VOLUME - II, PART - 2

SECTION – 4

DETAILED TECHNICAL SPECIFICATION - CONTROL & INSTRUMENTATION SYSTEM

TABLE OF CONTENTS

GENERAL

1.0 INTENT OF SPECIFICATION

1. The scope of this Tender Specification is for 2 X 0.5 MLD Desalination plant to supply clear water to 2375MW RE Park at great ran of Kutch area, in the State of Gujarat. including all mechanical, electrical, controls & instrumentation as specified herein covers design, engineering, procurement, manufacture, inspection and testing at the manufacturer's works, supply, packing & forwarding, transport and delivery at FOB (2375MW RE Park at great ran of Kutch area), erection, pre-commissioning, testing, commissioning, performance testing, Guarantee testing of all equipment's and operation for 5 years", forming a part of the power project, which are deemed to be part of Desalination plant Contractor's scope. It is not the intent to specify herein all details of materials. Any item related to this work not covered by this but necessary to complete the system will be deemed to have been included in the scope of the work.

2. It is not the intent to specify completely herein all details of design and construction of the equipment. However, the equipment will confirm, in all respects, to high standards of engineering, design and workmanship and be capable of performing in continuous commercial operations up to vendor's guarantee in a manner acceptable to Owner.

3. The general terms and conditions, instruction to Bidder and other attachments referred to elsewhere be hereby made part of the technical specification. The Bidder's offer shall conform to all requirements stipulated in the specification.

4. All instruments required for the PG test of Desalination plant shall be in the scope of Bidder.

5. The Instrumentation & Control (I&C) system for the 2 × 0.5 MLD desalination plant shall include complete design, supply, installation, testing, and commissioning of a fully automated, PLC–SCADA-based control system with redundant CPUs, power supplies, and communication networks. It shall cover all process areas — pre-treatment, RO, chemical dosing, CIP, product water, and brine disposal — and integrate with the plant's central monitoring system. The scope includes all field instruments (SMART transmitters, analyzers for pH, conductivity, turbidity, SDI, chlorine, silica, etc.), control valves, MOVs, Pressure Gauge, Temperature Gauge, communication network, and UPS with redundant DC supply.

6. The system shall ensure safe, reliable, and fail-safe operation with full alarm, event, and trend logging on SCADA with real time monitoring; include CCTV, fire detection, and intercom systems; and meet relevant IEC, ISA, and ISO standards. Each type of Calibration instruments required for Plant, documentation (I/O lists, logic, drawings), and FAT/SAT testing shall be part

of the bidder's scope, along with operator training and a comprehensive post-commissioning AMC of 3 years.

7. All supply, design, detailed Engineering, Erection and commissioning & O&M of the Desalination plant C&I system shall be based on this specification. It shall be noted by the bidder that the tender specifications given for PLC are only the minimum requirement and detailed specifications shall be furnished by the Bidder for Purchaser's review and approval during detailed engineering stage.

8. A consistent control and instrumentation philosophy shall be applied throughout the plant and be implemented in terms of a range of equipment exhibiting minimum diversity of type and manufacture.

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

2.0 TYPE OF INSTRUMENT & CONTROL

1. The complete operation, monitoring and control of the Desalination plant including Pre-treatment, RO and distribution shall be performed from the dedicated redundant PLC based control system located in the Desalination plant control room. Desalination PLC will be interfaced to PSS-1 HPCMS (Hybrid Park Control and Monitoring System) on MODBUS TCP/IP, for this required cables, ethernet switches, hardware and software shall be in scope of bidder. Bidder shall interface Desalination plant data with HPCMS for Monitoring.
2. Start / Stop command, On/off/trip status of all pumps/ blowers, drive motor, monitoring of vibration, etc. shall be provided with arrangement of local starting & stopping. Local starting shall be possible through remote/ local select switch.

3. Tripping of drive motors locally shall be possible irrespective of position of remote local selector switches. Necessary logics for control & operation of the plant shall be implemented in Desal PLC.

4. Annunciations for abnormal conditions like conductivity, pH and silica levels, shall be indicated in the Desalination control room.

5. The Bidder shall be fully responsible for design, materials selection, sizing and selection of the proper instruments for the C&I system.

6. The bidder shall refer to the attached Desalination Plant PLC system configuration drawing. (FCE-1721125-IWE-DWG-IC-6101-001)

7. Design, engineering, procurement, supply, calibration, installation, testing and commissioning of all local and remote instruments, Analysers , Water quality monitoring systems, Pneumatic control valves, MOVs with integral actuator, , PLC based control system, Operator workstation cum Engineering workstation, Local control panels, Redundant UPS & Batteries, Battery charger, Battery Health Monitoring system, Junction Box, Local Instrument enclosure, Control desk, operator chair, printer table, power, control, Instrumentation Cables, Communication cables, special cables, Fiber optical cables, CAT6 cables, earthing cables, Cable tray, conduits, pneumatic tubing and process piping, Erection hardware, Cable glands, Structure and supports, earthing, including performance test instruments and other facilities necessary to ensure the completeness of the Desalination plant and to meet the specification requirements is in Bidder scope.

8. Supply of hot redundant PLC based control system with Processor, Non-Redundant I/O modules, redundant communication modules, redundant power supply modules, redundant ethernet switches, relays, marshalling cabinets, LIU, media convertors, protocol convertors, patch cords, communication cables, etc. Hot redundant controllers shall be provided for Desalination Plant PLC. However, the final number of controllers shall be determined based on the I/O handling capacity, controller loading, and other technical specification requirements.

9. RIO panel in the PSS-1 AND PSS-2 of the GIPCL for the controlling of the loads from the PSS-1 and PSS-2 switchgear.

10. The Desalination plant control room shall be provided with one number of OEWS (32" LED monitor), The operation of Pretreatment, RO shall be fully automatic (sequentially).

11. Supply of Operator / engineering control desk, Operator chair and printer table for the Bidder supplied control system and facilities.

12. Supply of One (1) No. of Control desk for the purchaser supplied PLC Operator cum Engineering station in Desalination plant control room.

13. Supply of 3 no's of CCTV camera and 2 no's of telephones as per the technical specification and the interfacing with the existing telecom and the CCTV system in the existing plant. CCTV cameras shall be provided with remote terminal units, and the necessary UPS power supply shall be provided from the UPS supplied by the bidder for the control system. Fibre optic cables, Co-axial cables, control cables, Data cables, power cables & any other cables with cable accessories

such as cable trays conduits, supports etc as require for interfacing requirements shall be supplied as per the existing plant CCTV make and model numbers. The make and model number of CCTV shall be informed during the detailed engineering. Telecommunication cable shall be laid from the existing nearby JB to the telephone and shall be kept in the operator room. Bidder shall supply the CCTV Cameras compatible with the Existing system from the provided vendor list.

14. Supply of redundant UPS, Battery with 60miniutes Back-up time, Battery charger and BHMS for the complete control system and instrumentation with sufficient capacity is in Bidder scope including for the power supply requirement for the purchaser system.

15. The Desalination Plant PLC -based control system shall be connected to a dual redundant high-speed fibre optic data highway and interface with the purchaser's common DCS (Distributed Control System) located in the main plant's CCR (Centre control Room) for centralized monitoring. The Bidder shall provide the supply of redundant single-mode Fiber optic cable (SMFO) from the Desalination Plant PLC to the DCS. The Bidder shall also provide the Light Interface Unit (LIU), media converter, and patch cord at the Bidder's Desalination Plant PLC end.

16. The Desalination plant PLC shall be time-synchronized through the master clock system using the NTP (SMFO) protocol. The redundant SMFO cable from the Desalination plant PLC to the purchaser's Master Clock System panel located in the central control room of the GIPLC Main plant. The Bidder shall also provide the Light Interface Unit (LIU), media converter, and patch cord at the both the end.

17. Soft link interface with UPS, Battery charger, BHMS, Switchgear IEC 61850, etc. shall be provided with Desalination Plant PLC. Bidder to consider necessary Software and hardware in the respective systems / equipment.

18. The supply of all field instruments within the battery limit, as per the approved P&ID (Piping and Instrumentation Diagram), operation and control philosophy, protection, control, interlock, and monitoring schemes, etc. as approved during the detail engineering stage, shall be included in the Bidder's scope.

19. The supply of all Analysers, Water quality monitoring systems within the battery limit, the Analysers are as per the approved P&ID (Piping and Instrumentation Diagram), operation and control philosophy, protection, control, interlock, and monitoring schemes, etc. as approved during the detail engineering stage, shall be in the Bidder's scope.

20. The supply of all Pneumatic ON/OFF, control valves within the battery limit, as per the approved

P&ID (Piping and Instrumentation Diagram), operation and control philosophy, protection, control, interlock, and monitoring schemes, etc. as approved during the detail engineering stage, shall be included in the Bidder's scope.

21. The supply of all Motorized operated valve with integral actuator within the battery limit, as per the approved P&ID (Piping and Instrumentation Diagram), operation and control philosophy, protection, control, interlock, and monitoring schemes, etc. as approved during the detail engineering stage, shall be included in the Bidder's scope.

22. Supply of Junction box and local instrument enclosure for all the field instruments supplied by the Bidder.

23. Supply of complete Power, control, Instrumentation, special, communication Cable between all the field instruments, Analysers, Valves, MCC, Switchgear, Local control panels, JB, PLC, CCTV, Telephone etc is in Bidder cope.

24. Supply of erection hardware, tubes and fittings, cable glands, pneumatic and process hook up hardware, Cable tray, conduits, cable ties, structure and structure support.

25. Supply of Electrical and Electronic earth pit and earthing cables as required for the complete system is in Bidder scope.

26. Supply of necessary instruments for performance testing.

27. Supply of mandatory spares

28. Supply of any other control & instrumentation items as required for the successful completeness of the C&I system for desalination plant but not specifically indicated above shall also be is in Bidder scope.

29. Any other requirement found during detailed engineering, but not specifically indicated above shall also be complied by Bidder.

30. Erection, Commissioning, Trial run, Operation & PG test for the complete system supplied under this package.

3.0 DESIGN REQUIREMENTS

1. Redundant Control and Instrumentation systems shall be provided such that no single failure can cause a Desalination plant shutdown or process interruption or loss of pre-treatment, RO,

product water, brine disposal, CIP, and chemical dosing.

2. The design of the control systems and related equipment shall adhere to the principle of 'Fail Safe' operation wherever safety of personnel / plant equipment is involved. 'Fail Safe' operation signifies that the loss of signal, loss of excitation or failure of any component shall not cause a hazardous condition. However, it shall also be ensured that the C&I system design with respect to control and protection functions is 'Fault Tolerant' to single faults such that the occurrence of false trips and degradation of functions are avoided / minimized. The types of failure which shall be considered for ensuring operability of the plant shall include but not limited to.

    a. Failure of sensor or transmitter
    b. Failure of main and/or redundant controller, other electronic modules
    c. Loss of motive power to final control element
    d. Loss of control power
    e. Loss of instrument air

3. 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.

4. Standardization concepts shall be applied wherever possible to rationalize operation, maintenance and reduce spare parts. The choice of hardware shall also consider sound maintainability principles and techniques. The same shall include but shall not be limited to the following:

    a) Standardization of parts.
    b) Minimum use of special tools.
    c) Grouping of functions.
    d) Interchangeability.
    e) Malfunction identification facility/self-surveillance facility.
    f) Easy modular replacement.
    g) Fool proof design providing proper identification and other features to preclude.
    h) Improper mounting and installation.
    i) Appropriate derating of electronic components and parts.

5. The identification system (tag numbers) shall be in accordance with the ISA identification system and shall be subject to approval by the Owner / consultant.

6. The overall Control and Instrumentation (C&I) system design and philosophy shall ensure, the following:

a) Maximize safety for plant personnel and equipment.
b) Safe, reliable, efficient, and easy operation of the plant under all operating conditions.
c) Maximize availability and efficiency of the plant through system redundancy.
d) Consistent control and instrumentation philosophy - usage of standard functional modular hardware and software design
e) Ability to operate under all specified conditions (Start- up, normal operation, disturbance and shutdown) automatically and/or by remote manual control from relevant control room.
f) Malfunction of any component or loss of supply leading to fail-safe condition.
g) Provide accurate and reliable information to the plant operator and management.
h) Provide the operator the following facilities:
    - Complete information for plant equipment status/abnormal and critical Conditions.
    - Alarm notification.

7. The C&I system shall enable the operators a comprehensive operation and supervision of the plant. The following basic requirements shall be considered.

8. All functions for protecting plants and equipment shall proceed in all cases reliably and without manual intervention. The plant protection system shall prevent the unit from attaining impermissible loading conditions and, should any faults arise, shall keep their consequences within the specified limits. The same applies for switch-on and switchover functions of redundant and reserve equipment with the possibility for preselecting the operating equipment.

    a) Automated Plant startup and shutdown system through various group levels with minimal operator intervention control concept.
    b) All drives shall be remotely operable from the operator's console in the Desalination plant control room.
    c) To ensure the highest possible availability faults shall be automatically handled and recorded.

9. The implementation of the control and instrumentation system would be based on a state-of-the-art PLC based control system. The Desalination Plant PLC system shall be interfaced with the GIPCL PSS-1 HPCMS for monitoring from the plant centralized control room. Provision for Engineering laptop access shall be provided from the existing plant control room with necessary engineering license and the software provisions and shall be IP based communication shall be provided.

10. The PLC shall be of open architecture type having high system availability and reliability. The minimum target reliability of each electronic module/card, Power supply, Peripheral etc. shall be established considering its failure rate/Mean Time Between Failures (MTBF), Mean Time to Repair (MTTR), such that the availability of the complete C&I system is assured for 99.7%. The use of redundancy for the control system shall be in an extensive manner to ensure safety, availability and flexibility of operation. The general failure criteria as a minimum shall be that a single failure shall not cause any failure of control system, any plant equipment or trip the unit (single failure tolerance criterion). The design of the control systems and related equipment shall adhere to the principle of 'Fail Safe' Operation wherever safety of personnel / plant equipment is involved. 'Fail Safe' operation signifies that the loss of signal or failure of any component shall not cause a hazardous condition due to factors like failure of sensor or transmitter, controllers, power supply, instrument air etc.

11. For designing the system all the specification requirements shall be considered, wherever applicable. All components and systems offered by the Bidder shall be of established reliability. The maximum reliability shall be achieved by the Bidder considering the meantime between failures (MTBF) and meantime to repair (MTTR) such that system shall be available for 99.7% or better.

12. Provide control, operation, and monitoring of all the individual drives from PLC.

13. Provide alarm annunciation system, plant monitoring display, trend, logs, and reports.

14. The PLC shall be capable of fulfilling all the requirements of the plant in an optimal way. The offered system shall have been in satisfactory operation for at least two years in a similar plant of the same capacity and confirm guarantee against obsolescence for 15 years. The PLC offered shall be of the latest design & configuration available on the market. The operating system shall be based on the latest windows platform (Windows latest) with the latest service packs. The offered system should be of a single family of hardware/software and developed as a total system.

15. It is the responsibility of the PLC supplier to supply all necessary control system hardware and software equipment for the safe, efficient, and reliable functioning of the Desalination plant. Equipment and systems shall be provided with sufficient reserve margins and adequate redundancies to accommodate a wide range of operating conditions and to ensure both high availability and operational flexibility. The redundancy provided at different component levels shall enable online automatic bump less switchover to the healthy component in case of failure in any one of them. The faulty component shall be replaceable online without affecting the

functioning of the system. The equipment supplied must be well proven, safe, and meet the standards of good engineering practice. The detailed requirements to follow are not intended to constrain design, structural or operational characteristics to such an extent that conventional or proper features are omitted, nor do they relieve the Bidder of providing those features which are necessary or advisable for proper installation, startup operation and maintenance of the equipment.

16. Technical specifications specified for all types of hardware, equipment & software are the minimum requirements to be met and confirmed by the bidder.

3.1 The following control system redundancy shall be considered,

a) If PLC should be controller based and shall be hot redundant and shall be independent of the historian (3-year storage), engineering station or operator station.

b) The system shall be designed in such a manner that in the event of failure of the primary controller, the entire configuration of the failed controller shall be instantaneously and automatically transferred to the back-up controller without operator's intervention. Mode changeover in either direction will be bump less.

c) The communication sub system shall be a real-time reliable communication network between control processor, operator station.

d) Industrial graded Hooter annunciation shall be provided for audio annunciation of any abnormal conditions of the process system in addition to visual annunciation in workstations.

e) Each communication Network shall be industrial graded and shall be provided with 1Gbps speed, industrial grade managed type Ethernet switches, external surge protection system/devices and industrial firewall. Industrial grade managed type Ethernet switches shall be provided with in built diagnostic features, 20% spare ports.

3.2 The PLC shall have the following features:

a. The PLC system shall fulfill all demands emanating from the domains.
   - Automation
   - Monitoring
   - Process control
   - Management
   - Engineering

b. Uniform operator machine interface

c. Reliable user guidance
d. Comprehensive redundancy concept
e. Modern object-oriented software structure
f. Communication with external system and intelligent field equipment
g. Simple central project planning and configuration aids
h. Integrated documentation system
i. Integrated diagnosis and service
j. Commissioning support

3.3 The PLC will comprise of the following sub-systems / functions.

a. Measurement system
b. Control system including closed loop controls and interlock, protection, and sequential control system.
c. Data bus system for control and communication with the process
d. Man-machine interfacing system.
e. Maintenance engineer's system (Engineering Station)
f. Historical data storage and retrieval facility
g. Performance monitoring sub system
h. Interfacing with other control systems and equipment
i. Software & licenses

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

a. The system shall have the flexibility to easily reconfigure the 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.

b. Fault Diagnostics

The diagnostic system shall ensure that the faults are detected before any significant change in any controller output has taken place. Controller etc. shall be suitably grouped and annunciate to Annunciation facia on OWS.

c. Bidder to calculate the actual BOQ (No. of PLC panels, I/O Modules, CPU Modules, Fiber optic interface etc.) of the offered PLC as per technical specification/system requirement, PLC spare philosophy, CPU loading etc. for their entire system.

