Maharashtra Industrial Township Limited (MITL)

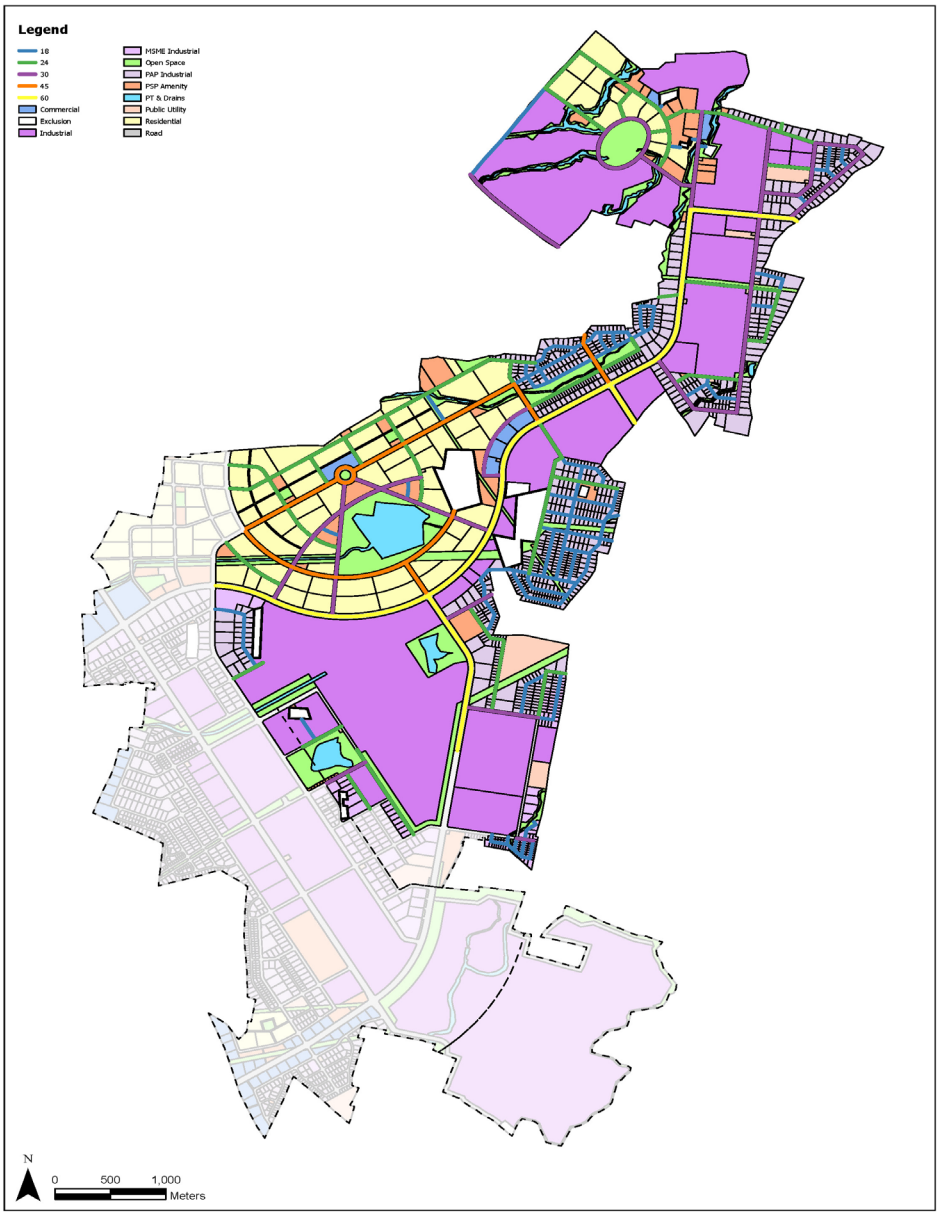
Design, Construction, Testing, Commissioning, Operation and Maintenance of Infrastructure Works at AURIC - Bidkin Industrial Area (BIA), Sector B & C on EPC Basis

Request for Proposal cum Request for Qualification

Volume II: Technical Specifications

Part G - Instrumentation, Control and Automation (ICA)

November 2026



This page is intentionally blank.

1. Contents

1 Instrumentation, Control, and Automation (ICA) 3

1.1 Scope 3

2 Abbreviations 5

2.1 Codes and Standards 5

2.1.1 Engineering Units 6

2.2 The contractor P&IDs. Accuracy 7

2.3 Repeatability 7

2.4 Ingress Protection and Instruments Materials 7

2.5 Lightning Protection 8

2.6 Mounting 8

2.7 Name Plates and Tagging 8

2.8 Qualification Criteria for Instrumentation and Automation Vendor/integrator 8

2.8.1 Utility and Earthing Requirement 9

2.8.2 Air Supply 10

2.8.3 Earthing 10

2.8.4 Electrical and Instrumentation Interface 10

2.8.5 Inspection and Testing 11

2.8.6 Quality Control 12

2.9 Installation and Commissioning 12

2.9.1 Training 12

2.9.2 Painting 13

2.9.3 Guarantee and Warranty 13

2.9.4 Drawing and Documents 13

2.9.5 Spares and Special Tools 14

2.10 Instruments, Actuators and Cables 15

2.10.1 General 15

2.10.2 Junction Box 15

2.11 Level Instruments 16

2.11.1 Ultrasonic Level Transmitter 16

2.11.2 Hydrostatic Pressure Type Level Transmitter 18
2.11.3 Level Gauges 18
2.11.4 Conductivity Probes 19
3 Float Switches 20
3.1 Flow Instruments 20
3.1.1 Electromagnetic Flow Transmitter 20
3.1.2 Ultrasonic Transit Time Flow Transmitter 22
3.1.3 Thermal Mass Flow meter 22
3.1.4 Open Channel Ultrasonic Flow Transmitter 23
3.2 Pressure Instruments 24
3.2.1 Pressure Gauges 24
3.2.2 Pressure Transmitter 24
3.3 Temperature Instruments 25
3.3.1 Temperature Transmitter 25
3.4 Analytical Analysers 26
3.4.1 Dissolved Oxygen Analyser 26
3.4.2 PH/ORP Analyser 27
3.4.3 Conductivity Analyser 28
3.4.4 Turbidity / TSS Analyser 28
3.4.5 Chlorine Analyser 29
3.4.6 H_2S Analyser 30
3.4.7 BOD/COD Analyser 31
3.4.8 Control Actuators 33
3.4.9 Instrument Cables 34
3.4.10 Online Monitoring System 35
3.4.11 Auto-composite samplers 36
3.5 Control and Automation Panels 36
3.5.1 Introduction 36
3.5.2 Scope of Works 37
3.5.3 Panel Type, Ingress Protection, Components and Enclosure Materials 37
3.5.4 Lightning Protection 39
3.5.5 Smart Rack Specifications:- 39
3.6 Programmable Logic Controller (PLC) 43

3.6.1 Introduction....43
3.6.2 Scope of Works....43
3.6.3 PLC Hardware Specifications....44
3.6.4 PLC Software Specifications....46
3.6.5 Alarm System....47
3.6.6 PLC Standards....48
3.6.7 Documents and Drawings....48
3.6.8 Spare Parts....48
3.6.9 Installation and Commissioning....49
3.6.10 Training....49
3.7 SCADA and HMI....49
3.7.1 Introduction....49
3.7.2 Scope of Works....49
3.7.3 Standards....50
3.7.4 SCADA Computers....50
3.7.5 SCADA Printers....51
3.7.6 Page Printer....51
3.7.7 Dot Matrix Printer....52
3.7.8 HMI Specification....52
3.7.9 SCADA/HMI Design Concept....52
3.7.10 SCADA/HMI Interfaces Central Monitoring and Control Room (At respective Water Utility Control Room)....53
3.7.11 Command Control Center SCADA (ICCC)....54
3.7.12 Power Scada for Pump House, Water utility Sub Stations SCADA Systems....55
3.7.13 Water Station SCADA Systems Monitoring and controlling of Water pumps....55
3.7.14 OFC Communication Network....56
3.7.15 Network Management software with server....56
3.7.16 SCADA/HMI Security System....56
3.7.17 SCADA/HMI Graphic Screens....57
3.7.18 Alarms Management System....58
3.7.19 Documents and Drawings....58
3.7.20 Spares....58
3.7.21 Installation and Commissioning....58
3.7.22 Training....58
3.8 Communication Network....61

3.8.1 Introduction.....61

This page is intentionally blank.

Disclaimer

This Tender is not an Agreement and is neither an offer nor an invitation by the Employer to the prospective Bidders or any other person. The information contained in this tender document or subsequently provided to Bidder(s), whether verbally or in documentary or any other form by or on behalf of the Employer or any of its employees or advisors, is provided to Bidder(s) on the terms and conditions set out in this tender and such other terms and conditions subject to which such information is provided.

The purpose of this tender is to provide interested parties with information that may be useful to them in making their financial offers (BIDs) pursuant to this tender. This tender includes statements, which reflect various assumptions and assessments arrived at by The Employer in relation to the Project. Such assumptions, assessments and statements do not purport to contain all the information that each Bidder may require. This tender may not be appropriate for all persons, and it is not possible for the Employer, its employees or advisors to consider the objectives, financial situation and particular needs of each party who reads or uses this tender. The assumptions, assessments, statements and information contained in the Bidding Documents, especially the Preliminary Design details/ information, may not be complete, accurate, adequate or correct. Each Bidder should, therefore, conduct its own investigations and analysis and should check the accuracy, adequacy, correctness, reliability and completeness of the assumptions, assessments, statements and information contained in this tender and obtain independent advice from appropriate sources.

Information provided in this tender to the Bidder(s) is on a wide range of matters, some of which may depend upon interpretation of law. The information given is not intended to be an exhaustive account of statutory requirements and should not be regarded as a complete or authoritative statement of law. The Employer accepts no responsibility for the accuracy or otherwise of any interpretation or opinion on law expressed herein.

The Employer, its employees and advisors make no representation or warranty and shall have no liability to any person, including any Applicant or Bidder under any law, statute, rules or regulations or tort, principles of restitution or unjust enrichment or otherwise for any loss, damages, cost or expense which may arise from or be incurred or suffered on account of anything contained in this tender or otherwise, including the accuracy, adequacy, correctness, completeness or reliability of the tender and any assessment, assumption, statement or information contained therein or deemed to form part of this tender or arising in any way for participation in this Bidding Process.

The Employer also accepts no liability of any nature whether resulting from negligence or otherwise howsoever caused arising from reliance of any Bidder upon the statements contained in this tender.

The Employer may in its absolute discretion, but without being under any obligation to do so, update, amend or supplement the information, assessment or assumptions contained in this tender. The issue of this tender does not imply that the Employer is bound to select a Bidder or Contractor, as the case may be, for the Project and The Employer reserves the right to reject all or any of the Bidders or Bids without assigning any reason whatsoever.

The Bidder shall bear all its costs associated with or relating to the preparation and submission of its BID including but not limited to preparation, copying, postage, delivery fees, expenses associated with any demonstrations or presentations which may be required by The Employer or any other costs incurred in connection with or relating to its BID. All such costs and expenses shall remain with the Bidder and The Employer shall not be liable in any manner whatsoever for the same or for any other costs or other expenses incurred by a Bidder in preparation or submission of the BID, regardless of the conduct or outcome of the Bidding Process.

