope.
- (iv) Maintenance of Plotter till FTO is required.
- (v) After FTO, DMS along with plotter & printer should be handed over in good working condition along with 2 No. cartridges, 2 No. A0 size paper Roller and other required material.

The system shall be implemented in following phases:

Phase-I:

Document Management System solution for all the documents collected at Owner's Office in respect of approval process for academic year 2022-23. Expected number of documents is approximately 1 Lac. Phase-I shall be completed within 30 days from the date of LOI.

Phase-II

Document Management System solution for the documents at all the locations as a routine matter for Four years after satisfactory completion of Phase-I. Expected number of documents is approximately 3 Lacs in every subsequent year.

It is preferred that Bidder's implementation team will involve ultimate users personnel during system implementation. Bidder shall provide the necessary resources: services, consulting, and software to Implement and maintain total solution for Document Management System.

- 20.10.01 System implementation shall be considered full & final, when complete documentation like each & every document, drawing, manuals, etc related to each & every package for subject plant shall be loaded and engineered.

Owner shall provide the power supply at one point and work space and storage space for Documentation Management system implementation, at Owner's Office, Except this complete scope of work & supply regarding Documentation Management system hardware, software, furniture, civil work & electrical work at Owner's Office are in Bidder scope.

20.10.02 All software user licenses shall be valid for entire life of power plant. User shall not have to pay any recurring licenses fee during the usage period of the system.

20.10.03 It shall be possible to upgrade the installed system with the latest available version of the software model for up to 15 years after commissioning.

20.11.00 **Training**

The Bidder is responsible for training the System engineers, HQ executives and plant operators, on the operation, maintenance and trouble shooting of the Documentation Management system. A detailed training schedule shall contain three training days, which makes the responsible persons of the power plant and Owner's HQ familiar with the operation and the technical concept of the system.

CHAPTER– 21

VIDEO CONFERENCING SYSTEM

- 21.00.00 This specification covers the system design, engineering, manufacturing, supply, assembly, packing, transportation, warehousing, field construction, erection, wiring, cabling, shop and site tests, putting them into successful commissioning as per instructions of Owner's personnel and all other services as specified in relevant sections in accordance with the intent and requirements of this specification of Video Conferencing System. The offered Video Conferencing System shall have at least one year's satisfactory operation prior to the date of Techno-Commercial bid opening in a large industrial setup viz power plant (Thermal or nuclear), cement plant, petroleum refinery, steel plants or coal mine.
- 21.01.00 Video Conferencing System shall be provided at the conference rooms in TG building and Service building. Video conferencing system facility with dedicated internet connection shall be provided as per in Vol. V, Part B, Chapter no.21, so as to talk to other thermal power stations, load dispatch centre, HPGCL Head quarters etc. Supplier shall have AVIXA/Infocomm, USA's Certified Technology Specialists (CTS, CTS I & CTS D). However, the CTS holder should be associated with a manufacturing organisation, not an individual like consultant. Documentary proof of CTS holder being a part of supplier shall also be submitted.

The quantities indicated after sr. no. xii (page-2) shall be for each Video Conferencing System

SYSTEM DESCRIPTION

- i. Video conference system shall be IP based system and shall work on IP Dial-in/ Dial-out topology.
- ii. Nominated conference site shall work as master unit and shall be provided with Multiple Conference Unit (MCU). This conference unit shall be connected to different end points located at Zonal HQ/Divisional HQ / any other important location.
- iii. Original Equipment Manufacturer (OEM) of video conferencing system shall have established manufacturing facility & office in India or their authorized representatives shall have service facility in India.
- iv. Manufactured products shall have quality system compliance and shall be UL , EN and FCC or CE certified.
- v. All core components of video conferencing system like camera, codec, MCU, Gateway, Gatekeeper and embedded software should be from same manufacturer.
- vi. All software and firmware upgrades shall be free of cost for a period of five years or as specified by Owner.
- vii. It shall be possible to dial-in any Video Conferencing (VC) site from the Divisional, Zonal Headquarters or any other locations or when ever desired with no extra hardware & software. LAN/WAN Connectivity for same shall be provided by Owner.

- viii. Every VC system shall be capable of getting connected over Ethernet network provided by Owner.
- ix. The power supply available at the locations shall be 230 V / 50 Hz AC \pm 10%. All modules of the video conferencing system should work using this power supply only. A UPS may be used for power backup for video conferencing equipment. UPS of suitable size shall be provided by the Bidder.
- x. All the cameras and other modules of video conferencing system shall be modular in construction. In case of up gradation of such modules in future, it shall be possible to upgrade them without replacing the entire system.
- xi. The system should have diagnostics facility for serial, video & network interfaces. System logging shall be possible either to a remote IP address or console port or on the system.
- xii. The supplier / manufacturer shall manufacture the equipment locally in India with international quality standards ISO 9001 for which the manufacturer shall be duly accredited. The quality plan describing the quality assurance system followed by the manufacturer shall be submitted.

S. No.	Description	Quantities
1	HIGH DEFINITION VIDEO CONFERENCING SYSTEM	1 set
2	Full HD 55 inches Professional Display Unit with built in speakers.	1 set
3	Standalone Video conferencing software for High quality audio, video and content sharing for PC/Laptop along with high resolution camera and USB powered speaker & Microphone.	1 set
4	6 Port Appliance based MCU	1 set
5	Minimum 6 KVA intelligent online UPS with 60 minutes Ni Cd battery backup.	1 set
6	Wall Mounting Bracket suitable for above display unit.	1 set
7	All required cables (with one spare set), erection hardware, etc	1 lot
8	Microphone in Conference room (Table mounted).	1 no. per user. (Total 25 users).
9.	External Speakers	2 nos.
10.	UPS Power Sockets & Station LAN/ Internet Communication Ports	1 set each

21.01.01 **High Definition Video Conference System**

S. No.	Specifications
1.	System

S. No.	Specifications
	<p>The proposed system must support PAL with a PTZ camera, microphone array with mute button on the mic, wireless remote control, etc. The codec must be based on industry standards wherever possible such as the H.323 and SIP umbrella standards for IP-based audio/video and H.320 umbrella standard for ISDN-based audio/video</p> <p>All the devices proposed should support 10/100/1000 mbps NIC port and IPV6 support.</p>
2.	Video Standards and Protocols
	Support for video protocols like H.261, H.263, H.263 ++, H.264, H.265
	Support for people + content using standards based H.239 and BFCP over SIP. Must also support audio from PC used for content sharing.
3.	Inputs (Video/Audio)
	1 input for connecting main HD camera
	1xDVI-I input for connecting PC/Laptop to share HD content
	1xMic input (quoted system should support upto 2 mic arrays)
	1xLine-Level stereo in (RCA)
	1x3.5mm stereo mini (PC Audio) i.e. for content audio
4.	Outputs (Video/Audio)
	HDMI / Full HD 1xDVI-I HD for connecting to main monitor
	HDMI / Full HD 1xDVI-I HD for connecting to 2nd monitor
	HDMI / Full HD 1xRCA for main monitor audio out or to external speaker system
	HDMI / Full HD 1xRCA for VCR/DVD player audio
5.	Network Interface
	Should have 2 port 10/100 auto NIC (RJ-45)
	The system must support H.323 and SIP at 4 Mbps and H.320 at 2 Mbps
	Serial Interfaces (V.35, RS449, RS530) upto 2Mbps
	QOS IEEE 802.1P/Q , Reconfigurable MTU Size, Lost packet recovery feature for H323 calls
	Support for NAT and firewall traversal
	Auto-Spid detection and line number configuration
	Support for Microsoft OCS 2007 integration, MS ICE and MS Lync
6.	Camera

S. No.	Specifications
	1/3" CMOS/CCD
	12x optical zoom, Auto Focus
	Upto 70 degree or more Horizontal Field of View
	Upto 40 degree or more Vertical Field of view
	Pan should be + 100 to - 100 degrees
	Must have tilt range of +20 to -30 degrees
7.	Video Resolution
	4SIF/CIF 30, 4SIF/CIF 60, SIF, CIF, QCIF
8.	Content Resolution
	Input: XGA, SVGA, VGA
	Output: XGA, SVGA at 30fps
9.	Audio Standard
	The system should support following audio standards and features
	22kHz bandwidth with crystal clear audio, stereo sound
	14kHz bandwidth with G722.1 Annex C
	7kHz bandwidth with G.722, G722.1
	3.4kHz bandwidth with G.711, G.728, G.729A
	Automatic Gain Control, Automatic Noise Suppression
	Keyboard noise reduction, Instant Adaptation Echo Cancellation
10.	Other Standards
	H.221, H.224/H.281, H.323 Annex Q, H.225, H.245, H.241, H.331, H.239, H.231, H.243, H.460, BONDING, Mode1, BFCP (RFC 4562)
11.	Security (Complying ISO 27000 standards)
	The system should support secure web, Telnet based access , Embedded AES, H.235V3 and H.233, H.234, Support for IPv6, NTLM authentication protocol.
	Remote monitoring of video through web interface, Far end camera control
	Directory services, System Management by web interface, SNMP, CDR
	Login access levels for web interface, whitelist feature for secure access i.e. list of IP addresses that can connect to codec over web interface.
	It should be possible to define the system access password policy, disable web based remote access, change default port 80 for web access for security reasons.
	Enable sessions list, Should be able to transfer logs manually and

S. No.	Specifications
	automatically to external USB storage device
	Support for IEEE 802.1X , H.235 Annex D
	Compatible to Cloud
	OWS alongwith PC/Laptop
	Calls recording management application & database management
Note: For each tabulated features, latest version/ standards as available at the time of supply shall apply.	

21.01.02 **TECHNICAL SPECIFICATIONS FOR 55" PROFESSIONAL DISPLAY.**

Display:

Screen size	55 inches (LED based)
Resolution	1920x1080 (16:9) 4K or better.
Brightness	700 cd/m2 minimum
Contrast ratio	3000:1 minimum
Pixel pitch	0.53025(H) * 0.53025(V)
Colours support	8bit – 16.7M

Signal Input:

Video Signal	Analog D-SUB, DVI-D, Display port, CVBS, HDMI1, HDMI2, S-Video inputs,
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Features:

Lamp error detection, Brightness sensor, Anti Retention, Temperature Sensor, /RJ45 MDC, Built in speaker(10W + 10W), Plug and Play (DDC2B), PIP/PBP, Video Wall(10x10), Pivot Display, Button Lock, Digital Daisy Chain, Smart Scheduling, Smart F/W update.

Software: As required

21.02.03 Stand alone Video conferencing software for High quality audio, video, and content sharing for PC/Laptop along with high resolution camera and USB Powered speaker& Microphone

Protocols Used	Audio	Video
• H.323	• 20KHz with G.719	• H.261, H.263, H.263+, H.264
• SIP	• 14kHz with Siren 14	• Multiple Monitor Support – must be supported by PC video card
• LDAP/H.350	• 7kHz with G.722, G.722.1	• Picture-In-Picture (PIP)
• AES-Media encryption	• 3.4kHz with G.711, G.728	Video Resolution
• H.460 Firewall Traversal	• Full Duplex Audio	• HD
Quality of Service (QoS)	• Echo Cancellation	• VGA (640x480) –

Protocols Used and experience –	Audio	Video
		High resolution webcam
<ul style="list-style-type: none"> • Error concealment for optimal experiences even over the public internet 	<ul style="list-style-type: none"> • Automatic Gain Control 	<ul style="list-style-type: none"> • Half-VGA (320x480)
<ul style="list-style-type: none"> • Network Address Translation (NAT) support 	<ul style="list-style-type: none"> • Automatic Noise Suppression (ANS) 	<ul style="list-style-type: none"> • CIF (352 x 288 pixels)
<ul style="list-style-type: none"> • Automatic gatekeeper discovery 	<ul style="list-style-type: none"> • Voice over IP (VoIP) 	<ul style="list-style-type: none"> • SIF (352 x 240 pixels)
<ul style="list-style-type: none"> • Configurable fixed port ranges 	Directory Services	<ul style="list-style-type: none"> • QCIF (176 x 144 pixels)
<ul style="list-style-type: none"> • Lip synchronization 	<ul style="list-style-type: none"> • Supports Global Address Book 	<ul style="list-style-type: none"> • QVGA (160 x 120 pixels) – Native Web camera resolution
Cameras Supported	<ul style="list-style-type: none"> • Support for Active Directory 	Content Video Resolution
USB 2.0 Web Cameras:	- LDAP through Global Address Book	<ul style="list-style-type: none"> • Show PC desktop as Content:
Microsoft® HD-5000	<ul style="list-style-type: none"> • Supports Local Address Book 	- Capture – Native resolution of computer desktop
Microsoft LifeCam Cinema™,	- Contact List	- Transmit and Receive – XGA (1024 x 768)
LifeCam HD-6000,	- Most Recently Called List	<ul style="list-style-type: none"> • 4CIF (704 x 576 pixels)
Logitech C100, C210,C310, C05	Dialing Capabilities	<ul style="list-style-type: none"> • CIF (352 x 288 pixels)
Logitech Webcam Pro 9000	<ul style="list-style-type: none"> • DNS alias 	Data
	<ul style="list-style-type: none"> • E.164 extension 	<ul style="list-style-type: none"> • H.323 Annex Q far-end camera control
	<ul style="list-style-type: none"> • IP address 	Security
	<ul style="list-style-type: none"> • H.323 external gatekeeper, gateway, and MCU support 	<ul style="list-style-type: none"> • H.235 v3 AES encryption
	<ul style="list-style-type: none"> • SIP URI 	
	Operating Systems:	
	<ul style="list-style-type: none"> • Windows 2000, XP, Windows Vista®, Windows 7/10/11 or latest version available 	
	Language Support	
	<ul style="list-style-type: none"> • English 	