3.5 Measurement System (MS)

The measurement system shall be complete with a processor, signal conditioning and

monitoring cards and function cards to perform measurement system functions. The system shall also be capable of transmitting the data to the HMI display unit for display to the operator.

3.6 Closed Loop Control System (CLCS)

The closed loop control system shall be complete with processor, signal conditioning and monitoring cards and function cards to perform control system functions. The system shall also be capable of executing commands from HMI through keyboards / from operational hardware located on the local control panels besides transmitting the data to the HMI display units and printers.

3.7 Interlock, Protection and Sequential Control System (Open Loop Control System)

Interlock protection and sequential control system shall be complete with processor, signal conditioning and monitoring cards and function cards to perform the sequential and combinational logic functions. The system shall also be capable of executing commands from HMI through keyboards / from operational hardware located on the local control panels besides transmitting the data to the peripherals.

3.8 Specific Design Requirements

The drive control philosophy for various drives to be followed as per attached Drive control philosophy document FCE-20123170-IC-DWG-DCP-4200-002

3.9 Final Actuators

All regulating type final control elements shall have actuators of pneumatic type/ Electrically actuated. Actuators shall be sized in such a way that the valves operate properly even when the upstream pressure exceeds 10% of maximum value. Actuators shall be provided with air failure lock to obtain the required fail-safe condition, control contacts as warranted, adjustable minimum / maximum stops, local position indication and two (2) wire electronic position transmitters with solenoid valves wherever necessary and air filter regulator. Fail safe action of the final actuator shall be as follows:

i. Modulating control - Stay put or move to safe-end-position
ii. ON/OFF control - Move to safe-end-position

All actuators shall be provided with hand wheel for local operation and motor operated valve (MOV) shall be of Integral starter type.

3.10 Control Valves

The control valves shall be capable of handling at least 130 percent of the required maximum

flow at full open condition. Control valves shall be provided with manual isolating and bypass valves for facilitating maintenance wherever alternative flow paths are not available. Current to pneumatic converters and positioners shall be used for all regulating services. Two wire electronic position transmitters with 4-20mA signals output and limit switches shall be provided on the valve wherever required depending upon the system requirement.

All control valves and control dampers and all On-Off Dampers shall have Pneumatic Actuators.

3.11 Instrumentation& Control (I&C) Cables shall have the following size:

a) Instrumentation cables single pair / multipair will be 0.5 sq.mm respectively.

b) Control wiring for actuating devices and solenoid valves of the interlock and shutdown system will generally be 1.5 sq.mm2 multicore armoured cable.

c) Control wiring for MCC/LT Drives to PLC shall be 1.5 sq.mm.

d) Multicore cables will run between control room and field junction boxes.

e) Power supply cables to field instruments will be minimum 2.5 mm2 (copper) armoured and will normally be laid directly to the instrument.

f) Individual pair shielded & overall shield twisted pair copper cables will be used for analogue signals & overall shielded cables will be used for digital signals.

3.12 Other requirements:

a. The bidder shall follow uniform Tagging philosophy and shall be of ISA.

b. All Local Panels shall be included as required. The bidder shall include in the offer a list of the same along with functional details.

c. The I&C equipment design shall be suitable for continuous operation under the environmental conditions specified under Project information.

d. All the communication cables shall be laid in conduits.

e. All statutory requirements shall be met as required.

f. Makes shall be as per the list of approved makes in this specification.

g. All specified documentation shall be submitted in both soft and hard copies as per Purchaser's requirement and format.

h. Separate redundant electronic earthing system with dedicated earth pit shall be provided for control system of each PLC's and its associated plant instrumentation.

i. The control system shall be provided with a high degree of automation to minimize operator intervention. The controls shall be configured in a hierarchical structure including Group control, Subgroup Control, Sub Loop Control and Individual Drive Control. All the required Hardware and software to implement the above hierarchical structure shall be included in the scope of work.

j. Trending and logging facilities shall be provided for all those parameters whose trends are necessary for safe and efficient operation of the plant and measurement of plant performance.

k. All I&C cables including compensating cable, special cable, Fiber Optic cable shall be shielded and armoured. The PLC and DCS serial link cables/Bus cables shall be through conduits. Direct cables between cabinets (whichever is not routed through conduits) shall be treated with Anti-Rodent treatment.

l. The enclosed Bid purpose flow diagrams are indicative only. The actual P&IDs of Bidder shall include all the specified requirements including those indicated in flow diagram, along with Tag numbers, functional description of the signals, control loop references for OLCS and CLCS, Legend etc. Also, the Bidder shall indicate all Field mounted, Local Panel mounted, PLC displayed Measurements using Standard symbols along with alarm, protection, interlock and control functions based on the Redundancy Philosophy mentioned in the specification.

m. The bidder shall include all the measurements necessary for the safe, efficient, reliable and fully automatic operation of the entire plant including all fail-safe requirements and recommendations of each equipment manufacturer.

3.13 Redundancy in PLC

The Cyber secured PLC systems shall be provided with redundancy for the processor modules, communication modules, SCADA servers, Power supply modules, I/O bus, data bus and the communication bus. Redundancy is not envisaged for the input/output modules. Redundant Processor shall be configured in Hot-standby.

The PLC processor shall perform CLCS, OLCS, MS functions simultaneously.

3.14 Sensor redundancy for OLCS

All sensors for the following causes of trips shall be dual and sensors for Closed loop control system (CLCS) shall also be dual.

- All HT equipment trips.
- LT equipment trips.

Single sensors shall be provided for the following

- Alarm,
- Permissive
- Indication

3.15 The control system shall be capable of total integration of the following functions / systems:

a. All instruments required for the automatic operation of plant shall be supplied as a minimum and comply with applicable requirements set forth in these specifications. The bidder shall confirm that the type, make, and model of all bought out items supplied by the bidder under the specification shall be subject to the approval of the Owner during detailed engineering stage.

b. All standards and codes of practice shall be of the latest version. Bidder shall refer relevant section for applicable codes and standards.

c. All equipment supplied against this specification shall be given tropical & fungicidal treatment in view of the environmental conditions prevailing at site as described under project data.

d. The design, material selection, constructional features, manufacture, inspection, testing and performance of all Instrumentation & Control equipment shall comply with all currently applicable statutory regulations and safety codes in the locality where the equipment are to be installed.

e. For Alarms, Protection & Interlocks, the instrument contacts (Pressure switches, Temperature switches, Level switches etc.) shall be avoided and transmitters shall be used. The corresponding Primary sensor / transmitter signals shall be used through PLC.

f. On failure of power supply or PLC / microprocessor fault, output shall be automatically switched over to fail safe mode - either locking in place or driving to open / closed position as required.

g. All signal schemes shall be audio-visual. When one fault is being announced, the system shall be capable of receiving the second fault. The audio signal shall be automatically silenced after a pre-selected time. The fault shall be always available on the video page

until the fault is cleared and acknowledged.

h. SS Legend plates shall be provided on the cabinet front and back, local panels, junction boxes, transmitter racks, instruments, control valves etc., for all items supplied to identify the equipment.

i. The Inside & outside colour of all instrumentation cabinets, control desks, consoles, local cabinets, marshalling cabinets, system cabinets, junction boxes, transmitter racks, etc. shall be RAL7035. This shall hold good for instrumentation cabinets of all auxiliary units also. However, this shall be approved during the detailed engineering stage.

j. Unless otherwise specified cable entry for panels / desks / cabinets shall be through bottom via glanding plate. Fireproof seal shall be used to seal the bottom to prevent entry of dust.

k. Equipment inside the cabinets shall be so located that their terminals and adjustments are readily accessible for inspection and maintenance.

l. All the equipment fed from electrical system and installations shall meet the statutory requirements of relevant Electricity Rules.

m. The transmitters and other instruments shall be grouped together and mounted:
    i. Local instrument racks (LIR) in covered areas.

n. Standpipes shall be provided as required in tanks for all level instruments (LT, LS & LG).

o. Enclosure outer shall be constructed from at least 3 mm thick steel plate and epoxy Painted to shade RAL7035. The base frame shall be made of 100mm and black colour finish.

p. All RTD and TC supplied for this project shall be duplex element type with remote mounted temperature transmitter.

q. Actuators shall be sized in such a way that the valves operate properly even when the upstream pressure exceeds 10% of maximum value. Actuators shall be provided with air failure lock to obtain the required fail-safe condition, control contacts as warranted, adjustable minimum / maximum stops, local position indication and two (2) wire electronic position transmitters with solenoid valves wherever necessary and air filter regulator.

r. The control valves shall be capable of handling at least 130 percent of the required maximum flow at full open condition. Control valves shall be provided with manual isolating and bypass valves for facilitating maintenance wherever alternative flow paths are not available. SMART type positioners with HART compatibility shall be used for all regulating services.

s. The instrumentation to be provided for each of the plant auxiliary 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 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.

t. Instrument material specification shall be consistent with the operating parameters like temperature, pressure, corrosion and other process conditions.

u. Screened cables shall be of twisted pair type and shield shall be earthed at one end only inside the control room.

v. All instruments mounted on pulsating service shall have pulsating dampers.

w. Conduits, junction boxes, and pull boxes shall be properly grounded.

x. All the cores of the cables shall be marked with ferrules. Identification no. of the cores shall be incorporated at regular short intervals. Metals tags shall be provided at both the ends of the cables for identification.

y. All electronic/electrical instruments, junction box and control panel shall be suitable for area classification as per IEC/NEC codes.

z. The transmitters and switch devices shall be grouped together and shall be placed in different local instrument enclosures in open and dust prone areas and in local instrument racks in covered areas in suitable locations. Measurement gauges shall be provided locally.

aa. After completion of cable laying work, all cable bushings on the cabinets & desk shall be filled with fire resistant sealing compound against the floor and pipe. The instrumentation earthing system wherever necessary must run to a common pit as per standard. All the cables entering the main control room shall be properly filled and sealed with fire resistant sealing compound against the floor and pipe.

bb. Bidder shall submit written description and logic scheme during engineering. Bidder shall also refer to the relevant section for documents to be submitted.

cc. All the instrument fittings and impulse tubing material shall be SS316 tubes and fittings.

dd. Separate junction boxes shall be provided for analog, digital, power (SOV & relay), thermocouple and RTD signals.

ee. All the instrumentation cables and trays shall be provided and installed from field instruments up to the field JBs.

ff. All local gauges as well as transmitters, sensors and switches for parameters like pressure, temperature, level, flow etc. as required for safe and efficient operation and maintenance as well as for operator and management information (including all computation) of equipment under the scope of specification shall be provided on as required basis within the quoted lump sum price. Tentative, minimum instruments have been indicated in the enclosed P & IDs. However, the bidder shall supply any additional local gauges/switches/transmitters/sensors required during detailed engineering for reasons mentioned above or required by owner without any additional cost to the Owner.

3.16 Measurement and Control System

- The measurement system shall have the following features:
- Linearization for temperature measurement i.e., mV Vs Deg. C, RTD vs. deg C.
- Square root extraction for flow measurement, where the measurement is in differential pressure.
- Integration for totalizing the flow measurement, wherever applicable.
- Compensation for variation in pressure or temperature or density for flow / level measurement.
- Limit value monitor for generation of contacts for alarm / interlock.
- All inputs which are shared between different systems e.g., PLC etc., shall be multiplied at the input level through diode auctioneering.
- Bad inputs, open loop inputs shall be automatically inhibited from controls, and a failure alarm shall be provided.

3.17 Basis for provision of instruments/tapping points

- Instrumentation and control systems shall be supplied in accordance with the various sections of the specification including the following:
- Redundancies in sensors shall be considered as specified elsewhere.

3.17.1 Pressure indicators shall be provided the applications include,

- Suction and discharge lines of each pump, including one header section, if two or more pumps are employed for the same service.
- Suction and discharge lines of fans, including on header section if two or more fans are employed for the same service.
- All input and output lines of process equipment.
- Inlets and outlets of heat exchangers (both the fluid media).

3.17.2 Pressure Switches shall be avoided as far as possible and in place, smart pressure transmitters with soft limit value monitoring in PLC shall be provided. The applications include:

- On all process lines / Equipment's where parameter abnormality/status including pre trips alarms to be communicated to the operator in control room.
- For all permissive and protection conditions governed by safety operation of the equipment. e.g. Pressure adequate, pressure very high/very low conditions.
- For all interlock conditions which govern starting of standby equipment or subsequent equipment for safety operation of the system.
- Two switches shall be employed for protection in case of critical applications.
- Inlet and outlet of filters/strainers.

3.17.3 Differential Pressure transmitters (indicating type) shall be provided,

- Across filters/strainers for remote monitoring

3.17.4 Differential Pressure Indicators shall be provided,

- Across filters/strainers for local monitoring

3.17.5 SMART Pressure Transmitter shall be provided,

- For all control applications included in Bidder's scope and as demand by the process. It shall be noted that for all critical control applications, 2 transmitters shall be provided.
- Pressure stubs with isolating valves shall be provided for mounting Pressure Transmitters

3.17.6 Differential Pressure Transmitter shall be provided,

- For all the requirements of Diff. pressure, flow, level measurement.
- Pressure stubs with isolating valves shall be provided for mounting Pressure Transmitters.

3.17.7 Temperature indicators (Thermometers) shall be provided,

- On all process lines where local indication is warranted by the system either for monitoring or testing.

3.17.8 **Temperature Elements:** RTDs shall be provided for casing metal temperature monitoring and bearing temperature monitoring of all HT drives/motors.

- All thermocouples and RTDs as required for implementation of control & monitoring in Bidder's system, shall be supplied.
- All temperature elements shall be supplied with associated junction box.
- All JB terminal strips shall be of copper or of the same Thermocouple material.
- Six nos. (2 nos. per phase) Resistance temperature detectors (RTDs) shall be provided for all HT motors, for winding temperature monitoring. Each element shall be a 3-wire type, duplex with thermowell assembly. RTDs shall be terminated in the external terminal box, for connection to the PLC system.
- Temperature gauge shall be provided for the bearing temperature monitoring in local.
- Use of temperature switches shall be avoided.

3.17.9 Smart Temperature Transmitters shall be provided where TCs/RTDs are for all the applications.

Wherever possible, for the purpose of Alarms, Protection &Interlocks, the instrument contacts (Pressure switches, Temperature switches, Level switches etc.) shall be avoided. The

corresponding Primary sensor / transmitter signals shall be used through PLC.

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

3.17.11 Level switches shall be provided where only it is not possible to provide level transmitters:

- On all equipment (storage vessel) where parameter abnormality/status must be communicated to the operator in the control room.
- All permissive, interlock and protection conditions governed by the safety operation of the equipment. For all critical services, three switches shall be provided for protection applications.
- The instrument shall be external cage type with SW connection with isolation facility for surface mounted tanks and top mounted with still pipe for all sumps. Still pipes shall be provided with adequate support.

3.17.12 Level transmitters stubs with impulse pipes, root valves for mounting Level transmitters shall be provided on process equipment where continuous remote monitoring and/or control of level is envisaged. Wherever necessary standpipes or float chambers shall be provided and makeup line for filling up the constant level vessel shall be provided.

- Ultrasonic Level transmitter shall be provided for all water applications.
- Radar type level transmitter shall be provided for application of slurry, foaming, liquid with temperature, viscous, etc.
- The instrument shall be differential pressure type for other applications.

3.17.13 Pneumatically Operated Control Valves shall be provided for all control applications. If the process demands any other control, then control valves shall be provided for those applications also. Where a single control valve cannot meet the turn down ratio as dictated by the process, control valves with split range application shall be provided. All bypass valves of control valves shall be motor operated valves suitable for inching operation provided with position transmitters. All integrated bypass valves shall be motor operated.

- Pressure test points & drains shall be provided across each control valve.
- The pneumatically operated control valves shall be provided with Smart Positioners, diagnostics and HART compatibility. Control Valve diagnostics shall be transmitted through this HART Protocol to PLC.

3.17.14 Position Transmitters

Shall be provided for all motorized inching valves and control valves. Position transmitters shall be 24 VDC, 2 wire, System. Electro-Pneumatic Positioners shall be provided for all pneumatically operated control valves, power cylinders etc., for converting controller output of 4-20 mA to 3-15 PSI (0.2 -1 kg/cm2) for interfacing with pneumatic actuators.

3.18 Air filter regulators along with gauges shall be provided in each of the following:

- Air supply line to valve positioners /power cylinders
- Air supply line to electric to pneumatic converters
- Air supply line to pneumatic interlocked block valves
- Transmitter Racks

3.19 Junction Boxes/Field Termination Cabinet:

All JBs shall be FRP. All Field mounted JBs shall be provided with canopy. Junction Boxes shall be provided for

- Termination of all sensors located equipment wise.
- Termination of Duplex Thermocouples / RTDs
- Termination of limit switch, torque switch, position transmitter and control demand, independently for each valve.

3.20 Instrument Air Supply System

Dry instrument air shall be distributed to various equipment of C&I system like control valves, Analyser purging, Transmitter racks, pneumatic On-Off dampers. The Bidder shall arrange to be required instrument air with necessary reservoir for the Instrument air supply. Necessary compressor/ blower shall be included in the scope of the bidder.

3.21 Impulse pipes/tubes & fittings

Impulse pipes, fittings and air supply and signal piping/tubing shall be supplied for all the instruments. Instrument piping shall be designed for maximum design pressure and temperature of the process. Pressure measurement connection shall be ½'' or 12mm pipe depending on the temperature and pressure conditions of the fluid. Instrument on Vacuum system should have vent lines connected to high point. The instrument air tubing shall be SS316.

3.22 Instrumentation & control cables and Prefabricated Cables with Anti-Rodent treatment shall be supplied to

(a) Connect field instruments to field junction boxes/Local Panels. For switches, both the SPDT contacts of switches shall be wired to J.B.

(b) Connect limit switches, torque switches and position transmitters to their respective

field junction boxes.

(c) Compensating cable shall be supplied for connection between the element and the respective junction boxes / system cabinets as per guidelines.

(d) Prefabricated cable for connecting between system cabinets, marshalling cabinet to system cabinet, system cabinet to relay rack, system cabinets to Operator workstations, system cabinets to Engineering workstations etc. shall be in bidder's scope.