Nothing in this tender shall constitute the basis of a contract which may be concluded in relation to the Project nor shall such documentation/information be used in construing any such contract. Each Bidder must rely on the terms and conditions contained in any contract, when, and if, finally executed, subject to such limitations and restrictions which may be specified in such contract.

The Bidders are prohibited from any form of collusion or arrangement in an attempt to influence the selection and award process of the Bid. Giving or offering of any gift, bribe or inducement or any attempt to any such act on behalf of the Bidder towards any officer/employee of Employer or to any other person in apposition to influence the decision of the Employer for showing any favour in relation to this tender or any other contract, shall render the Bidder to such liability/penalty as the Employer may deem proper, including but not limited to rejection of the Bid of the Bidder and forfeiture of its Bid Security.

Laws of the Republic of India are applicable to this tender.

Each Bidder’s procurement of this tender constitutes its agreement to, and acceptance of, the terms set forth in this Disclaimer. By acceptance of this tender, the recipient agrees that this tender and any information herewith supersedes documents(s) or earlier information, if any, in relation to the subject matter hereto.

ICA Specifications

This page is intentionally blank.

1 Instrumentation, Control, and Automation (ICA)

1.1 Scope

The specification covers the general requirements of the Instrumentation, Control, and Automation (ICA) system for utilities including Water systems explained in Vol 2 of the Bidkin Industrial Area.

The Contractor shall be responsible for the design, engineering, sizing, selection, procurement, supply, delivery to site, secured storage, installation, FAT/testing, pre-commissioning, and commissioning of all equipment, fixtures, and fittings necessary to complete the ICA installation whether detailed herein or not. The P&IDs indicate the requirements and locations of instrumentation necessary to control and monitor the utility or any other infra-utility operation. If any equipment is not shown in the P&ID, but necessary for the safe and reliable operation as per the client requirement, then it shall be the responsibility of the Contractor to fulfil the requirement at no extra cost and no time delay to the Owner.

The contractor shall submit its design, calculations, control philosophy, detailed functional design specifications, SAT and FAT procedures, testing and commissioning along with detailed engineering documents for the systems to be implemented in accordance with this RFP.

Supply and installation of all latest model ICA items to comply with the design philosophy along with the minimum requirements indicated in the P&ID.

Supply and installation of control system (SCADA, PLC, Panels) and associated equipment required for safe, efficient and reliable control.

Supply and installation of instrumentation cables and associated supports and accessories. The cabling installation shall include supply, installation, glanding, termination, labelling, and testing. All instrumentation and telemetry/signal cabling associated with the ICA system shall be provided and installed by the contractor.

Supply and installation of all bulk items like Junction boxes, trays, glands, canopies, conduits etc.

Construction and installation of all required cable draw-pits, ducts, and trenches.

Interfacing with the Integrated Control and Command Centre (ICCC) (by others) shall be in the scope of the Contractor. The Contractor has to ensure the availability of communication protocols in their respective PLC communication system for the connectivity with the ICCC modules (by others)

Compliance with the requirements of this specification does not relieve the Contractor from the responsibilities of furnishing the Instrumentation and Control with proper design, meeting all the specified rated operating and service conditions.

The SCADA interfaces and functional scope for substation & Street lighting have been explained in Vol II, Power System Specifications. While For Water System , it has been mentioned in this volume at section 1.5. Also SCADA compatibilities explained for

various components explained in Power specifications in relevant sections. The broad configuration for SCADA shall be as per drawings.

"All process, E&I Schemes and their SLDs, Flow Block Diagrams, P&IDs to be displayed at their respective Operator station screens for Control and monitoring and ICCC Screens for monitoring with real dynamic status"

2 Abbreviations

API – American Petroleum Institute.

PVL – Proposed/Preferred Vendor List.

BSI - British Standards Institute.

WTP – Water Treatment Plant

STP – Sewage Treatment Plant.

CETP – Common Effluent Treatment Plant

CPCB – Central Pollution Control Board

EWS- Engineering Workstation

FAT – Factory Acceptance Test.

HMI – Human Machine Interface.

ICA – Instrumentation, Control and Automation.

IEC - International Electrotechnical Commission.

ISO - International Organization for Standardization.

I/O- Input / Output

LCP: Local Control Panel

LAN: Local Area Network

MCC – Motor Control Centre.

NEMA – National Electrical Manufacturers Association.

NFPA - National Fire Protection Association.

OCU – Odour Control Unit.

OWS- Operator Workstation

P&ID - Process and Instrumentation Diagram.

PLC – Programmable Logic Controller.

PCS – Process Control System.

RTD- Resistance Temperature Detector

SAT – Site Acceptance Test.

SCADA – Supervisory Control and Data Acquisition.

VDU- Visual Display Unit.

2.1 Codes and Standards

The installation, testing and commissioning shall be done in accordance with the latest revision of applicable local and international codes, standards, and regulations. Where conflicts exist between the local codes and standards, local codes shall govern.

A non-exhaustive list of applicable standards are as follows:

BS 1646	Symbolic Representation for Process Measurement Control Functions and Instrumentation - Basic Requirements.
BS 60529	Degrees of Protection Provided by Enclosures (IP Code).
BS 7671	Requirements for Electrical Installations. IEE Wiring Regulations.
BS EN 60228	Conductors in Insulated Cables.
BS EN 837	Pressure Gauges.
BS EN 6447	Specification for Absolute and Gauge Pressure Transmitters with Electrical Output.
BS 6739	Code of Practice for Instrumentation in Process Control Systems: Installation Design and Practice.
IEC 60447	Basic and Safety Principles for Man-machine Interface, Marking and Identification - Actuating Principles.
IEC 61131	Programmable Controllers.
BS EN 60204	Safety of Machinery
BS EN 50170	General Purpose Field Communication
ISBN 0 86341 233 5	IEE Guidelines for The Documentation of Computer Software for Real Time and Interactive Systems
BS EN 61000	Electro-Magnetic Compatibility
IEC 60654	Operating Conditions for Industrial Process Measurement and Control Equipment.
IEC 60625	Interface System for Programmable Measuring Instruments
IEC/EN 61810	Interposing Relays and Switching Interfaces
IEC 60902	Industrial Process Measurement and Control – Terms and Definitions
IEC 60839	Alarm and Warning Systems
IEC/EN 61643	LV Surge Protection Devices
ISO 3511/1	Process Measurement Control Functions and Instrumentation Symbolic Representation

2.1.1 Engineering Units

The instrument ranges and scale calibration shall be in metric units according to the international system of units (SI) as listed below:

Parameters	**Unit**
Flow liquid and vapour	M^3/hr.
Gas	Nm^3/hr.
Volume	M^3
Pressure	bar
Level	Mm, m Note-1

Parameters	Unit
Temperature	Deg C
Conductivity	Micro Siemens / cm
Turbidity	NTU
Ph	pH
BOD	mg/l
TSS	mg/l
Gas Concentration	PPM
Rotating Speed	RPM
Frequency	Hz
Current	A
Voltage	V

Note: HMI display of level instruments shall be shown in %.

2.2 The contractor P&IDs. Accuracy

a) The intended use of a measured value will determine the accuracy requirement. Those instruments whose measured values are used directly by an automated control system will demand high accuracy (±0.5%). Instruments that measure values used by operators to monitor the process but do not directly control the process may be of lower accuracy (±1.0%). Where instruments are provided purely for display, these may be low accuracy (±5.0%). Accuracy for particular instrument types will be specified in the relevant sections below.

b) The method or location of installation can have a major effect on the accuracy of the measurement generated by any instrument. All instruments shall be installed in accordance with the instrument manufacturers' installation requirements.

2.3 Repeatability

a) Repeatability is defined as the ability of the system to reproduce output readings when the same measurement is made under the same conditions and in the same direction. It is thus a measure of consistency of measurement.

b) A highly accurate instrument shall give highly repeatable measurements, however, an instrument which gives highly repeatable measurements may not give accurate measurements. All instruments, regardless of accuracy, shall be required to give repeatable measurements.

c) Repeatability for all instruments provided shall be ±0.5%.

2.4 Ingress Protection and Instruments Materials

Outdoor instruments shall be weatherproof to a minimum standard of IP65 as per IS/IEC 60529 and for services (such as valve chamber, wet well, and flow meter chamber) where there is a risk of flooding, the IP rating shall be IP68. Instrument materials shall

be adequately corrosion resistant. In general, all wetted parts, process connections and dial display materials of instruments shall be stainless steel 316.

2.5 Lightning Protection

Any exposed cable connecting to an instrument which is located outdoors shall be provided with a lightning protection barrier in the form of a Low Voltage SPD at the entry point of the Instrumentation and Control panel (ICA Panel).

2.6 Mounting

a) Field-mounted instruments shall be mounted on purpose-made brackets, welded, bolted, or clamped to the equipment structural steelwork or building fabric/steelwork. No cutting away of structural steelwork or building fabric/steelwork shall be carried out without the written consent of the Engineer.

b) Brackets shall be fabricated from stainless steel 316.

c) All fixing lugs shall be used. Where it is necessary to drill holes in any enclosure for fixing purposes, washers shall be fitted to maintain the original enclosure IP rating.

d) The bolts in brackets or supports that are subject to vibration shall have spring washers fitted. All fixing nuts, bolts and washers shall be of stainless steel 316.

e) All instruments shall be installed so that they are not subject to excessive vibration or to mechanical stress and are not exposed to extreme high temperatures or direct sun radiation.

f) Instruments shall be installed in such a way they can be easily mounted, removed, and can be easily read.

g) As a minimum, all equipment mounted in control rooms shall be suitable for operation at 45°C. Field-mounted equipment shall be suitable for operation up to 50°C and shall be provided with sun shields.

2.7 Name Plates and Tagging

All field instruments and cabinets/panel-mounted instruments shall have 316 stainless steel tag plates/name plates permanently attached to them. Details of proposed inscriptions shall be submitted to the Engineer for approval before any labels are manufactured. The nameplates shall be fixed to the mounting plate, the mounting bracket, or the junction boxes door/cover with stainless steel (type AISI 316), M4 bolts and nuts, self-tapping screws or pop-rivets

2.8 Qualification Criteria for Instrumentation and Automation Vendor/integrator

a) All the instrumentation and control system items shall be from the Approved vendor list. In case name of vendor is not indicated for any instrument or equipment the contractor shall request approval of vendor as per following qualification requirements

b) Supplier/Manufacturer qualifications, indicating years in business, service capabilities and policies, warranty definitions, spare parts support, and a list of similar installations.

c) The Manufacturers / Suppliers shall be operating under an accredited ISO 9001 or above Quality System. All hardware shall be of the most current technology and Versions from the Manufacturer. All hardware and software shall be from the system manufacturer.

d) The SCADA /Automation sub-contractor shall be a reputed System manufacturer or System integrator with experience having executed ICA projects within India or outside India and shall demonstrate capability and resources for integrating/interfacing control systems from different manufacturers as well as coordination with multiple agencies for contract execution.

e) The system supplier must be an authorized system integrator for the named PLC hardware/SCADA & ODMS software supplier. Verification certificates shall be submitted directly from the manufacturer of the PLC hardware/SCADA & ODMS software supplier. In addition, submit references for a minimum of (5) locations where the automation equipment has been successfully installed, including name, address, and telephone number for the appropriate utility person to contact.

f) All hardware and software proposed shall have been successfully used in a similar water application for a period of at least five (5) years and be from established and reputable suppliers.

g) Upgrades and improvements to the manufacturer's standard system that are released before the expiration of the warranty period shall be supplied, installed, and commissioned at no additional cost.