21.02.04 **6 Port Appliance based MCU for central location**

6 port MCU Specs
The MCU shall be at least 1U or more provided with all the necessary accessories to integrate into a 19 inches or 23 inches rack.
The MCU shall operate on a non-Windows based operating system.
The MCU shall have 10/100/1000 Mbps Ethernet interface for IP communication.
The MCU shall support a dedicated serial/USB connection for maintenance/upgrade.
MCU must have AC Voltage range:100-240 VAC \pm 10%, 47-63 Hz
System Capacity
It should be a standalone multi point conferencing unit with support for 5 ports in Continuous presence (CP) at 4Mbps over IP from the day one with AES encryption.
Entire equipment should be rack mountable with clean wiring.
H.263, H.264,capability of delivering Up to 30 frames per second at 4CIF and CIF and SIF for Video & VGA, SVGA for content.
It must support 64 Kbps to 4 Mbps conference data rates.
There should not be any port loss while doing simultaneous conferences on MCU. All the end points should be able to show all the MCU features (H.239 data collaboration, etc) without any port loss.
H.261, H.263 H.264 video coding support
The MCU should support bandwidth management features from day one in order to have best performance at lower bandwidths.
The MCU shall be capable of supporting H323, SIP, and H.235 v3 at the same time. The MCU should support H.264 in H.323 & SIP conferences
The MCU should support H.239 and encryption
The MCU shall interoperate with multiple vendors' endpoints. The supported mediums should be IP v4 and IP v6.
The MCU shall support at least 30 frames per second on each port at video resolutions from QCIF up to SD.
The MCU shall support video codecs: H.261 (for legacy interoperability) and H.263, H.263++ and H.264.
The MCU shall support traditional audio codecs: G.711, G.719, G.722, G.723.1 and G.729, and high-fidelity audio codecs: MPEG-4 AAC-LC or MPEG-4 AAC-LD (20KHz audio) or equivalent and better.
MCU Features
The MCU shall support dual video H.239 and an additional feature to allow users to ping the address for network connectivity.
The MCU shall support aspect ratio of 16:9 and 4:3 as well as H.243/chair control.
The MCU shall support a mix of resolutions in both Voice Activated mode and Continuous Presence. Each endpoint shall receive at the maximum of its capacity

without reducing the capacity of another.
The MCU shall support an embedded management tool, scheduling and address book containing upto 3000 entries or more.
The MCU shall support management of MCU loggers by enabling, disabling & renaming them.
The MCU shall support user management by implementing strong password, aging rules for passwords, displaying login records, implementing maximum no. of concurrent user sessions and user session timeout etc.
The MCU shall support down-speeding and packet error/loss concealment methods to ensure optimum video and audio quality.
The MCU shall support H.320 through an embedded or external gateway without loss of capacity or functionality.
Dynamic CP layout adjustment (MCU will choose the best video layout according to the number of participants in the conference). Must support embedded site naming, Active speaker with border highlight and active speaker indication for active video participant.
The MCU shall support a direct link to an external recording server and video-on-demand solution.
The MCU should support distributed architecture with intellegent and automatic call routing.
The MCU must support native integration with Microsoft Exchange and Microsoft Outlook
The MCU should be able to register and authenticate with the Microsoft Lync server, as well as an H.323 gatekeeper
Conferences and Scheduling
The MCU shall support conferences that permanently exist but use no resources if no participants are in the conference.
The MCU shall support an embedded reservation plug-in for scheduling calls without need for external scheduler.
The MCU shall provide a built-in Web server, for configuration and administration. Localized language shall be supported. A client based plug-in must be supported for secure communication additionally.
The MCU shall support various user privileges from administrator to simple guest.
The MCU shall have a built-in address book and built-in scheduling.
The MCU shall support scheduled conferences and ad hoc conferencing mode at the same time.
The MCU shall support a predefined and unique PIN for each conference.
The MCU shall allow users to create conferences on the fly from their endpoints without the need of an operator and PC.
The MCU should support User and managed mute control, DTMF support, Echo and keyboard noise suppression, Echo cancellation.
The MCU shall allow different audio and video settings on individual conference

basis i.e. different conferences with different profiles must exist simultaneously.
The MCU shall support resolutions like QCIF, CIF, 4CIF, VGA, SVGA.
The MCU shall transcode video and audio on all ports, without loss of port count, regardless of bitrates (128Kbps to 4 or more Mbps), resolutions or codecs that endpoints connect with.
The MCU should have easy to use tool on the GUI to adjust video and audio resources which should get activated without restarting the MCU.
The MCU shall allow participants to change the layout they see using their endpoint's remote control. This shall not affect the layout that anyone else sees.
The MCU shall support forcing the video to all the connected endpoints in PAL or NTSC standard.
The MCU shall support self-view when in a continuous presence layout. It shall be able to turn this on or off.
The MCU shall allow the operator of a conference to define a custom layout per conference and per participant, thus customizing global layouts or personal layouts and deciding how the conference is seen on the terminals' displays.
It should be possible for the operator to move the participants from one CP conference to another, this activity must be available in the call details recorded in the MCU.
Conference Features
The MCU must support following conference features:
• Must be able to see 16 sites in Continuous Presence Layout or higher
• Must support minimum 30 conference layouts
• Must provide option for Personal layout
• Must support Auto layout
• Choose site to see
• Provision to choose from multiple Layout skins
• Lecture and presentation mode
• Must support Roll call feature during the conference
• Must support multiple Conference profiles
• Conference templates
• Gathering Slide, Customized Welcome Slide
• Far-end camera control (FECC) H.224/H.281, H.323 annex Q and SIP FECC
• Conference dial out and dial in
• Advanced IVR flow
• Must have support for both message overlay and closed caption
• Must allow conference participants to perform certain actions like mute/unmute, recording start/stop, enable roll call/disable roll call, terminate conference, secure/unsecure a conference using the remote control of video system.

• Conference chairperson
• Customizable GUI
• Speaker Notification
• Unlimited Simultaneous Conferences (up to maximum MCU port level)
• Auto termination of conference should be supported when Chairperson or Last Person Leaves
• Conference Templates for up to 1000 virtual conference rooms
• Must have Operator Assistance Option which allow user with required assistance by operator for conferencing application.
Network and Security
The MCU shall support AES encryption using H.235 V3 for every participant without affecting any other feature, functionality or port count. AES Encryption should be provided with 256 bit Key Size, making it the strongest encryption standard
The MCU shall have 3 settings per conference for encryption: Required, Optional and off
MCU should have strong password policy which can maintain password`s history check and their expiration time.
The MCU must support separation of management and media networks.
The MCU must support TLS for SIP
QoS - Diffserve, IP Precedence. The MCU must provide standards based on method of compensating and correcting for packet loss of media streams.
End to end solution should be from same OEM to avoid any interoperability issues. The MCU should be interoperable with endpoints of different make especially the legacy systems.

- 21.03.00 All software user licenses shall be valid for entire life of power plant. User should not have to pay any recurring licenses fee during the usage period of the system.
- 21.03.01 All the cameras and other modules of video conferencing system shall be modular in construction. In case of up gradation of such modules in future, it shall be possible to upgrade them without replacing the entire system.
- 21.03.02 The system should have diagnostics facility for serial, video & network interfaces. System logging shall be possible either to a remote IP address or console port or on the system.
- 21.03.03 All core components of video conferencing system like camera, codec, MCU, Gateway, Gatekeeper and embedded software should be from same manufacturer.
- 21.03.04 Original Equipment Manufacturer (OEM) of video conferencing system shall have established manufacturing facility or office in India and their authorized representatives shall have service facility in India.

21.03.05 All software and firmware upgrades shall be free of cost for entire life of power plant.

21.04.00 **Recording and Streaming Server**

Application Features:

- It shall record single point or multipoint conferences with full BFCP content capture.
- It shall have high definition (HD) support with 1080p & 720p with H.264 video coding.
- It shall have high capacity recording for 5 recording simultaneous sessions.
- It shall support playback of video content from endpoints or web browsers.
- It shall have BFCP standards-based for use with conferencing systems.

Audio/Video Support:

- It shall support Video Resolutions: Upto HD 720p 30fps.
- It shall have audio support: G.711, G.722, G.722.1 / G.728 / G.729, Annex C.
- It shall record in Window Media (WMV) or MP4 video formats.

Recording:

- It should support 7 concurrent video conferencing recording sessions with full video, audio and content.
- It shall record audio/video at varying bit rates – 128 kbps to 4 Mbps.
- It shall support recording in resolution up to 1080p. It shall record stereo calls in single point and multipoint calls.
- It shall be configurable recording templates to specify multiple bit rates for streaming/ recording, video file formats and content options.
- It shall record presented content through BFCP standard.
- It shall have IVR support to provide users verbal/visual indicators of status (recording, pause, etc.) or any other equivalent method.
- It shall support multiple methods for recording – direct from a video endpoint, MCU/bridge or from the admin user interface.

CHAPTER – 22**COMMUNICATION SYSTEM****22.01.00 INTENT OF SPECIFICATION**

- 22.01.01 This specification is intended to cover the design, manufacture, assembly, testing, supply and delivery, properly packed for transport for site of telephone system, complete with all materials & accessories for efficient and trouble free operation. The scope of work shall also include detail engineering, complete installation, testing, commission and putting into successful commercial operation of the telephone system inclusive of it supply of all labor, tools, implements and supply.
- 22.01.02 The technical specifications that follow serve as the guide specification for the Telephone Systems Interfaces with external systems and off site units are also addressed. Plant Communication System shall comply with the latest norms and standards in line with latest communication generation protocol at the time of supply.
- 22.01.03 In conformity with the guidelines provided in the specification, the scope of works shall completely cover all the Telephone Systems, functions, activities and documentation specified under the accompanying Technical Specifications. It will include but not limited to the following:
- (a) Detailed design and engineering of the manufactured equipment; system integration and system engineering.
 - (b) Complete manufacture including shop testing.
 - (c) Specifying, procurement, quality inspection of bought-out items from sub-suppliers. Design co-ordination for and integration with bought-out items with sub-suppliers.
 - (d) Providing engineering drawings, documents, licensed copy of software and developmental tools, data, instruction, operation and maintenance manual etc. for Owner's review/approval/record.
 - (e) Arranging for Owner's inspection and testing of manufactured as well as bought-out items at the respective works.
 - (f) Packing and transportation of instruments, equipment, accessories and erection hardware from the manufacturer's works to the site, including transit insurance.
 - (g) Receipt, storage, preservation and conservation of instruments, equipment and erection hardware at the site.
 - (h) Fabrication of site-constructed items.
 - (i) Pre-assembly (if any), erection, testing and commissioning of all the equipment and instruments in totality (including erection hardware, accessories/devices etc).
 - (j) Prepare and submit all approved and as-built drawings both in hard and soft copies.

- (k) Furnishing of spares, tools and tackle, test instruments.
- (l) Fulfilling post-commissioning liabilities.
- (m) Arranging for training of Owner's personnel of different categories.
- (n) Other activities detailed in the previous and subsequent sections of the Specification.
- (o) Any other activity, not mentioned explicitly, but felt by Bidder as essential for successful completion of work.

22.01.04 The requirements enumerated in this specification are based on typical configuration of the plant for bidding purpose. It shall be the responsibility of Bidder to interact with other agencies and package vendors during the time of detail engineering and installation and offer the Telephone Systems to meet the actual functional requirements of the plant.

22.01.05 It is not the intent to completely specify all details of design and construction features herein. Nevertheless, the equipment and their installation shall conform to high standards of engineering design and workmanship in all respects

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

22.02.00 **SCOPE OF WORK**

22.02.01 **SCOPE OF SUPPLY**

22.02.01.01 **TELEPHONE SYSTEM**

The equipment and materials shall include but not be limited to

- (a) a) One (1) no. 300 lines Microprocessor based Digital Electronic Private Automatic Branch Exchange (EPABX) for the entire Unit such as Main Plant, Coal Handling Plant, Ash Handling Plant, Plant Water System, CW & ACW System, FGD, switchyard and the fuel oil transfer system Marshalling panel, capable for expansion up to 500 lines with 16 P&T lines, 8 digital lines, 8 tie lines, with necessary Operator Console associated printer, Main Distribution Frame (MDF) for the exchange etc. EPABX system shall be DIGITAL ISDN IP enable system. The system should be true ISDN digital switch with all types of connectivity like E1, E&M, BRI, PRI, V- SAT, Internet etc. The Exchange will be located at ground floor of service building and also interface with Plant PA System.
- (b) Three Hundred (300) nos. Telephone sets as listed elsewhere in this specification.
- (c) Supply and installation of all necessary hard wares such as cables, junction box, telephone hand sets, conduits, sockets, matching plugs, etc. are under the scope of this Package.
- (d) OWS based operator console with required peripheral such as monitor, printer etc.

- (e) Sub-distribution frame.
- (f) Grounding material & connection
- (g) Special tools & tackles
- (h) UPS with battery for minimum 1 hour backup.
- (i) Any accessories, equipment, not specifically mention above but required for completion of the system.
- (j) Mandatory spares.
- (k) All relevant drawings, data and instruction manuals.

22.02.01.02 The EPABX shall have full self diagnostic. All faults besides being annunciated by high intensity LED on the EPABX and audio alarm shall also be displayed on the OWS indicated in clause (l) above with component level fault being displayed in plain English.

22.02.01.03 The cables shall be suitable for ISDN, DTMF, FAX etc. and shall generally conform to the requirements specified else where in this specification.

22.02.01.04 System shall be made for interfacing the Raw water intake Pump house communication system (UHF), any other remote area and PLCC.

Unit Public Address System (PAS) shall cover all operational areas of generating unit from transformer yard to I.D. Fans. PAS for coal handling plant shall cover all its operational areas from wagon tipplers to bunker filling floor of all units.

The common Plant PAS shall be provided to link all Control Rooms, Shift In-Charge Room, D.G. Room, Compressor House, Fuel-Oil Pump House, Water Treatment System Control Room, Ash Handling Plant Control Room, CHP Control Room and other off-site/auxiliary buildings distributed throughout the plant area.

The Bidder is advised to refer to the general layout plan for understanding the relative location of various system/requirement etc.

22.02.01.05 For specification of UPS & battery being used in communication system please refer Cl. 7.01.05 (A) of Vol V, Part B, Chapter 7. No battery health monitoring system is to be supplied with the UPS.

22.02.02 **SCOPE OF SERVICE**

22.02.02.01 Carrying out detail engineering, preparation and submission of all drawings as specified elsewhere in this specification including preparation and submission of area wise bill of materials, layout and erection drawings showing location of all system equipment and components, cable tray/ rack and conduit routing.

22.02.02.02 Installation and Commissioning of the Telephone system including laying of the cables, furnishing of all labors (skilled and unskilled), supervisory personnel, erection tools and tackles, testing equipment, implements, supplies, consumables & hardware and transport for timely and efficient execution of the contract work. The Plot Plan shall be referred for estimation of cable. Training to be provided to personnel for maintenance.