(e) Entire I&C cable within the battery limits.

3.23 Instruments for Performance Testing

All instruments required for performance testing to prove the guaranteed performance of the plant shall be supplied by the Bidder for the Performance Test. These test instruments shall have test certificates from reputed test house, valid for the duration of the performance test.

3.24 Instrument Air Supply System

Dry instrument air shall be generated and distributed to various equipment's of I&C system like control valves, Transmitter racks, pneumatic On-Off valves, dampers.

3.25 Cable Tray Grouping

a) A separate cable tray shall be provided for instrumentation cables extension cables, etc. Instrumentation cables shall run through the topmost cable tray.

b) A maximum of two Layers of cables shall be laid in each cable tray.

c) Inside the control room the system cables and Bus cables shall run only through cable trays or conduits. Also, the PLC cables through the false flooring shall also be through dedicated closed cable trays and conduits.

d) All the control room cabinets, field JBs etc. shall have bottom Cable entry.

3.26 Selection of ranges for instruments

The ranges of the instruments shall be selected based on the following philosophy indicated below:

- For pressure and draft measurements, the maximum operating pressure shall be within 70 to 80% of the maximum scale range. All pump suction measurements and steam pressure measurements in extraction steam and in heaters shall cover the negative

pressure range also and all draft gauges shall cover the negative pressure as well as the positive pressure.

- For temperature measurement, the maximum operating temperature shall be within 80 to 90% of the maximum scale range.
- For pressure switches and temperature switches, the set points shall fall within 40% to 70% of the scale range selected.
- For level measurement, the maximum of the range shall cover the overflow point or six inches from the top of the vessel and the minimum of the range shall be six inches above the bottom of the vessel. Also, the gauge glasses shall be stacked with overlap to cover permissive, alarm and trip levels.
- For flow measurement, the maximum range shall be fixed at about 10 to 15% above the maximum operating flow.
- For electro-chemical measurements (conductivity, pH, dissolved O2, Silica etc.), the maximum range shall be around 10 to 15% higher than the recommended alarm settings.

3.27 Size of Tapping Point Stub, No. and Size of Root Valves for Different Type of Measurements

- Impulse pipes, seamless tubes, fittings, manifolds etc. required for the installation of I&C equipment within the battery limits along with cable accessories will be provided. Instrument tubing shall be SS.

- Size of tapping point stub, No., and size of root valves for different type of measurements, these shall be as follows:

Sl. No.	Quantity of Root Valves	Size of Stub and Root Valve	Service Condition
Pressure and differential pressure measurement			
(i)	2	15 NB (Min)	≥ 40 Bar (OR) 425 Deg.C
(ii)	1	15 NB	< 40 Bar (AND) 425 Deg.C
Level measurement			
a)	**Level Gauge & Switch**		
(i)	2	40 NB	≥ 40 Bar (OR) 425 Deg.C
ii)	1	40 NB	< 40 Bar (AND) 425 Deg.C

Sl. No.	Quantity of Root Valves	Size of Stub and Root Valve	Service Condition
b)	**Level Transmitter (Displacement type)**		
(i)	2	40 NB	≥ 40 Bar (OR) 425 Deg.C
ii)	1	40 NB	< 40 Bar (AND) 425 Deg.C
c)	**Standpipe for level measuring instrument**		
(i)	2	80 NB	≥ 40 Bar (OR) 425 Deg.C
(ii)	1	80 NB	< 40 Bar (AND) 425 Deg.C
Flow measurement			
(i)	2	15 NB (Min)	≥ 40 Bar (OR) 425 Deg.C
(ii)	1	15 NB (Min)	≥ 40 Bar (OR) 425 Deg.C
Sampling system measurement (steam & water service)			
(i)	2	15 NB (Min)	≥ 40 Bar (OR) 425 Deg.C
(ii)	1	15 NB (Min)	< 40 Bar (AND) 425 Deg.C

3.28 Environmental Conditions

a. 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 if temperature may rise to 50 deg. C.

b. The period for which the equipment/system can function satisfactorily without A/C shall be mentioned by the bidder.

3.29 Topicalization

All equipment supplied against this specification shall be given tropical & fungicidal treatment in view of the severe climatic conditions prevailing at site as described under project data.

Tropical protection shall conform to IEC 60068 for environmental testing of electronic equipment and products to assess their ability to perform under environmental conditions.

Dust particles: Heavily dusty with abrasive dust and coal particles of size 5 to 100 microns present in the atmosphere.

3.30 Protection Class of Cabinets / Panels, Enclosures, etc.,

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

Sl.no	Area	Protection class
1.	In-door Air-conditioned (A.C.) areas	IP32 (min.)
2.	In-door Non A.C. areas:	
	a. Ventilated enclosures	IP42
	b. Non-Ventilated	IP55
3.	Outdoor	IP65 (min)

b. 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.

c. Enclosures for peripheral equipment like printers, etc. shall ensure minimum possible noise disturbance to the working personnel.

d. Guards, barriers, 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.

4.0 CODES AND STANDARDS

The design, manufacture, inspection, testing, site calibration and installation of all equipment and systems covered under this specification shall conform to the latest editions of codes and standards mentioned below and all other applicable ANSI, ASME, IEEE, NEC, NEMA, ISA, DIN, VDE, NFPA, BS, ISO, IEC, API, ASTM and their equivalents.

Other recognized equivalent international standards will be utilized as required to serve design, fabrication, and construction guidelines when not in conflict with the above listed standards. Such acts of the Bidder shall be brought to the Owner / consultants notice before proceeding with the same.

The equipment, systems and services furnished as per this specification shall conform to the codes and standards mentioned in this Section below. However, in the event of any conflict between the requirements of two standards or between the requirements of any standard

and this specification, the more stringent requirements shall apply unless confirmed otherwise by the Purchaser in writing. The decision of the Purchaser shall be final and binding in all such cases.

The requirements of statutory authorities / World Bank standards with regards to various plants areas like Fire Fighting system, Emission Measurement etc. shall be complied with even if not actually spelt out.

For PLC the following standards are to be followed by the bidder

1. IEE Guidelines for the documentation of software in industrial computer systems
2. IEC 61000-4 Electromagnetic Compatibility
3. ISO 11064-3 Ergonomic Design of Control Centers
4. ISO 9241-3, -5 Ergonomics requirements for office work with Visual Display Terminals (VDTs)
5. IEC 62443 for industrial cyber security
6. 61499 Standards for creating PLC/DCS
7. IEC 61131 Languages selection for PLC controller

5.0 TECHNICAL SPECIFICATION FOR PLC

5.1 GENERAL DESIGN REQUIREMENTS

The Instrumentation and Controls shall be designed for maximum availability, reliability, operability, and maintainability.

All components shall function in a satisfactory manner within their rated capacity under the specified conditions for the entire life of the plant.

The Systems should preferably offer by Direct OEM or through Authorized System Integrator, However Authorized system integrator letter need to submit the OEM authorization letter with the competency declaration for taking part in this enquiry to fulfil the technical expectation and execution capability. The PLC/SCADA vendor submit the relevant documents like completion certificates obtain from any desalination or water treatment projects executed in the last 5 years.

All I&C equipment shall be designed for their specific application within the Desalination plant and shall be furnished for required control, protection, alarm, and remote monitoring. The application and selection of these C&I equipment including signal converters, interposing relays, microprocessors, etc. shall be the responsibility of Bidder.

The PLC panels shall include Interposing relays, Marshalling / termination cabinets for termination and system cabinets.

A truly integrated PLC is envisaged with all the self-sustaining subsystems communicating with each other over the bus network and thus ensuring that the system has a truly global database.

The fundamental functions of control, alarm, monitoring and protection shall be functionally and physically segregated to the greatest practicable extent so that failure of a function does not result in the failure of other functions. Special attention should always be given to the independence of the protection function so that the safety of plant personnel and equipment is preserved.

The active control system including the plant protection system is the heart of the PLC system and therefore the most stringent safety, availability and reliability requirements must be fulfilled by this subsystem.

A functional group control hierarchy shall be devised for the plant equipment and their auxiliaries to allow operator to select a lower level of certain system or equipment.

In the case of field redundant Analog and Binary Signals, these shall be connected to different input modules.

5.1.1 Control system shall comply with following general failure criteria:

a. No single fault can cause a complete failure of the control system.

b. The grouping of control functions into system blocks shall be arranged such that failure of any one block will only partly degrade the control of the overall system. Such degradation shall always be manageable by operator intervention.

c. The control system shall be structured to reflect the redundancy provisions of the plant so that no single fault within the control system can cause the failure of the duty equipment or make the standby equipment unavailable.

d. As a result of a control system fault, a plant item or control function shall always respond to its controls at the actuator level (i.e., remote manual control). That item or control function shall be required to be isolated from automatic control system.

e. No single random fault in the entire automation and control system will cause a plant trip.

f. No two simultaneous faults shall lead to or potentially cause damage to the plant.

g. Safety related Instrumentation and Control shall be designed with a fail- safe mode.

h. No single fault shall jeopardize the functioning of the entire system.

i. The control and automation system and the field instruments and actuators as well as its support systems, power supplies and data networks shall be immune to electromagnetic interference and shall conform to the internationally accepted standards.

j. To meet the operational and safety requirements, the control system hardware and software shall conform to a modular, hierarchical architecture.

k. When more than one device utilizes the same measurement or control signal, the transmitter and other components shall be fully equipped to provide all signal requirements without overloading and with proper isolation. Transmitters required to serve multiple receivers shall be arranged so that disconnecting, shorting or grounding of one receiver device shall not have any perceptible influence on any other consumer point of the same signal nor shall change the transmitter calibration.

l. The system shall have built in redundancies for all system functions both at the processor and device level. No failure of any single device or processor shall lead to any system function being lost. It shall have redundant data highway on a "master less" principle.

m. Redundant equipment wherever provided shall be powered from redundant power supply units to improve system availability and reliability.

n. The system shall have the capability and facility for expansion through the addition of station/drops, controllers, processors, processors, processors, processors, processors, processors, process I/O cards etc., while the existing system is fully operational. The system shall have the capability to add any new control loop in CLCS and new group, subgroup, drive functions in OLCS while existing system is fully operational.

o. All the basic systems shall be connected through redundant data highway/bus system. The local bus system with associated bus couplers shall be provided for communication

between different I/O modules and processors. The communication system shall be designed keeping in view the integrity & security aspects of the control system. In case the system employs master communication controllers, facility for 100% hot backup controllers with automatic switch over shall be provided and it shall be ensured that no loss of data takes place during failure of communication controller.

p. The PLC shall be fully capable of operating the plant in all regimes of plant operating conditions, including emergency operation/trip conditions, blackout conditions etc. without resorting to manual control. The PLC shall be capable of bringing the plant to safety state automatically without operator interventions.

q. The application programs for the functional controllers shall reside in EPROMS or in non-volatile RAM or Flash Memory Cards. The application program shall be alterable by access through programmer's console. Parts replacement or parts removal shall not be required for accomplishing changes in application programs including control loop tuning. The CPUs shall not be loaded over 60% of the Individual capacity even under worst data loading conditions. RAM shall not be utilized more than 50%. Operator station CPU loading shall not exceed 50%. The PLC shall provide historical data storage, configurable and retrieval.

r. To meet the above failure criteria the I&C system shall incorporate self-checking facilities so that internal faults can be detected within the system itself prior to any resulting disturbance to the process. In addition, the protection and safety systems shall incorporate channel redundancy or diversity of measurement as well as self-checking and adequate test facilities. For some important systems, "online" test shall be employed with no effect to the proper functioning of the protection system.

s. To meet the stringent failure and self-checking requirements for C&I system, measurement redundancy shall be provided for all such parameters which can cause a direct system trip.

t. To make sure that the PLC is an extremely user-friendly system a centralized engineering subsystem is envisaged. An integrated subsystem must be provided which takes over the complete task of planning, I/O allocation, generation of function schemes and wiring documentation (in design stage) and finally the automatic linking and loading of the planned functions in the target hardware.

u. The complete engineering of all the automation and data acquisition functions should be possible from this central tool. This shall include all modulating and sequence

control functions as far as the automation is concerned, generation of plant graphics, logs and other MMI functions. In addition, the central engineering system must support all service, maintenance and commissioning assistance functions.

v. The measurement for the functions of control, indication and protection may be appropriately combined, provided the integrity of measurement is ensured by adequate channel redundancy. Where a signal is required for control purposes only or for both control and data indication, the signal shall be derived from the conditioned output of several detectors. Where a signal is required only for data indication, then it may be derived directly from a detector, if necessary, via a suitable conditioner. For some critical parameters, three independent measurements shall be provided. Median signal shall be selected for control and direct wired indication. An alarm shall be provided for large deviation from the median signal.

w. For selected protection applications, multi-channel measurements shall be provided incorporating 2 out of 3 trip actions. Facilities for the on-line testing of each independent channel shall be provided without loss of protection. Each measurement channel shall include discrete transmitters and instrument loops, i.e., multi-channel measurement of the same process variable shall not be derived from common instrument.

x. Both redundancy and diversity of trip criteria shall be considered to achieve sufficient guarantee against non-operability or unnecessary operation of the protection system. The principle of de energized to trip (Fail safe logic) shall be adopted.

y. Individual control elements shall be equipped with permission to prevent the in-appropriate operation of the item and “active interlocks” to trip the item in case of dangerous operation conditions.

z. Each of the multifunction controller together with its I/O and drive level control modules is to be understood as a self-sustaining automation island, which executes the function allocated to it independently and is not affected by a disturbance in the adjacent island. To lateral communication between the automation islands, a high-speed bus (the so-called control bus) should be provided which should be solely responsible for the automation (control) signal exchanges.

aa. Alarms shall be provided for all abnormal conditions over which the operator has control in the control room, plus those abnormal conditions which are of interest to the operator because they may affect plant operation or security.

bb. The following colors shall be selected for equipment status indicating lights, however the same shall be subject to finalization during detailed engineering.

Red	:	Energized, Running, Valve open
Green	:	De-energized, Stopped, Valve closed
Light Yellow	:	Abnormal, Discrepancy
White	:	Control power available

cc. AC power from UPS supply for control cubicles of each control and monitoring system shall be derived from two independent sources shall be furnished to guard against the total loss of power supply. The arrangements for power supplies shall be such that no single fault could interrupt either supply or no control system malfunction shall occur because of supply changeover.

dd. Industrial grade managed type Ethernet switches within built diagnostic features, 20% spare ports & redundant power supply shall be provided with control system.

ee. Depending upon the input power, i.e., 24 V DC or 110 V AC/DC or 230 V AC/DC, suitable Surge protection devices (SPD) with proper surge rating must be supplied. Input to UPS shall be protected from lighting strikes by using proper SPDs.

ff. The necessary power supply 24 VDC / 230 VAC for field solenoid valves shall also be considered under PLC vendor scope.

5.1.2 DISTRIBUTED PROCESSING UNITS (DPU)

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 backup controllers shall be able to perform all the tasks of their corresponding main controller. The 100% hot backup 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. Engineered solutions for redundancy in CPU are not acceptable. Dual redundant controllers shall be placed separately.

Any switchover from main controller to 100% hot backup 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 an alarm on all operator stations (OS).

In case of switchover from main controller to backup controller, the backup controller shall be designated as the main controller.

All the input variables shall be available to the main controller as well as its 100% hot backup controller so that any failure within the main controller shall not degrade the input data being used by the 100% hot back-up controller and vice versa.

The CPUs shall not be loaded over 60% of the Individual capacity even under worst data loading conditions. Each controller shall have battery backup or NVRAM for program memory.

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

For controller, the worst loading condition shall include the following tasks:

a) All process inputs scanning and processing is in progress and all the data is transmitted over the main data bus everyone (1) second.
b) All closed loop controls in operation
c) All open loop controls in operation
d) All output devices are in operation with rated performance/speed.
e) Control/information request is initiated on all control operating stations.
f) In burst mode operation (in case of major equipment trip), 100 digital alarms are generated per second for a period of 10 seconds.

The grouping of control loops in controllers shall be done by the Bidder based on the Input/output (I/O) handling capacity of the individual controllers and fulfilling the specification requirements.

5.1.3 REDUNDANCY IMPLEMENTATION

The system shall have 1:1 hot redundancy with respect to the processor modules, power supply modules, communication modules and network interface. Field and System power supplies shall be separate and redundant.

The system shall be designed in such a manner that in the event of failure of the primary controller, the entire configuration of the failed controller shall be instantaneously and automatically transferred to the back-up controller without operator's intervention. Mode

changeover in either direction shall be bump less and procedure less.

Measurement system (MS), Closed Loop Control System (CLCS) and Open Loop Control System (OLCS) shall be configured with redundancy at processor modules, communication modules, data bus and power supply modules.

The communication sub system shall be a real-time reliable communication network between control processors, operator stations, printers and engineering station.

The plant bus shall have dual redundancy.

All field redundant IO signals shall be wired to separate input modules in separate racks/nodes, so that even if one input module fails or the rack/node communication fails, the signal shall be available from the other input module.

Bidder to note that all I/O cards shall be sourced from their original Principal's works.

Each of the dual redundant binary & analog inputs shall be wired to separate input modules, so that even if one input module fails, the signal shall be available from the other input module. Implementation of multiple measurement schemes of these inputs shall 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.

In all Operating system (OS), controller card, power supply module shall be redundant, and Operating System shall be fault tolerant.

Redundant Data highway shall be provided.

Redundant Cooling fans with fire retarded filter for panels/cabinets.
The maximum number of Input / Output points per card shall be as follows,

Analog Input module	: 8
Analog output module	: 8
Digital Input module	: 16
Digital output module	: 16

Individual input channels shall have galvanic / optical isolation. Output points shall also have optical / galvanic isolation. The minimum isolation level between I/O module and external

circuit shall be 1100 Volts DC. Merely fusing of individual or a group of channels is not acceptable. The I/O cards shall be rack or DIN rail mounted. Failure of Analogue I/O cards, binary cards / modules shall also be displayed on the Engineering cum diagnostic station. All electronic modules input, and output modules shall be short circuit proof. These shall also be tropicalized & components shall be of industrial grade or better.