2.8.1 Utility and Earthing Requirement

1 Power Supply Requirement

Table 2-1: Power Supply for Project

S. No.	Description	230VAC, +/- 2%,50 ± 1% Hz. UPS	110V DC (± 10%)	24V DC (Note-1)	415V AC, ± 5% VAC 50 ± 2% Hz (3 phase)	230 VAC, +/- 10%, 50 ± 1% Hz. Non-UPS
1	SCADA / PLC	☒	☐	☒	☐	☐
2	Package Control System	☒	☐	☒	☐	☐
3	Solenoid Valves	☐	☐	☒	☐	☐
4	2- wire Instruments	☐	☐	☒	☐	☐

S. No.	Description	230VAC, +/- 2%,50 ± 1% Hz. UPS	110V DC (± 10%)	24V DC (Note-1)	415V AC, ± 5% VAC 50 ± 2% Hz (3 phase)	230 VAC, +/- 10%, 50 ± 1% Hz. Non-UPS
5	Input Interrogation Voltage	☐	☐	☒	☐	☐
6	F&G Devices	☐	☐	☒	☐	☐
7	Fire Alarm Panels	☒	☐	☐	☐	☐
8	Building Cabinets Lighting	☐	☐	☐	☐	☒
9	Local Panel Cabinets Lighting	☐	☐	☐	☐	☒
10	4- wire Instruments	☒	☐	☐	☐	☐
Note: 24 VDC for all the field instruments will be derived from respective systems.						

2.8.2 Air Supply

a) Instrument air shall be the medium for pneumatic actuation.

b) All pneumatic instruments and actuators shall have enough margins such that they can even operate satisfactorily with 4 bar air supply pressure.

c) For packages instrument air shall be provided at 4 bars at the package skid battery limit. Further distribution shall be done by the package vendor.

2.8.3 Earthing

a) Internal grounding up to the earth busbar shall be done by the PLC / LCP Supplier. External grounding i.e. cabinet / LCP to main earthing system shall be done by the CONTRACTOR.

b) Earth studs which can accept up to 50 mm2 earthing conductors shall be provided for the cabinet / LCP.

c) Junction boxes shall be connected to the nearest electrical earth via a 10 mm2 earthing conductor.

2.8.4 Electrical and Instrumentation Interface

a) Signals for monitoring and control of motors/drives shall be hardwired to Wet Utility PLC/SCADA from the switchgear. Digital outputs to switchgear shall be provided with Slim UL-approved lower power consumption 24 VDC interposing relays with Built-in Fuse options located in the respective switchgear panels.

b) For all motors/drives following signals shall be hardwired to the PLC/SCADA:

i. Motor Available Status (no fault in electrical system and H-O-A switch in auto position)

ii. Run Status

iii. Trip Status

iv. Speed signal from VFD and speed reference to VFD.

v. START/STOP maintained Command from PLC/SCADA, as applicable.

vi. TRIP Command from PLC/SCADA, as applicable

c) Motor winding temperature signals shall generally be wired directly to MCC, if not specified otherwise on the P&ID(s) for packages.

d) Bearing RTD and vibration signals, if any, shall be wired to PLC/SCADA.

e) Where two or more motors are in duty/standby configuration, then a duty/standby switch is to be provided in the PLC/SCADA.

2.8.5 Inspection and Testing

a) Inspection and testing of instrumentation and control shall be performed by a third-party inspection agency appointed by the contractor.

b) The owner / Engineer will witness the factory acceptance testing for the Control System, Package PLC system and LCP. The owner / Engineer also reserves the right to witness the testing for instrumentation.

c) The vendor shall provide a complete inspection and testing plan and the test procedures (FAT, SAT, etc) for review by the Owner / Engineer.

d) The contractor shall provide method statements and procedures for each of the instrumentation and control site works.

e) Factory Acceptance Test (FAT) and Site Acceptance Test (SAT). the contractor shall submit the FAT/SAT procedure for PLC/SCADA and other Electrical and Instrumentation items for the Engineer’s approval along with QAP before the Call for Inspection and testing.

f) The contractor shall submit a written plan of testing at least 15 days prior to the test demonstration for the control system. The plan shall be submitted for approval by the Engineer/Owner. It shall include procedures to be applied in the testing of hardware and software systems including a description for each system, test methods, testing instruments and a list of the equipment involved together with the functional parameters to be recorded on each item.

g) Tests based on the approved procedure shall be witnessed by the Engineer and Owner at the Manufacturer / Supplier’s facility for the FAT).

i. The Contractor shall provide the following:

ii. Test procedure (For FAT and SAT)

iii. ICA shop drawings

iv. Calibration certificate

v. Test documentation, schedules, and logs.

h) Manufacturer's internal factory acceptance test results and records prior to witnessing FAT/SAT.

i) Factory tests carried out for primary elements and instruments shall include pressure and calibration tests. Certificates shall be provided for pressure tests, calibration tests and conformity to specifications.

j) Contractor to submit FAT/SAT procedure for PLC/SCADA for Engineer's approval along with QAP before Call for Inspection and testing.

2.8.6 Quality Control

a) The contractor/vendor shall demonstrate that he operates a quality system in accordance with an internationally recognized standard such as ISO 9001:2000. The effectiveness of the quality system and the Vendor's compliance with it shall be subject to monitoring by Owner / Engineer and in addition, may be audited by an agreed period of notice.

b) The contractor/vendor shall submit a quality control program for Owner / Engineer review at the time of proposal. The contractor/vendor shall provide facilities for and cooperate with the Owner / Engineer and its designated authorized inspectors during manufacturing, assembly, and testing.

c) All signed records shall be provided for calibration, installation, functional testing, loop checking, SAT, pre-commissioning checks.

2.9 Installation and Commissioning

The Contractor shall install and commission the supplied instruments. The Contractor shall provide the following:

a) Commissioning Plan

b) Commissioning Manual

c) Commissioning Log

d) Test Documentation, schedules, logs, and final status report.

2.9.1 Training

a) Training shall be provided for the operators, maintenance personnel, and engineers for the control system, package PLC, analysers, and complex instruments as per project need and shall be decided by Employer‘s Engineer.

b) Training shall be as per the terms and conditions in the purchase order and shall cover the following areas as a minimum:

i. Operation

ii. Maintenance/troubleshooting

iii. Configuration

2.9.2 Painting

Steel is cleaned, degreased (alkali based), nanoceramic pretreatment, phosphate, electrophoretic dipcoat primed and polyester powder-coated in RAL 7035.

2.9.3 Guarantee and Warranty

The contractor/vendor shall guarantee the mechanical design, material of construction, workmanship and performance of the instrumentation and control for the specified application and operation of the package equipment. This guarantee shall be for a period of Twelve (12) months from the date of commissioning or Eighteen (18) months from the date of supply whichever is earlier.

2.9.4 Drawing and Documents

a) As a minimum, the Contractor shall submit the following for Engineer/Owner's review and approval:

   i. Control Philosophy for the operation and control of each equipment supplied by the contractor

   ii. Details of the proposed interface (both software and hardware) with the equipment in other packages supplied by others.

   iii. All pertinent information regarding the reliability and operation of the equipment to be supplied.

   iv. Manufacturer's original format catalogue data and descriptive information for all major components of the system.

   v. The Owner or the Engineer, at their sole choice and discretion, may request a demonstration of the proposed equipment.

   vi. Equipment other than specified may be considered for approval. It shall be the Contractor's obligation to submit data and information to allow the Owner and Engineer to consider the equality of the substituted items to that specified. It is the Contractor's responsibility to meet the entire intent of the specifications. Deviations from the specified items shall be at the risk of the Contractor until the date of final acceptance by the Owner and the Engineer. Accepted submittals on substitute equipment shall only allow the Contractor to proceed with proposing a substituted item and shall not be considered equal until such time as the Owner and the Engineer have completely accepted the substituted item.

b) The Contractor shall submit comprehensive documentation (issued for approval) including but not limited to:

c) Instrument data sheets.

d) Calculations

e) Functional specification for SCADA / PLC system

f) Instrument Index including packages.

g) I/O List with alarm and instrument settings

h) Instrument cable schedule.

i) Instrument junction box schedule.

j) Interconnection wiring diagrams.

k) Cable block diagrams

l) Instrument hook-up drawing.

m) Instrument Installation drawings.

n) Cable / tray routing drawings

o) Control System architecture.

p) Control room layout.

q) Instrument location plan.

r) General arrangement drawings of instrument and control panels, fully dimensioned in plan and elevation views, showing foundation and fixing details, access doors, clearances, cable-entry positions, weight and lifting arrangement.

s) Other vendor drawings for Instruments/valves and control system

t) Inspection test plan

u) Certificates (calibration, material, electrical etc.)

v) Instruments loop-diagram

w) Spare part list & M manual

2.9.5 Spares and Special Tools

a) Spares shall be provided as recommended by equipment manufacturers and as per the requirements of the Contract.

b) Installed Spares shall be defined as follows:

i. Each Junction Box shall be designed to accommodate all 25% spare cables (wired Terminations)

ii. Cable Tray / trench shall have 20 % spare space for future cables.

iii. Instrument Air Sub-header size shall be as Up to 5 users (4 users + 1 spare)

iv. Multi Cable Transit (MCT) / Conduit shall have 50 % spare space for future cables.

c) Installed Engineering Spares to the tune of 20 percent for each sub-system and for each type of module. The basis is explained below:

i. 20 percent spare input/output of each type shall be considered for calculating the I/O modules and related accessories.

ii. For all serial input/outputs, 20 percent serial I/O ports of each type shall be provided.

iii. 20 percent spares for relays, switches, lamps, fuses, circuit breakers, barriers, isolators, terminals etc.

d) Spare pairs of the incoming cables shall be terminated on spare terminals in the marshalling and other cabinets.

e) Engineering shall consider 20 percent installed engineering spares including processor loading.

f) Special tools required (if any) shall be part of the vendor scope of supply. Special tools shall cover maintenance and configuration tools for instrumentation and control.

2.10 Instruments, Actuators and Cables

2.10.1 General

a) All Control and Instrumentation systems shall be designed for a minimum life of 10 years. Spare parts and support shall be available for this period.

b) Engineering units shall be as per clause no.1.5 of this document.

c) Makes (manufacturer) for the instruments shall be as per the proposed/preferred vendor list (PVL).

d) All field transmitters shall be smart transmitters with 4-20mA, 2-wire HART output. All transmitters shall be provided with integral digital indicators configured in engineering units. Sunshade shall be provided for all transmitters located in open areas.

e) Additionally, a removable enclosure with a transparent window shall be provided for instruments where water splashing occurs like water tank, cooling towers etc.

f) Material of construction shall be as per the piping material specification and instrument data sheets. The contractor/vendor may propose other material, subject to Owner / Engineer approval, if it is superior to specified.

g) Flying leads are not acceptable; hence all field instruments shall be provided screw-type terminals.

h) All electrical entries shall be NPT type. Unused entries shall be provided with suitable blanking plugs.

i) Switches (pressure, level, flow, temperature, etc.) shall not be used and their use requires Owner / Engineer approval except for pump seal instrumentation, and fan vibrations.