22.03.00 **GENERAL REQUIREMENTS**

22.03.01 **CODES AND STANDARDS**

22.03.01.01 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS), Indian Post & Telegraph Departments Standards (ITD) except where modified and/ or supplemented by this specification.

22.03.01.02 Major standards, which shall be followed, are listed below. Other applicable Indian standards for any component part, even if not covered in the listed Standards, shall be followed:

- | | | |
|-----------------------------|---|---|
| IS 13947(Part 1):2004 | : | Low-voltage switchgear and controlgear: Part 1 General rules (superseding IS 2147 & 4237) |
| IS 13947(Part 2):1993 | : | LV Switchgear and controlgear: Part 2 Circuit breakers (superseding IS2516 & its parts) |
| IS 13947(Part 3):1993 | : | Low-voltage switchgear and controlgear: Part 3 Switches, disconnectors, switch-disconnectors and fuse combination unit (superseding IS 4064 (part 1 &2) |
| IS 13947 (Part 4/Sec1) 1993 | : | Low-Voltage switchgear and controlgear: Part 4 Contactors and motor starters,Section 1 Electromechanical contactors and motor starters[superseding IS 2959 and 8544 (all parts)] |
| IS 13947 (Part 5/Sec1) 2004 | : | Low-voltage switchgear and controlgear: Part 5 Control circuit devices and switching elements, Section 1Electromechanical control circuit devices (first revision){Superseding IS 6875 (All parts)} |
| IS 5831:1984 Nov 2011 | : | IEC 60502:1983 PVC insulation and sheath of electric cables (first revision) |
| IS 694:2010 | : | Polyvinyl chloride insulated sheathed and unsheathed cables with rigid and flexible conductor for rated voltages upto and including 450/750 V : Part 1 General requirements (fourth revision) |
| IS 694:1990 Feb 2010 | : | IEC 60227-1to5:1979 PVC Insulated cables for working voltages upto and including 1100 V (Third revision) |
| IS 1554(Part 1):1988 | : | PVC insulated (heavy duty) electric cables: Part 1 For working voltages upto and including 1100 V (third revision) IEC 60502:1983 |
| IS 1554(Part 2):1988 | : | PVC insulated (heavy duty) electric cables:Part 2 ForIEC 60502:1983 working voltages from 3.3kV upto and including 11 kV (Second revision) |
| IS 3961(Part 1) | : | 1967 Recommended current ratings for cables: Part 1 Paper insulated lead sheathed cables |
| IS 3961(Part 2) | : | 1967 Recommended current ratings for cables: Part 2 PVC insulated and PVC sheathed heavy duty cables |
| IS 3961(Part 3) | : | 1968 Recommended current ratings for cables: Part 3 Rubber insulated cables |

- IS 3961(Part 5) : 1968 Recommended current ratings for cables: Part 5 PVC insulated light duty cables.
- IS 9537(Part 1):1980 : Conduits for electrical installations: Part 1 General IEC 60614-1(1978) requirements
- IS 8130:1984 : Conductors for insulated electric cables and flexible cords
- * IEC 60228:1978 : (first revision)
- IEC 268 & ITU-T CCITT standard Indian Post & Telegraph Departments Standards (ITD) except where modified and/or supplemented by this specification.

22.04.00 **DESIGN CRITERIA**

- 22.04.01 The EPABX should be fully digital and should employ Stored Program Control (SPC) using Pulse Code Modulation (PCM) and Time Division Multiplexing (TDM), confirming to latest ITU-T (earlier CCITT) standards.
- 22.04.02 The system shall be 100% non-blocking.
- 22.04.03 The Central Processing Unit (CPU) of EPABX should use 32-bit or more as available at the time of supply microprocessor with system memory on a MMC card and not on EPROM or a floppy disc drive.
- 22.04.04 The System should have Integrated Modem on the central motherboard for remote maintenance.
- 22.04.05 Exchange shall be connected to OWS for exchange administration and call billing. Necessary software for exchange administration and billing shall be provided by Bidder. OWS is in Bidder scope.
- 22.04.06 The system should be suitable to accommodate both Decadic Pulse (DP) and DTMF telephones. The system should support outgoing DTMF transmission even from Digital phones.
- 22.04.07 The system software should be protected against loss/alteration of memory due to power failure, unauthorized command or any other faulty condition.
- 22.04.08 The system should work with any type of public exchange or similar network to which it will be connected without requiring any modification in networks. It should be possible to network with exchanges of different makes/technologies using either E & M lines or ISDN BRI/PRI lines.
- 22.04.09 The system should have a modular design for further expansion of hardware.
- 22.04.10 The equipment should have flexibility to add/delete/modify service features and other facilities without requiring extensive modification. These changes should be possible via a Digital phone.
- 22.04.11 The EPABX System shall have the interfacing capability with Plant Intercommunication System.

22.05.00 **SYSTEM CONCEPT**

- 22.05.01 The telephone exchange shall be microprocessor based digital electronic private automatic branch exchange for industrial telephone communication



system. The exchange shall have the facility to connect P&T, TRUNK, ISDN, PRI/BRI lines.

- 22.05.02 The exchange shall have the facility to connect broadband, data terminal, facsimile, multifunctional telephone, computers, video conference etc. without changing the control cords or system software.
- 22.05.03 The supply and installation of necessary cables, conduits and other accessories, as required in the aforesaid areas shall be under scope of this package. In order to have a complete coverage for the areas, the Bidder shall be free to install Sub Distribution Frame (SDF) at a number of strategic locations so that the areas near the SDF shall be covered by laying the cables from the corresponding SDF.
- 22.05.04 Supply and installation of the subscriber handset stations with all other accessories, for efficient and trouble free operation of the EPABX system for all the stated areas shall also be under the scope of this package. Further, the Bidder shall supply and install the necessary cables, conduits and other accessories as required.
- 22.05.05 The Bidder shall supply and install the necessary cables, conduits and other accessories as required to run the system successfully.
- 22.05.06 The Bidder shall provide facility for connection to PLCC (power line carrier communication) system.

22.06.00 **TECHNICAL DATA OF EPABX AND OTHER ASSOCIATED EQUIPMENT**

22.06.01 **EPABX**

- | | | | |
|-----|----------------------|---|-----------|
| (a) | Make | : | By Bidder |
| (b) | Type/ Model No. | : | By Bidder |
| (c) | Connecting lines | : | 300 |
| (d) | P & T lines | : | 16 Trunk |
| (e) | No. of Tie lines | : | 8 |
| (f) | System configuration | : | DUPLEX |
| (g) | System features | : | As under |

- (i) The system should have a battery backup of at least 100 hours for the office data memory.
- (ii) The system should be able to restart automatically without human intervention when the external AC power supply is resumed after complete power failure i.e. even after the batteries are discharged.
- (iii) The System should have Integrated Modem on the central motherboard for remote maintenance.
- (iv) There should be an LED indication on each card, which can help determine the status of the card.
- (v) The system should be suitable to accommodate both Decadic Pulse (DP) and DTMF telephones. The system should support outgoing DTMF transmission even from Digital phones.

- (vi) It should be possible to remove and put back line or trunk cards from the system even in online condition.
- (vii) The system software should be protected against loss/ alteration of memory due to power failure, unauthorized command or any other faulty condition.
- (viii) The system should work with any type of public exchange or similar network to which it will be connected without requiring any modification in networks. It should be possible to network with exchanges of different makes/technologies using either E & M lines or ISDN BRI/PRI lines
- (ix) The exchange shall accept different types of trunk signaling such as:
 - EDSS1/1TR6 for ISDSN BRI and PRI
 - Ringdown
 - 2W/4W E & M signaling, Type 1 to Type 5
 - Analog C.O.Lines
 - DTMF Signaling
- (x) The exchange should be suited to work on an AC mains supply of 240V with a tolerance of +10V and -15V.
- (xi) The system should be ventilated by conventional airflow. No cooling fans should be used in any part of the EPABX cabinet.
- (xii) The system should have a modular design for further expansion of hardware.
- (xiii) The equipment should have flexibility to add/delete/modify service features and other facilities without requiring extensive modification. These changes should be possible via a Digital phone.
- (xiv) The system should have emergency transfer facility to automatically route the C.O. lines to predefined extensions in case of power failure.
- (xv) The system should support simultaneous voice and data capability over the same single pair telephone cable in (2B+D) ISDN BRI format. The system shall also support PRI ISDN in (30B+D) Format.
- (xvi) The system should support Voice processing applications such as Voice Mail, Auto attendant.
- (xvii) The extensions, both analog and Digital phones, should be able to initiate a 5 party conference with up to 4 external parties
- (xviii) System should also support up to 6 simultaneous 5 party conferences.
- (xix) The system should have integrated Modem for remote maintenance, The system should also support LAN based remote maintenance

- (xx) The system should support centralized system administration using SNMP (Simple Network Management Protocol)
- (xxi) Status of tie lines (blocked/unblocked), status of individual extension/group should not be alter due to power failure/system reset.
- (h) Float cum Boost Charger - Power Supply
 - (i) Power requirement sat 415V: kVA (To be decided by the Bidder)
 - (ii) Type of Battery for Emergency supply: 24V/ Ah, Ni-Cd type

22.06.02 MAIN DISTRIBUTION FRAME (MDF)

- (a) Make & Type : To be decided by the Bidder
- (b) Material const. : SS304 Sheet steel, closed type wall mounted
- (c) Number of lines : 500
- (d) Deg. of protection : IP 54
- (e) Dimension : To be decided by the Bidder

22.06.03 SUB-DISTRIBUTION FRAME (SDF)

- (a) Make & Type : To be decided by the Bidder
- (b) Material const. : SS304 Sheet steel, closed type wall mounting type
- (c) Number of ways : 100 pair & 50 pair
- (d) Deg. of protection : IP 54 for indoor & IP 55 for outdoor
- (e) Dimension :
 - (i) For 100 pair : 305 x 216 x 76 mm
 - (ii) For 50 pair : 205 x 216 x 76 mm

22.06.04 JUNCTION BOXES

- (a) Make & Type : To be decided by the Bidder
- (b) Material cons. : SS304 Galvanized sheet steel, closed wall mounting type
- (c) Number of ways : 20 pair & 10 pair
- (d) Deg. of protection : IP 65
- (e) Dimension : 165 x 114 x 76 mm

Note:

Other details for JB's / Enclosures/ Distribution Boxes shall be same as per Chapter-9.

22.06.05 CABLES

- (a) Cables for outdoor area: Jelly filled cable. Diameter is 0.63 mm, 650 V grade
 - (i) No. of pair : 100, 50, 20, 10 & 5 pair
 - (ii) Conductor : Solid annealed Cu (single/0.63mm)

- (iii) Insulation : Polythene, Class - C
 - (iv) Screening : Poly Aluminium
 - (v) Inner sheath : LDPE Black
 - (vi) Outer sheath : LDPE Black
 - (vii) Armour : Galvanized Steel Tape/ Wire
- (b) Cables of Indoor area: PVC, tinned cu conductor, 650 V grade
- (i) Conductor : Annealed tinned cu (one/0.60)
 - (ii) Insulation : PVC
 - (iii) Inner & Outer Sheath : PVC compound TM2
 - (iv) Armour : Galvanized steel wire
- (c) Cables for wiring at Subscriber's end Twin core flat Cu cable. 50 V grade.

22.06.06 **Battery & Charger**

- (a) Battery : Ni-Cd
- (b) Ah capacity : Ah (To be decided by the Bidder and as approved by owner)
- (c) DC voltage : 24V
- (d) Charger : Float cum Boost
- (e) Rating : 24V/Ah (To be decided by the Bidder and as approved by owner)

Note:

Other details for Battery & charger shall be same as per Vol-5, Part-B, Chapter-7, UPS System & 24 V DC System.

22.07.00 **SPECIFIC REQUIREMENTS - SUPPLY**

22.07.01 **TELEPHONE SETS**

22.07.01.01 Telephone sets shall be of the following types :

- (a) Desk Top push button operated Decadic type (ordinary) – "Type-X".
- (b) Desk Top push button operated Decadic type with 10 number memory storage – "Type-Y".
- (c) Desk Top Rotary type – "Type-Z".

22.07.01.02 All telephone sets shall be suitable for use with digital EPABX system.

22.07.01.03 Desktop push button operated Decadic type (ordinary) (Type-X) telephone sets & Desktop push button operated Decadic type with 10 number memory storage (Type-Y) telephone sets shall be mounted on desktop. Desktop Rotary type (Type-Z) telephone sets shall be mounted on teak wood stands painted black and fixed on to wall/column/structure.



- 22.07.01.04 Telephone sets shall be compact. The body of the telephone sets shall be of injection moulded plastic for strength & durability. The body of the telephone sets shall be available in different colors.
- 22.07.01.05 Telephone sets shall provide for side tone balance, impedance level matching, and protection against surges, transients etc.
- 22.07.01.06 Desk top push button operated Decadic type ordinary (Type-X) and with 10 number memory storage (Type-Y), shall have features like tone ringer, last number redial facility etc. Desk top push button operated Decadic type with 10 number memory storage (Type-Y) shall have in addition, features for storage & recalling of 10 telephone numbers.
- 22.07.01.07 Desk top rotary type (Type-Z) telephone sets shall be dial type conventional telephone sets with direct dialing facility.
- 22.07.01.08 All telephone sets shall be suitable for Decadic signaling.
- 22.07.01.09 The microphones and receivers of telephone sets shall be of electromagnetic /piezoceramic type. Carbon microphones are acceptable only for Desktop Rotary type (Type-Z) telephone sets.
- 22.07.02 Main Distribution Frame (MDF), Sub-Distribution Frame (SDF) and Junction Boxes
- 22.07.02.01 The MDFs, SDFs and junction boxes shall be sheet steel enclosed, corrosion resistant, dust and weather proof complete in all respects with inspection covers, terminal strips etc. The covers shall be gasketed.
- 22.07.02.02 The MDFs shall be of minimum 14 SWG M.S. sheet enclosed over suitable angle iron frame work, base channel etc. The MDFs shall be installed indoor. The MDFs shall be complete with requisite number of test jack assemblies. All incoming & outgoing telephone cables to/from MDF in the telephone Exchange room for the subject EPABX type exchange shall be terminated on the MDF in Telephone Exchange Room for which suitable connecting facilities shall be provided on the MDF in Telephone Exchange Room.
- 22.07.02.03 The SDFs & Junction Boxes shall be of minimum 14 SWG M.S. sheet enclosed over suitable angle iron framework with base channel, pedestals etc. as required for outdoor installation.
- 22.07.02.04 Numbering/identification in Main Distribution Frame (MDF), Sub- Distribution Frames (SDF), Tag Blocks and distribution pillar boards shall be carried out by the Bidder.
- 22.07.02.05 MDFs shall be provided with all necessary protection arrangement, such as, over voltage, over current surge arrestors etc.
- 22.07.02.06 MDFs shall be suitable for bottom entry of cables and the MDFs shall have removable type cable gland plates at the bottom for cable entry.
- 22.07.03 **SOCKETS, MATCHING PLUGS FOR CONNECTION OF TELEPHONE SETS**
- 22.07.03.01 Heavy duty, flush mounting, indoor type, 2 pin sockets shall be furnished in Control Equipment Rooms, Unit Control Rooms & other areas/control rooms & various rooms of Technical Office Building. Concealed type conduit wiring for each telephone set for above areas/rooms shall be terminated to the 2 pin socket to which the respective telephone set shall be connected through matching plugs.