I/O subsystem should have redundant link with the controller.

The data communication system of the PLC including that of its redundant system bus with hot backup and other allied buses such us I/O bus, local bus etc., shall fulfill the following minimum features. The Bidder shall furnish all the calculation details of CPU utilization and Bus loading. The bidder shall also furnish the communication protocol used for the offered PLC.

5.1.4 RESPONSE TIMES

The system shall have adequate speed of response through all regimes of system loadings. The minimum criteria to be ensured are as follows: -

a) Keyboard command to field equipment shall be executed and its confirmation shall be displayed on the screen within 1 second.

b) The response for operator requested display (time between pressing of last key and appearance of last character on screen) shall be of the order of one to two seconds under all loading conditions.

c) Dynamic parameters in the OS displays shall be updated in one second interval.

d) The cycle time for Open and closed loop controls as follows: -

   i. Critical closed loops cycle time shall be max. 100 milli seconds.

   ii. Non-Critical Loops -max 500 milli seconds.

   iii. Open loops, sequential interlocks & Protections, it shall be max. 250 milli seconds.

   (The loop cycle time is defined as the time taken from change at input module to change in output module for command).

e) Data for critical loops shall be acquired & data base updated at a faster rate to suit the requirements above.

f) The system shall acquire & check all inputs at the input scan rate. If the input is in alarm state (i.e., the input is in an off normal condition) the alarm status shall be announced, printed out and displayed within 1 second after the input is scanned

5.1.5 SPARE REQUIREMENTS

a) Over and above the equipment and accessories required to meet the fully implemented system, PLC shall have spare "Usable" capacity and necessary hardware/ equipment/ accessories to meet following requirement for future expansion at site:

b) The PLC shall be provided with the capacity and capability to handle either 20% additional modules for each type of modules or 20% 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 a decrease in system response time (i.e., control response time, display response time, etc.).

c) 10% spare relays of each type and rating, mounted and wired in relays cabinets. All contacts of relays shall be terminated in terminal blocks of relay cabinets, additionally in each of the relay cabinets, 10% spare terminal blocks shall be 'provided so that additional relays can be mounted and wired. i.e., All signals shall be wired through marshalling cabinet for all inputs, the spare terminals, fully wired up to marshalling cabinets are also to be provided.

d) Wired-in "usable" space for 10% modules in each of the system cabinets for mounting electronic modules shall be provided by the bidder. Empty slots between individual modules/group of modules, kept for ease in maintenance or for heat dissipation requirement as per standard practice of Bidder shall not be considered as wired-in "usable" space for I/O modules. Field Terminal assemblies, PCB/ Connectors (if any in the offered system), corresponding to the I/O modules shall be provided for the above-mentioned 10 % blank space.

e) 20% spare I/O channels shall be provided in each I/O module. In addition to this 10% extra assigned complete spare cards fully wired mounted in the cabinets for each type of I/O modules shall also to be provided.

f) The spare capacity as specified above shall be uniformly distributed throughout all controller systems. The system design shall ensure that the above-mentioned additions

shall not require any additional controller / processor / Peripheral drivers in the system delivered on site. Further, these additions shall not deteriorate the system response time / duty cycle, etc. from those stipulated under this specification and shall meet redundancy / functional requirement.

5.1.6 DISPLAYS

a) Displays shall not be limited to no. of screens as dictated by the Bidder. It is Bidder's responsibility to develop and establish the displays as per process and complete plant requirement to meet the total satisfaction of the owner and efforts shall be made by the Bidder to establish displays till the successful handing over of the system without any cost implication to the owner.

b) The operator station shall be responsible for handling all commands as well as generating desired displays, logs, reports, alarms and printouts. Security at different levels shall be provided to prevent unauthorized access to the system.

c) Programming shall also be permissible by drawing ladder or Boolean diagram or through any easily understandable language. Single programming instruction / command shall be sufficient to delete a program rung from memory. Similarly, any rung can be inserted into the existing program. The active and the standby CPU programs shall equalize automatically once the new program is permitted to 'RUN'.

d) Updating time and reaction time (system's response to an operator's command) shall be provided for operator station as follows.

a. Calling up a mimic : 1 sec or better

b. Updating status signal in mimic : 1 sec or better

c. Updating variables in a mimic : 1 sec or better.

d. Issuance of command to output : 2 sec. or better

(Without considering travel time and process lag)

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

f) The displays at the operator console shall be classified into overview Display, group display, point display, alarm display, bar chart displays, Operator guidance message

displays and trend display.

1. Overview display – This display enables the operator to set an overview of the entire plant section.

2. Group display – The group display page shall display several sub-sections & present status information.

3. Point display – Along with the specified parameter value, this page should indicate historical trend of the parameter.

4. Trend display – This display includes real time/historical trend display facility including Dynamic Graphic Display & Bar Graph Display.

5. Alarm Message Display – It shall be possible to display the process as well as system and diagnostic alarms for operator's attention and action. Alarms shall appear immediately on the operator station as and when they occur on a priority basis. In addition to alarms appearing on displays, the system shall also be able to display alarm summary and alarm history listing the date and time of occurrence, tag number, point description, type of alarm (absolute value or deviation), serial number of alarms in the sequence of occurrence etc. Alarm shall disappear from display only when they are acknowledged and cleared. Any abnormal condition in any sub-system or any other function devices shall be displayed as a system alarm message on the operator console irrespective of the display selected.

g) The system shall print the following logs as minimum as defined in the following clauses. The printing of these logs shall be initiated automatically at prescribed time intervals or initiated on demand by the occurrence of predefined events.

5.1.7 SALIENT HARDWARE / SOFTWARE FEATURES OF THE PLC SYSTEM

Each controller envisaged shall have the following features as a minimum.

i. Processing word length of 32/64 bit
ii. Redundant power supplies
iii. Power fail/auto start feature
iv. Watch Dog timer.
v. Memory protection
vi. Direct Memory Access feature
vii. Easy modification of control functions
viii. RISC based.
ix. Real time data controller, Computer/PC based soft controller are not acceptable.
x. Memory expandability
xi. Non-volatile memory (NVRAM) in which data remains stored even if it is powered off.

5.1.8 INPUT / OUTPUT MODULES:

Bidder to note that all I/O cards shall be sourced from their original manufacturers. No. of channels per I/O card may reduce to meet the I/O cards features specified in the specification. The salient features of the Input / Output modules are as follows

All I/O cards offered shall meet the following minimum requirements:

Input / Output modules shall have the following features.

5.1.8.1 Digital Input Module

- The number of channels per module shall be maximum 16.
- Signal isolation (Optical/Galvanic)
- Fuse protection.
- Contact bounce protection.
- Contact interrogation voltage 24 V DC.
- Short circuit protection
- Configurable as status input, latched input, or accumulator input
- Direct or reverse sense
- Alarming of abnormal state
- Diagnostics:
  i. Input simulation.
  ii. Wire break detection
  iii. short circuit

5.1.8.2 Digital output Module

- The number of channels per module shall be maximum 16.
- Individual contact suppression
- Configurable as momentary, latched or pulse-width Modulated outputs.
- Individually definable default state
- Contact interrogation voltage 24 V DC.
- Output read back verification.
- Short circuit protection

5.1.8.3 Analog input Module

Analog inputs can be 4-20 mA DC, RTD, Thermocouple. A/D converter or voltage inputs. Functions performed on analog inputs shall include.

- Number of channels per module shall be maximum 8.
- Signal isolation (Galvanic / optocoupler)
- Short circuit protection.
- Transmitter power supply at 24 V DC
- Input filtering for noise level.
- Cold junction compensation for thermocouples
- Transmitter monitoring for parity, wire break, live zero and end limit values.
- Square root extraction
- Monitoring of A/D conversion
- Test for substituted value.
- Conversion to engineering units
- Test for normal or extended range.
- Detection of open circuit for thermocouples
- Alarm limit testing for high, low, high high and low low substituted values.
- Rate of change – positive and negative dead band

5.1.8.4 Analog output Module

Analog outputs shall be 4-20 mA DC with the following Characteristics:

- Number of channels per module shall be maximum 8.
- Direct or reverse operation
- D/A per output and power regulator per output
- Loop back check of output
- Default options upon failure.

All fault conditions like power supply failures, open circuit, short circuit etc., shall be displayed on LED with proper identification for easy diagnostics and rectification.

Transmitter outputs going beyond the limits shall be displayed on LED for immediate attention. The modules shall be insensitive to noise and other signals realised by filters, integrated circuits of the A/D converter etc.

All modules shall have self-checking and self-diagnostic checks. Signal to Noise ratio shall be indicated for the various modules.

All PLC Modules shall be hot swappable.

5.1.9 INTERPOSING RELAYS (IPR)

Electromagnetic type IPRs with modular design, plug-in type connections, suitable for channel/DIN rail mounting in cabinets; coil rating 24V D.C; 2 set of change over contacts rated for 2A 220 V DC/5 A 240 V AC. Freewheeling diode across relay coil and self-reset type status LED indicator flag (electronic) shall be provided. Manual forcing/override facility is required.

5.1.10 SPECIFICATIONS FOR OPERATOR WORKSTATION

Each operating workstation and any other workstation / PC envisaged in plant shall meet following minimum requirements & as per latest trends at the time of supply:

- Commercial grade machine
- On board Intel – Xeon quad core, 3.46 GHz processor, 4.0 GHz Turbo
- 16GB (1 x 16 GB) Dual Rank x8 DDR4 (32GB Total)
- System chipset - Intel
- 1GB Graphics Accelerator
- 500GB Mixed Use SFF SATA SSD
- Embedded 2-Port 1 Gbe Ethernet 1 Gb 2-port 332i Adapter – (Onboard)
- PCIe Dual NIC
- Serial port
- Total USB 3.0 Ports (2 front, 2 rear, 1 Internal)
- Total USB 2.0 Ports (2 rear, 1 Internal)
- PCIe 3.0 x 16 slots (1 occupied by GPU Module)
- PCIe 3.0 x 4 slots (x8 Mechanical)
- PCIe 3.0 x 8 slots
- 2 Nos of HDMI port on rear
- Optical mouse

- Sound card.
- Internal speakers
- Wireless internet & Blue tooth Interface
- 24", Colour LED monitor
- Resolution :1920 x 1080
- ASII Keyboard
- MS Windows latest with multimedia, MS-Office Professional, Adobe Acrobat, Anti-virus, etc.
- Application engineering & HMI software as per project requirement.
- All OWS shall be interchangeable.

5.1.11 Full flat Monitors with LED back lighting

The Bidder shall furnish OWS/EWS with colored full flat monitors with LED back lighting. OWS/EWS with monitors shall have a fast cursor control device like a track ball/optical mouse. All monitors shall be of high resolution colour graphics type and with not less than 32 colors. The picture frequency shall not exceed 85 Hz. The resolution required is 1920 X 1080 pixels or better. The picture shall be stable and completely free of any flickering. The screen illumination shall be enough to give good readability. The screen dimensions shall not be less than 24" screen diagonal.

Antiglare hard coating shall be provided. High reliability and long life 32" or better size monitors shall be supplied by the Bidder. Monitors shall be equipped with all adjusting elements accessible on the front plate. Monitors with 3D capabilities for graphics shall be provided by the bidder.

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

Monitors along with keyboard & optical mouse shall be mounted on supervisory control console specified elsewhere in the specification.

5.1.12 KEYBOARD

Functional keyboards for plant operator station shall be of special type adapted to operation tasks and monitor functions. Multi- function keys shall be provided with automatic display for modified functions.

Keyboard with USB interface and sufficient cable length from the CPU to the operator station working level.
Access the special function keys without having to first press on the Function key.

The keyboard shall have a minimum of 109 configurable keys for assigning the most frequently used displays.

Provision of functional keyboard shall be in addition to facility for operator control through mouse/track ball.

Adjustable slope, 10 million cycles activation, Maximum 55 dB noise, Scissor type key structure, key cap printed with legends, illuminated keys.

5.1.13 NETWORKING (LAN) COMPONENTS

Networking (LAN) components including Industrial graded Ethernet 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 as required to meet the equipment specification and system performance meeting the reliability and availability explained elsewhere in the specification.

5.1.13.1 Ethernet Switches

a. Redundant, High Performance Industrial Grade Managed switch with optical fibre interfaces, Fan less design and IEEE 61850-3 with KEMA certification, IEEE 1613 complaint, Gigabit Ethernet Ports.

b. Latest versions of SNMP, RMON, VOIP, VLAN, Multi link Trunk support features

c. Auto configuration adapter support

d. Broadcast/multicast storm control.

e. Supervisor Engine redundancy capability

f. Redundant Power Supplies

g. Extra expansion slots for future up gradation.

h. Integrated Security features (IPS, ACL, Firewall)

i. Inbuilt Diagnostic features

j. 20% Spare ports shall be provided on each ethernet switch.

k. Expandability / stack ability through a dedicated high speed expansion port, Routable, remotely manageable, configurable features shall be provided.

l. The Ethernet switch shall be provided with all accessories such as an Auto configuration adapter, etc.

5.1.13.2 Firewall

Redundant, Industrial graded firewall shall be provided. Firewall appliances should facilitate multi-vendor, multi-application environment and should support third-party products on open alliance. It should support Active-standby configuration.

a. The firewall should contain following features:
   i. Stateful inspection of packets.
   ii. NAT functionality, including dynamic and static NAT translations.
   iii. Latest version of SNMP

b. The firewall must send log information to a separate log server via an encrypted connection. Firewall logging must not impact firewall performance.

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

d. 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.

e. A 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).

f. Any changes or commands issued by an authenticated user should be logged into 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.

g. The firewall must not support any unencrypted means of access to the firewall.

h. It should Monitors all network traffic-traffic at Firewalls (Internet and external networks), in the DMZ and detect known threat through deep packet inspection.

i. Detects unknown threats via anomaly scanning.

j. Detect unknown threats via behavior pattern to protect from zero-day attacks.

k. Keeps up to date on new threats and vulnerabilities.

5.1.14 CYBER SECURITY

The plant control systems are critical for plant safety and operation. If degraded or sabotaged they put people, environment, production and assets at risk. The requirements for security are therefore high.

To ensure availability, confidentiality and integrity, the Bidder shall include the following requirements within their scope of work:

a. The scope of supply and service shall be designed with security measures, segregation, and availability features to reflect the plant requirements.
b. Implement measures to detect intrusions (IDS = Intrusion Detection System),
c. Implement measures for system hardening authentication and access control.
d. Implement measures for malware protection.
e. Implement measures to protect information systems (including control systems) from unauthorized access from external systems including the office data network.
f. Implement measures that enable secure remote operation according to process requirements.
g. Implement measures for disaster recovery,
h. Firewall management shall be implemented.
i. Considering password and privilege management.
j. Implement backup and recovery strategies.
k. Implement measures for removable media control.
l. Implement measures for monitoring and management of capacity.

Bidder to develop detailed Cyber Security specification and implement in different IT /OT systems (like PLC, package Control system, IT/telecom systems, communication interfaces among different systems etc.). This specific Management (include various design & control requirements such as Network Management, Security measures, Industrial firewall, Access control and User Authentication, Anti-virus including spyware and malware detection, patch management, backup and restore, IDS/IPS, White-listing, Security Incident Event Management (SIEM), Disaster Recovery, Cyber security Risk Assessment etc. as stated in relevant international standards such as NIST.SP.800-53, NIST.SP.800-82 and IEC 62443.

5.1.15 SOFTWARE LICENSE:

a) The Bidder shall provide a software license for all software being used in PLC / any other electronic/microprocessor-based system. The software licenses shall be provided for the project (e.g., Organization 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 PLC / any other electronic/microprocessor-based system at site.

b) In case the s/w license is dependent on no of points, then quantity to be considered is 30% above the finally implemented points.

c) Licensed copies of all software applications being used in the PLC system. All licenses shall be valid for the entire life of the plant. Where deemed necessary, provide USB hardware dongle keys for applications to improve security and prevent unauthorized access.

5.1.16 SOFTWARE UPGRADES

For Owner 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.

5.1.17 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 PLC 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.

5.1.18 PROGRAMMING, DIAGNOSTIC AND ENGINEERING WORKSTATION

a. The Engineering stations provided with PLC shall have all the functions of programming/ configuration/modification/ reconfiguration and documentation. The features and facilities to be included are as under: -

i. Configuration or re-configuration of a system.
ii. Possibility to introduce or modify parameters.
iii. Documentation of system configuration.
iv. Calculation program functions.
v. Graphic editing program.

b. This workstation shall be able to design, configure, monitor documents or trouble shoot the process activities as desired.

c. The workstation shall be used for designing and redefining control strategy, configure system modules, modify the configuration, build and implement computing logic's, alarms and display functions, save and retrieve system configuration schemes, monitor process variable, tune or adjust process parameters, display and trend information, produce system documents etc. The station shall be able to produce generic logic control drawings, configuration drawings etc.

d. The control engineering software system shall include text, computer aided design, ladder diagrams, logging database, graphic package etc.

e. Combined with a printer, the engineering station generates logic control drawings configuration drawings, module list, specification list, and function blocks for cross reference list.

f. Engineering station shall have capability of online and offline program modification without affecting the performance of the system / process. While online, connected to process, the engineering station shall provide real time tuning and trouble shooting. On offline, the engineering station allows control system configuration.

g. The proposed workstation can be used to implement or redefine process control strategy for control computing, logic, alarm, list display of process functions. In addition, the station shall have an elaborate facility for diagnostic functions.

h. The diagnostic station shall assist in detection of system faults and malfunctions and faults in field inputs along with identification of their locations. It provides automatic display and recording of such disturbance and thereby enhances the system availability. Sensors, binary switches, transmitters, input/output processing modules, controllers, peripherals and multipurpose bus communication systems etc. are fully and comprehensively monitored. For this purpose, all processors, modules etc. shall have self-diagnostic features and disturbance shall be communicated to central diagnostic station. All failures, anomalies and missing functions shall be automatically detected, alarmed & displayed with clear text, showing the exact origin and the kind of failures. The failure shall also be signaled at concerned equipment.

i. Detailed information of disturbance messages shall be displayed in the engineer's OS and printout. Typically, an engineer's OS shall also have facility to windows for

progressive detailing of diagnostic information wherein a permanently displayed window for plant diagnostics shows disturbance of the over-all system level. By activating a cursor/key a station diagnostic window is opened to show the details of the station with all installed equipment. The diagnostic data for an item of equipment identified as disturbed can be called up for subsequent windows and finally the last window can be opened to obtain information such as type, location and possible causes of disturbance and suggestion for its rectification. Any alternative method of diagnostic display is also acceptable, which provides detailed information during disturbance.