2.10.2 Junction Box

a) Instrument junction boxes shall be IP 65 certified.

b) The material of construction of the JB shall be CRCA with 1.5 mm thickness with single sheet construction for non-loading members and 2 mm for loading members;

c) Each junction box shall have an identification label, in addition to the manufacturer's certification label, attached with 316 SS screws.

d) All enclosure cable entries shall have NPT threads.

e) The junction box shall have two nos. M6 screws on the outside and one no. on the inside for earthing purposes.

f) All the multi-pair cable entries shall be from the sides and single-pair cable entries shall be from the bottom of the junction box.

g) The terminal blocks inside the junction box shall be of screw type with an individual isolation facility for each signal to facilitate maintenance work without the need to disconnect the terminals.

h) The junction box shall have a front openable door with a hinged and bolted cover.

i) All terminals shall be mounted on MS DIN Rail. The DIN Rail shall either be nickel-plated or treated with yellow passivation.

j) The junction box shall have 20% spare terminals as well as 20% spare cable entries of each type. The spare cable entries shall have a blank plug. The working cable entries shall have double compression glands with black PVC hoods. M4 grease shall be applied to the glands prior to covering it with a hood.

k) In case of outdoor installation, shade/canopy shall be supplied by the manufacturer.

l) It shall have PU Foam gasket.

m) It shall be duly painted with nanoceramic coating ,electrostatic dip coat priming followed by powder coating with RAL-7035 paint shade.

n) It shall be suitable for mounting on a wall/column/steel structure frame.

2.11 Level Instruments

2.11.1 Ultrasonic Level Transmitter

a) Ultrasonic level detectors shall be used for most situations where a continuous level measurement is required. The ultrasonic level detector system shall comprise a transducer, a separate transmitter unit and an interconnecting cable, operating on the time-of-flight principle. For Reservoir levels measurement ULT shall be used.

b) The transducer shall be a non-contact type suitable for continuous measurement of level. The transducer shall be weather-resistant and safe against submersion (IP 68) and shall incorporate an integral temperature sensor to allow for temperature compensation of the measured level. The transducer shall not be affected by the measured liquid and shall be insensitive to dirt build-up. The transmitter shall

support fixed target suppression (removal of false echoes) and first echo recognition (for correct indication in spite of double echoes).

c) The transmitter shall be microprocessor-based with an integral operator interface housed within a corrosion-resistant enclosure. The operator interface shall have a numeric display, a bar graph display, and a simple push-button interface. All error codes, process variables, configuration data and other internal values shall be accessible and displayable on the integral operator interface. It shall be possible to limit access to configuration data parameters by means of a configuration password.

d) The transmitter will be powered from a 24 VDC supply. Output shall be by 4-20 mA DC with HART superimposed and shall be proportional to the measured value. A digital output shall also be provided which shall be configured to generate an alarm in the event that the level detection system fails.

e) The transducer shall have a blocking distance no more than 10% of the measurement range and a 3dB beam angle no wider than 10°. The system shall give a measurement of ±0.5% of the measurement span.

f) Ultrasonic Level Transmitter with two sensors and two analogue (4-20mA) HART superimposed outputs.

g) An Ultrasonic level transmitter with two separate sensors shall be used where a continuous differential level measurement is required. The ultrasonic level detector system shall comprise separate two transducers, one transmitter unit with two analogue outputs and two numbers interconnecting cables.

h) The transducer shall be a non-contact type suitable for continuous measurement of level. The transducer shall be weather-resistant and safe against submersion (IP 68) and shall incorporate an integral temperature sensor to allow for temperature compensation of the measured level. The transducer shall not be affected by the measured liquid and shall be insensitive to dirt build-up. The transmitter shall support fixed target suppression (removal of false echoes) and first echo recognition (for correct indication in spite of double echoes).

i) The transmitter shall be microprocessor-based with an integral operator interface housed within a corrosion-resistant enclosure. The operator interface shall have a numeric display, bar graph display, and a simple push-button interface. The transmitter shall have a simple push button to alternate between readings of two sensors. All error codes, process variables, configuration data and other internal values shall be accessible and displayable on the integral operator interface. It shall be possible to limit access to configuration data parameters by means of a configuration password.

j) The transmitter will be powered from a 24 VDC supply. Output shall be by 4-20 mA DC, HART superimposed and shall be proportional to the differential level. A digital output shall also be provided which shall be configured to generate an alarm in the event that the level detection system fails.

2.11.2 Hydrostatic Pressure Type Level Transmitter

a) The transmitter shall comprise a hydrostatic pressure sensor suitable either for mounting on a flanged connection or for insertion through a borehole by means of a connecting cable. This specification is based on the latter application, which requires the most stringent features. The flanged type shall generally follow the same specification except for the enclosure class that may be relaxed to IP65.

b) The hydrostatic pressure sensor shall comprise a measuring cell mounted in a stainless-steel probe tube fitted with a stainless-steel diaphragm. The diaphragm shall be protected by a fine mesh metal grid and a protective cover. The probe tube shall be filled with silicon oil which shall transmit the hydrostatic pressure of the liquid column to deflect a silicon diaphragm with a thin film strain gauge. The contractor shall provide a certificate for non-toxicity for the filling fluid. Variations in pressure on the surface of the liquid shall be compensated by an air tube passing through the connecting cable to the other side of the silicon diaphragm. The transducer should have over pressure rating of at least 4 times nominal pressure. A durable conical cable sealing shall be fitted on the probe tube with a moisture barrier on the pressure compensation line for long term stability. In case of failure, the sensing module shall be replaceable.

c) Used materials shall be AISI 316 Stainless Steel for Sensor Tube and Diaphragm, Viton for Gasket and Polyethylene insulated and bound with steel webbing for cable.

d) The probe and cable shall be mounted by stainless steel 316 pressed clamps cable holder including a connection box or housing with a 38mm (nominal) threaded connection. The diameter of the sensor shall be less than 30 mm to facilitate easy insertion and withdrawal from the guide tube.

e) The cable probe shall be certified for IP68 and the housing/connection box to a minimum of IP65 above ground level. Minimum over pressure resistance shall be 10 times.

f) The transmitter shall be microprocessor based with a remote operator interface housed within a corrosion resistant enclosure. The operator interface shall have a numeric display, a bar graph display, and a simple push-button interface. All error codes, process variables, configuration data and other internal values shall be accessible and displayable on the operator interface. It shall be possible to limit access to configuration data parameters by means of a configuration password.

g) The transmitter shall be powered from a 24 VDC supply. Output shall be by 4-20 mA current loop and shall be proportional to the differential level value. A digital output shall also be provided which shall be configured to generate an alarm in the event that the level detection system fails.

2.11.3 Level Gauges

a) Local level gauges for the surge vessels shall be of the direct reading magnetic type where a permanent magnet mounted in a float drives a series of flaps. A small

permanent magnet shall be attached to each flap to ensure that the flaps remain in a given position even when severe vibration occurs. The float shall be a concentric magnetic design with unsupported sections to provide a strong and uniform magnetic field. The external mounted float guiding tube/chamber shall be of 304 SS and the float shall be AISI 316 SS. The housing of the flaps shall be dust and watertight. A graduated scale made of stainless steel with 1 cm division shall be fixed adjacent to the float guiding tube/chamber.

b) Only one (1) level gauge shall preferably be used on a vessel. If, however, two (2) or more level gauges are required, they shall be installed in such a way that the visible lengths overlap by at least 50 mm.

2.11.4 Conductivity Probes

a) Conductivity probes shall be used to give point level measurements. These may be used for control of simple applications, as backup control devices for a continuous level instrument or to generate alarms.

b) A minimum of two electrodes are required, a metallic earth electrode which extends to the lowest point in the vessel, and a level electrode. The metallic level electrode is set at the desired switching point. When the liquid covers the tip of the electrode, an electrical circuit is completed between the level electrode and the earth electrode.

c) The electrodes and their fixings shall be manufactured of non-corrodible metal, suitable for intermittent submersion.

d) The control/switching unit shall be suitable for mounting within a control panel on DIN rail. Output shall be volts' free contact or open collector. Sensitivity shall be easily adjustable to allow fine-tuning of the switching threshold.

e) The switching element shall be a hermetically sealed snap acting micro switch rated for 2 amps at 24 V DC with gold plated contacts. Each switch shall be provided with SINGLE POLE DOUBLE THROW RELAY (SPDT) contact arrangements. The switch enclosure shall be weatherproof to IP 65 of IEC 60529. Cable entry shall be ½" NPT.

3 Float Switches

a) Float switches shall be used to give point level measurements. These may be used for control of simple applications, as backup control devices for a continuous level instrument or to generate alarms.

b) The float switch shall comprise a tilt switch housed within a sealed plastic bulb. When no liquid is present, the bulb shall hang upright, supported by the instrument cable. The bulb shall be buoyant and float on the surface of the liquid, so that when the liquid level rises, the bulb floats on the surface. As the bulb makes the transition from hanging to floating on the liquid surface, the tilt switch inside shall operate.

c) The cabling shall provide cores for normally open and normally closed switching contacts, allowing the float switch to be used to detect a rising level or a falling level.

d) The switching element shall be a hermetically sealed snap acting micro switch rated for 2 amps at 24 V DC with gold plated contacts. Each switch shall be provided with SINGLE POLE DOUBLE THROW RELAY (SPDT) contact arrangements. The switch enclosure shall be weatherproof to IP 65 of IEC 60529. Cable entry shall be ½" NPT.

3.1 Flow Instruments

The provision of flow meters shall require the instrument to be fitted in accordance with the manufacturer's recommendations. It must include, if required, reduction tapers necessary to obtain suitable flow velocities past the detector heads. Indicate if the pipe is full filled pipe or partially filled pipe where this will affect the reading.