22.07.03.02 Heavy duty, wall/column mounted, outdoor weatherproof type 2 pin sockets, metal clad, gasketed construction, screwed metal cover tied to it by a metal chain, 20mm conduit entry, suitable for both indoor & outdoor installation shall be furnished. Telephone lines shall be terminated to these sockets to which telephone sets "Type-Z" with 5 meters of coupling cables (telephone cables) terminated on matching plugs can be connected.

22.07.04 **NAMEPLATE**

Nameplates shall be furnished for identification of devices and circuits. All switches, controls and indications shall be permanently and legibly marked in English as to their functions.

22.07.05 **TROPICAL PROTECTION**

22.07.05.1 All equipment, accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects and corrosion.

22.07.05.02 Screens of corrosion resistant material shall be furnished on all ventilating louvers to prevent the entrance of insects.

22.07.06 **PAINTING**

22.07.06.01 All steel surfaces of all equipment enclosures shall be sand blasted, grounded and pickled as required to produce a smooth, clean surface free of scale, grease & rust.

22.07.06.02 After cleaning, the surfaces shall be given a phosphate coating followed by two coats of high quality primer and stoved after each coat.

22.07.06.03 Equipment enclosures shall then be finished with two coats of synthetic enamel paint of approved shade. For the battery charger enclosure, the synthetic enamel paint shall be RAL 7032 for external & Brilliant White for internal.

22.07.06.04 Sufficient quantity of touch-up paint shall be furnished for application at site.

22.07.07 **SAMPLES**

Owner reserves the right to call for samples if considered necessary and the same shall be submitted by the Bidder free and without any obligation.

22.08.00 **SPECIFIC REQUIREMENTS – SERVICES**

22.08.01 **RESPONSIBILITY OF ERECTION**

22.08.01.01 The Bidder shall be fully and finally responsible for proper erection, safe and satisfactory operation of plant and equipment to the entire satisfaction of the Owner.

22.08.01.02 If in the opinion of the Bidder any work is insufficiently specified or require modification, the Bidder shall refer the same in writing to the Owner and obtain his instruction/ approval before proceeding with the work.

22.08.01.03 If the Bidder fails to refer such instances any excuse for the faulty erection, poor workmanship or delay in completion shall not be entertained.

22.08.01.04 Equipment and material which are wrongly installed shall be removed and re-installed to comply with the design requirement at the Bidder's expense, to the satisfaction of the Owner.

22.08.02 **SUPERVISION**

22.08.02.01 The Engineer shall have the overall responsibility for coordination of Bidder's work and his direction shall be final.

22.08.02.02 Such direction and supervision however shall not relieve the Bidder of his responsibility of correctness and quality of workmanship and of other obligation under the contract.

22.08.03 **DRAWINGS**

22.08.03.01 The Bidder shall prepare and furnish to the Owner for approval, layout and erection drawings showing location of all system equipment & components, cable routing in cable trays/racks/ trenches/buried underground, conduits routing along with distribution schemes of the system.

22.08.03.02 After installation, the Bidder shall furnish to the Owner "AS BUILT" layout and erection drawings along with distribution schemes of the system properly incorporating changes/alterations/field modifications, if any, as carried out at field.

22.08.03.03 Such revisions, corrections, shall not be considered to change the scope of work.

22.08.04 **CONSUMABLE AND HARDWARE**

22.08.04.01 The Bidder shall furnish all consumables, hardware and erection materials as required for the completed installation.

22.08.05 **METHODS, MATERIAL & WORKMANSHIP**

22.08.05.01 All work shall be installed in a first-class, neat and workmanlike manner by mechanics/electricians skilled in the trade involved.

22.08.05.02 The erection work shall be supervised by competent supervisors holding relevant supervisory license from the Government.

22.08.05.03 All details on installation shall be electrically and mechanically correct.

22.08.05.04 All materials shall be new, of best quality and standard products of reputed make. Such materials shall be got approved by the Owner before their use.

22.08.05.05 All equipment and connections shall be installed in such a manner as to preserve access to any other equipment installed.

22.08.06 **PROTECTION OF WORK**

22.08.06.01 The Bidder shall effectively protect his work, equipment and materials under his custody from theft, damage or tampering.

22.08.06.02 Finished work where required shall be suitably covered to keep it clean and free from defacement or injury.

- 22.08.06.03 For protection of his work Bidder shall provide fencing and lighting arrangement, connect up space heaters and provide heating arrangement as necessary or directed by the Owner.
- 22.08.06.04 Bidder shall be held responsible for any loss or damage to equipment and material issued to him until the same is taken over by the Owner according to contract.
- 22.08.07 **SAFETY MEASURES**
- 22.08.07.01 All safety rules and codes applicable to the work shall be followed without exception.
- 22.08.07.02 All safety appliances and protective devices such as safety belts, hand gloves, aprons, helmets, shields, goggles etc. shall be provided by the Bidder to his personnel.
- 22.08.07.03 The Bidder shall provide guards and permanently display caution notice if access to any equipment/area is considered unsafe or hazardous.
- 22.08.08 **CO-OPERATION**
- 22.08.08.01 The Bidder shall at all times work in close co-ordination with the Owner's supervising personnel and afford them every facility to become familiar with erection and maintenance of the equipment.
- 22.08.08.02 The Bidder shall submit in advance his erection programme clearly indicating items of work, their sequence and estimated completion time for each item of work.
- 22.08.08.03 The Bidder shall start erection only after obtaining Owner's approval of his programme and shall adhere to this approved programme as far as practicable.
- 22.08.08.04 If for any reason the work is held up, the Bidder shall bring it to the attention of the Owner in writing without any delay.
- 22.08.08.05 To ensure completion within stipulated time, the Owner shall have the right to instruct the Bidder to increase manpower and/or working hours per day and/or tools & tackle, and the Bidder shall comply with such instruction forthwith.
- 22.08.09 **ERECTION TOOLS AND TACKLE**
- 22.08.09.01 The Bidder shall provide all tools, tackle, implements, scaffoldings, ladders, etc. which are required for handling and erection of the equipment and materials.
- 22.08.10 **TESTING EQUIPMENT**
- The Bidder shall provide checking and testing equipment as required.
- 22.08.11 **CABLING/WIRING**
- 22.08.11.01 Distribution of telephone system shall be done by cables generally laid on ladder type cable trays.
- 22.08.11.02 In the buildings and areas where ladder type cable trays will be available 15 meters of telephone cables, however, shall be run through conduits from the

nearest available cable trays to individual telephone sets and group of telephone sets, junction boxes, sub-distribution frames etc. depending on the location of telephone sets for termination & connection.

22.08.11.03 In the buildings and areas where, cable trays are not available for distribution of Telephone cables average 100 meters of telephone cable shall be run through conduits for termination & connection of each telephone sets within the buildings/areas from the entry point of cabling to such buildings and areas.

22.08.11.04 In the cases of telephone cables for entering a particular building/area, where cable trays are not available, for a part of the main cable running outside the building, the telephone cables shall be laid directly buried underground for that part.

For telephone cables laid on ladder type cable trays, the telephone cables shall be clamped at an interval of 300 mm.

22.08.11.05 For telephone cables run through conduits, the telephone cables shall be drawn through conduits fixed along wall/column. Conduits shall be installed as per relevant IS code. Conduit supports shall be provided in the conduit runs at an interval of 1000 mm for horizontal runs and 750 mm for vertical runs. All conduits, junction/pull boxes shall securely fixed and grounded.

22.08.11.06 For Telephone cables laid directly buried underground, the telephone cables shall be laid by excavating trench in normal soil up to a depth of 1 meter unless otherwise specified, providing 75 mm of sand or riddle earth both above and below cable, providing precast concrete slab on top and bricks on sides for cable protection against damage and back filling. The precast concrete slabs on top as specified above shall be marked "Telephone Cable".

22.08.11.07 Straight through joints in underground cables shall be avoided. The cables shall be terminated through tag blocks fitted inside outdoor type completely weatherproof junction boxes.

22.08.11.08 Distribution of communication system in Unit Control Rooms, Control Equipment Rooms, DAS Rooms, Shift Charge Engineer Rooms, SWAS Rooms, ESP Control Rooms, other areas/Control Rooms and various rooms of Technical Office Building shall be through concealed cabling which may be effected by running telephone cables through PVC pipes concealed in the walls. The telephone cabling & wiring in each such rooms & areas shall be terminated to two pin sockets, to which respective telephone sets shall be connected with matching plugs.

22.08.11.09 In all the Telephone Cables, out of total number of pairs 20% pairs shall only be utilized considering the requirement of various equipment, items, components of the Telephone System to be supplied & erected and also the provision for future as specified & balance 20% pairs shall be kept as spare.

22.08.11.10 Underground buried cables shall be jelly filled type.

22.09.00 **INSPECTION AND TESTING**

22.09.01 On completion of erection work, the Bidder shall request the Owner for inspection and tests.

- 22.09.02 The Owner shall arrange for joint inspection of the installation for completeness and correctness of the work. Any defect pointed out during such inspection shall be promptly rectified by the Bidder.
- 22.09.03 The installation shall then be tested and commissioned in presence of the Owner and put on trial run for stipulated contract period.
- 22.09.04 All rectification, repair or adjustment work found necessary during inspection, testing, commissioning and trial run shall be carried out by the Bidder without any extra cost.

22.10.00 **DRAWINGS, DATA AND MANUALS**

22.10.01 **TO BE SUBMITTED WITH THE BID**

- a) A block diagram of the system offered with a brief write-up on operation.
- b) Bill of Materials
- c) Cable connection diagram of all system equipment & components of the whole system clearly indicating cable sizes, number of pairs/cores etc.

22.10.02 **TECHNICAL LEAFLETS AND CATALOGUES ON**

- (a) Telephone sets.
- (b) Sockets, matching plugs.
- (c) Main Distribution Frame.
- (d) Sub Distribution Frame
- (e) Junction boxes
- (f) Cables
- (g) Conduits etc.
- (h) Type test certificates of all the system equipment & components.

22.10.03 TO BE SUBMITTED AFTER AWARD OF CONTRACT.

- a) Detailed dimensional General Arrangement drawings of all telephone sets,
- b) Sockets, matching plugs, Main Distribution Frames, Sub Distribution Frames, and Junction Boxes.
- c) Consolidated Bill of Materials.
- d) Cable Schedule & Interconnection Diagram of the whole system.
- e) Telephone system layout, erection drawings and distribution schemes for "approval".
- f) "AS BUILT" combined system layout, erection drawings and distribution schemes after installation.
- g) Datasheets and Technical Leaflets on each piece of equipment furnished.

22.11.00 **PUBLIC ADDRESS SYSTEM**

The Bidder scope shall include successful demonstration of performance testing specified herein complete in all respects along with cables, junction boxes, earth wire and accessories like standard bracket, nut-bolt, glands, lugs, conduit sleeves, etc. as required, to complete the proper installation of all equipments, accessories and facilities required for completeness of this system shall be

furnished by the Bidder within the quoted lumpsum price, whether these are specifically mentioned herein or not.

22.11.01 **Codes Standards**

The equipments furnished under this specification shall conform to the latest revisions of the following standards:-

1. IS-10426: PA System Amplifiers
2. IS-1882: PA System-code of practice for outdoor installations
3. IS-1881: Indoor amplifying and sound reinforcement system-code of practice for installation
4. IS-1031: Method of measurements on loudspeaker and loud speakers system
5. IS-2382: Recommended mounting dimensions of loudspeakers.
6. IS-9302: Characteristics and methods of Measurements for sound system equipment
7. IS-616: Code of safety requirement for mains operated electronic and related apparatus.
8. IS-7441: Specification for loudspeaker.
9. IS-9000: Basic environmental testing procedures for electric and electronic items.
10. IS-2147: Degrees of protection provided by enclosures for low voltage switchgear and control gear.
11. IS-9537: Specification for conduits for Electrical (Part-I,II) installation/wiring.
12. Surge withstand capability (SWC) requirements of ANSIC37.90 A/EEE standard 472-1989 or equivalent.

22.11.02 **General Requirements**

22.11.02.01 The Public Address System shall consist of zones, sub-zones and Exchanges /Server to interface all these zones among them selves. The major zones shall be as under:

- (1) One zone for each of the generating units.
- (2) One zone for common plant system.
- (3) One zone with at least two sub-zones for coal handling system.

Also refer Drawing # D4029-3260-01, Block Diagram of Public Address System for further details.

1. All the above zones shall be connected with a central exchange/server to be located in Control Equipment Room. Another exchange, to be located in Coal Handling Plant (CHP) Control Room, shall connect all the sub-zones of Coal Handling Plant. The Sub zones of CHP areas shall be connected to the Central Exchange through this exchange only. CHP sub exchange shall have control desk/table top mounted MCU.
2. Central exchange shall be able to cater all the specified zones along with the ability to interconnect at least ten (10) more zones for future expansion. Suitable built in interface shall be provided for connection with employer's main telephone exchange in the Central Exchange

and/or Master Control Units through which it shall be possible to communicate with any station in any zone from any telephone set through Central Exchange/Server and/or Master Control Unit.