5.1.19 POWER SUPPLY SYSTEM

a. Each electronic cabinet shall be equipped with redundant power supply source with auto change over circuit with changeover time less than 10 ms to guarantee hold capacity of feeders for modules and I/O signals. 24 DC power supply system shall furnish power supply to the equipment located inside the cabinet, via. selector circuit mounted on DC output, made of block back-up diodes, with the aim of preventing energy exchange between power sources. A continuous monitoring apparatus watches the voltage and alarms power supply failures. PLC system shall work on 24V DC supply and computers & peripherals shall work on single phase AC supply from UPS.

b. Supply of redundant UPS, Battery with 60miniutes Back-up time, Battery charger and BHMS for the complete control system and instrumentation with sufficient capacity is in Bidder scope including for the power supply requirement for the purchaser system.

c. The Bidder is to provide redundant 10KVA UPS / ACDB feeder from the Bidder supplied UPS for the purchaser FPS PLC system.

d. The Bidder is to provide redundant 10KVA UPS / ACDB feeder from the Bidder supplied UPS for the purchaser CCTV/PA/EPBAX system.

e. All power supply in the cabinets shall be redundant and have auto change over facility or diode auctioneering.

f. A 20% Spare feeder shall be provided in the ACDB.

5.1.20 SYSTEM GROUNDING

i) Two separate earth circuits shall be provided for earthing, one as electronic earth (or instrument grounding) through separate redundant circuits for earthing of instruments & electronics and second safety earthing for earthing of system cabinets. These two earth circuits will be electrically isolated from each other.

ii) Electronic earth shall be grouped to common JB / panel and will be wired through redundant earth pit via redundant cables.

iii) Each cabinet shall be provided with a minimum copper busbar 25 mm wide, 6 mm thick and of suitable length with tapped holes to suite M6 bolts of brass.

iv) The copper bus shall be mounted suitably inside the cabinet and shall be electrically isolated from cabinet steel structures through insulated spacers.

v) The exact grounding scheme shall be finalized during detailed engineering.

6.0 TECHNICAL SPECIFICATION FOR INSTRUMENTATION

1. Instruments, control devices and other equipment accessories covered under this specification shall be furnished in accordance with I&C specification sheets and drawings enclosed herewith and the requirements of all applicable clauses of this specification. All field Instruments, Junction Boxes etc. shall be provided with Non-Metallic canopies for protection against rain and fire water spray

2. The Instrumentation and Control equipment shall conform to all applicable codes and standards. All equipment and systems shall also fully comply with the design criteria stated.

3. The Bidder shall furnish all Instrumentation & Control equipment and accessories under this specification as per technical specifications, ranges, makes and model numbers approved by the Owner during detailed engineering.

4. All instruments, devices and accessories furnished by the Bidder as per this specification shall be designed and constructed to perform normally and meet all guarantee when subjected to the environmental and service conditions and other applicable specification documents.

5. Design criteria for continuous online analytical measurements of water media will be based on microprocessor-based instruments only.

6. All transmitters will be of SMART type.

7. The necessary root valves, impulse piping, drain cocks, gauge zeroing cocks, valve manifolds and all other accessories required for mounting/erection of all local field instruments shall be provided by Bidder as per approved hook up drawings.

8. 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 and an anti-corrosive paint shall be applied to the field mounted enclosures / instruments. All the field instruments shall also be provided with SS tag nameplate and double compression type nickel-plated brass cable gland. Gaskets, fastener, counter and mating flange shall also be included wherever required with instruments.

9. All transmitters will be Smart, analog two-wire type, capable of driving an output impedance of 600 ohms minimum at 24 V DC and will be generally powered from the control system I/O cards.

10. Pressure, flow, differential pressure, level, temperature, and other miscellaneous transmitter accuracy will be within ±0.0.075% of calibrated span.

11. Instrument tags plates of Stainless-Steel material should be permanently attached to the device. If this is not possible, the instrument tag should be fastened to the instrument with stainless steel wire.

12. Instruments handling chemicals / corrosive materials will be provided with diaphragm seals / purges.

13. Field Instruments enclosures of all electronic instruments will conform to IP- 65. All JBs in the field will be IP-65.

14. All instruments power supply can be used of 230 VACS except where it cannot be used.

15. Field switches will be micro switch type with auto reset. Switches will have NO and NC contacts. Switch contacts will be snap acting, SPDT, potential free with a maximum contact rating of 240 V AC, 5A.

16. For water analyzers the material of pipes, tubes & erection hardware will be SS.

6.1 Minimum Requirement of Field Instruments

Following minimum requirement of field instruments shall be fulfilled by Bidder (In addition,

1. Level switches for very high / high / normal / low / very low interlocks (type as per Owner approval).

2. Tapping points/test points shall be provided.

3. All Field Instruments used in acid or alkaline atmosphere shall be with standard anti-corrosion coating i.e. the combination of polyurethane and epoxy resin baked coating (ANSI/ISA-71.04).

4. All limit switches shall be conforming to IEC-60947-5-1.

5. Above are the min. requirements, however, actual quantities shall be as decided during detailed engineering. Other pressure gauges for systems shall be decided during detailed engineering.

6. Switch actuation point shall be field adjustable with a calibration scale to indicate the set point. Switches shall have a capacity of 5.0 amps at 240V AC or 0.5 amps at 220V DC. Level switches for general service shall be float type.

7. Field instruments shall be supplied & offered as per data sheets specified below:

6.2 Transmitters, Switches, Gauges and Panel Mounted Instruments

1. The enclosures of all field instrumentation will be SS316 / FRP or better to suit the ambient and process conditions.

6.3 Pressure, Differential Pressure, Level and Flow Transmitters (PT, DPT, LT & FT)

a. Smart Transmitters of the electronic type shall be furnished.

b. Transmitters shall be equipped with mounting brackets suitable for mounting in transmitter enclosures.

c. In general, Transmitters are envisaged to be grouped at several places as to be decided during detailed engineering stage. For this purpose, suitable enclosures complete with all tubing, fittings, purge meters, loop cable trays etc. shall be provided.

Type/Construction	:	Sealed capacitance/ Inductance/ Silicon resonance type
Material		
Body	:	Die cast Aluminum with epoxy coating for air
		SS316 for other services
Diaphragm	:	Material shall be suitable to applications
Measurement element	:	Diaphragm
Valves	:	Carbon steel for non-corrosive Applications
		SS316 for corrosive applications.
Output signal	:	4 to 20 m Amp. DC (Two wires)
		HART Compatible
Local Indicator	:	LCD indicator (5 digit) with scale of Engg. Unit
Overall Accuracy	:	± 0.075% or better of FSR
Turn down ratio	:	10:1 for vacuum / very low-pressure application 30:1 for other applications
Stability	:	± 0.15% for 5 years.
Response time	:	100 msec.
Power supply	:	24V DC nominal
Drive capability	:	500 Ohms minimum
Enclosure Class	:	IP-65
Span and Zero	:	Locally adjustable, non-interacting
Zero suppression / elevation:		At least 100% of Span
Connection		
Process	:	Half (1/2) inch NPT (F)
Accessories	:	Span and zero adjustment facility only through HART Management system / communicator
For Absolute Pressure		
Transmitters	:	Two (2) valve SS316 manifold
For Gauge & Vacuum		
pressure transmitter	:	Three (3) valve SS316 manifold
For DP, level & flow		
Transmitter	:	Five (5) valve SS316 manifold
For oil and corrosive liquids	:	Separator diaphragm seals
For all transmitters	:	Mounting bracket

d. In case it becomes necessary to use a DP transmitter for pressure measurement, then a 3-Valve manifold shall be used in place of 2-valve manifold. Manifold shall not be mounted on the transmitter; It shall be non-integral type. Pulsation dampeners shall be used where the process media is unstable for measurement such as the discharge of a pump. Overrange protection shall be used where necessary. Transmitters shall be provided with suitable drain & vent points.

e. As for the water flow measurements, necessary flow elements/ transmitters are chosen in the process line.

f. 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 hazardous areas, explosions proof enclosure as described in NEC article 500 shall be provided.

6.4 Pressure Switches (PS) & Differential Pressure Switches (DPS)

Type/Construction	:	Bellows /Sealed Diaphragm for low pressure / vacuum and Piston Actuated preferable for high pressure. Indicators with contacts are not acceptable.
Materials-		
Bellows, Bourdon tube & Movement	:	Material shall be suitable to applications as specified above
Protective Diaphragm	:	Die-cast aluminum with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere.
Accuracy	:	± One (1) percent or better
Repeatability	:	± 0.5(half) percent or better
Setting & Differential	:	Adjustable
Over pressure range	:	Fifty (50) percent of full scale.
Contact	:	
Number	:	DPDT /2 SPDT
Type	:	Auto reset with internal Adjustable snap action micro switch
Rating	:	5 Amp, 240V AC / 0.5 Amp, 220V DC
Connection – instrument	:	Half (1/2) inch NPT male Process

Over range protection	:	Fifty (50) percent full scale
Enclosure	:	IP 65
Accessories		
3 / 5 valve manifold	:	For all switches
Self-cleaning type	:	Pump and compressor discharge lines
Pulsation dampeners/Snubber		
Protective separating diaphragm	:	For Corrosive liquid lines.

6.5 Pressure & Differential Pressure Gauges (PG & DPG)

Sensing Element and Materials	:	Bourdon for high pressure, diaphragm/bellow for low pressure
		Material shall be suitable to applications as specified above
Case	:	SS 316/ Die-cast aluminum with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere.
Protective Diaphragm	:	Teflon
Dial size	:	150mm with shatter proof glass
Scale Details	:	Graduations in black lines on white dial, 270 Deg pointer defection scale provided with glass cover. Smallest scale division shall be one (1) percent of full-scale value or smaller. Pointer stops for all gauges.
Accuracy	:	± One (1) percent or better
Connection – Instrument Process	:	1/2-inch NPT Male Bottom
Mounting	:	Local
	:	1/2-inch NPT Male (Back entry) mounted on local gauge board.
Accessories		
3-way needle valve/manifolds	:	For all gauges
Self-cleaning type	:	Pump and compressor discharge lines
Pulsation dampener/snubber		
Protective separating	:	For corrosive liquid lines
Other particulars		

Zero & span adjustment	:	For all gauges
Safety device		
Housing	:	IP 65
Ranges 5 to 20 Kg/cm^2	:	Rubber blow out disc with open front construction
Ranges above 20 Kg/cm^2	:	Neoprene safety diaphragm at the back with solid front construction
Over range protection	:	Fifty (50) percent of full scale
	:	Movement mechanism shall be glycerin filled for oil services & vibration prone area.
	:	For corrosive liquid lines diaphragm type sensors required. Armored capillary of 10 mtrs for Corrosive liquid service
	:	Contact type pressure gauges are not acceptable for interlock & protection.
Identification	:	Identification engraved with service legend or laminated phenolic name plate.

6.6 Resistance Temperature Sensors with thermowells

Applicable Standard	:	DIN 43760 for RTD -Latest Revision
Element	:	Platinum, R0=100 ohm 3 –wire Duplex
Sheath Material/ Insulation	:	316SS metal sheathed /Compacted Magnesium Oxide
Sheath OD	:	8 MM
Terminals	:	Spring loaded
Calibration	:	As per DIN Standard – 43760, Class A
Head	:	SS 316 (Screwed) with galvanized chain
Response Time	:	< 20 Sec for measurement
		< 10 Sec for Control
Accuracy	:	±0.35° C or class A DIN 43760 whichever is better.
Electrical connection	:	lugs
Enclosure	:	IP 65
Thermowell		

Applicable Standard	:	ASME PTC 19.3 TW
Construction	:	Tapered drilled from Bar stock for SS316 material thermowell. Tip diameter 8mm.
Material	:	Material shall be suitable to applications as specified above
		Bidder shall provide calculation for thermowell as per ASME – PTC-19.3.
Process Connection	:	Flanged
Immersion Length (U-length)	:	Within ±10 mm of center line of pipe
Extension neck length (T-length)	:	Minimum 100 mm above Insulation of pipe and Minimum 160 mm when there is no insulation on pipe.
Total Length (E)	:	U+T
Test Certificate	:	Hydro-test, Material Test Certificate & Radiography.

6.7 Level Switches (LS)

Type/Construction	:	a) External float cage type with magnetic switch actuator for tanks and vessels.
		b) Displacer –Top mounted for all clean water sumps.
		c) RF type level switches for slurry application.
Materials		
- Body	:	For corrosive liquids suitable anti-corrosive coat/lining shall be provided.
- Float/Displacer	:	Material shall be suitable for the applications
-Wire rope	:	Material shall be suitable for the applications
Differential & Setting	:	± 12 mm minimum (Adjustable) Contacts
-Number	:	DPDT/2 SPDT
- Type	:	Snap action micro switch Auto reset with internal Adjustable
- Rating	:	5 Amp 240V AC, 0.5 Amp 220V DC & Suitable for 24 VDC
Connection –		
Process	:	One (1) inch ANSI Flanged
		Four (4) inch ANSI Flange for sump services.

Enclosure protection	:	IP 65
Temperature/pressure rating:		As per service conditions
Accessories	:	Counter flanges, still pipe of requisite length with anticorrosive coating for sump services.

6.8 Capacitance Type Level Switch

Type	:	Capacitance type
Probe	:	a) Rod or suspended electrode
		b) Rope type probes may be used only where the required probe length is greater than 3 meters.
Probe Mounting	:	Stainless steel 1-1/2 ANSI RF Flange / ¾ "NPT (M)
Material of construction	:	Material shall be suitable for the applications specified above
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, Division 1 area)
Repeatability	:	± 0.5% of full range.
Ambient temperature	:	0-60 ºC.
Mounting	:	On top
Supply voltage	:	240V AC, 50Hz / 24V DC
Relay output	:	2SPDT
Contact rating	:	5A min. at 240V AC on resistive load & Suitable for 24 VDC
Response time	:	100 msec or better
Cable connection	:	3/4" ET
Accessories	:	Counter flange, Cable gland, prefab cable and stainless-steel name plate engraved with alpha numeric.

6.9 Level Indicators (Gauge Glass) (LI)

Type/Construction	:	a) Reflex
		b) Tubular (For tanks open to atmosphere only)
Material:		

a) Glass	:	Tempered toughened borosilicate resistant to thermal shock
b) Body material	:	SS 304
c) Integral cocks and	:	i) Forged carbon steel with drain valves stainless steel internals
		ii) Rubber lined corrosion resistant stainless steel 316 (for demineralized and Osmosis water service)
d) Fittings	:	i) Forged carbon steel
		ii) Rubber lined 316 steel/PVC for corrosive liquids Demineralized and Osmosis water service)
		iii) 304 Stainless Steel for non-corrosive liquids
e) Packing	:	Teflon
Dial size/scale	:	150 mm /1.4 Meters maximum length with shatter Proof glass
Scale details	:	SS316 scale Graduated in mmwc
Connection	:	25 Nb/40 Nb ANSI Flanged
Enclosure protection	:	IP 65
Accessories	:	a) Integral cocks
		b) Drain/vent valves 15 NB
		c) Bolts, nuts and gaskets for all KEL-F shield for
		transparent type
		d) Illuminating lamps as required
		e) Periscope as required
Tests	:	Tested at two hundred (200) percent of the maximum process pressure

Other details	:	For larger lengths, additional gauge glasses shall be provided with a minimum of 50 mm overlap.

6.10 Flow Transmitter (Ultrasonic)

Type	:	ULTRA SONIC 2-wired. (Clamp on Type)
Sensing element	:	Non-contact.
Output	:	4-20mA with HART Protocol.
Accuracy	:	± 0.1% FS.
Supply	:	24 V DC.
Enclosure class	:	IP-65.
Transmitter		
Mounting	:	On Nozzle.
Mounting position	:	Top mounted.
Housing	:	Plastic.
Display	:	Head mounted LCD Display & remote display.
Accessories	:	As per process requirement.
Process connection	:	1/2″ NPT.
Electrical connection	:	1/4″ NPT.

Turn Down ratio	:	1:100.
Measuring range	:	Adjustable (as per process requirement).
Totaliser	:	Required.
Enclosed for class	:	IP-65.

6.11 Flow Transmitter (Electromagnetic)

Output	:	4-20mA with HART Protocol.
Accuracy	:	± 0.5% FS.
Supply	:	230 VAC
Enclosure class	:	IP-65.
Process connection	:	Flanged
Transmitter		
Mounting	:	Easy man accessible place with extension cable (Remote mounting)
Mounting position	:	Pipe mounted/ Head mounted.
Housing	:	SS316

Display	:	Head mounted LCD Display / Remote LCD Display.
Accessories	:	As per process requirement.
Process connection	:	Flanged
Electrical connection	:	1/2" NPT 2 No's
Turn Down ratio	:	1:100.
Measuring range	:	Adjustable (as per process requirement).
Totaliser	:	Required.
Enclosure class	:	IP-65.

6.12 Positive Displacement Flow Transmitter

Positive displacement flow transmitters shall be offered. An electronic totalizer shall be provided for each flowmeter with IP 65 protection and the location of the totalizers shall be acceptable to the Owner. Air eliminators shall also be provided to ensure maximum accuracy.

6.13 Electromagnetic Flow Meter

Electromagnetic flow meters shall have separate transmitter having accuracy ±0.2% with zero stability feature, electrode material shall be suitable for the applications specified above, liner material Teflon and enclosure IP65, local digital display, 4-20 mA output HART signal with zero and span field adjustable. Application – DM Water and for other application as decided by owner.