3.1.1 Electromagnetic Flow Transmitter

a) The flow meter shall comprise of a flow sensor and a transmitter unit. The transmitter shall be integral to the flow tube for above ground installations and separate from the flow tube for below ground installations such as chambers. The flow meter shall be of the electromagnetic type utilizing pulsed DC excitation and shall be microprocessor based. Each unit shall be of stand-alone type.

b) Electromagnetic flow meters shall operate on electromagnetic induction principles and shall consist of a detector head and signal converter system which shall comply with BS EN ISO 6817 and Traceability Group A1 of BS ISO 11631. The flow metering system shall provide pulse and analogue current outputs proportional to volume and rate of flow respectively.

c) The flow meter shall feature on-site field validation for the sensor, transmitter, and interconnecting cable. The flow meter shall be calibrated at the factory to its actual flow range in m3/hr. A factory calibration certificate shall be provided with the meters.

d) The flow sensor shall be manufactured from AISI 304 stainless steel metering tube with a non-conductive hard rubber liner to withstand process temperatures as per

the data sheet. The liner material shall be abrasive resistant and approved for potable water use by WRC-UK or equivalent internationally recognized authority.

e) There shall be 2 nos. of measuring electrodes with built in reference electrode and empty pipe detection electrode as a standard item. The reference electrode shall ensure potential equalization between the sensor and the fluid and proper grounding of the installation. Electrode material shall be SS 316L or Hastelloy.

f) Detector heads shall be flanged to BS EN 1092. The flanges shall be compatible with those specified for the associated pipe work. Detector heads shall be fitted with an anti-roll system to prevent damage during storage. The flow meter shall have an empty pipe detection facility. The input impedance shall be 1015 ohms or greater so that electrode fouling does not affect signal and electrode seal integrity. The sensor data shall be stored in a built-in EPROM module.

g) Automatic cleaning of electrodes shall be possible through the transmitters.

h) Power and signal cables to the detector head shall be factory sealed only, potting ‘on Site shall not be acceptable.

i) The electrical connections for cable entry for sensors with remote transmitters shall be ½” NPT with appropriate cable glands.

j) A minimum of ten (10) metres of interconnecting cable between the sensor and the remote transmitter unit shall be included in the scope of supply. The interconnecting special cable shall be supplied by the manufacturer of the flow meter.

k) The transmitter unit shall be either integral with the flow sensor or remotely mounted to suit the application requirements.

l) The transmitter unit shall be microprocessor based, of modular design and shall be easily configurable through integral keypads. The electronics shall be of modular construction for ease of maintenance and future expandability.

m) The transmitter shall be provided with at least three (3) lines illuminated display for rate of flow and totalized flow indication. The data storage shall be on EEPROM to preserve data on power failure without battery backup. The unit shall have high electromagnetic compatibility according to IEC 801 recommendations.

n) The transmitter shall be housed in a robust die-cast aluminium enclosure with IP65 protection for both compact and remote versions and shall be IP68 for submerged applications.

o) The unit shall be provided with extensive self-diagnostics for operational security with resulting error messages enunciated at the alarm output.

p) The transmitter will be powered from a 230 VAC or 24 VDC supply. All inputs and outputs shall be galvanically isolated from the power supply, the measuring circuit and each other.

q) The following outputs shall be available and configurable by the user:

i. Analogue, 4-20 mA. Analogue signal proportional to flow rate.

ii. Active / Passive (open collector) selectable to Pulse/Frequency output.

iii. Status configurable for limit values, end value switching, empty pipe detection, flow direction over ranging or instrument fault.

r) The transmitter unit shall be provided with two (2) nos. of suitable cable glands for power supply and signal cables.

s) Accuracy shall be better than + 0.25% of reading (actual flow rate) at flow velocity > 1 m/s with repeatability within + 0.1% of flow rate. The measurement shall be insensitive to entrained solid particles.

t) The transmitter unit shall be suitable for operation in an ambient temperature range of 0 to 50°C.

3.1.2 Ultrasonic Transit Time Flow Transmitter

a) Swimming waves against the flow requires more power and more time than swimming with the flow. Ultrasonic flow measurement is based on this elementary transit time difference effect.

b) Two sensors mounted on the pipe simultaneously send and receive ultrasonic pulses. At zero flow, both sensors receive the transmitted ultrasonic wave at the same time, i.e. without transit time delay.

c) When the fluid is in motion, however, the waves of ultrasonic sound do not reach the two sensors at the same time. This measured "transit time difference" is directly proportional to the flow velocity and therefore to flow volume.

d) The flow meter shall comprise of two flow sensors and a transmitter unit. The flow sensor and the transmitter shall be supplied as an integral unit, or the transmitter unit shall be remotely mounted from the flow sensor. The transmitter will be powered from a 24 VDC supply.

e) Output shall be by 4-20 mA, HART superimposed, current loop and shall be proportional to the flow value. A digital output shall also be provided which shall be configured to generate an alarm in the event that the flow detection system fails.

3.1.3 Thermal Mass Flow meter

Design	**Insertion probe with remote transmitter**
Function Principle	Heat dissipation technique (calorimetric), primary signal mass flow proportional, independent of pressure and temperature
Sensor Details	2 X Pt-100 RTD with ceramic wire-wound sensor element in SS-316 tube. (4-wire Technique)
Sensor Material	SS-316 or better
Fluids	Air & Exhaust Gases
Flow Range	0.6 – 100 Nm/s
Turndown ratio	100 : 1
Accuracy (%)	±2.0% reading or better

Design	Insertion probe with remote transmitter
Repeatability (%)	±0.5% of reading
Operating temperature	0 - 200ºC
Operating pressure	16bar(g) Max. PN16
Ambient temperature	-20°C to +60°C
Process connection	½"BSP(M) SS-316 Compression Ferrule
Power Supply	24VDC (18 - 36VDC) OR 100 – 265 VAC@50Hz
Power Consumption	< 5 watts
Display	16 X 4 LCD Backlit Display
Signal Output	0/4-20 mA DC; 1 NO / NC Relay contact
Ingress Protection	Sensor probe: IP67, Signal Transmitter: IP65 or better
Enclosure MOC	ABS Plastic
Certifications	In house Calibration Lab recommended
Connecting Cable	As per site condition
(Electronic Converter to Probe)	

3.1.4 Open Channel Ultrasonic Flow Transmitter

a) The method to measure the volumetric flow in an open channel will be achieved by installing a flume or weir in a channel with a free discharge and measuring the liquid level upstream of the flume or weir. The level measurement shall be taken by an ultrasonic system using the time-of-flight principle.

b) The transducer shall be a non-contact type suitable for continuous measurement of level. The transducer shall be weather resistant and safe against submersion (IP 68) and shall incorporate an integral temperature sensor to allow for temperature compensation of the measured level. The transducer shall not be affected by the measured liquid and shall be insensitive to dirt build-up.

c) The transmitter shall be microprocessor based with an integral operator interface housed within a corrosion resistant enclosure. The transmitter shall be pre-configured with common flow/height characteristic curves for measuring flow rates with flumes and weirs. Other flow/height curves may be entered, measured values being obtained by interpolation between entered data. The operator interface shall have a numeric display, bar graph display, and a simple push button interface. All error codes, process variables, configuration data and other internal values shall be accessible and displayable on the integral operator interface. It shall be possible to limit access to configuration data parameters by means of a configuration password.

d) Input power required will be from a 24 VDC supply. Two analogue outputs shall be provided, corresponding to measured level and calculated flow, and a pulse output shall be provided along with a digital output to indicate fault status and total flow. The analogue outputs shall be by 4-20 mA current loop with HART

superimposed and shall be proportional to the measured values. The pulse output shall be an open collector output. Fault status shall be indicated by an open collector output, indicating system or process error, flow direction or low flow (if enabled).

e) The transducer shall have a blocking distance no more than 10% of the measurement range and a 3dB beam angle no wider than 10°. The system shall measurement level to an accuracy of ±0.5% of the measurement span. The flow measurement shall be accurate to ±1.0%.

3.2 Pressure Instruments

3.2.1 Pressure Gauges

Pressure gauges shall be used for absolute pressure measurement. They shall be Bourdon tube, direct measure type with dial size 150mm. Wetted parts and case material shall be SS316. Shatter proof window and blow-out safety back plate shall be provided. Pressure gauge case shall be liquid filling with bottom process connection and SS flexible pointer stop on dial. IP protection grade shall be minimum IP65 and accuracy ±1% of full scale for installation inside the chamber. Overload protection shall be 130%. Separate calibration certificate for each instrument shall be provided.

3.2.2 Pressure Transmitter

a) Pressure transmitters shall be of the direct sensing type with the sensing element as per manufacturer's standard. The diaphragm shall be hermetically welded to the measuring element assembly.

b) The transmitter shall be of a smart type. The measuring element shall be able to withstand a temporary/permanent overpressure to at least 30% of the specified range limits without calibration shift.

c) All wetted parts and the diaphragm shall be compatible with the process fluid and shall be of minimum AISI 316 SS/ceramic. The measuring assembly fill fluid shall be silicon oil, unless otherwise specified.

d) PTTE gaskets shall be applied as a standard, unless otherwise specified. The bolts and nuts shall be high tensile stainless steel.

e) The transmitter cover material shall be low copper aluminium. Enclosure class shall be according to IP 65 of IEC 60529, as a minimum.

f) The process connection shall be 1/2" NPT (M) and the electrical signal cable entry connection shall be ½" NPT unless otherwise specified in the data sheet. Unused electrical connections shall be plugged off with a recessed head screw in compliance with the specified electrical safety requirements. The screw material shall be of stainless steel for stainless steel enclosures. The signal cable termination points shall of the screw type.

g) The transmitter output signal shall be 4-20 mA with HART superimposed.

h) The transmitter power supply voltage shall be 24 VDC, for two-wire transmission system with a minimum power supply voltage of 12.5 VDC.

i) The transmitter electronics shall be microprocessor based.

j) The electronics system shall be provided with a reverse polarity protection circuit.

k) Zero and span shall be non-interacting, easily and continuously accessible. The external adjustment(s) should be provided with an environmental protection cover. Pressure gauges and transmitters shall have primary isolating valves, 2 or 3-way valve manifold and vents, in such a way that it has the facility to calibrate the gauges or transmitters without removal.

l) The transmitter shall be provided with integral digital indicator with scale identical to the calibrated range as indicated in the instrument data sheet.

m) The performance of the transmitter shall be as follows:

n) The transmitter accuracy including combined effect of linearity, hysteresis and repeatability shall be equal to or better than ± 0.25% of calibrated span.

3.3 Temperature Instruments

3.3.1 Temperature Transmitter

a) The temperature transmitter shall comprise of a RTD sensing element in a thermowell with a head mounted transmitter unit.

b) Resistance thermometer shall consist of an outer metal sheath, containing a sensing element of annealed platinum resistance wire. The resistance and connecting wires shall be electrically insulated from the outer sheath by compacted magnesium oxide or suitable alternative compatible with the RTD operating temperature. The sheath end closure by seal welding shall be impervious to gases and liquids. Cracks, holes, or defects penetrating the wall shall not be permitted. The tip shape is optional, rounded, flat or conical; the other end shall be hermetically sealed, suitable for an operating temperature as per the data sheet, to prevent the ingress of moisture. The sealed end of the element shall be provided with flange in accordance with DIN 43734, for terminal block and/or transmitter mounting and spring-loaded screws for adjustment.

c) RTD elements shall be offered in 3-wire duplex configuration. The sheath shall have a nominal outside diameter of 6 mm + 0.1 mm.

d) The platinum resistance thermometer performance shall be in accordance with the requirements of IEC 60751, Pt 100 elements, having a resistance of 100 ohms at 0°C, with a fundamental interval of 38.5 Ohms to 100°C.

e) The resistance tolerance shall comply with Class A according to IEC 60751, where Class A tolerance (deg C) is 0.15 + 0.002 [t].

f) [t] = modulus of temperature in degrees Celsius without regard to sign.

g) The RTD elements shall be supplied with thermos-wells of 316 SS. The Thermowell shall be drilled from bar stock. Insertion length shall be to suit the application

requirements. The transmitter shall be of a smart type with modular design and compatible with 3-wire RTD sensor. The transmitter shall be attached directly to the sensor assembly.

h) The transmitter cover material shall be of low copper aluminium. Enclosure class shall be according to IP 65 of IEC 60529, as a minimum.

i) The electrical signal cable entry connection shall be 1/2" NPT, unused electrical connections shall be plugged off with a recessed head screw in compliance with the specified electrical safety requirements. The screw material shall be of stainless steel for stainless steel enclosures. The signal cable termination points shall of the screw type.

j) The transmitter output signal shall be 4-20 mA with HART protocol. It shall be possible to upgrade the transmitter output to foundation field bus standard in the near future.

k) The transmitter power supply voltage shall be 24 VDC, for two-wire transmission system with a minimum power supply voltage of 12.5 VDC.

l) The transmitter electronics shall be microprocessor based.

m) The electronics system shall be provided with a reverse polarity protection circuit.

n) Zero and span shall be non-interacting, easily and continuously accessible. The external adjustment(s) should be provided with an environmental protection cover.

o) The transmitter shall be provided with integral digital indicator with scale identical to the calibrated range as indicated in the instrument data sheet.

p) The performance of the transmitter shall be as follows:

q) The transmitter accuracy including combined effect of linearity, hysteresis and repeatability shall be equal to or better than ± 0.1 deg C.

r) The transmitter shall be provided with EMI/RFI integral transient protection also when the cover has been removed. The protection level shall be as per NAMUR recommendations and EMC directive compliance.