- 2.11.02.02 This specification covers requirements for selection, design, engineering, manufacture, shop testing, type testing, erection and commissioning of Public Address System.
- 22.11.02.03 The Bidder's scope shall also include successful demonstration of performance testing specified herein complete in all respects alongwith cables, junction boxes, earth wire and accessories like standard brackets, nut-bolts, glands, lugs, conduit sleeves, etc., as required, to complete the proper installation conforming to IS: 1881, IS: 1882 of all the equipments supplied as covered in this specification. All equipment, accessories and facilities required for completeness of this system shall be furnished by the Bidder within the quoted lumpsum price, whether these are specifically mentioned herein or not.
- 22.11.02.04 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.
- 22.11.02.05 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.
- 22.11.02.06 Unit Public Address System (PAS) shall cover all operational areas of generating unit from transformer yard to I.D. Fans.
- 22.11.02.07 PAS for coal handling plant shall cover all its operational areas from wagon triplers to bunker filling floor of all units.
- 22.11.02.08 The common Plant PAS shall be provided to link all Control Rooms, Shift In-Charge Room, D.G. Room, Compressor House, Fuel-Oil Pump House, Water Treatment System Control Room, Ash Handling Plant Control Room, CHP Control Room and other off-site/auxiliary buildings distributed through out the plant area.
- 22.12.00 **POWER SUPPLY ARRANGEMENT**
- The Bidder shall provide power to the Public Address System from UPS system.
- 22.13.00 **SYSTEM DESCRIPTION**
- 22.13.01 **Communication within a zone**
- 22.13.01.01 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 complete system is divided into zones as per technical specifications. The PA system shall be designed such that no single failure shall disrupt the availability of complete system. A redundant server will cater to all zones of the plant. However, one server shall be located at Unit CER and another server shall be located at CHP CR. These shall be interconnected through redundant OFC based network.

22.13.01.02 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).

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 each PC station, located at Unit CER & CHP Control Room 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.

22.13.01.03 (a) 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.

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.

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.

22.13.01.03 b) Communication within a zone

The PA system shall allow party calls i.e. between one call station to another and also Group/ conference calls i.e. simultaneous conversation amongst multiple call stations. Party calls and group/conference calls shall be in full duplex mode.

Each call station shall be able to broadcast a message to all the associated call stations or selected call stations in a zone. The priority of call mode or broadcast mode or Emergency priority settings shall be configurable for each call Station.

- 22.13.01.04 Portable type handsets with Multipin plugs shall be used at certain locations where operational personnel are not present normally. Necessary sockets, wiring, etc., shall be provided at these locations. The locations (distributed in the unit and CHP zones) etc. shall be finalised during detailed engineering.
- 22.13.02.00 **Inter Zone Communication**
- 22.13.02.01 Minimum one no. indoor desktop mounted call station in each zone shall be Master Control Unit. Any interzone communication shall be possible through this master control unit.
- 22.13.02.01 The communication facilities (including broadcast) amongst call stations of different zones shall be such as if they have now become a single zone.
- 22.13.02.01 Multiple group or individual calls shall be possible at the same time across multiple zones without interfering with each other.

All the communication facilities like paging and party mode communication as described above between the two zones shall be possible as if they have now become a single zone.

- 22.13.02.02 All the master control units shall be connected in parallel. Any interzone communication shall be possible through this master control unit. Further, it shall be possible to broad cast recorded speech, music etc. over the loudspeakers.
- 22.13.02.03 Communication/announcements within a zone shall not be heard in loudspeakers of other zones. It shall be possible to communication from a station in one zone to another station in other zone through the master control unit(s) only.
- 22.13.02.04 It shall be possible from a station in one zone to communicate with another station in a different zone, both in party/page mode through the master control units located on each unit control desk at control room and Shift Incharge Room.

22.14.00 **HANDSET STATIONS**

22.14.01 Handset stations shall be of the following types:

- (a) Outdoor Wall/column mounting type.(Type - A)
- (b) Indoor desk-top mounting type. (Type - B)
- (c) Indoor control desk mounting type. (Type - C)

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

One - telephone handset, LED indicator, 10 digit dial pad & 2 special keys, One Cradle switch for resetting the handset., One "Press to Page" push button, One "Press to Mute Loudspeaker" push button, Pre-amplifier and Power amplifier, Indication for 'POWER SUPPLY ON' and Indication for 'PARTY CHANNEL BUSY' as a minimum.

- 22.14.02 Each Call Station shall have LED indicator keys. 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 IEC: 60947-1. The indoor desk-top mounting type call station shall have a degree of protection of at least IP-40. All call stations and their components shall be capable of continued satisfactory operation at an ambient temperature upto 55 Deg C.

Technical parameters- Weatherproof Outdoor Call Station (Type-A)

- a. Glass FRP / ABS housing, pilfer proof type
- b. Plug in front unit with all functional parts
- c. Dial keypad
- d. Call or busy signal by light emitting diodes
- e. Noise compensated inbuilt microphone with dynamic compression and PTT operation
- f. Microphone sensitivity and volume control
- g. Potential free relay point
- h. Connector for optional amplifier booster amplifier
- i. Direct intercom connections
- j. Can be switched to low volume
- k. Led indication of incoming call and line busy, prioritized
- l. Supply voltage range : 48-60 v dc
- m. Max. Quiescent current : 25 mA
- n. Max. Operating current : Approx. 125 ma
- o. External Loud speaker : 25 W
- p. Frequency range : 300 hz to 3.4 khz
- q. Electrical data booster amplifier - output power: 25 w / 400 ohm
- r. Operating temperature : -10° to +60° Celsius
- s. Protection class : IP-65
- t. Area of use : Non hazardous
- u. Inbuilt Loudspeaker : 1 watt

Technical Parameters- Master Call Station (Type-B)

1. Frequency range : 300 Hz to 7 khz
2. Inbuilt Loudspeaker : 1 Watt/80hm
3. Protection class: IP30 or better
4. Microphone : Gooseneck & handset
5. Enclosure : ABS plastic
6. Number of Keys : 40 direct keys with individual labelling area & LED

TECHNICAL PARAMETERS- DESKTOP MOUNTED CALL STATION (TYPE-C)

1. Frequency range : 300 Hz to 7 khz
 2. Inbuilt Loudspeaker : 1 Watt/80hm
 3. Electrical data booster amplifier : output power: 25w / 400 Ohm
 4. Protection class : IP30 or better
 5. Microphone : Gooseneck & handset
 6. Enclosure : ABS plastic
- 22.14.03 The Control-Desk mounting type handset stations shall be suitable for flush mounting on Control Desk.
- 22.14.04 Handset transmitter/microphone shall be noise canceling type and all switches and push buttons provided on the handset station shall be of encapsulated contact type. Handset transmitter/microphone shall have filters to protect from dust. Each handset shall be provided with one meter (extended) retractable coiled type of cable.
- 22.14.05. All handset stations shall have a compact, robust, rust resistant, shock-resistant body made of high impact polystyrene or equivalent. The Type-A handset shall be inside an enclosure with transparent glass door which can be opened through number padlock only.
- 22.14.06 The handset stations in the noisy areas like Turbine Hall, BFPs, Mill area, etc., shall be housed in Acoustic hoods. An industrial type free standing, floor mounted hood shall be used for providing the above requirements. The design noise level within the hood shall be limited to a maximum of 60 dB SIL.
- 22.15.00 **AMPLIFIERS**
- 22.15.01 Amplifiers shall be solid state, class-D, push-pull type, in built with the field call station.
- 22.15.02 Amplifiers shall have 0-100% volume control setting. with facility for coarse and fine setting alongwith following controls which shall be located inside the Handset Station. Input sensitivity control, Receiver volume control, Bass cut filter and below technical parameters:
 Output Power - 500W/250W
 Operating Voltage- 48 to 68V DC or 230V AC (Dual Power Inputs)
 Quiescent Consumption- 0.25A
 Max. Current Consumption - 13A
 Frequency Response- 90 to 20000Hz
 Operating Temperature- from -5 C to +40 C
 Air Humidity - 5% to 95%
 Degree of protection - IP50
 Enclosure Dimension - 88x482x256
 Maximum weight - 16,5 kg / 12,5 kg
- 22.16.00 **LOUDSPEAKERS**
- 22.16.01 Indoor loudspeakers shall be cone type housed in sturdy metal cabinet suitable for wall/column mounting. The cabinet shall be treated with acoustic under-coats to prevent resonance. They shall have IP-52 degree of protection as per IS: 13947.

22.16.02 Outdoor loudspeakers shall be industrial horn type and of pressure die cast aluminium construction. The mounting bracket shall be with adjustable base suitable for vertical and horizontal orientation. They shall have IP-55 degree of protection as per IS: 13947. Degree of protection for outdoor loudspeakers shall be IP-65 for all types.

22.17.00 **CENTRAL EXCHANGE & MASTER CONTROL UNIT**

22.17.01 **Central Exchange**

22.17.01.01 Central exchange shall be wide band microprocessor server based on state of art IP technology. The server should support protocols including SIP or equivalent, TCP, IPV4/ IPV6, Codec based having associated circuitry for calling station identification and of modular design.

G.722, SNMP, RTP, NTP etc. The required no. of all hardware/subscribers should not depend on the no. of the licences.

The server shall be capable of self-recovery in case of any fault/ network break down. Alternately the system shall operate without server.

All programming tools & software that are required to program/ reprogram the system shall also be provided. This exchange shall consist of all the necessary control hardware, required for operation, monitoring, protection, indication, switching, testing, measurement of all the voltages and load conditions of the entire system, facility for checking of the operation of all the stations and quality of speech from the master control units etc. Systems bandwidth shall be at least 200-10 kHz (± 10 dB) and shall not alter frequency response of the open line system. All the central exchange shall be enclosed in a freestanding cabinet to be located in control equipment room all the cable entries shall be from bottom only. Further, all the programming tools that will be required to program/reprogram the system shall also be provided.

Exchange/Server		
S. No.	Technical Parameters	Specifications
1	Operating voltage	100V to 240V, 60Hz
2	Maximum power consumption	200, 350VA
3	Network interface	10Base-T, 100Base-TX, 1000Base-T
4	Interface for peripheral devices	USB, COM, VGA
5	Dimensions	437x43x503 MM
6	Max weight	8.5kg
7	Signaling protocols	SIP, DSS/EDSS (Q.931)
8	Network protocols	SNMP, RTP, IGMPv2
9	Operating system	CentOS v7
10	Electrical safety class IEC 61140-2012	I
11	Air humidity	upto 90%
12	Operating temperature	from -10 C to +35 C
13	E1(G.703/G.704)	300mA
14	RJ 45 Ethernet Connection	from 2 to 4
15	Hardware Architecture	x86

22.17.02 **Master Control Unit**

22.17.02.01 Master Control Units shall be microprocessor based and of modular design. These units shall be table top type along with luminous miniature push buttons for interzone communications, alarm tone generation, fire alarm tone generation etc. The Master Control Unit shall facilitate interzone communication amongst different zones. It shall have minimum 40 direct access keys with LED indication, which shall be configured as per requirement, a goose neck type Microphone and a hand receiver unit attached to it. Emergency announcement facility like fire alarms etc., shall be done from master control unit automatically.

22.18.00 **CABLES AND JUNCTION BOXES**

The Bidder shall supply the cables required for PA system on as required basis. The cables shall be armoured FRLS type. Colour of the outersheath shall be YELLOW. Sizes and details of cables are given below:

- a. Mains cable : Multipair of minimum 1.5 mm² cross-section Copper conductor cable with at least one spare pair.
- b. Signal cable : Multipair multistrand with at least one spare pair, twisted pair Loud Speaker, minimum 0.5 mm² cross section annealed copper cable (shielded)

22.18.01. **Junction boxes**

22.18.01.01 The junction boxes to be used for the Public Address System shall be as specified in Sub- Section, Chapter 9, Inst. Cables, Part-B, Vol. V of Technical Specifications. These junction boxes shall be supplied on as required basis.

22.19.00 **TECHNICAL PARTICULARS**

22.19.01 Public Address Systems shall conform to the following technical parameters.

Items	Technical Particulars
(i) Overall Installation	
Band width (± 3 db)	: 100-16000 Hz
(ii) Amplifiers	
(a) Band width (± 3 db)	: 200-10000 Hz
(b) THD	: not more than 0.5% at 1 KHz at rated output
(c) Signal to Noise Ratio	: Minimum 80 dB
(iii) Microphones	
(a) Band width (±3 db)	: Codec G.722 200-7000 Hz
(b) Type	: Omni directional and dynamic Noise cancelling type
(iv) 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)

22.20.00 **WIRELESS SYSTEM (WALKY TALKIE SYSTEM)**

22.20.01 Design Criteria

This system shall be a two radio communication system consisting of repeater, a VHF/UHF antenna & included the following:

Required base stations with antennae, power supply units, inverters, voltage stabilizers, RF cables and all other accessories.

Following minimum areas are envisaged for providing the Base Stations. However, during detailed engineering, for coverage of 100% plant area if any Base Station is required to be provided in any other area, the same shall be supplied without any price implications:

- Main Plant control room
- CHP control Room
- AHP Control Room
- Raw water In-Take pump house
- Raw Water Pump House
- DM Plant Control Room
- Rail Marshalling Yard
- FGD Control Room

- a. Fifty (50 Nos.) hand held two way transmitter receiver sets.
- b. Battery charger for hand-set batteries-50Nos. Rapid Charger (which can charge 10 handset batteries at a time) shall be provided in PHB main plant control room.
- c. The battery and battery charger shall also be provided for operating the base system

The following minimum features shall be providing

- a. Dispatcher Radio identification facility
- b. Call alert provision
- c. Auto-check if radio is operating or within range
- d. Dual tone multi-frequency signal facility with easy access to a landline telephone network
- e. Easy to read on-screen display indicator alert user on low battery strength /signal strength /caller ID.

The system shall be capable of being coupled with the EPABX and PA system such that any wireless set can be contacted from any of the EPABX intercom extensions or PA System and any wireless set can be used to contact any of

the PABX-intercom number/pager through the EPABX. It shall also be possible to make a page call on the paging system from the wireless sets. The wireless sets shall be addressable type and light weight. The system shall have a minimum operating range of 10 km

The Bidder shall get the necessary license in the name of Owner for operating Wireless system from the competent authority.

22.20.02 **System Description**

22.20.02.01 **Base Station**

- a) Following features shall be included
- b) Full band coverage
- c) 14-character alphanumeric dot matrix text display
- d) Busy channel lockout
- e) Low battery alert
- f) Coded squelch
- g) Channel Scan & Priority Scan
- h) Selective Call Signaling
- i) Call Alert
- j) Auto acknowledgement and Automatic Number Identification

The power supply to the base station shall be through the UPS to allow the radio communication during "Black out" condition also .