6.14 Flow Gauges (FG)

Type/Construction	:	a) On-line type rotameter for 50 Nb & below lines.
		b) Bypass type rotameter for above 50 Nb lines. Material -For On-line type
Metering tube	:	Borosilicate glass
Float	:	316 SS
Packing	:	Teflon
End fittings	:	304 SS
- For bypass type		
Metering Tube	:	Borosilicate glass
Float	:	316 SS
Packing	:	Teflon
End fittings	:	304 SS
Orifice Plate	:	316 SS
Carrier ring	:	304 SS
Flanges & Mating flanges	:	Same as pipe material, 200 lbs. ANSI – RF.
Impulse pipe	:	Same as pipe material.

Fittings	:	2000 ANSI, SW ends to match with pipe material.
Dial size / Scale length	:	250mm.
Scale Details	:	Direct reading type engraved on detachable aluminium scale.
Accuracy	:	± Two (2) percent.
Reproducibility	:	Half (1/2) percent.
Connection	:	SCRD NPT
Enclosed for class	:	IP-65.
Accessories	:	a) Isolating valves (for Bypass type only).
		b) Bolts, Nuts and Gaskets as required.
Tests	:	Shall be tested at two hundred (200) percent of the maximum process pressure.

6.15 Sight Flow Glass Indicators

Type/Construction	:	Rotary type/ Flapper type as per process requirement.
Materials		
Body	:	SS
Glass	:	Toughened Borosilicate
Gaskets	:	Neoprene.

Bolts & Nuts	:	SS
Flappers / Rotating Wheel	:	316 SS
Flappers / Rotating Wheel holder	:	304 SS
Process Connection	:	SW
Enclosed for class	:	IP-65.
Accessories	:	Bolts, Nuts, Cover plates and Gaskets as required.
Tests	:	Tested at two hundred (200) percent of the maximum process pressure.

6.16 Flow Switches

The sensing element for the flow switches shall be either mechanical i.e. paddle/vane type or based on electronic technology subject to Project Company approval. The flow switches shall be provided with gold plated contact output (DPDT) rated for 5A at 240 VAC which shall be high quality snap acting and hermitically sealed or solid-state outputs as applicable. Outputs with lower current rating is also accepted for connection to digital input cards or other low drain current circuits subject Project Company approval. Flow switches shall be generally used for ON-OFF signal transmission. Housing shall be dust and weather tight protected to IP-66 (min) and materials of wetted parts shall be aluminium bronze alloy, Monel, 316L SS or similar as specified in the project data sheets. Electrical connection shall be ½" NPT with weatherproof cable glands to suit the connecting cable.

6.17 Analyser Instruments:

6.17.1 General requirements for Analyzers:

a. 6"-10" display to be provided for the monitoring and configuration of all the parameters.
b. The preferred power supply of all the Analyzers shall be 24 VDC.
c. Availability of Calibration records, Data-logs, parameter changes etc.
d. Parameters availability through 2-wire Modbus (RS-485), Modbus TCP/IP etc.
e. Minimum cable length of the Sensor to be defined (if applicable)

If any calibration software shall be required, the same shall be supplied by bidder/supplier and the license of the software shall be perpetual in nature

6.17.2 Common requirements:

Output signals	
Analog	4-20 mA DC galvanically isolated. If analyser provides superimposed HART signal on 4-20 mA DC output, it shall have provision also to be connected to PC based station.
Zero & span Adjustment	To be provided with a range selection facility.
Ambient temp.	50°C
Indication	Digital Alphanumeric Display. Display of reading in engineering units shall be provided.
Enclosure	Type/Material Weather & Dust proof (IP 65) /SS.
Type of Electronics	Microprocessor based with self-diagnostic.
Digital Signal transmission	HART / RS 485 Port Modbus Protocol / Ethernet TCP/IP protocol for communication with plant control system.
Calibration	Auto & Manual (from Remote)
Power Supply	To be arranged by Bidder subject to Owner's approval
Enclosure class IP-65.	IP 65
Others	All interconnection tubing and cabling between probe and analyzer / analyzer panel and cabling from analyzer/ analyzer panel to local junction box are to be provided

	All the calibration gases required for one-year continuous operation shall be provided. The calibration gas container material shall not contaminate the calibration gas.

6.18 Conductivity analyser

Type:	:	
i) Cell drawable	:	Flow through type/ removable type (with
		with sealing valve)
ii) Monitors with multi range facility	:	Electronic (Microprocessor based) indicating type
Material:		
i) Cell	:	Epoxy resin/SS316
ii) Electrode	:	Platinised/SS316
iii) Monitors body	:	Carbon steel/Aluminum/Polycarbonate
Monitor output	:	i) 4-20 mAmp D.C. with HART protocol spare out put
		ii) 4-20mA DC with HART protocol for DDCMIS
Output load	:	500Ω
Power supply	:	240V, AC, 50 Hz from UPS
Accuracy	:	+ 1% of full-scale span
Stability	:	+ 1% of full scale per month non-cumulative

Repeatability	:	+ 0.3% of span
Connection:		
i) Cell	:	Online/pipe mounted
		(ONLINE in sample table)
		1/4 (Quarter) inch NPT (F) SCRD for
		on-line type and three quarter (3/4) inch NPT (M)
SCRD for pipe mounted.		
ii) Monitors	:	flush panel mounting
Electrical	:	Half (1/2) inch NPT (F) SCRD
Accessories	:	i) Automatic temperature
		compensation in the range 0-100deg.C
		ii) Ammonia (NH3) removal equipment.
		iii) Sample coolers
		iv) Flow and pressure regulators
		v) SS316 impulse tubing and fittings
		vi) Isolation & drain valves as required
		vii) other accessories as required
		viii) Adequate length of cables for connecting
coils to monitors		
		ix) Sample rate set valve
Other particulars	:	Cell shall be suitable for maximum pressure of
		7 kg/cm2 and maximum temp. of 100deg.C

6.19 Turbidity Analyser

SENSOR		
Reference type	:	Online
Operating principle	:	Alternating Light Source
Cleaning	:	Self Cleaning
Electrode holder – type	:	Flow Through
Body Material	:	CPVC
Process Connection	:	½" NPT (F)
Pre-Amplifier	:	Built-In
TRANSMITTER		
Type	:	Microprocessor Based
Transmitter Output	:	4-20 mA DC
Enclosure Protection	:	IP65
Enclosure material	:	polycarbonate
Electrical connection	:	½" NPT (F)
Local Indicator	:	Provided (LCD Display)
Accuracy	:	0.2 NTU or ± 2% of reading
Repeatability	:	± 0.1% of span
Temp. compensator	:	built-in
Cable between transmitter & sensor	:	To be provided

All analysers shall be supplied with chemicals/regents required for 12 months' operation. 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 analyzer solution.

6.20 Technical Specification of pH Cell and Transmitters

a) Type	:	
i) Cell	:	Measuring and Reference Electrode

Combination with Flow through type (SS316/Polypropylene flow chambers) for desalination plant's water application. Sensor shall not be affected by flow variation. The sensor shall be designed for desalination plant applications.		
ii) Monitors	:	Electronic (microprocessor based)
		indicating type with adjustable range facility.
b) Material:		
i) Measuring & reference	:	Toughened sensitive
ii) Electrode	:	pH glass
iii) Monitor body	:	Carbon steel / Aluminum /
		Polycarbonate
c) Monitor output	:	i) 4-20 mAmp D.C. with HART protocol
spare out put		
		ii) 4-20mA DC with HART protocol for
DDCMIS		
Output load	:	500Ω
e) Power supply	:	240V AC, 50 Hz from UPS
f) Accuracy/repeatability	:	+/- 0.01 pH
g) Resolution	:	+ 0.01 pH or 1 mV. 1C
h)Stability	:	0.02 pH per week
i)Connection	:	
i) Process	:	One-quarter (1/4) inch NPT(F) SCRD
ON-LINE		
ii) Electrical	:	Half (1/2) inch NPT(F) SCRD
j) Mounting	:	
i) Cell	:	Pipe Mounted
ii) Monitors	:	Flush panel mounting
l) Accessories	:	i) Automatic temperature
Compensation with fast response integral temperature sensors in the range 0-100deg.C		

	ii)	Co-axial cable as required
	iii)	Sample coolers
	iv)	low and pressure regulators
	v)	Standard pH solutions
	vi)	SS316 impulse tubing and fittings
	vii)	Isolation & drain valves as required
	viii)	Electrode holders
	ix)	other accessories as required
	x)	Sample rate set valves
	xii)	RFI/EMI shielded, weather and corrosion proof casing

6.21 Flow Elements

The equipment furnished to this specification shall conform exactly to the requirements herein, unless modified by the respective datasheet of the equipment

6.20.1 Orifice Plate

Features	:	Essential/Minimum Requirements
Type ISA RP-3.2, 1960 or BS-1042	:	Concentric as per ASME PTC-19.5 (Part-II),
Material	:	Material to suit application as specified above.

Thickness 3 mm for pipe dia. up to 250 mm
6 mm for main pipe Dia above 250 mm
10 mm for main pipe dia. 500 & above.
Material of branch pipe : Same as main pipe
Root valve type : Globe
Root valve material : 316 SS

Root valve size	:	1 inch
Impulse pipe of same material	:	Required
up to root valve		
Tapping's	:	Flanged weld neck. 3 pairs. of tapping. / Asper the
process requirement		
Beta Ratio	:	0.34 to 0.7
Beta Ratio calculation to be	:	Yes
submitted		
Assembly drg. and flow Vs	:	Yes
DP Curves		
Accessories	:	Root valves, flanges, Vent/drain hole (As
required)		

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 computed flow calculations.

The design, material, construction features, manufacture, inspection and testing of flow elements 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.

6.22 Technical Specification of Dissolved Oxygen Analyser

Make	*
Model number	*
Quantity	One
Operating principle	Electrochemical
Service	*
Range	*
Calibration	Automatic calibration, 2 points
Sensor	
Type	Galvanic cell
Cathode	Silver/gold
Anode	Lead/silver
Gas permeable membrane	Teflon
Body	Poly propylene
Mounting	In-line flow chamber
Response time	90% in 20 seconds
Flow chamber	
Type	In-line
Material	PVC
Inlet connection	1/4" npt
Outlet connection	1/2" npt
Operating conditions	
Operating temperature	*
Operating pressure	*
Transmitter	
Output	4 - 20 ma dc isolated
Load resistance	600 ohms
Power supply	110v ac
Accuracy	±1% of FSD
Repeatability	±1% of FSD
Alarm contacts	1 high, 1 low - adjustable
Contact rating	220vdc, 5a o 110vdc, 5a o 24vdc, 2a o
Case colour	Stoved, Enameled black
Case material	Die cast aluminium
Enclosure	Ip 65 O ex-proof o

Area classification	Cl ..... Div ..... Gr .....
Sample conditioning	
Flow regulation	By constant head units and flow control valve
Temperature compensation	Automatic by thermistor
Accessories	
Local indicator in transmitter	Required
O-rings, diaphragm	Required
Cable from sensor to transmitter	Required
Mounting hardware	Required
Ss tag & name plate	Required

6.23 PTZ Dome cameras

High Definition PTZ cameras

Image Device	1/2.8-1/3" Progressive scan CMOS
Lens	4.45-4.7 /89-94.0 mm focal length
Optical Zoom	35 X or better
Digital Zoom	12 X or better
Number of Pixels	1920 X 1080 (Full HD) 2MP at 25/30 IPS
Video compression	H.264 Main Profile/High profile
Sensitivity(at 6dB)	color mode 0.6 lux , B/W mode 0.04lux @30IRE, F1.6
Horizontal Angle of view	55.4 deg(wide)- 3.5 deg (Tele) minimum
Focus	Auto with Manual Override
Iris Range	F1.6-F2.9
Iris Control	Auto with Manual Override
Back Light Compensation	Required
White Balance	Automatic with mode selection options
Electronic Shutter	1/50 to 1/10000 Auto
S/N Ratio	>50dB
Automatic Gain Compensation	Up to 18dB
Power Supply	As per manufacturer's standard to be arranged by bidder
Gain Control	Auto/Off
Day/Night selection	Auto On-Off/Forced
IR cut-filter	Required (in built)
Protocols	

Other Features	IPV4/IPV6,RTP, UDP, TCP, IP, HTTP, HTTPS, FTP, DHCP, IGMP V2/V3, ICMP, ARP, SMTP, SNTP, SNMP or equivalent.
Security	Password protection
Standards	ONVIF / ITU
Auto Resume after Power Failure	Yes
Multiple Streams	H.264 /H.264 & H.264/Motion JPEG
Operating resolution	Primary stream – 1920X1080 at 25/30 FPS & other minimum 720X576 at 25/30FPS
Analytics	Motion detection & Tamper alarm & Power failure
PoE supply IEEE 802.3af compliant or better	Yes
Rate Control	VBR/CBR
	On Screen Menu Display, contour correction and contrast compensation control
	Automatic Picture Enhancement to give a balanced picture where there is too much/too little light
	Synchronization selection for line lock and free running
	Minimum 2 Alarm I/Ps
Housing	IP65 (Minimum), Weather proof IP 67 for outdoor applications. Ex. Proof for hazardous areas.
PTZ Specifications	
Pan	360 Deg Continuous
Tilt	90 deg
Manual Tilt Speed	0.1 deg/sec to 45 deg/sec
Manual Pan Speed	0.1 degfsec to 80 deg/sec
Preset Positions	Minimum 256
Preset Pan Speed	280 deg/sec min
Preset Tilt Speed	160 deg/sec min

6.24 Fixed DOME Type IP camera:

Fixed type cameras shall be dome type and with features mentioned below
a) Image Sensor: 2-megapixel Progressive,1 / 3" CMOS/CCD sensor, Minimum illumination
0.1 Lux.
b) Min Luminous: 0.5LUX(Color) 0.05Lux (Black)
c) Camera Enclosure Type: IP66 Grade
d) Iris/Focus: Auto/Manual
e) Video Compression: Dual Stream H.264 and MPEG 4 user selectable
f) Support Dual stream: primary/secondary stream, H.264/MPEG 4 optional
g) Video Definition: Primary stream:1600x1200,1280x960,1280x720, Secondary
stream:800x600,400x288,192x144
h) Video Parameters: Brightness, hue, contrast, saturation and image quality
i) Video Frame Rate: PAL: 1-25frames/second, NTSC:1-30frames/second
j) Video Compression BR: 32Kbit/S - 6Mbit/S
k) Video Output: One channel composite Streaming
l) Supported Protocols: TCP, UDP, IP, HTTP, FTP, SMTP, DHCP, DNS, ARP, ICMP,
POP3, NTP, IPsec, UpnP, RTP, RTCP
m) Operating Temperature: -5 ~ +50°C
n) Operating Humidity: 10 ~ 90%

6.25 PANELS, DESKS, RACKS AND CUBICLES

6.24.1 Constructional features of panels, consoles, Cubicles and enclosures

1. All panels, cubicles, consoles, and enclosures furnished as per this specification shall be of free-standing type and shall be constructed of specified gauge of steel plates. i.e. CRCA.

2. The minimum sheet thickness of panels shall be as follows unless otherwise specified herein.

   - Sheet Steel (CRCA) main frame made up of folded profile.
   - Cubicle / Enclosure: CRCA 2mm
   - Panel Top & Side & Thickness: CRCA, 1.6mm
   - Panel Door plate & Thickness: CRCA, 2 mm
   - Panel Gland plate & Thickness: CRCA, 3 mm
   - Plinth & Mounting plate: CRCA, 3 mm

3. The panels, consoles/desks shall be reinforced as required to ensure true surfaces and adequate support for instruments mounted thereon. All instrument cut-outs, mounting studs, and support brackets shall be accurately located. All welds on the exposed panel surfaces shall be ground smooth. Finished panel surfaces shall be free from waves, bellies, or other imperfections. Unless specified, otherwise, panel doors shall be 4 points hinged and shall have turned back edges and additional bracing where required to ensure rigidity. Door hinges shall be of the concealed type with 120-degree swing. Door latches shall be of the three-point type to ensure tight closing. Door locks shall be furnished which will allow actuation of all locks by a single master key. All panels shall have removable lifting eyebolts for safe lifting from the top during storage and installation handling.

4. Cabinet doors shall be hinged and shall have turned back edges and additional braking where required ensuring rigidity. Hinges shall be of concealed type. Door latches shall be of three-point type to assure tight closing. Detachable lifting eyes or angles shall be furnished at the top of each separately shipped section and all necessary provisions shall be made to facilitate handling without damage. Front and rear doors shall be

provided with locking arrangements with a master key for all cabinets. If the width of the cabinet is more than 800 mm, double doors shall be provided.

5. The cabinets shall be of max. 2200 mm height excluding base channel, to the extent possible. The base channel shall be 100 mm. All cabinets i.e. PLC, network panels, power supply cabinet, relay cabinet, etc. shall be of the same height.

6. System & non-system cabinets shall have a "look alike" appearance.

7. Enough power receptacles with disconnect switches shall be installed within panels, enclosure and racks.

8. All panels & cabinets shall have bottom entry for cables unless otherwise specified. The bottom of panels, cabinets, enclosures shall be sealed with bottom plate, compression cable glands and fireproof sealing material to prevent ingress of dust and propagation of fire. The Cabinets shall be designed for front & back access to components, terminals and wiring.

9. The cabinets shall be provided with bottom two/three-piece gland plates which shall be removable from inside and shall be provided with sufficient no. of knockouts. The details of knockouts shall be provided during detailed engineering. All knockouts shall be provided with pluggable grommets.

10. All panels shall be mounted on vibration dampers, which are secured to channels mounted on the floor. The channels shall be field welded to steel plates set into the concrete flooring. The steel plates shall be located such as to approximate the outline of panel bases. The exact mounting details shall be as approved by the purchaser during detailed engineering stage. All panels shall be provided with adequate ventilation louvers, fans and packaging density of components shall be restricted to limit the temperature rises above ambient to 10°C under the worst conditions. All electronic system cabinets shall be designed for 50 degC operating under maximum ambient temperature without air conditioning system in service. All panels shall have an auto on/off switch for internal lighting. All the power supply circuits for control panels shall be provided with auto changeover circuitry.