3.4 Analytical Analysers

3.4.1 Dissolved Oxygen Analyser

a) Dissolved oxygen monitoring systems shall comprise a transducer, transmitter, and interconnecting cable.

b) The transducer assembly shall comprise the sensor and mounting hardware. Mounting hardware shall be provided for either rigid wall mounting, freely swinging suspended wall mounting or a floating installation with the float suitably anchored to a fixed location, as required by the application. The sensor shall be membrane covered amperometric type suitable for constant immersion, giving high O2 selectivity and minimal maintenance requirements. The sensor shall also incorporate an integral temperature sensor. Cabling between the sensor and transmitter shall

be easily disconnected from the sensor using a plug-in connector to allow quick and easy substitution of sensors in the event of a sensor failure.

c) Also, the sensor can be an optical sensor working on the fluorescence quenching principle suitable for constant immersion giving minimum maintenance and maximum availability. The sensor shall compensate for fluid temperature and air pressure. Cabling between the sensor and transmitter shall be easily disconnected from the sensor using a plug-in connector to allow quick and easy substitution of sensors in the event of a sensor failure.

d) The transmitter shall be microprocessor based and shall include an integral display and a simple push button user interface. The display shall indicate oxygen content and provide the option of displaying temperature if desired. The display shall be capable of displaying all error codes, process variables, configuration data and other internal values. Calibration shall be a simple procedure, requiring minimal operator input.

e) Input power required will be from a 24 VDC supply. An analogue output shall be provided along with a digital output to indicate fault status. The analogue output shall be by 4-20 mA current loop and shall be configurable to be proportional to the measured value or follow a user specified curve. Fault status shall be indicated by an open collector output, indicating system or sensor error.

f) The instrument shall give measurements at an accuracy of ±0.5% of the measured value and have quick response time. Drift shall be no greater than 1% of full scale per month, such that sensor recalibration shall not be a frequent requirement.

g) Ingress protection shall be IP65 as minimum.

3.4.2 PH/ORP Analyser

a) PH/ORP monitoring systems shall comprise a transducer, transmitter, and interconnecting cable.

b) The transducer assembly shall comprise the sensor and any mounting hardware required. The sensor shall use a glass membrane electrode, the outer layer of which shall give high H+ ion selectivity, to supply an electrochemical potential dependent upon the PH/ORP value of the process fluid. The sensor shall be suitable for constant immersion, with minimal maintenance requirements. The sensor shall also incorporate an integral temperature sensor. Cabling between the sensor and transmitter shall be easily disconnected from the sensor using a plug-in connector to allow quick and easy substitution of sensors in the event of a sensor failure.

c) The transmitter shall be microprocessor based and shall include an integral display and a simple push button user interface. The display shall indicate PH/ORP and provide the option of displaying temperature if desired. The display shall be capable of displaying all error codes, process variables, configuration data and other internal values. Calibration shall be a simple procedure, requiring minimal operator input.

d) Input power required will be from a 24 VDC supply. An analogue output shall be provided along with a digital output to indicate fault status. The analogue output shall be by 4-20 mA current loop and shall be configurable to be proportional to the measured value or follow a user specified curve. Fault status shall be indicated by an open collector output, indicating system or sensor error.

e) The instrument shall give measurements at an accuracy of ±0.5% of the measured value and have quick response time. Drift shall be no greater than 1% of full scale per month, such that sensor recalibration shall not be a frequent requirement.

f) Ingress protection shall be IP65 as minimum.

3.4.3 Conductivity Analyser

a) Conductivity monitoring systems shall comprise a transducer, transmitter, and interconnecting cable.

b) The transducer assembly shall comprise the sensor and any mounting hardware required. The sensor shall comprise two coaxial graphite electrodes arranged similarly to a capacitor. The electrical resistance (and hence its' reciprocal, conductivity) is measured according to Ohm's law. Specific conductivity is determined using a cell constant that is particular to the sensor geometry. The sensor shall be suitable for constant immersion, with minimal maintenance requirements. The sensor shall also incorporate an integral temperature sensor. Cabling between the sensor and transmitter shall be easily disconnected from the sensor using a plug-in connector to allow quick and easy substitution of sensors in the event of a sensor failure.

c) The transmitter shall be microprocessor based and shall include an integral display and a simple push button user interface. The display shall indicate conductivity and provide the option of displaying temperature if desired. The display shall be capable of displaying all error codes, process variables, configuration data and other internal values. Calibration shall be a simple procedure, requiring minimal operator input.

d) Input power required will be from a 24 VDC supply. An analogue output shall be provided along with a digital output to indicate fault status. The analogue output shall be by 4-20 mA current loop and shall be configurable to be proportional to the measured value or follow a user specified curve. Fault status shall be indicated by an open collector output, indicating system or sensor error.

e) The instrument shall give measurements at an accuracy of ±0.5% of the measured value.

f) Ingress protection shall be IP65 as minimum.

3.4.4 Turbidity / TSS Analyser

a) Measurement of turbidity/suspended solids concentration is important to allow the solids content to be assessed at various points in the networks, treatment process.

Turbidity/suspended solids monitoring systems shall comprise a transducer, transmitter, and interconnecting cable.

b) The transducer assembly shall comprise the sensor and any mounting hardware required. The sensor shall function by the 90° scattered light principle. Light in the near-infrared range shall be emitted by an LED at a defined angle. Particles in the process liquid will scatter incident light and a photodiode shall measure light reflected back towards the sensor. The LED and photodiode shall be sealed within the sensor behind scratch resistant windows. The sensor shall be suitable for constant immersion, shall incorporate a wiper to ensure that the LED light source and photodiodes remain clean at all times with minimal maintenance requirements. The sensor shall also incorporate an integral temperature sensor. Cabling between the sensor and transmitter shall be easily disconnected from the sensor using a plug-in connector to allow quick and easy substitution of sensors in the event of a sensor failure.

c) The transmitter shall be microprocessor based and shall include an integral display and a simple push button user interface. The display shall indicate turbidity and provide the option of displaying temperature if desired. The display shall be capable of displaying all error codes, process variables, configuration data and other internal values. Calibration shall be a simple procedure, requiring minimal operator input.

d) Input power required will be from a 24 VDC supply. An analogue output shall be provided along with a digital output to indicate fault status. The analogue output shall be by 4-20 mA current loop and shall be configurable to be proportional to the measured value or follow a user specified curve. Fault status shall be indicated by an open collector output, indicating system or sensor error.

e) The instrument shall give measurements at an accuracy of ±0.5% of the measured value.

f) Ingress protection shall be IP65 as minimum.

3.4.5 Chlorine Analyser

a) Measurement of total free chlorine residual is important to allow chlorine dosing to be controlled to ensure that effluent is adequately dosed to ensure satisfactory disinfection but not excessively dosed which is wasteful of chemicals. Total free chlorine monitoring systems shall comprise a transducer, transmitter, and interconnecting cable.

b) The transducer assembly shall comprise the sensor and any mounting hardware required. The system shall not require chemical reagents to make measurements. The sensor shall measure the concentration of free chlorine by amperometric principles. Total free chlorine shall be in the form of hypochlorous acid contained in the medium, which shall diffuse through the sensor membrane. Once inside the sensor, the hypochlorous acid is reduced to chloride ions (Cl-) at the cathode, whilst at the anode, silver is oxidised to silver chloride. A current flow results from the electron release at the cathode and electron acceptance at the anode. The

current flow is proportional to the total free chlorine concentration in the medium under constant conditions. The concentration of hypochlorous acid in the medium depends on the pH value. Accordingly, the sensor shall incorporate a pH sensor and the transmitter shall adjust the free chlorine measurement to compensate for pH. Cabling between the sensor and transmitter shall be easily disconnected from the sensor using a plug-in connector to allow quick and easy substitution of sensors in the event of a sensor failure.

c) The transmitter shall be microprocessor based and shall include an integral display and a simple push button user interface. The display shall indicate free chlorine residual and provide the option of displaying pH if desired. The display shall be capable of displaying all error codes, process variables, configuration data and other internal values. Calibration shall be a simple procedure, requiring minimal operator input.

d) Input power required will be from a 24 VDC supply. An analogue output shall be provided along with a digital output to indicate fault status. The analogue output shall be by 4-20 mA current loop and shall be configurable to be proportional to the measured value or follow a user specified curve. Fault status shall be indicated by an open collector output, indicating system or sensor error.

e) The instrument shall give measurements at an accuracy of ±0.5% of the measured value and have quick response time. Drift shall be no greater than 1% of full scale per month, such that sensor recalibration shall not be a frequent requirement.

f) Ingress protection shall be IP65 as minimum.

3.4.6 H_2S Analyser

a) Toxic gas detectors shall be capable of detecting H2S at ppm concentrations utilizing Smart electrochemical sensors.

b) The detector shall have a range of 0 to 50ppm H2S and shall operate using a 4 to 20 mA 24V DC HART loop. The detector shall be HART compliant, full maintenance diagnostics and configuration properties shall be available via a HART protocol signal overlaid onto the analogue signal. It shall be possible to fully configure the transmitter via the handheld terminal or a suitable HART connection.

c) The transmitter unit shall have a GRP housing fitted with mounting brackets and rated IP65, certified EEx 'ia' IIC T5. The transmitter shall be fitted with a GRP EEx 'e'certified junction box and shall be suitable for use in ambient conditions.

d) An LCD on the measuring head shall continuously display the measured gas concentration. Adjustment of zero and span shall be carried out using the integral keyboard to enable one-man calibration in the field.

e) It shall be possible to carry out calibration without activating the field horns.

f) The detector shall offer the following standard features:

g) Automatic sensor self-test.

h) Easy configuration of measuring ranges.

i) Remote (e.g. workshop) pre-calibrated sensors.

j) Fully automatic electronic integrity test.

k) Inbuilt maintenance diagnostics.

l) Sensor sensitivity indication.

m) End of sensor life pre-warning with countdown.

n) Failsafe detection.

o) Fixed H2S monitoring shall be capable of providing 2 independent alarm settings (High and High-High).