Base Station shall be complete with Omni directional Antenna, RF low loss coaxial cable type RG8, Loud speaker, Desktop Microphone, Power Supply Cable

Technical Parameters

• Frequency Range	136-174MHz/403-470MHz/450-527 MHZ
• Channels	20 or more
• Channel spacing	12.5/25kHz
• Frequency stability	+/- 2.5 ppm
• Audio distortion	<3%
• Hum & Noise	40 db

22.20.02.02 **Portable Handset**

Following features shall be included

Full band coverage

14-character alphanumeric dot matrix text display

Busy channel lockout

Low battery alert

Coded squelch

Channel Scan & Priority Scan



Selective Call Signaling
Cal Alert
LLE feature for voice quality
Zone selection

22.21.00 Tests

All the equipment covered in this specification shall be subjected to routine tests as per relevant standards. Type Test certificate shall be submitted for review.

22.22.00 The type of cables and their technical particulars shall be as per the requirement of the system for giving best performance.

22.23.00 List of Drawings and documents to be submitted for communication system & PA system along with bid documents

1. Make and experience list of the offered system
2. Descriptive literature/Catalogues
3. Write-up on the system offered
4. General arrangement drawing
5. Block Diagram

22.24.00 CONTRACT QUANTITIES

Refer Appendix-I to Part-A, Vol.-V of Technical Specifications. Quantities indicated are the minimum requirements, however each & every item shall be provided as per system requirements.

CHAPTER – 23

MATERIAL SUPPLY, WARE HOUSING, ERECTION, TESTING AND COMMISSIONING

23.00.00 General Requirements:

This section covers supplies – cum – services bidder’s responsibilities for packing, shipping, ware-housing and the installation and commissioning of all equipment and materials furnished and installed under this specification for complete C & I system. Though specifically the work of dismantling of the existing equipments / instruments is not mentioned here it shall be assumed as an integral part of erection work .The work involved in dismantling is elaborated while defining the scope of work and scope of supply in this specification. The requirements of this section supplement other applicable sections/chapters of this volume and Volume II, chapter 6 – Erection Condition of contract.

All materials fabricated and installed shall conform to the latest edition of applicable codes and standards. Work shall be carried out in accordance with the various International & Indian Standards and any local statutory regulations as applicable, listed below, though not limited to them:

- i) ISA - Instrument Society of America, Standards and Recommended Practices
- ii) ANSI - American National Standard Institute, B2.1 Pipe Threads B16.5 Steel Pipe Flanges & Flanged Fittings
- iii) ISI - Indian Standards Institute
- iv) NEC - National Electric Code
- v) API - American Petroleum Institute
- vi) ASME - American Society of Mechanical Engineers
- vii) IBR - Indian Boiler Regulations
- viii) NFPA - National Fire Protection Association
- ix) BS - British Standards
- x) IS - Indian Standards

The work shall also conform to installation standards, hook-up drawings, and support standards. Layout drawings or any other drawings, documents or schedules submitted by the bidder and approved by the Owner.

All site-mounted instruments, junction boxes, air headers, tubing and wiring terminations shall be labeled or tagged in a manner approved by the Owner. Terminals for electrical connections shall be numbered and identified to indicate polarity, ground connections, test connections and any other pertinent information

23.01.00 MATERIAL SUPPLY AND WAREHOUSING

23.01.01 Delivery Schedule.

The equipments specified herein are required to be delivered at site as per the agreed schedule owner indicated. The delivery schedule shall be clearly indicated and guaranteed.



23.01.02 **Crating**

All equipment and materials shall be suitably coated, wrapped or covered end boxed or crated for moist humid tropical shipment and to prevent damage or deterioration during handling and storage at the site.

Equipment shall be packed with suitable desiccants sealed in water-proof, vapour-proof wrapping, and packed in lumber or plywood enclosures, suitably braced tied and skidded. Lumber enclosures shall be solid, not slatted.

Desiccants shall be either silica gel or calcium sulphate, sufficiently ground to provide the required surface area and activated prior to placing in the packaging. Calcium sulphate desiccants shall be of a chemical nature to absorb moisture. In any case, the desiccant shall not be of a type that will absorb enough moisture to go into solution. Desiccants shall be packed in porous containers strong enough to withstand handling encountered during normal shipment. Enough desiccant shall be used for the volumes enclosed in the wrapping.

Review by the Owner or Consultant of the Bidder's proposed packaging methods shall not relieve the Bidder of responsibility for damage or deterioration to the equipment and materials specified.

All accessory items shall be shipped with the equipment. Boxes and crates containing accessory items shall be marked so that they are identified with the main equipment. The contents of each box and crate shall be indicated by marking on the exterior.

All boxes, crates, cases, bundles, loose pieces, etc. shall be numbered consecutively Form No.1 upward throughout all shipments from a given port to completion of the order without repeating the same number.

All itemized list of contents shall be enclosed inside each case, and one other copy securely fastened to the outside of the case in a tin or light weight sheet metal envelope or pocket. The lists shall be plainly marked and placed in accessible locations to facilitate receipt and inspection. The packing list shall indicate whether shipment is partial or complete and shall incorporate the following information on each container, etc. according to its individual shipping number:

- a) Export case markings.
- b) Case number.
- c) Gross weight and net weight in Kilograms
- d) Dimensions in centimeters.
- e) Complete description of material including order number.

Packaging or shipping units shall be designed within the limitations of unloading facilities and the equipment which will be used for transport. It shall be the Bidder's responsibility to investigate these limitations and to provide suitable packaging to permit safe handling during transit and at the job site.

Electrical equipment controls and instrumentation shall be protected against moisture and water damage. All external gasket surfaces and flange faces, couplings, motor pump shafts, bearings and like items shall be thoroughly cleaned and coated with rust preventive compound as specified above and protected with suitable wood, metal or other substantial type covering to ensure their full protection.

Coated surfaces shall be protected against impact, abrasion, discoloration and other damage. Surfaces which are damaged shall be repaired.

All exposed threaded parts shall be greased and protected with metallic or other substantial type protectors. All female threaded openings shall be closed with forged steel plugs. All piping, tubing and conduit equipment collections shall be sealed with metallic or other rough usage covers and taped to sealed the interior of the equipment piping, tubing or conduit.

Provisions shall be made to ensure that water does not enter any equipment during shipment or in storage at the plant site.

Returnable containers and special shipping devices shall be returned by the manufacturer's field representative at the Bidder's expense.

23.01.03 **Shipping**

The Bidder shall be fully responsible for the safe and timely delivery of all equipment and materials furnished under this specification.

The Bidder shall discuss with the Owner, the routing of shipments and shall route the same as indicated by the Owner, provided freight rates are no greater than by other routes.

Shipment of all equipment and materials across land shall be by truck or rail. The Bidder shall take into consideration the effects of shock and vibration to equipment during transit and shall provide safeguards against same. Transfer of equipment between carrier vehicles shall be held to an absolute minimum.

Ships used for the transportation of equipment shall have the capability of on-board lifting and off-loading all shipments of equipment and materials. "On deck" shipment will not be permitted unless prior approval has been obtained from the Owner.

23.01.04 **Factory Assembly:**

All trend recorders, cathode ray tubes, keyboards and printers shall be individually packed for shipment. Electronic control modules of plug-in type shall be removed from equipment racks after factory check-out and individually packed for shipment. Other equipment shall be fully assembled at the factory, except for necessary shipping splits in cabinets. Indicators, recorders, electrical meters, monitors, work station CPU, servers, keyboards, printers and any other electronic item/equipment etc. shall be individually packed for shipment.

23.01.05 **Consolidated shipments**

Except where authorized by the Owner in writing, the Owner will not accept direct shipments of bidder furnished materials and equipment from sub-bidders. The bidder shall assembly-shipping units composed of those items of materials and equipment, which he obtains from sub-bidders. Shipping unit assembly shall be at one of the bidder's regular business addresses. Each item shall be tagged with its individual identification used on the drawings for this contract and shipped as part of as shipping unit to the construction site.

23.01.06 **Shipping List:**

The Bidder shall submit to the Owner duplicate copies of shipping notices describing each shipment of material or equipment. The shipping notices shall

be mailed to arrive approximately 10 days ahead of the estimated shipment arrival. The addressed for each shipping notice will be determined later.

23.01.07 **Materials List:**

The Bidder shall prepare and submit with the first shipping notice duplicate copies of an itemized materials list covering all material and equipment furnished under these specifications. The materials list shall be in sufficient detail to permit an accurate determination of the completion of shipment.

23.01.08 **Inspection at Job Site:**

The Bidder shall inspect all shipments upon arrival at the job site to determine possible damage or shortages and to record the equipment received in each shipment. The Bidder shall maintain accurate upto-date records of all equipment and materials received. These records shall be itemized for ease of comparison with the materials list specified above. All damages shall be corrected promptly and to the satisfaction of the Owner. The bidder shall submit to the owner copies of all receiving and damage reports for a shipment within two working days immediately following receipt of that shipment. All report forms shall be furnished by the Bidder and shall be acceptable to the Owner.

23.01.09 **Receiving and handling**

The Bidder shall be responsible for the prompt unloading of all equipment and materials furnished by these specifications and shall pay all demurrage incurred. The Bidder shall handle all equipment and materials carefully to prevent damage or loss, shall store them in an orderly manners shall keep adequate and convenient records of their location and shall keep a continuously accurate inventory.

The Bidder shall be responsible for the return of his own special containers and shipping devices.

23.01.10 **Warehousing:**

The owner will provide open space for construction of a warehouse of appropriate construction for storage of the bidder's equipment and materials. The Bidder shall be responsible for the construction of the warehouse and the interior partitions as required to separate his assigned spare from that of other parties. The bidder shall be responsible for the safety and security of his property while in the warehouse. Space requirements shall be as mutually agreed between the Bidder and the owner.

The readiness of the warehouse for C&I part shall be completed by bidder before the arrival of C&I items/panels/electric modules to site.

23.01.11 **Storage:**

Stored equipment and materials shall be adequately supported and protected to prevent damage. Equipment shall be moved into the permanent buildings or onto its permanent foundation as soon as construction will permit.

Stored materials and equipment shall not be allowed to contact the ground. In warehouses that do not have dry concrete or suspended floors, materials and equipment shall be stored on platforms or shorting.

Strip heaters and similar heating devices furnished with electrical equipment shall be electrically connected to provide protection during storage. Heaters shall be energized immediately upon placement of the equipment in storage. Equipment not having integral heating devices shall be heated by alternate methods acceptable to the Owner.

Mechanical dehydrators provided in the cubicles shall be maintained in operation from the date of receipt of equipment until directed by the owner.

All storage equipment excluding warehousing hall remain the property of the Bidder and shall be removed from the job site following construction.

23.02.00 **ERECTION & COMMISSIONING**

23.02.01 **General Requirements**

All erection hardware, junction boxes instrumentation cables, control cables, compensating cables etc. shall be in line with the approved installation diagrams and cable schedule.

All cables shall be as specified in chapter 9, Vol. V. All cables will be supplied, laid, terminated and commissioned by bidder.

The equipment erection shall be complete in all respect with all mountings fixtures and accessories to form a completely operational system/sub system whether such fixtures are specifically mentioned are not. Supply and erection of flexible conduits trays supports from field devices to first junction box/transmitter enclosures. Complete trays for the compensating cables, irrespective of the scope of primary elements covered under scope of erection by vendor. The instruments should be mounted in a location where there is minimum vibration. Pressure switch to be mounted in such a way that diaphragm is vertical i.e. It should not be either horizontal or slanting position.

Cable glands for all junction boxes, Cubicles, panels supplied under this contract are included in bidder's scope. Erection scope of vendor includes supply and erection of drainpipes, interconnection of drain pipes to plant drain header. Such special cables with necessary cable trays, supports shall be furnished on as required basis for the satisfactory operation of any instrument/devices/subsystems/systems furnished under this specification by the bidder.

- i) This section describe the scope of Bidder's responsibilities for erection & commissioning of the equipment / system, supplied by the bidder as part of this specification though even not specifically brought out under Clause No. 23.02.02. In general, bidder shall erect and commission all the equipments supplied under his scope.
- ii) The Bidder shall prepare detailed installation drawings for each equipment furnished under this specification for owner review. Installation of all equipment / system furnished by this specification shall be as per owner approved drawings. In general bidder shall erect and commission all the equipments supplied under his scope.
- iii) Erection procedures not specified herein shall be in accordance with the recommendations of the equipment manufacturers. These procedures shall be acceptable to the Owner.

- iv) Instrumentation workshop must be prepared first of all before starting the C&I erection work, in order to ensure proper calibration of various instruments.

23.02.02 **DETAIL OF WORK**

- 1 This specification covers the various jobs listed below though not strictly limited to them. The scope of work shall also include all other items of work required to complete the job in all respects as per specifications, drawings and instruction of the OWNER. Bidder to follow the safety procedures as per the instruction of OWNER

- 2 The scope of systems shall be limited to calibration and installation of the following types of instruments and accessories. The bidder shall submit and get approval for the detailed procedures for calibration and installation of the following instruments:-
 - i) Pressure transmitters (Electronic) with output indicator and with manifolds.
 - ii) Differential Pressure Transmitters (Electronic) with output indicator for flow and differential pressure with manifolds.
 - iii) Level switches, Pressure switches & Flow switches
 - iv) Proximity switches, vibration sensors & speed sensors
 - v) All type of gauges
 - vi) Control system as described.
 - vii) Solenoid valves.
 - viii) Thermocouples, RTDs with/without thermo-wells.
 - ix) Air filter regulators.
 - x) Displacement transducers & other field mounted transducers (I/P converters, P/I converter etc.)
 - xi) Junction boxes (Analog/Digital/Thermocouple K type).
 - xii) Control valves.
 - xiii) Water & Flue gas Analysers.
 - xiv) Instrument enclosures.
 - xv) Steam and water analysis system dry and wet panel. Analysis system
 - xvi) Any other field instrument included in the specification.

23.02.03 **Work Included**

The Bidder shall be responsible for furnishing materials and performing field construction as outlined below:

The Bidder shall be responsible for furnishing materials and performing electrical field construction as outlined but not limited to the followings: -

1. Erection & commissioning of UPS and 24V DC sytem for C&I system. The bidder shall include all required tools and special instruments required for the installation, testing, erection & commissioning of the UPS and 24V DC sytem.