11. All panel doors (Left and Right) shall be provided with door switches (Left and right) for open/close indication.

12. Exhaust Fans with louvers & filters shall be provided on the upper side to remove hot air in all consoles and panels. All the panels, including relay panels shall be provided with exhaust fans arrangements.

13. Power supply failure/ healthy indication shall be provided in each cabinet & remote indication shall be hooked up to PLC annunciation & suitably grouped.

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

15. Doors shall be provided with neoprene /Polyurethane gaskets.

6.26 Surface Preparation and painting

1. All panel exterior steel surfaces shall be ground smooth, and painted as specified below:

2. Suitable filler shall be applied to all pits, blemishes and voids on 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 one or more solvent cleaning methods. Alternatively, 7 tank process shall be followed.

3. 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 color (Catalyzed epoxy finish) shall be applied to all surfaces of dry film thickness 2.0mil. The finish colors for exterior and interior surfaces shall conform to RAL7035.

4. One uniform color shade as finalized shall be applicable for complete plant. Painted 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 expense of the Bidder.

6.27 Internal wiring

1. The wires shall be neatly looped and supported in non-flammable plastic wiring raceways. The wiring is to be of general-purpose classification for non-hazardous areas as per the applicable standards. Slotted wire-ways should be used and sized, such that

no more than 50% of the cross-sectional area of the wire –way is filled. All AC wiring in a cabinet should be routed in steel wire –way to reduce noise in instrument signal wiring. If this is not feasible, it should be physically separated from the DC signal wiring as much as possible. Parallel runs of AC and DC wiring closer than 300 mm should be avoided. Power supply to each instrument / equipment shall be through double pole miniature circuit breaker (MCB) of adequate rating. All these MCBs shall be housed in a separate switch box mounted inside the cabinet. All wiring shall be carried out with 600 V grade, single core, stranded copper conductor wires with PVC insulation. The minimum number of strands per conductor shall be seven.

2. Terminal blocks of size suitable for 2.5 mm^2 cable shall be provided for all external wiring. Adequate space/ partitions shall be provided to prevent touching electronic hardware when working at terminal blocks.

3. Wire terminations shall be made with solder-less crimping type of tinned copper lugs, which firmly grip the conductor. Insulated sleeves shall be provided at all the wire terminations.

4. Tag no. engraved identification markers made of PVC, plastic or suitable material shall be fitted at both ends of each wire. The marker shall not fall off when the wire is disconnected from terminal blocks. Single lettered ferrules are not acceptable. The 'Cross ferruling' method shall be used for identification i.e., ferrule shall identify the terminal numbers to which both ends of the wire is connected.

5. Terminal blocks shall be shrouded 600V grade clip-on type, complete with identification strips. A minimum clearance of 100 mm shall be provided between blocks of terminals. Not more than two wires shall be connected to a single terminal.

6. Terminal blocks shall be readily accessible and mounted not less than 12 inches above the floor and 6 inches below the top of the cabinet.

7. At least 20% of spare terminals shall be provided for each cabinet, and this shall be distributed uniformly in all terminal blocks. 20% spare space in the marshalling compartment shall be considered,10% spare space for future rack in system cabinet,

8. Each row or column of terminal blocks shall be identified with a unique identification and the terminals in a block shall be sequentially numbered.

9. Necessary cable glands shall be provided for glanding all incoming and outgoing cables. All cable glands shall be of nickel-plated brass and double compression type. At least 20% glands of each size shall be supplied as spare.

10. All the signals connected to a module shall be grouped and wired to a single terminal block in the marshalling / IO and system cabinets. The field cables shall not be directly wired to the I/O modules. Marshalling cabinets shall be provided such that PLC/DCS system wiring shall be done independent of field cable grouping. The terminal blocks shall be suitably tagged for easy identification.

11. For all hardwired signals, separate dedicated cable cores shall be used i.e. no common cable cores shall be shared between any two or more signals.

12. The following colour code shall be used for cabinet wiring.

230 V AC wiring	Phase	-	Black
	Neutral	-	Red
D.C. wiring	Positive	-	Blue
	Negative	-	Grey

Interlock wiring powered by external sources – Yellow.

Earthing – Green or Green with yellow stripes

6.28 Interior lighting and receptacles

1. Each cabinet shall be provided with a LED lighting fixture rated for 230V, 1 phase, 50 Hz supply for the interior illumination of the cabinet during maintenance. The fitting shall be complete with MCB, and the respective cabinet door switch shall control the switching of the fitting.
2. Each cabinet shall be provided with a 230 V AC, 1 phase, 50 Hz, 5 Amps, 3 pin receptacle switch mounted inside, at a convenient location.
3. Each cabinet shall have document pockets.

6.29 Operator /Engineering Console

1. Ergonomically designed modular consoles shall be provided.

2. The Basic Structure of Operator engineering console consists of Extruded Aluminum Profiles. The desktop / Working Surface should be made in 12mm Solid Acrylic Panel Cladded on 25mm Medium density Fiber (MDF) Board.

3. The Front, Rear and either Side wall / Sheet / Panel shall be made of min. 18 mm thick Pre- laminated MDF Board. The Front & Rear shall double leaf type doors with MS hinges. All panels must be attached to the frame with concealed fasteners. The Front panel should be positioned in such a way that there should be sufficient leg space (min of 400mm from the front edge of the Tabletop).

4. The CPU modesty shall have concealed cable & wire way management system. Louvers with filters shall be provided on the front wall for Air inlet and Louvers with Fan & filters shall be provided on Rear side for Air outlet. The cabling / wiring between OWS & CPU's, power supply cables etc. shall be aesthetically routed and concealed from view. Retractable trays shall be provided inside the desk for mounting the CPU. The Frame Structure shall have integrated cable management.

5. There should be separate PVC Cable Raceways (Both Vertical & Horizontal) for routing of Power & Data Cables. Necessary power Plug sockets (both flat & Round pin), MCBs, etc. shall be provided. A cooling fan, LED light, Door switch, power socket, Electrical / electronic earthing strips, power terminal blocks, spike buster, RJ45, RJ 11 for Data and networking, etc. shall be provided.

6. Separate power supply terminals for 230VAC redundant power supply and 230VAC non-UPS power supply shall be provided along with all the internal wirings.

7. A levelling foot adjustment shall be provided.

8. Monitor Arm shall be provided.

9. Provision for mounting emergency pushbuttons shall be provided along with suitable closed cover.

10. Console size shall be approx. 750(L)X900(B)X750(H) mm. The dimension of Height mentioned is from ground to worksurface.

11. The curvature of consoles as required during detail engineering shall be provided based on the architectural and layout requirements.

12. The customer logo shall be printed / embossed on a glass plate which shall be fixed on either side of the control desk.

13. Suitable mounting stands and accessories with rotating & height adjustable features shall be provided for mounting Telephones and PA system on Desks & Tables.

14. Ergonomically designed modular type Footrest shall be provided for each section / table.

15. General arrangement and wiring drawings shall be submitted during detail engineering. The colour of consoles and chairs shall be finalized & approved by Purchaser during detailed engineering.

6.30 Operator Chair

1. Industry standard wheelchairs with provision for pneumatic adjustment of height, headrest shall be provided for the operator & unit in charge & other personnel. Armrest shall be provided. These shall be designed for sitting for a long duration such that these are comfortable for the back.

2. 360 Deg. revolving type with Stainless steel wheels shall be provided. Distinctively and characteristically designed tilt mechanism offering a very smooth and fluidic reclining motion with tension adjust knob and importantly offering seat to back recline ratio, optimal for good back support. Multi-lock mechanism is fabricated from CR Sheets, undergo through CO2 welding process imparting uniform surface finish and tensile strength. The components are processed with a high degree of precision and care to assemble with other parts in perfect harmony to give smooth and effortless reclining experience. Tension springs shall conform to International Standards. Also provided with release levers for locking mechanism and height adjustment of seat. Mechanism aids to operate the height adjustment, and has been equipped with 4 locking positions, back rest return prevention function.

6.31 Name Plates

All components mounted inside the cabinet shall be provided with individual nameplates with the tag no. and service engraved. The nameplates shall be mounted directly below the respective component. Also, the cabinet shall be provided at the top with a nameplate engraved with cabinet designation. Nameplates shall be made of anodized aluminum engraved with white letters on a black background.

7.0 TRAINING

a. The bidder shall provide training on the proper application and maintenance of each type of control system and field instruments. The bidder shall be responsible for hiring specialist help from vendor for training of the plant management and O&M engineers.

b. The cost of training shall be in the bidder's scope. The same shall be separately indicated in the commercial offer.

c. The Training shall include Man Machine interface, Hardware and operating systems, Engineering and application software, modules & interface with OS, Development of mimics (Pre-treatment, RO, product water, chemical dosing, and reject. Include SDI, TDS, and pH trend graphs), Database organization & development, other application like calculations, logs historical storage functionalities & use, Communication with MMI & other system, Application for implementation of Control functions, Study of standard algorithms & development of new algorithms, Critical analysis of control loops, field instruments, etc.

d. The Contractor's personnel at site shall continuously and intensively instruct and train adequate number of the Owner's operating and maintenance personnel at site during erection and commissioning of the equipment to enable them to take over the proper operation and maintenance of the equipment after commissioning.

8.0 START-UP & COMMISSIONING SPARES

A list of Startup & commissioning spares proposed by Bidder should be provided with the Bid for the complete controls & instrumentation.

8.1 TOOLS & TACKLES

Bidder to offer the following minimum tools for PLC and field instruments along with any other special tools required for the maintenance of the PLC system shall be supplied.

- One set of Screw drivers
- One set of Allen keys
- One set of Spanner
- One no of Controller / IO module configurator
- One no of multifunction Loop calibrator
- One HART communicator
- One set of special tools & Tackles

9.0 PERFORMANCE REQUIREMENTS

9.1 Performance requirements for CLCS

The Bidder shall guarantee that the control system provided by him shall be responsive and stable and shall maintain the deviation of controlled variables from set point within the limits specified so that the equipment being controlled shall operate as specified over the range required. The controls shall operate automatically, with no assistance from the operator. The Bidder shall successfully demonstrate the performance of Closed Loop Control Systems before acceptance and taking over of this system by the Owner.

9.2 PLC Parametric test

The following parametric tests shall also be conducted under worst case loading conditions.

i. Processor Spare Duty Cycle (Free Time)

(a) For Control System: -
CPU loading, cycle time/controller reaction time and memory spare capacity

(b) For MMI: -
CPU loading, spare duty cycle, spare memory capacity

ii. Spare duty cycle for system bus

iii. Various display response time

iv. System accuracy

v. Monitor update time.

For the parametric test, the following requirements shall be met.

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 anyone-minute period.

Under worst case loading conditions of control system control system processor shall have 20% free time when measured over anyone-minute period. The Bidder shall furnish all necessary data to fully satisfy the Owner that the processor 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. The spare capacity of working and bulk memory shall meet the specification requirements.

9.3 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.

9.4 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 requested display or Acknowledgment 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:

01. All control related displays	:	1 sec.
02. Control command execution time	:	1 sec.
03. Point details display (single point)	:	1-2 secs.
04. Bar chart display (20 points, current data)	:	2-3 secs
Operator guide / plant start-up guide message display (full screen of alphanumeric information and a maximum of ten numbers of dynamic data items)	:	1-2 secs.
Plant mimic display of fair complexity with a minimum of 120 numbers of dynamic data items e.g., values, macros, line segment, etc.	:	2-3 secs.
Group review display (current values of twenty points)	:	2-3 secs.
X-Y plot display (2 X-Y- plots and a single display requiring both historical as well as current data)	:	3-4 secs.
X-T plot display (trend of 6 analog points and a single display requiring both historical as well as current data)	:	3-4 secs.
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).	:	3-4 secs.

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 two seconds (excluding the drive actuation time).

9.5 System Accuracy Requirements

The overall system accuracy from signal input terminals to output presentation on monitor display and printers for the least accurate input range and maximum scan rate shall be no worse than +/- 0.2% of full scale of the process range.

9.6 Screen updated rates.

All monitors shall be updated at least every two seconds.

9.7 Availability Tests

PLC availability tests shall be performed to establish the system availability guarantee of 99.7%. Bidder shall submit the availability test procedure for Owner's approval.

a) Bidder shall guarantee 99.7 percent system availability for a period of 72 hours. An Availability Guarantee Test shall be conducted to assure this level of availability. If the accrued down time exceeds 0.3 percent of 72 Hours, during availability test run, a new 72-hour test run shall start at the time when the system becomes available again. Loss of availability 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 percent of the I/O points shall not be considered as complete loss of availability. Loss of a function for more not more than five percent of the points shall be treated as partial unavailability and the corresponding outage time shall be weighted with respect to function and the 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 guaranteed accuracy and repeatability and system parametric requirements specified elsewhere shall be maintained for the entire 72 hours run without any manual recalibration or any other changes made to the system.

b) Downtime shall start upon loss of a system function and shall end upon full restoration of the affected system function.

c) If availability is lost due to Owner, down time shall not be charged to Bidder.

d) Test Dates starting date of the test shall be decided based on mutual consent of both Bidder and Owner.

e) Test Duration and Definition

1) The availability test duration shall be 72 hours of accumulated test duration time. Such duration time shall be continuous from the start of test, except as defined hereinafter.
2) The availability shall be expressed by a percentage which shall be calculated as 100 x [Test Duration Time - Accumulated System Outage Time]
   Test Duration Time
3) The accumulated system outage time shall be a total of time in which the system functions are not available. A weighing factor shall be used to determine the amount of outage time assessed due to partial failures. System outage time shall be calculated as: (Outage time) x (Weighing factors)
4) System outage time shall be accumulated over the test duration and shall be the accumulated system outage time.
5) A minimum of one hour's down time shall be charged for each loss of availability in determining system availability.

a) Outage Time and Weighing Factors
   1) Bidder shall submit a list of weightage factors for all system elements / components of the PLC which shall be agreed upon by the Owner before award of Contract.
   2) Outage time shall be assessed for the length of time in which all or any part of any of the functions are either continuously available or not available to the operator.

b) Conditions
   1) Downtime shall start at the time of notification exclusive of actual travel time required by Bidder's specialist (wherever required) but not more than 48 hours.
   2) Bidder shall include commissioning spares for performing the above tests.
   3) Failure of peripheral output devices shall be counted as outage time if failure of the device affects any or part of any function as per clause.
   4) Any degradation of function shall accrue to outage time regardless of system configuration.
   5) During a period of partial system outage, Owner shall be permitted to use other operable functions of the system if such use does not interfere with maintenance of the inoperable functions or hardware as determined by the Bidder. Should Bidder determine that partial use of the system by Owner shall interfere with Bidder's maintenance procedures, system outage time shall accumulate with a weighing factor of 1.0 since no functions are available to Owner. This shall include off-line servicing.

9.8 TESTING & INSPECTION

1. A 100% integrated system simulation test shall be carried out in the shop to test all hardware and software.

2. Purchaser /Owner /consultant's inspectors will participate in the Factory Acceptance Test (FAT) at shop, prior to dispatch. FAT shall be carried out as per final approved drawings /documents and FAT procedure. The bidder shall carry out a performance test at site.

3. FAT procedure shall be submitted to Purchaser /Owner /consultant for approval well in advance to the commencement of FAT.

4. Factory Tests :Automatic Control and Monitoring system (PLC) 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 Purchaser approved Quantity Assurance Program, to demonstrate to the Purchaser 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.

9.9 Surge Protection Test for Solid State Equipment

1. All solid-state equipment shall be able to withstand the noise and surge inherent in a Powerhouse and shall strictly comply with SWC tests ANSI/IEEE C 37.90.1, 2002 Complete details of the features incorporated in electronic system to meet this requirement the relevant test carried out, and the test certificates shall be submitted along with the offer.

2. All instruments and control equipment supplied against this contract shall be factory calibrated at least at five (5) points throughout the range and checked for their functional/performance requirements. The instruments shall also be calibrated at site prior to commissioning.

3. The type, routine and acceptance testing of all equipment supplied under this contract shall be in accordance with relevant international standards, in addition to the requirements of Purchaser approved Quality Plans. Six (6) copies of test reports shall be submitted to the Purchaser for approval prior to dispatch of the respective equipment.

4. The representative of Purchaser / Owner / consultants shall be given opportunity to witness the factory tests which shall be mutually finalized during the progress of the contract.

5. 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, MANUAL/AUTO station, other system modules, alarm contactors and multi-conductor interconnecting cables. The tests shall be performed with all 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 the control system, which simulates dynamic inputs and monitors system outputs.

6. Certain control loops shall be factory tested using closed loop mathematical simulation techniques. The purchaser has discretion to test and all control loops during simulation testing.

7. 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.

8. 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.

9. Availability of a simulated type test for automatic control loops specified with a detailed description of testing methods utilized shall be indicated.

10. A brief description of all tests proposed to be conducted on automatic 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.

9.10 Test requirements.

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

Process input/output conditions and other load on the system to be stimulated either by hardware/software.

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

9.11 Test documents drawings.

Total system configuration drawings /GA /IGA /Wiring /BOQ, Logics, HMIs, etc., and other documents as approved during detailed engineering.

9.12 FAT procedure consisting of

- Test Equipment
- Test Environment
- Test Configuration
- Test Procedure
- Test Schedule
- Test Venue
- Test Reports- specimen copies.
- Function design specification for each equipment / system

9.13 Preliminary checks

- General appearance check and bill of materials check
- Construction checks as per overall general arrangement drawings.
- Dimensional check
- Labelling, terminal arrangement and equipment identification check
- Power supply voltage level check and power LED-ON check
- Cooling fan operation check
- Grounding network check

9.14 System checks

- Power supply under voltage and over voltage check (± 10%)
- Processor & main data bus network redundancy check, if applicable
- Communication module of the controller to network redundancy check
- Power supply redundancy check
- Hardware on-line maintainability check

9.15 Controller check

- Closed loop control simulation check
- Open loop control simulation check
- Control loop response check.
- Bump-less auto manual transfer check.
- Operating station – graphic overview check
- Operating station- trend check
- Operating station- real time trend check
- Operating station- mimic / graphic check
- Operating station- check for operating control directly from mimic/graphic

9.16 Operating Station- Function Keys Check

- Operating station- analog control display check
- Operating station- sequence control display check
- Operating station- operator guidance message check
- Operating station- alarm management function check
- Operating Station – Logging function check
- Operating station / response / updating check.
- Keyboard lock function check
- Operating station interchange ability and assign ability check.