3.4.7 BOD/COD Analyser

a) Analyser should be able to produce analytical valid results and flag sensor fault.

b) Sensors should be robust and rugged and is capable of operating in variable and extreme measurement condition, and still maintaining its calibrated status.

c) The entire monitoring station including the sensors and hardware should be tamper proof.

d) The analyser should record all operation information in log files.

e) Should have non-volatile data logger for recording at least one-year continuous data.

f) Should have facility of plant level data viewing and retrieval with selection of Ethernet, wireless, Modbus and USB.

g) Records of calibration and validation should be automatically uploaded on web server to CPCB and another third-party server.

h) Online diagnostic features should be available.

i) System should have expandable program to calculate parameter load daily, weekly, or monthly basis for future evaluation with flow rate signal output.

j) BOD/COD measurement should be based on the Total organic Carbon (TOC) measurement / UV Visible spectroscopy double beam complying to US EPA 415.1 / 415.2 or equivalent standard for effluent/sewage/wastewater.

k) The equipment should be TUV, MCERT, USEPA certified.

l) Certificate from OEM for authorization of data management.

m) Every system supplier will comply with testing/calibration protocol as per international standards of the CPCB.

Technical Specification for online COD, BOD, Measurement.

Analyzer Type	Cabinet Type & Multi-parameter
Parameter to be measured	BOD & COD

Analyzer Type	Cabinet Type & Multi-parameter	
Principle of measurement	TOC (Total organic carbon measurement) principle / UV-Vis Spectrophotometry (double beam with entire spectrum scanning.	
Measuring Range	COD	0 to 500 mg/lit. Accuracy ± 10%
	BOD	0 to 200 mg/lit. or higher. Accuracy ± 10%
Operating Pressure	4 Kg/CM^2	
Operating Temperature	Sample temperature: 0 ºC to 50 ºC / Ambient temperature – 50o C	
Operating Flow	0 - 5 L/MIN	
Enclosure protection	IP65 or better	
Analog output	4-20 mA output for individual parameter	
Communication	-RS232 required (Sub-D 9 ways female connector) with 2 meters cable for PC -RS485 required for the connection of external probes -USB port required for USB key connection	
Memory	5000 records (up to 16 measurement channels) with date and time	
Display	Colour TFT LCD/LED (alpha numeric display of parameter in engineering unit)	
Measuring time/Response time	3 minutes or better	
Measuring Cycle	Continuous	
Power supply	230 VAC 50 Hz	
Cleaning method	Automatic	
Calibration requirement	Zero Calibration Facility should be there. Span adjustment either not required or should be adjustable.	
Reagent if any	Not required	
Additional Features	Analyser should be cabinet type for easy operation, maintenance & troubleshooting.	
	USB port is required for recorded measurement download, screen copy function (easy troubleshooting) & software update	
	Wi-Fi & Ethernet module should be available for remote data transfer.	
	Reagent-free measurement	

Analyzer Type	Cabinet Type & Multi-parameter
	Maintenance Free.
	Operating cost should be low.
	Data Transmission from Analyzer to PC, CPCB & another server. Supplier to make available all the measurement data to CPCB server so that on-line data is available at CPCB server.
	Auto calibration facility.
	All the accessories required for mounting the sensor are to be provided.
	Self-cleaning (automatic)

3.4.8 Control Actuators

a) For control and on/off valves and penstocks, electric actuators shall be used.

b) Each control valve/penstock actuator shall include an inductive position transmitter with 4 – 20 mA output signal. This transmitter shall be protected from mechanical damage by a friction clutch.

c) Electric actuator enclosures with position transmitters and limit switches shall be provided with space heaters (if required) to maintain the inside temperature above dew point.

d) A hand wheel shall be provided for manual operation. Movement from motor operation to hand wheel operation shall be accomplished by a positive declutching knob, or lever, which will disengage the motor and motor gearing mechanically but not electrically. Provision of locking device for manual operation to prevent unauthorized operation of actuator shall be provided.

e) Actuators with servomotors shall have a self-locking characteristic in order to maintain its last position in case of switching off the motor or power failure against 120 % counter force/torque. If the motor is not fitted with a brake for these purposes, a gear box with a self-locking characteristic may be used.

f) All power gearing and rotary thrust conversion shall be oil or grease lubricated with an approved lubricant, which is suitable for at least four years' operation under the given ambient conditions.

g) All actuators for above ground service shall be of ingress protection class IP 65 and for the below ground service the ingress protection class shall be IP68.

h) All actuators are to be equipped with mechanical stops adjustable to the used travel range in order to prevent the actuator and the associated equipment from travelling past its normal range in the event that the limit switches fail to operate.

i) If the actuator design requires a switching off in the end positions, the actuator shall be equipped with a travel limit switch mechanism. If the actuator with these cut-off switches is proposed then a minimum of two switches, one for the closed position and one for the opened position shall be provided.

j) The electrical motor operated valve actuators shall be suitable for power supply at 415V ± 10%, 50 Hz ±3%, 3 phase, unless specified otherwise in the data sheet.

k) Safety factor shall be 1.5% and 200% for general purpose and shutdown application respectively.

l) In case pneumatic control valves shall be used, they shall be supplied with spring return actuator, positioner, and other accessories.

3.4.9 Instrument Cables

a) Signal cables shall be used for carrying low voltage, low power instrumentation signals between various field, plant, and control room locations. In general, the signals shall be one of the following categories:

b) Analogue 4-20 mA

c) Digital 24V DC

d) Resistance Temperature Detector

e) Pulsed DC

f) All cables shall be suitable for operation under the following conditions:

g) Directly buried in ground

h) Run in buried P.V.C., concrete or all steel ducts.

i) Runs fastened to cable tray in open air.

j) Cables shall comply with Cables shall comply with BS EN 50288, Multi-elements metallic cables used in analogue and digital communication and protocol. Each cable shall consist of twisted pair or twisted triple conductors, with single pair or single triad having individual screen, and multipair, multitriads collective and individual screen, together with drain wires, fillers, shielding, Armour and outer sheath as specified. Fire and Gas detector cables, if not 4-20mA signal cables, shall require overall shield only. The metric system shall be adopted throughout.

k) Sizes, lengths, and other specific requirements of the cables shall be as indicated in the Request for Quotation and/or Purchase Order (RFQ/P.O.)

l) Thermocouple cables shall be in accordance with IEC 60584-3.

m) Conductor insulation shall be flame-retardant Cross-Linked polyethylene (XLPE).

n) The electrical characteristics C, L, and L/R ratios for intrinsically safe cables shall be in accordance with EN 50288.

o) The PVC outer sheath for all cables shall be anti-vermin impregnated, flame retardant to IEC 60332 Part 3 CAT ‘A’. The oxygen index for the outside sheath shall be 30 (minimum). Type of compound inner/outer sheath to be A/ST1 of IEC 60502.

p) All intrinsically safe cables shall be manufactured with the overall PVC sheath colour Blue. Non I.S. cables shall have sheath coloured Black.

q) Each cable shall be identified by a 3-digit number which will be used throughout on all documentation prepared for the contract. This includes Block Diagrams, Loop Diagrams, Plant Layouts, Cable Schedules, and Termination details if required. Each cable is to be prefaced with a designation letter to identify the duty and as follows:

r) Power

s) Control

t) Metering

u) Earthing

v) Numbering of cables for the identifier following the 'duty' prefixed letter is to be sequential in pre-designated groups. Similar numbers having different identifiers can be used. Each cable is to be identified on the Block Diagram with the number of cores contained in the cable. The number of cores shall be stated on the drawing adjacent to a diagonal line across the cable. Each core is to be double ferruled at the point of termination.

3.4.10 Online Monitoring System

a) Online monitoring system shall be installed as per CPCB Guidelines for Online Continuous Monitoring System for Effluent.

b) Online monitoring analyser shall be rugged, tamperproof and shall not require manual intervention except routine checks.

c) Online monitoring analyser shall be field operational and tolerant to extreme environmental conditions in India, in high or low temperatures, high humidity and high temperature.

d) Online monitoring analyser shall be working on optical technology and based on UV-Visible spectrometry principal and capable to measure all general parameter pH, COD, BOD, TSS, TDS, Ammoniacal Nitrogen, Phosphate with individual calibration. No Calculation, from one parameter to another shall be carried out.

e) The UV analyzer shall have multi-wavelength scanning range from 220 – 720 nm.

f) There shall be no interference from high chloride, inorganics, colour, TSS/Turbidity, and changes in wastewater sample matrix.

g) There shall be no pumping and moving parts in Online Monitoring Analyzer. Compressed air can be used for automatic cleaning of sensor.

h) The analyzer shall be pre-calibrated for local Industrial wastewater matrix and shall have facility to add multipoint calibration to automatic adapt frequent matrix change in wastewater discharge from Industries to get accurate analysis all the time.

i) All maintenance and diagnostic features shall be accessible through menu guided, easy to use software.

j) The analyzer controller and monitor shall have bright colour display for clear local parameter visualization and data trend analysis.

k) All operator activities done in analyzer shall be recorded within logbook of control module.

l) The analyzer shall not require regular continuous hazardous reagents/chemicals/consumables nor any carrier gas for routine operation.

m) Parameter display shall be extendable for future provisions.

n) Sensor & parameter validation as well as event detection shall be integrated part of the software.

o) Power consumption of the Analyzer will be maximum 30-60 Watts with sleep mode facility for power savings.

p) The material of spectro-photometric probe shall be stainless steel 1.4404 (SS316) or superior to withstand the operating conditions.

q) The analyser shall have minimum IP 68 protection and display unit shall have minimum IP 65 protection.

r) Performance specifications for analyzers are listed below:

Sr. No.	Specification	Tolerance range or values
1	Zero drift / weekly	$\leq$ 1%
2	Span drift / weekly	$\leq$ 1%
3	Analyzer's linearity	< 1% of full scale
4	Accuracy	+/- 10% of compared reference measurement

3.4.11 Auto-composite samplers

Auto composite sampler shall be stationary vacuum pump-based sampler. It shall be designed to handle extreme environments. The sampler shall use vacuum pump technology to draw water through their intake tubing, so as to have minimum disturbance of the sample. It shall include steel enclosure with locking doors and bolted down instrument panels. The water samples shall be deposited into one container (20 lit capacity). Sampler shall have refrigeration unit/temperature regulation unit to maintain the water temperature as per APHA standards at all times.

3.5 Control and Automation Panels

3.5.1 Introduction

a) The monitoring, alarm and control of the Utilities shall be achieved via PLC control and ICA panel.

b) A PLC-based control system together with the HMI in each local ICA panel shall monitor and control its associated part of the utility. SCADA system and ICA panels shall communicate with one another via a self-healing, fault-tolerant and

redundant communication network. Single-ring topology is not allowed. Dual Ring redundant topology to be proposed.

c) The contractor/vendor shall submit the overall system architecture with the bid.

3.5.2 Scope of Works

The contractor shall supply and install ICA panels of approved make, PLC and HMI as per the approved vendor list enclosed with the tender document. All other components shall be selected where practical from a single manufacturer's range. The vendor for the ICA panel shall be subject to approval by the Engineer/Owner.