2. Refurbishment & Erection of junction boxes. The bidder to supply of necessary JB's as per site requirement.



3. Refurbishment & Erection of control valve instruments i.e. I/P converter, air lock switches, and air header.
4. Loop checking of field signals up to field JBS and between field JBS and control system cabinet.
5. Erection and installation of SWAS panels such as sample conditioning panel and analyser panel.
6. Erection, installation & commissioning of STG panels, SG panels, BOP panels, DDCMIS panels, PLC panels, relay based control panels, GIUpannels, and any other control panels as part of this specification.
7. Fabricated panels supporting framework shall be provided with a drilled base plate capable of supporting the weight of the panel. The bare plate shall not extend beyond the out line base dimensions of the panel.
8. Vibration damping equipments shall be installed wherever required. Control panels and desks shall be mounted on vibration dampeners which are secured to channels mounted on control room floor. The channel shall be field welded to steel plate set into the control room floor concrete. The panels and cabinet in bidder's scope shall be appropriately mounted so as to match the cutouts provided for each cabinet and panel
9. Cable entry shall be from the bottom connecting directly into junction boxes. Cable shall enter the panel via a stuffing gland, with base frame.
10. Installation & calibration of air lock valves.
11. Junction box and terminal boxes shall be placed with the bottom entry gland at least 300mm above the panel base. Termination shall not be situated higher than 1.8m above the panel base.
 - All cable glands shall be of Nickel - plated brass and shall be double compression type with end connection.
 - Plugs $\frac{3}{4}$ ", (as per cable schedule) shall be provided to close spare entries.
 - Tag plate and nameplate shall be provided on each JB.
 - Tag plate and nameplate shall be SS with black engraved letters and shall be screwed on JB.
 - Earthing lugs shall be provided on JB's.
 - All necessary attachments and mounting brackets shall be provided.
 - Cable glands and plugs quantity shall be provided as per the actual cable schedule.
 - 20% of spare glands and plugs shall be supplied with JB's
12. All tubings and fittings shall be of 316 SS as a minimum.
13. Gauges shall be labelled with tag number and service on the front of the gauge board.
14. Installation of all cables raceways and conduit for instruments.

15. Installation of all required temporary construction power wiring, receptacles and lighting.
16. Bidder shall furnish, install, terminate all cables including prefabricated cables, instrumentation cable, special cables like coaxial, fibre optic cables (soft link) required for the interconnection of all the bidder furnished components irrespective of other end scope.

Scope of supply, laying, installation, termination of cables and loop check outs are included under this specification .Bidder shall include all the cables his scope in this and confirm compliance to scope specifically in his bid. Complete scopes of work are in EPC bidder scope irrespective of other end scope.
17. Check for continuity & termination at both ends for all power feeders, which provide power to all equipment.
18. Furnish, install, test, terminate and check for continuity of all cables required for grounding & electronics earthing of control system, cabinets, equipments etc. All cables used for grounding of DDCMIS, DCS, PLC, & STG control panels and any other control panels shall be supplied by equipment supplier.
19. Furnish, install, test, terminate and check for continuity of all data high way cables and network cables including station LAN etc. required for interconnecting logic cabinets, MMI etc. supplied under this specification. The routing of these cables shall be separated from other instrumentation cables.
20. The bidder shall commission the C&I parts of the total plant.
21. The bidder shall provide the list of calibrated equipments with its calibration certificate.
22. low pressure welding if required.
23. Cable & instrument tagging and cable dressing. The bidder shall provide the ferruling at DDCMIS/DCS/Control panels, JB's, and instruments end. All panel wiring shall have appropriate strip type ferruling for clear identification. Ferruling shall be in such a way that both end termination address must be clear at any end. Also all cable terminals shall be 'O' ring type only, as pushfit terminals give regular bad contact problem.
24. The bidder shall do the material reconciliation with respect to the material erected and obtain the material reconciliation completion certificate before handing over.
25. Primary impulse piping shall be supported at an interval not exceeding 1.5 meter. The bidder shall provide necessary fixtures either by welding or by bolting on columns and structures to support the pipe. Hangers and other fixtures shall be provided either by welding or by bolting on walls, ceilings and structures to support tube trays. Aluminum tubing supports with all necessary fittings, spacers and clamps etc. shall be provided by bidder. The Bidder shall clearly identify through colour marking or by other means the different type of impulse pipes, isolating valves etc. before these are to be stored at site.

26. Fabrication and installation of primary piping/tubing for all field instruments complete with manifolds as per owner approved standards.
27. Fabrication and erection of stanchions/supports for all local instruments, junction boxes, etc. Fabrication and erection of suitable supports for surface mounted instruments.
28. Fabrication and erection of structural steel plates, angles, pipes, required for supporting ducts, trays, local instruments, panels etc complete with bolts & nuts (GI bolts and nuts shall be used wherever applicable or directed).
29. Fabrication and laying of conduit pipes wherever required including provision of bends, sealing of conduits, chipping of paved areas and refilling them. All conduits pipes shall be filled with sand before completion of job.
30. Excavation, construction of earth pit, earth pit material filling, 8/4backfilling for making earth pits as per standards including supply of material.
31. Sealing of trench entries into control room after laying of all cables including supply of sealing compound.
32. Completion/updating of drawings/documents as per the work done at site. This should be done before applying for completion certificate.
33. Supervision of installation of control valves.
34. Pre-commissioning service and commissioning assistance during start-up of plant, wherever required.
35. Provision of copper wire, GI wires to panel earth bus, laying and grounding of the same to the system earth pits. Providing earth pits as per requirements of the system supplied.
36. Connection of pneumatic tubings to control valves, positioners, dampers etc.
37. Fabrication and erection of canopy (single) for instruments, wherever required.
38. Degreasing of handwheels of control valves, studbolts, nuts of side and bottom flanges of control valves, other primary element flanges, impulse lines and instruments as per standards and manufacturers' instructions and other items as required by the Owner.
39. Reversing the action of control valve either by replacement of springs, accessories or in positioner wherever required.
40. Minor modifications/repairs required to be done on the existing instruments namely, replacement of damaged signal tubes, tapping of damaged threads on couplings, tees and other fittings on control valve.
41. Drilling holes on all junction boxes etc for cables/glands/grommets, if required, after obtaining approval from the consultant.

42. Grounding of shield for all shielded cables respective instrument earth bus provided in the thermocouple head/junction boxes.
43. Sealing of safety valves/switches with standard lead seals after final setting in the presence of Owner.
44. Painting of junction boxes, pipes etc as per painting specifications.
45. Preparation and submission of as-built drawings as required as a part of complete documentation after erection, commissioning is over.
46. For successful functioning of the instruments, any changes from standard hook-up diagrams (attached with this specification) shall be done by bidder without any extra cost implication.
47. Any fault found at the time of commissioning assistant due to the wrong method of installation or any fault in the instruments or any calibration required for commissioning are to be done by the bidder without any extra cost implications.
48. Complete material reconciliation after the completion of equipment erection and commissioning shall be carried out by the Bidder. Relevant documentation in this regard shall be provided to the Owner.
49. The bidder shall be fully responsible for correct installation of all thermowells (in bidder's scope) welding on stubs on process pipe lines, though welding of these thermowells on stubs will be done by the Bidder.
50. For all mosaic panel mounted instruments in bidders' scope necessary supports and fixtures shall be provided to maintain the aesthetic look of panel after the removal of mosaic grids for this purpose. All prefab cables and other accessories required for these panels mounted instruments installations are in bidder's scope.
51. Nameplates shall be provided for all instruments and devices or instruments are themselves provided with a service engraving. Embossed plastic nameplates of acceptable design shall be provided inside the panel section for all devices located there.
52. Scope of erection work include Installation and interconnection of all equipment, system, control room desks, cabinets / console, along with other accessories shall be in the bidder scope.
53. UPS, 24V DC sytem & Battery bank unloading, transporting, erection & commissioning shall be bidder scope.
54. DDCMIS/DCS/PLC related all panels; control desk erection shall be bidder scope.
55. Cable Schedule and Interconnection Diagram preparation, between field instruments to junction boxes and Field Junction Box to DDCMIS/DCS/PLC and any other control panel or wherever single end are in bidder scope, shall be under the scope of the Bidder.
56. All cable lugs (socket) shall be insulated type.
57. Ferrule for cable shall be machine printed and used long lasting type tape.

58. All instruments, control valve, MOV, equipments, special equipments commissioning by expert shall be bidder scope.
59. All tray work shall from 750mm to 50mm (ladder/perforated) for instruments main and branch cable tray erection with Steel support structure shall be bidder scope. Installation of all cables and accessories including cable trays from primary sensor / transmitters to first junction box / marshalling box in field.
60. Any consumable items required for fabrication of steel support, mounting of steel support, welding, jointing and bolting for Control and Instrumentation system shall be in the scope of Bidder.
61. Erection of all type cable trays shall be complete with necessary coupler plates, bolts, nuts & washers and shall be part of cable tray erection.
62. Fabrication of Cable tray Bend, Tees, Reducers, Horizontal and Vertical Elbows required during erection of cable tray shall be in the scope of Bidder and no readymade bend, Tees, Reducers, Elbows shall be provided to Bidder and shall be the part of Cable Tray erection.
63. Construction of Treated Earth Pit including Salt Layer, Charcoal Layer, Sand Layer, and Brick Layer from 3mtr of Finished Ground Level shall be the part of Treated Earth Pit. No separate price shall be considered.
64. Bidder to show the treated Earth Pit resistance between 0.5 to 1 Ω by Earth Pit Resistance Meter. Arrangement Earth pit resistance shall be in the scope of Bidder.
65. FO & Network Cable shall be laid on separate cable sub-trays inside building area. When the cables are laid outside buildings area, GI conduits shall be used with support from cable tray/Tressle structure. In areas where the same are required to be buried, the same shall be buried in separate trench approx. 1.0 mtr. Depth to be laid in 2" rodent proof HDPE Pipe covered with sand, brick laid breadth-wise and soil along the pipe line route by bidder. While crossing roads- to be laid in rodent proof HDPE Pipe with sand filling at bottom and sand, soil filling at top with cement concrete. While crossing canals/river to be laid in rodent proof HDPE Pipe within hume pipe. and same shall be in the scope of bidder. Cutting, Jointing, Bending, Fittings and Clamping required for laying of FO & Network Cable through rodent proof HDPE Pipe shall be part of laying of HDPE Pipe.
66. Bidder shall provide instrument/service air line at TG floor/building, boiler area/floor and wherever required.
67. All unused cable gland hole in JB/panels shall be sealed by plastic hole cover to protect dust and water.
68. During commissioning period bidder shall provide sufficient expert engineer/manpower with sufficient tools & tackles as 24 hours basis (shift wise) without any cost implication to owner.
69. Each terminal point shall be clearly identified. Sample terminals shall be identified by name and number. Stamped metal tags attached with stainless steel wire shall be provided at the sample inlet bulk head fittings.

23.02.04 Equipment Installation

The Bidder shall furnish all construction materials, tools & equipment and shall perform all work required for complete installation, commissioning of all equipment furnished under this specification. The scope of installation shall include all work up to and including placing the equipment in successful operation. Erection procedures not specified herein shall be in accordance with the recommendations of the equipment manufacturers.

23.02.05 Installation Materials

All materials required for complete installation of the equipment shall be furnished including concrete bases with anchor bolts and grouting..

23.02.06 Regulatory Requirements

All installation procedures shall conform with accepted good engineering practice and to all applicable governmental laws, regulations and codes.

23.02.07 Equipment Assembly

Equipment installed under these specifications shall be assembled if shipped unassembled. The equipment shall also be dismantled and re-assembled as required to perform the installation and commissioning work described in this specification.

23.02.08 Equipment Setting

All free standing instrumentation cabinets and panels shall be located within the construction tolerance of plus or minus 3% of the location dimensions.

23.02.09 Free Standing Equipment

Free-standing cabinets shall be attached to the floor on concrete equipment bases of supporting steel as indicated on the manufacturer's approved drawings and the owner's plant arrangement drawings. The cabinets shall be shimmed for proper alignment before bolting them to the floor. Adjacent enclosures shall be shipped to maintain mutually level appearance before they are attached to the floor. Vibration isolating pads of min. 15 mm thickness shall be furnished for all cabinets.

23.02.10 Defects:

All defects in erection shall be corrected to the satisfaction of the Owner and the Engineer. The dismantling and reassembly of bidder furnished equipment to remove defective parts, replace parts or make adjustments shall be included as a part of the work under this specification

23.02.11 Equipment Protection

All equipment to be erected under this specification shall be protected from damage of any kind from the time of contract award until handling over of each unit.

The equipment shall be protected during storage as described herein.

Equipment shall be protected from weld spatter during construction.

Equipment having glass components or equipment having other easily broken components, shall be protected during the construction period with plywood enclosures or other suitable means. Broken, stolen or lost components shall be replaced by the bidder.

23.02.12 **Repair of Painted Surfaces:**

After erection, touch-up paint shall be furnished and applied to all abraded or damaged areas on shop painted equipment surfaces.

Surfaces shall be properly prepared before application of paint. The touch-up paint shall be of a type equivalent of the shop paint.

23.02.13 **Equipment Location guidelines:**

- i) All individual items of equipment not located in cabinets or on panels and racks are located approximately according to the floor elevation and the nearest burning column.
- ii) Solenoid valves, electric to pneumatic converters and other control loop accessories not located in enclosures or mounted on valves shall be mounted in easily accessible protected locations near the components with which they are associated.
- iii) All instruments to be locally mounted (those not in instrument enclosures or on valves) shall be mounted on building walls, columns, or local stands approximately 152 mm above floor level. These local instruments shall be mounted to permit ease of adjustment. Local instruments shall not be located outdoors except when approved by the owner. Air filter regulator sets, valve manifold etc. shall be supplied and installed. No field mounted shall be installed such that it depends for support or rigidity on the Impulse piping or on electrical connection to it.
- iv) All brackets, stands, supports, and other miscellaneous hardware required for mounting devices shall be furnished.
- v) Permanent temperature wells on the main steam, hot reheat and cold reheat piping shall not be installed until steam blowing has been completed.
- vi) Any required adapting hardware such as pipe bushings, nipples, drilled caps and the like shall be provided for complete installation of control devices into process connections
- vii) Indicating type field mounted instruments shall be installed in such a way that center of indicating dial shall be about 1600-1800 mm from operating floor level. Non-Indicating type field instruments shall be installed such that operating handle of that instrument comes within 1600 mm from operating floor level.