9.17 Graphic display building function check

- As per the approved DES and P&ID

9.18 Maintenance check

- Closed loop control system modification check
- Open loop control system modification check
- Alarm display prioritization check.
- System security check
- System alarm check
- System diagnostic function check
- Point detail configuration check.
- Control loop tuning check.
- System self-documentation check

Any other checks as per the approved factory acceptance test procedure during detailed engineering.

9.19 Site Acceptance test procedure.

A detailed Site acceptance test procedure (SAT) shall be submitted to the purchaser/owner/consultants for review and approval during detailed engineering.

10.0 LAYOUT & MAINTENANCE REQUIREMENTS

1. For PLC systems with OWS, the entire PLC system comprising the human machine interface (HMI), PLC cabinets, power distribution cabinets, UPS etc. shall be housed in the respective package control rooms that shall be air-conditioned. PLC systems provided with LCD display/ keypad or conventional operational hardware shall be mounted in the respective switchgear rooms / near the equipment controlled by them as per layout finalized during engineering.

2. All the cabinets shall be the same height, depth and color. The BIDDER shall submit a control room layout drawing clearly indicating all the dimensions of the control panels / desks, doors, knockout doors, floor opening required for cable entry, etc.

3. Computer grounding shall be separate from station grounding.

4. Any specific recommendation regarding the location and limiting distances between the different equipment to be in the control room and in the annex of the control room shall be detailed and the layout for the same shall be furnished during detailed engineering stage for Purchaser's / Purchaser's Representative approval.

5. The location of transmitter enclosures/field instrument enclosures/ junction boxes shall be designed depending on the equipment / tapping point location. The number of transmitters to be housed in each transmitter enclosure shall be limited to five.

6. The exact routing of impulse pipes / tubes shall be decided at site during erection depending upon the location of tapping points and location of transmitter enclosures. PURCHASER reserves the right to approve the suitable location of the transmitter enclosures and field mounted junction boxes.

7. All I&C equipment being supplied by the BIDDER shall be supported adequately to prevent vibration and anchored sufficiently to prevent undue strains on the equipment served. Hangers and supports shall be so installed as not to interfere with free expansion and contraction of the piping and tubing between anchors. Suitable spring hangers, vibration dampers, etc. shall be provided wherever necessary. In addition, care shall be taken that the arrangement of piping, tubing, cable trays and supports shall provide for safety under working stress and shall protect the piping and tubing from

detrimental sagging, mechanical injury, abuse to unusual service conditions from sources other than those due to pressure, temperature and vibrations.

8. The tapping point instruments shall be located at an appropriate location to meet the purpose of the instrument provided.

9. Local panels shall be mounted near the equipment.

10. For vertical heaters, the floor openings considered shall include the depth of impulse line, standpipe and local instruments, all added together,

11.0 I&C MAINTENANCE REQUIREMENTS

All equipment furnished by the bidder shall be designed for ease of maintenance to help achieve a high meantime between failures (MTBF). All equipment shall be of modular design to assure a short mean time to repair (MTTR)
The following specific provisions shall be made to achieve the above objective:

a) The bidder shall furnish the details of the maintenance requirements of each equipment, indicating a list of parts, which require regular maintenance, and frequency of maintenance for these parts. Based on bidder's experience, documentation giving a recommended maintenance program to achieve a high MTBF for the system shall be furnished.

b) The bidder shall furnish sufficient documentation to ensure efficient maintenance and troubleshooting of equipment and modules. This shall include point to point wiring diagrams and schematic diagrams of all electronic assemblies supplemented with concise description of theory of operation of individual subsystems. Expected faults, troubleshooting hints, checkout lists and a list of sub-components prone to failure shall also be provided.

c) All equipment shall have extensive self-diagnostic features, test points and clearly labeled error indicating lamps, which help in speedy identification of faulty modules.

d) Provision shall be made for isolation of sub-systems / modules which are identified to be faulty, thus enabling on-line replacement without taking equipment off-line.

e) Adequate number of test equipment, test sockets, test cables, digital voltmeters, signal generators, card extenders, maintenance equipment tools, special erection tools, etc.,

shall be provided by the bidder to facilitate ease in maintenance and to have minimum down time.

f) Components of same function shall be as far as possible interchangeable.

g) The standardization concept shall be used in setting the components for the system.

h) All the documentation shall be in the English Language.

i) All the documentation shall be provided on Hard Disks in addition to the printed documents. All the software to retrieve online documentation shall be supplied.

j) All required maintenance tools and inspection devices shall be included in the system.

k) Access stairs, maintenance platforms and ladders as required shall be provided for all instruments, transmitters, analyzers, etc. near the respective tapping points.

l) All the I &C equipment and systems covered in the specification shall be derived for maximum reliability and availability.

m) The I &C system shall be designed with extensive self-diagnostics and troubleshooting features. Facilities shall be provided for quick repair/maintenance and on-line replacement of faulty modules.

n) Control valves/dampers/motorized valves shall be mounted taking care of the access maintenance requirements. The selection of the valve vis a vis the piping layout shall match.

12.0 ERECTION, AND COMMISSIONING REQUIREMENTS

1. A minimum of thirty days prior to commencement of any installation work, the Contractor shall provide a schedule detailing the dates when work will be undertaken.

2. The Contractor shall provide a written plan detailing the work to be performed for the installation of the system. The site installation plan shall be submitted for approval at a minimum of thirty calendar days prior to the commencement of any work.

3. No installation or commissioning work shall be started at any site until the Contractor has obtained client approval for the FAT results and approval for the applicable 'issued for construction' drawings. The Contractor shall be responsible for obtaining all necessary permits and permissions to perform the required installation work
4. The Contractor shall check the system as soon as it is installed at site to confirm that

the system is still fully calibrated and functional after shipment and installation. The Contractor shall be required to maintain the commissioning team of the vendor on site to cover any failures during the commissioning period. The Contractor shall supply on site, software and hardware support expertise during commissioning of the system and during the complete thirty-day performance test period from the PLC/SCADA system vendor.

5. The successful commissioning of the instrumentation and control system for the desalination plant shall remain within the scope of the bidder. In the event that any additional materials, instruments, or devices are identified during the engineering, erection, or commissioning phases, the bidder shall ensure their provision and integration as necessary to achieve successful commissioning, without impacting the overall project cost or completion schedule

12.1 Erection requirements

a) The actual location of instruments, junction boxes etc. shall be decided by the bidder depending on the site conditions considering the layout and maintenance aspects.

b) The bidder shall get prior approval as per the approved quality assurance plan of the Purchaser / Purchaser's Representative before any installation work starts. If any work is carried out by the bidder before prior approval from Purchaser / Purchaser's Representative and modification is sought by Purchaser / Purchaser's Representative later, then the work shall be redone by bidder without any cost / material implications to the Purchaser / Purchaser's Representative.

c) Impulse / sample piping, air supply and pneumatic tubing, cable trays and equipment shall be supported rigid enough to prevent vibration and anchored sufficiently to prevent strains on equipment installed. Supporting clamps shall be provided at least at every one-meter distance for better rigidity. Impulse / sampling piping shall be provided with adequate slope, (preferably 1:10). Hanger and supports shall be so installed as not to interfere with free expansion and contraction of the piping and tubing between anchors. Suitable vibration dampeners, etc., shall be provided wherever necessary. In addition, care shall be taken that the arrangement of impulse / sampling piping, air supply and pneumatic tubing from detrimental sagging, mechanical injury, abuse due to unusual service conditions from sources other than those due to pressure, temperature and vibrations. All impulse lines of joints shall be welded type unless otherwise specified. Argon arc welding shall be employed.

d) All the panels, desks, and cabinets supplied by the bidder shall be welded or bolted to

the floor channel. Before fixing the panels, desks, or cabinets, the bidder shall obtain approval from the Owner/Consultant to determine whether they should be fixed by welding or bolting, based on the site requirements.

12.2 Testing Requirements

a) The bidder shall follow the standard procedures for calibration of various instruments and as set by the manufacturer of instruments and as instructed by the Purchaser including any requirements of field calibration. First, the calibrations shall be carried out independently by the Bidder and later in the presence of the Purchaser who shall certify the same. Proper documentation in this regard shall be maintained and handed over to the Purchaser.

b) All the instruments shall be calibrated for the entire range of the instrument for which it is designed. Calibration shall include a test for repeatability. After first commissioning, the instruments shall be tested for calibration again to check whether the instrument maintains its zero and maximum of the range.

c) All instruments and control equipment shall be calibrated to read correctly to the satisfaction of the equipment supplier / Purchaser.

d) All switches shall be tested for the actuation of both normally open and normally closed contacts at the desired set points and for the fixed / differential settings.

e) All the float operated level switches shall be tested for the movement of the float and linkages to make to break the switch contacts by filling up with water before installation. For such tests, the necessary testing set up required shall be arranged by the bidder. All the conductivity type probes and switches shall be tested for performance before installation.

f) Air leak tests shall be performed on all air supply and pneumatic lines. Necessary equipment such as portable compressors, connecting pipes, materials, cables and test gauges shall be provided by the bidder.

g) Hydrostatic and pneumatic tests to be performed on all pipes, tubing's and systems shall confirm to ANSI B31.1. Necessary equipment such as hydro test pumps and temporary piping to the required point, fill pump etc., materials such as temporary gaskets, miscellaneous fasteners, etc. tools and tackles including test pressure gauges, etc. are to be provided by the bidder.

h) For all electrical actuators of the valves, functioning, setting and performance of limit

switches / torque switches of various positions shall be checked before and after installation of the actuators. The position transmitters for inching applications shall also be calibrated.

i) Pneumatic actuators shall be calibrated at site.

12.3 Commissioning Requirements

a) Prior to taking the instruments in service, all impulse lines, sampling lines and air supply lines shall be blown as required with the establishment of adequate line pressure and temperature conditions to keep the lines thoroughly clean.

b) On-line i.e., without removing control valves from the pipe, calibration of the positioners and stroking of control valves / control dampers shall be carried out as required during control system tuning.

c) Pre-commissioning checks, individuals loop checks, power initialization, verification of system functioning, troubleshooting final solutions to application and / or instrument problems, etc., is Bidder's responsibility. All the required software and hardware changes shall be incorporated as required for successful commissioning to Owner / Consultant satisfaction.

d) Any other tests may be directed by the Owner / Consultant Representative.

e) After delivery of the equipment, the Bidder shall locate all the equipment including electronic cards in its final position, check all the power wiring, grounding and interconnection cables, all in accordance with the manufacturer's recommendations. The Bidder shall perform initialization of system power, field loading of system configuration / software and data base, demonstration of system functionality to verify conformance with manufacturer's instructions and specifications, tuning of control loops, implementation of any configuration changes including hardware, software and additional tapings / instruments, cabinets as required and providing general trouble shooting and final solutions to application and / or instrument problems.

12.4 Specific requirements for Erection, Testing, Calibration and Commissioning

The erection of instrumentation system shall be carried out generally conforming to General Technical standards However, the bidder shall select and adopt methods and procedures for equipment erection to suit the nature of equipment and erection, involved according to the best modern practice and his own experience.

12.5 Scope of Work for Erection

1. The bidder shall be required to erect all cabinets, consoles, desks, all cables, conduits, equipment of PLC etc. required for completion of PLC package covered in this specification.

2. The bidder shall provide all necessary skilled supervisory manpower for timely efficient erection and testing.

3. The bidder shall maintain a proper record of the materials at the place of storage for quick identification as and when required.

4. The bidder shall be responsible for replacing any parts or components that are damaged during transit or subsequent storage, as well as for replacing any lost parts, at no extra cost to the owner and without extending the project timeline.

5. The bidder shall furnish a detailed erection schedule, which shall be finalized along with the offer keeping in view the overall erection and commissioning schedule.

6. The erection schedule as agreed with the PURCHASER shall be strictly adhered to by the bidder
   The erection work shall include but not limited to the following:

   (i) Transportation of the tested and calibrated equipment to the place of installation without any damage.

   (ii) Installation of PLC equipment as per bill of material and as per relevant approved G.A and disposition drawing.

   (iii) Installation of the necessary cable and racks with posts, brackets, and fasteners.

   (iv) Installation and termination of electrical, measuring, control, power supply, and signal lines, from the available / to be erected marshalling cabinets to I/O cabinets System cabinets as per relevant interconnecting and terminating drawings prepared by the successful bidder. This includes laying of all control cables, compensating cables etc.

   (v) Supply, fabrication and erection of structural steel plates, angles, pipes required for supporting cable trays complete with bolts and nuts.

(vi) Providing identification of cable by engraved Aluminum tag plates at both ends inside the cabinets, consoles as per cable schedule.

(vii) Preparation of separate earthing pits as recommended by the PLC system supplier, laying and connection of the earthing cables from different equipment to the respective earthing pit.

12.6 Erection

12.6.1 Cabinets and desk

a) The bidder shall arrange for the transportation and handling of cabinets and desks from stores to work site suitably without any damage. If any damage is observed before handling, this shall be brought to the notice of the PURCHASER.

b) Before installation of cabinets and desks, the necessary openings and inserts required to be made on the floor by the Bidder shall be checked and then after proper alignment, the cabinets and desks shall be installed on the floor by the bidder. All necessary civil work to be carried out for this shall be in Bidder's scope of supply.

c) The cabinets and desks shall be cleaned by blowing air to remove dust or foreign particles.

d) The bidder's scope of work and supply shall also include tightening of wires, replacement of broken items and retouching of damaged painted surface of cabinets that have taken place during transport from store to work site and during installation.

e) The cabinets and desks shall be suitably earthed as per requirement and as per approved documents by the main earthing strip provided in the cabinets and desks.

12.6.2 Cables, cables trays and conduits

a) All cables shall be tested for insulation level. Cable ends shall be properly cleaned.

b) The entry to and exit from pipes shall be smooth and free from burr where cables are run through pipes. Cable shall be pulled into the pipes in such a way that there shall be no damage to the cables.

c) Flexible conduits shall be provided wherever necessary.

d) Cable in hot areas shall have proper heat protection.

e) cable tray size length, cable segregation and min. distance between cable shall be as follows

f) "Cable Trays shall have standard widths of 50mm, 100mm, 150mm, 300mm & 600mm and standard lengths of 2.5 meters.

g) Each tray shall be filled with a maximum of two layers for instrument and control cables and one layer for power cables providing 20% spare space in the number of layers specified.

h) Instrument Cable Trays shall be erected vertically as far as possible to avoid dust accumulation.

i) All the cables laid shall be tied individually to the Tray.

j) The cabling accessories shall include cage-clamp type terminal blocks, splicing materials, crimping tools, cable support grips, insulating tapes, GI flexible conduits, conduit fittings, GI perforated covered trays, supports, accessories, and cadmium plated trays & cable glands.

12.7 Loop testing

a) The action of the controller is set as prescribed. Controller settings for various modes of operation (Proportional band, reset and rate action) are at nominal value.

b) For current signals, 4 – 20 mA shall be injected and checked the loop for 0%, 25%, 50%, 75% and 100% of full-scale inputs.

c) For temperature loops with thermocouples, a known milli volt signal shall be injected, and the output display shall be checked for input signals of 0%, 25%, 50%, 75% and 100%.

d) For temperature loops with RTDs, a known resistance shall be injected in the control cable through decade resistance box.

e) Output display shall be checked for 0%, 25%, 50%, 75% and 100%.

f) For field mounted switches for alarms / interlocks, the action shall be simulated by disconnecting the wires / shorting the terminals and the function of the associated system shall be checked.

g) Any special equipment required by the Bidder for testing, calibration and commissioning shall be brought by the Bidder to site. The list of such equipment shall be furnished along with the offer.

12.8 Commissioning

a) The Bidder shall take care to complete all pre-commissioning activities and simulation tests after erection to suit the overall startup of respective plant equipment.

b) The pre-commissioning activities of the system shall be completed at least two (2) days in advance as per the schedule of plant start-up.

c) The controllers shall be tuned as per the process requirement. The list of set points, alarms / Interlocks, settings for the controllers shall be furnished in the standard format and handed over to the Owner / Consultant.

d) Control loops shall be put in auto mode as per the operational requirement of different phases.

e) Before taking over the plant by the OWNER / CONSULTANT, all the system and auto control loops shall run satisfactorily for 72 Hrs. at varying loads without disturbing any adjustment.

f) The performance test shall be carried out for the system offered and certificates to these effects shall be approved by the OWNER / CONSULTANT.

13.0 QUALITY ASSURANCE

1. The Bidder shall furnish a detailed Quality Assurance/ Quality Control Plan (QA/QC) for each Instrument / System covered under this specification for OWNER / Consultant review and approval. The QAP shall be subject to the Owner's Approval.

2. Bidders shall offer for inspection as specified.

3. Inspection and Testing Procedures: Detailing the methods for inspection and testing at various stages of the manufacturing, installation, and commissioning process.

4. Quality Control Documentation: Such as test certificates, calibration records, inspection reports, etc.

5. Bidders shall offer for inspection the instruments/systems as specified in the technical requirements, including any factory acceptance tests (FAT) or site acceptance tests (SAT) that may be required. The Bidder shall provide the necessary documentation and access for inspection at all stages.

6. Calibration and Certification: The Bidder must provide certificates of calibration for all measurement instruments and systems used in the project.

7. Traceability: The Bidder shall ensure full traceability of all components and processes, from procurement to installation, with reference to appropriate documentation (e.g., certificates of origin, serial numbers, test results).

8. Final Documentation: The Bidder shall submit a Final Quality Report upon completion, including a summary of inspections, tests, and corrective actions taken (if any), submission of inspection photographs by bidder (photographs must have Time and Date stamp)

9. Bidder shall Arrange Proper Arrangement of remote FAT in such case of required by owner.