23.02.14 **Installation of Field Mounted Instruments and Devices**

The Bidder shall submit installation drawings for all field mounted equipment furnished under this specification for Owner's approval. These drawings shall meet the requirements of this specification applicable codes and standards and recommendations of manufacturers of instruments / devices. All installation

work under this specification shall be strictly as per installation drawings approved by the owner.

23.02.15 **Piping Connections Guidelines:**

- i) All equipment having piping connections shall be leveled, aligned and wedged in place but shall not be grouted or bolted prior to the initial fitting and alignment of connecting piping. All equipment shall, however, be grouted or bolted to its foundation prior to final bolting or welding of the connection piping.
- ii) All flanged joints shall be checked and retightened after approximately 10 days of operation at normal operating temperature.

23.02.16 **Equipment Check-out:**

- i) All equipment shall be cleaned after installation. Equipment subject to pressure differential shall be checked for leakage.
- ii) After erection, all equipment having moving parts, having electrical apparatus, or subject to pressure differentials shall be trial operated.

23.02.17 **Conductor Accessories**

All conductor accessories including terminal materials, lugs, splicing materials, markers, tying materials, support, grips, insulating compounds, tapes.. cable cushioning and glanding materials shall be furnished and installed by the Bidder, if the end wire preparation is necessary to fit cables to individual system elements or components (printed circuit cards).

Bidder's installation instructions shall be obtained for cable accessories. These instructions shall be in the possession of the craftsmen while installing the accessories and shall be available to the owner for reference.

23.02.18 **Splicing Connectors**

Splices in control or signal conductors shall be made with compression type half ring type terminal lugs. The lugs shall be jointed using bolts, booth lock washers and hex nuts, each being of copper or copper bearing metal. Bolt size shall match the opening in the terminal lug.

23.02.19 **Crimping Hand Tools:**

The crimping hand tools used in securing the conductor in the compression type connectors or terminal lugs shall be those made for that purpose and for the conductor sizes involved. The crimping tools shall be of the ratchet type which prevents the tools from opening until the crimp action is completed. Such tools shall be a product of the connector manufacturer.

23.02.20 **Screwless cage clamp type Connections:**

The connections from control cubicles to termination cabinets and other cubicles shall be screwless cage clamp type. For this proper tools shall be arranged by bidder as on required basis.

23.02.21 **Support Grips:**

Cable support grips shall be either split or closed woven wire type.

23.02.22 Wire and Cable Markers:

Markers for wire and cable circuits shall be made of halogen & silicon free polyamide material with inflammability class V2 as per UL 94, ensuring scratch proof printing with the use of environment friendly solvent free ink & latest BLUEMARK UV technology so as to comply the WIPE RESISTANCE according to DIN EN 61010-1/VDE 0411-1.

Markers for wire and cable circuits shall be arranged to include a marker board, non releasing holding device, and cable fastening tail. The marker board shall not be less than 1 cm wide, 2 cm long and 0.5 mm thick. One side shall be roughened to hold black nylon marking ink. Identification shall be permanent and water proof. The holding device shall be designed to allow the fastening tail to pass around the cable through the holding device, and prevent the removal of the tail without cutting it loose from the marker.

23.02.23 Lacing Materials:

Lacing materials for field installed cable shall be non releasing nylon ties.

23.02.24 Splice Insulation:

Splices in control and signal wiring shall be insulated with all weather vinyl plastic electrical tape.

23.02.25 Installation:

Immediately prior to the installation of each cable or cable group, the raceway route to be followed shall be inspected and ascertained to be complete in installation and free of all materials detrimental to the cable or its placement. All cable assigned to a particular duct or conduit shall be grouped and pulled in simultaneously, using cable grips and acceptable lubricants.

All cables shall be routed as required by the circuit schedule.

If at any time during the progress of the work the Bidder finds raceways which appear inadequate to accommodate the assigned cable, he shall notify the owner at once and shall discontinue any further work on the questionable raceway until advised by the owner as to how he shall proceed.

All cables shall be carefully checked both as to size and length before being pulled into conduits or ducts. Cable pulled into the wrong conduit or duct or cut too short to rack, train, and splice as specified herein, shall be removed and replaced by and at the expense of the Bidder. Cable removed from one conduit shall not be installed in another conduit or duct without permission of the owner.

Fiber Optical Cables shall be routed through suitable grade permanently lubricated HDPE protection pipe as per IS 4984, IS 12235 & TEC.G/CDS-08/01 of suitable size @53% fill factor.

23.02.26 Termination:

The termination of cable shall be in accordance with the following requirements:-

- i) Train cable in place and cut squarely to required length. Avoid sharp bends.
- ii) Remove necessary amount of cable jacket and insulation without damage to the conductor.
- iii) Install terminals or connectors as required ensuring a firm metal-to-metal contact.
- iv) Terminate cable shields on one end only to the grounding bus provided in each I/O sub-system cabinets. Isolate these shields at field terminations and in junction boxes cabinets and panels when shielded cables connect between such equipment and the I/O sub-system cabinets.

23.02.27 Test after Installation:

All prefabricated cables furnished and installed under this specification shall be electrically tested after installation.

All cables shall be tested with the circuit complete except for connections to equipment.

All circuit failing in test satisfactorily shall be replaced or repaired and retested by the Bidder at his expense, as directed by the owner.

Cables which are only terminated by the Bidder shall be checked for continuity as they are terminated.

All equipment and labour required for testing shall be provided by the Bidder. Test instruments shall be directly traceable to the National Physical Laboratories as far as calibration is concerned.

23.02.28 Continuity, Identification and Short Circuit Tests:

All insulated conductors shall be tested for continuity and checked for conductor identification. In addition, all insulated conductors of multi-conductor cable shall be tested for short circuit. Short circuit tests shall include all tests necessary to confirm that no conductor of a multi-conductor cable is short circuited to another conductor in that cable.

23.02.29 Insulation Tests:

All insulated conductors shall be tested with a 1000 Volt megger or an equivalent testing device. Insulation resistance measurements shall be made between each conductor ground and between each conductor and all other conductor of the same circuit. Minimum acceptable resistance values shall be 500 mega-ohms.

23.02.30 Additional Tests and Checks:

The Bidder shall perform additional tests and construction checks in accordance with the sections of this specification dedicated to shop and site tests.

23.03.00 Bidder must offer general tools & tackles and special calibration instruments required during start-up, trial run, operation and maintenance of the plant.

S.No.	Details
1	Crimp pliers, for ferrules as per DIN 46228 Part 1+4, 0.14 - 10 mm ² , lateral insertion, square crimp
2	Cable cutter for copper and aluminum conductors
3	Stripping tool, for wires and conductors of 4 - 16 mm ² , self-adjusting, stripping length up to 18 mm, cutting capacity up to 10 mm ² stranded /1.5 mm ² solid
4	Screwdriver, bladed, matches all screw terminal blocks up to 4.0 mm ² connection cross section, blade: 0.6 x 3.5 mm, without VDE approval
5	Screwdriver, blade: 0.6 x 3.5 x 100 mm, length 180 mm
6	The digital multimeters with volt sensor function as per the internationally applicable standards IEC/EN 61010. The devices can be used in the case of voltages of up to 600 V, category III or 1000 V, category II.

23.03.01 The testing and commissioning tool shall be used for trial run/test operation of any drive in absence of DDCMIS/DCS/PLC during initial trial run and commissioning. While the tool shall be used for all type of drives envisaged in the technical specification, it is designed to be operated for one drive at a time. Minimum 2 nos. Portable trolley mounted system completed with necessary hardware like controller, I/O cards, relays, power supply modules, display etc. for operating the drives and monitoring its parameter shall be supplied by Bidder.

23.04.00 **Calibration, Testing, Installation and Commissioning:**

Bidder shall provide all testing facilities for each and every equipment/instrument in his scope as per detailed description provided in this specification. It is Bidder's responsibility for correct installations and commissioning of all equipment/ instruments in his scope. Bidder shall provide a group of highly skilled personnel for installation and commissioning of the entire equipments supplied under this scope.

23.04.01 **CALIBRATION**

- a) All instruments shall be calibrated strictly as per the manufacturer's instructions prior to installation. The scope of calibration includes all field instruments of all types namely electronic, electrical etc. Bidder shall use his own oil free instruments and air compressor for calibration purposes. Conversion from one unit to another for the purposes of calibration is not allowed.
- b) Procedures for calibration for different items are as outlined below. However, the detailed procedure shall be submitted to Owner for approval before proceeding with the calibration:-
 - i. All pressure and differential pressure transmitters shall be

calibrated to the settings as per instrument data/specification sheet and instruction of Owner. Pressure instruments shall be calibrated by applying pressure to the instrument using dead weight tester and manometer (for low pressure).

- ii. Receiver instrument shall be calibrated and aligned using test hookup as per instruction from the manufacturers/Owner.
- iii. Pressure transmitters shall be calibrated at 0%, 25%, 50%, 75% and 100% and vice-versa of range using dead weight tester.
- iv. DP transmitters shall be calibrated at 0%, 25%, 50%, 75% and 100% and vice-versa of range using dead weight tester.
- v. Control valves and positioners shall be checked for hysteresis and linearity and calibrated for rated strokes. Prior to calibration, valves shall be cleaned externally. The stem shall then be lubricated, if required and stroked few times to extreme positions of plug to ensure that movement is free from friction. The valve shall then be calibrated for rated stroke and linearity also. Subsequently, the valve shall be checked for hysteresis to the accuracy of 1% FS.

All calibration readings shall be recorded in the prescribed format and submitted to the Owner for approval. Where significant deviations from specifications are obtained, the matter shall be brought to the immediate notice of Owner for corrective actions. The bidder is responsible for calibration of all instruments/ items covered under the scope of works. The test reports shall be submitted to Owner on a daily basis. Calibration test facility shall be located near the work site.

23.04.02 LOOP TEST

- a) Loop test shall be performed after calibration of all instruments and leak test of signal lines. Loop test is conducted to check the functional performance of all elements comprising the loop thereby ensuring proper connections and operations. Before proceeding for loop test, the calibration results of individual elements shall be recorded on the prescribed Performa and shall get it approved by Owner for correctness of installation, measurement and calibration results. Loop testing for all control loops shall be generally by simulation of process conditions and shall fix points namely 0%, 25%, 50%, 75% and 100% of full scale inputs. Detailed procedure shall be submitted to Owner for approval before proceeding with the loop testing.
- b) The field/receiver pressure switches are simulated for abnormality by disconnecting the wires of terminals and function of all associated system are checked. Performance of individual loops may be accepted for an overall accuracy of $\pm 0.5\%$. Where deviations exist, bidder shall recalibrate the instruments, which forms part of the loop checking where required, at no extra cost. After the loop test is complete, the bidder shall connect back any terminations and connection removed for loop check. A loop shall be considered as completed, only after measurements in that particular loop are complete and certified by the Owner, in addition to loop sheets being duly filled in all respects and

approved by the Owner. Final certified loop sheet shall be submitted in four copies and one transparency.

1. Loop checking of following shall be carried out:
 - 1.1 All local loops
 - 1.2 All loops upto local (control) panels
 - 1.3 All loops unto control room
 - 1.4 All loops to control rooms for non-DCS/DCS instruments such as gas detectors, fire detectors and other special instruments.

23.04.03

TESTING**a) INSTRUMENT IMPULSE PIPING**

- i) Flushing of impulse piping shall be carried out while the line is pressurized after the isolating valve of the instrument is closed. The connection near the instrument shall be opened so that no dirt enters the instrument. Testing of impulse piping/tubing shall be carried out after the installation of instrument with primary piping/tubing and flushing is complete in all respects and approved by the Owner. Primary piping/tubing shall be tested hydraulically to 1.5 times the maximum operating pressure.
- ii) After thorough flushing, lines shall be isolated from both instrument and vessel/piping ends. After pressurization, the source shall be cut-off and the pressure shall not drop during 15 minutes testing period. The lines shall be blown with air, after hydraulic test. In case, no isolation valve is provided near the instrument, impulse piping/tubing shall be pressurized along with the instrument to the maximum pressure of the scale in case of pressure instrument and maximum operating pressure in case of differential pressure instruments with equalizing valve open. In special conditions, where hydrotesting is not permissible due to service requirement, the testing shall be carried out by using air/nitrogen as per instructions by the Owner.

b) INSTRUMENT AIR LINES/SIGNAL TUBING

- i) Flushing of instrument air lines shall be carried out while the line is pressurized to 7 kg/cm²g after disconnecting the SS316 tube at each air regulator upstream end. The line shall be blown for 15 minutes to remove trace of oil and dirt. The air regulator shall be taken in line, the SS316 tubing at the instrument end is disconnected and blown for 3 minutes to remove trace of dirt.

Testing of instrument airlines shall be carried out with instrument air at 7 kg/cm²g upto the upstream of filter regulators after thorough flushing. All lines shall be checked with soap solution and bubbler unit for possible leak at joints. All the signal tubing shall be tested with 1.5 kg/cm²g air after proper flushing.

- ii) All air tubing shall be tested and inspected by one of the methods given in ISA RP 7.1 "Pneumatic Control Circuit Pressure Test". Clean & oil-free instrument air shall be used for the test instrument air tubing and piping shall not be hydrostatically tested. Instrument air mains shall be isolated from the instrument and pressurized to 7 kg/cm²g. Then they shall be isolated from the pressure source and pressure reading on the gauge shall not fall by more than 1 psi in ten minutes or as per the acceptance of Owner.
- c) All cables (signal, control, T/C extension, special, power supply, etc) shall be laid as per the junction box/cable schedule. Before and after laying, the cables shall be tested for continuity and for the insulation resistance by a certified megger and checked for proper connections and results recorded and approved by the Owner. The testing shall be done after disconnecting the cable at both the ends. Cables shall be identified with aluminium tags at both ends and termination ends by PVC ferrules. Wiring shall be checked to ensure that is correctly connected and properly grounded. Correct connections of all electric switches shall be checked. Alarm operation checks shall be made by the bidder to check functionally all alarms and trip system. Wherever possible, process conditions shall be simulated to check the operation. Faults in wiring or piping shall be corrected in the presence of Owner.
- d) Earthing of local panels/cabinets etc shall be done as per the documents and instructions of the Owner. Erection procedure will be further discussed in detail after award of contract and shall be subject to the approval by client.