3.5.3 Panel Type, Ingress Protection, Components and Enclosure Materials

a) ICA panel shall be Form 2 free standing, IP 54 suitable for indoor mounting. Panel depth shall be 800 mm. Painting - nanoceramic coating, electrophoretic dip followed by powder coating to RAL 7035.

b) All components shall be coordinated with the short circuit protective device such that a flow of current will cause no damage, and that normal operation of the equipment is unaffected.

c) The slim 6.2 mm wide lower power consumption UL approved interposing relays shall be used for both Digital Input as well as Digital Output which must have built-in fuse options for protection. Separate fuse terminal blocks shall not be used.

d) Proper ventilation system shall be considered for each panel which will include G3 type EN 779 compliant Filter Fans and Louvers with IP 54 Ratings along with UL approved DIN Rail Mountable Hygro-thermostats. The panel's construction shall be such as to allow full accessibility from the front. Floor support and fixing bolts shall be provided by the contractor.

e) The panel shall be sealed so as to be substantially dust proof. Cables shall enter and leave from the bottom. The panel shall be provided with a removable rustproof plated gland plate.

f) The Contractor shall provide and fit all necessary cable glands. Each cubicle of the panel shall be equipped with an UL approved PIR sensor-based LED Light having 1200 Lumens and electrical life of 60000 hours to be operated without the need for a door limit.

g) Control Panel shall have 20% free space for future expansion. Enclosure for Control ICA Panels shall be designed such that extensions can be made at either or both ends. The panel should be designed so that if required it may be split into sections for transportation bearing in mind the transportable weight. Each section is to be fitted with removable lifting eyebolts to facilitate handling. With transportation splits provision is to be made for any interconnecting wiring connections.

h) Enclosure shall be made from Multi folded frame of a single sheet with seamless 25 mm pitch all over the frame, with load carrying capacity of a maximum 1800 kg with option of door interchangeability, 180 Degree Hinge, special C fold in punch section, Clip-in holders and positioning aid for easier attachment and positioning

of enclosure panels, PU foam gasket with sustainable IP throughout product life with single tool installation, enabled with e Pocket for ease of documentation. Laminated GI mounting plate without scratches having provision to get installed from outside frame. Enclosure with the following certifications – UL/ cUL/CSA/TÜV/Germanischer Bureau Veritas.

i) The height of instruments, switches, and indicators should be no more than a maximum of 1800 mm or less than a minimum of 500 mm above the base of the panel assuming floor mounting unless otherwise specified.

j) Enclosure shall be sealed at cable entries with glands that have an IP56 protection degree. Gland plates shall not form part of the enclosure. Suitable cleats and supports shall be provided to ensure that cables are not supported by the cable glands.

k) All cabling shall be glanced directly in the section housing its terminals. Cabling between compartments shall be via termination chambers, and terminals shall be provided at the point at which the control panels are split for shipping.

l) All doors shall be earthed via flexible conductors. Every section of the panel shall be connected to the main earth bar. It shall be terminated in a separately mounted earth stud.

m) A continuous copper earth bar of not less than 25mm x 6mm cross section shall run the full length of each panel and shall be securely fixed and bonded electrically to the main frame. Control panels shall be completely wired to the terminals at the factory itself, requiring only connections to the external wiring circuits at site.

n) Extra electrical sockets for test and repair purposes shall be provided in the local ICA panels. These sockets shall be according to British Standards suitable for flat and round pins. Local ICA panels shall also be equipped with space heaters, if required.

o) The door shall have. type F lock inserts, or lock and pushbutton inserts with a length of up to 26.5 mm with tool free installation. Each lock shall be provided with 2 keys. A document pocket containing a set of drawings and/or schedules shall be provided within the panel in an easily accessible position.

p) Complete Fan Filter unit without EMC but with G3 qualified Filters as per EN 779 Standards for tool less operation. Fan air throughput must be in line with the required heat dissipation of the panels with a standard protection class of IP54 for Indoor and IP 55 for outdoor applications in conjunction with a hose-proof hood. The Fan must have UL approval and an electrical life of at least 50000 Hrs.

q) Wherever required Energy efficient panel AC Blue e+ shall be provided. Panel A.C shall be TUV /UL/CSA certified.

r) Components shall be mounted on a separate removable mounting plate. The only exception being front of panel mounted equipment.

s) Where removable covers exceed 1000 mm in height, they shall be fitted with an engagement lip or similar to assist removal or replacement.

t) Internal wiring shall be adequately sized for the required voltages and currents. Cable ducts shall be provided with at least 20% spare capacity after complete wiring. Separate ducting shall be provided for the wires carrying different voltages.

u) ICA panels shall be of high standards and quality in terms of visual appearance, colour, finish, and smoothness of surface.

v) Labels shall be provided for all instruments, indication lamps, selector switches and push buttons installed in the panel door.

w) Titles on name plates shall be written in English. Materials for nameplates shall be selected in accordance with the weather data and area conditions and shall be of the non-metallic type, with black inscriptions on a white background.

x) There shall be an HMI with a minimum display size of 15 inches (Refer to HMI specs in the below section).

3.5.4 Lightning Protection

An exposed cabling connecting to an instrument located outdoors shall be provided with a lightning protection barrier in the form of pluggable DIN Rail Mountable SPDs for power data and signal lines at the point of ICA panel entry.

3.5.5 Smart Rack Specifications:-

Dimension of racks: for Server, 600 X 2000 (42U) 1200D, For Network, 800 X 2000 (42U) X1200

Each Rack should include: Top Cover must be removable type with Polyurethane Gasket with cutouts for mounting Fans and cable entry cutouts.

Bottom cover with Cable entry provision.

The frame of rack should folded rolled hollow frame section minimum 16 Fold frame with punched in 25mm DIN pitch pattern .

All profile edges are radiused. The corners are stiffened with welded MS die-cast, Copper coated, corner connectors,Frames are bayable, scalable and modular. Safe Load carrying capacity: 1400 kg on enclosure frame, and 1000 kg. on 19" mounting angles.

Perforated Doors: Up to 68% perforation surface area, sheet steel, with foamed seal polyurethane gasket, square section tubular frame with punching in DIN pitch pattern, rod-type 3 point lock system and double-bit inserts to DIN 43668 (Option of Ergo form handle), (with single door: hinge fitting r/h or l/h freely selectable on site). Hinges with captive hinge pins, door-opening angle 130ø to VDI, can be retrofitted for 180ø. Gasket, Side panel, 1.5 mm without vents with PU Gasket ,

Full Height 19” angle, Zinc Plated. Mounted on Installation bracket for stability and strength. 4 fans mounted on top for the Air Exhaust .

Heavy Duty underneath castors without brakes 750KG Load Bearing Capacity with leveling feet, (Castors should not be visible from outside), Earthing kit, Stationery shelf 1no. / racks,

MS Closed Vertical cable managers on both sides in networking racks with back to back cable routing facility.

Horizontal cable managers with PVC Loops (5No. / Rack),

Hardware pack of 20 (2pack. / Rack)

All Products should be certified according to ISO 9001, 14001, 18001. Comply with EIA 310, and IEC 297 standards

Surface Finish: Nano Ceramic Coated, electro-dipcoat primed to 10-15 microns and powder coated with textured polyester RAL 9005 /RAL 7035 to avg 80 to 120 microns.

Wall Mount:-Size 600Wx500deep

Structure: Enclosures in sturdy sheet steel construction consisting of a 0.8mm sheet steel frame folded from one piece and welded, with vents at top and bottom .rear side open with holes for wall mounting. With 1 pair of 19" Mounting angles mounted in the front, which can be recess able for Extra cable management. Top and bottom cutout with rubber grommets for cable entry provision. Top 2no Fan cutout provision.

Doors: 0.8mm sheet steel glass door with 4mm thick Glass with surface mounted, fixed hinges Which can be changed for left-hand or right-hand door hanging (for Single door enclosures), 130ø opening angle which can be retrofitted with Lock and key.

Surface finish: Sheets cleaned, degreased, phosphated, powder coated with textured paint RAL 7035.

Smart Rack consisting of 42U Rack, cooling system, UPS, Security and monitoring:

Specification of Smart Racks: Smart Rack Solutions have a minimum 1 No. rack with 7 kW cooling system with redundancy (N+N) and UPS System 10 kVA with 10 minutes backup.	
Specification	Description of Items
Modular Design	(i) Smart rack consists of 42HU x 1No. suitable for free standing installation. (ii) Provisioning of Smart for further extension.
Racks and Accessories	1.42U x 1 No.- 1000 mm Wide x 2000mm Height x 1200mm Deep maximum. Rack should have base frame of 100mm height for stability. Load bearing capacity of rack frame should be 1400 Kgs. Rack should be made of CRCA sheet steel with minimum sixteen folded frame with 1.5 mm thickness with surface finish Nano Coated, electro-dip coat primed to 20 microns and powder coated to 80 to 120 microns.

Specification of Smart Racks: Smart Rack Solutions have a minimum 1 No. rack with 7 kW cooling system with redundancy (N+N) and UPS System 10 kVA with 10 minutes backup.	
	Top cover and bottom cover should have cable entry provision. Rack front and rear door should have PU gasket. Each rack should have 2 Nos. vertical and 4 Nos. horizontal cable manager. Each rack should have 10 Nos. toolless banking frames of 1U size. Required total 7 KW cooling capacity with redundancy N+N. Racks should have rodent repellent. Rack front door should have electronic keypad system. Rack rear door should be equipped with auto opening system. Rack should have air baffle plate. Racks should have water leak sensor. Rack should have provision to mount the cooling system inside in vertical form without consuming any u space within the rack side panel. Rack, cooling system, IPDU, Smoke detection, Front door access, Auto door opening system, monitoring and WLD are required from single OEM for better services. Each rack with minimum 34U usable space. OEM should have at least seven year experience for smart rack in PSU/ Govt organization.
Rack door Access System	The Front door of smart rack should be fitted with High Security Electro-mechanical code combination lock of nine digit & Rear with auto door opening system.
Cooling System	Cooling System Harmonized modular components should ensure an energy-efficient dissipation of heat. The external unit (condenser) should be designed on the basis of latest technology. Cooling unit mount should be mount vertical to provide the uniform air flow inside the rack, Unit should not take any U space. **Smart rack system should include:** 2x Heat exchanger (evaporator) for placing on the inside of the system. 2x Condenser external unit works with R410A / R510 A refrigerant. DX control box to activate the evaporator.

Specification of Smart Racks: Smart Rack Solutions have a minimum 1 No. rack with 7 kW cooling system with redundancy (N+N) and UPS System 10 kVA with 10 minutes backup.	
	LCD display, digital temperature display between 18 and 29°C. Cooling system mount in vertical form to provide the uniform air flow in the rack. Cooling system should not occupy any U space in the rack. Cooling unit should be mount within the rack side panel in vertical form without consuming any U space.
Electrical Power Distribution System	Provisioning of structured power distribution system. The 3-Phase commercial conditioned 440V/50Hz power supply will be made available by the user at the Distribution panel along with MCCB. This Main Distribution panel will be used to distribute power to all power consuming devices used in Smart EDGE rack such as: UPS, Air-Conditioning system.
Power Distribution Units for Racks	Vertical mount metered IPDU for Racks with industrial socket 32A/1P. Smart rack should have 2 Nos. PDU. IPDU should have 24 Nos. IEC 13 and 2 Nos. IEC 19 sockets with 2.5 Mtr. connection cable with industrial sockets. Smart rack should have 2 Nos. I PDU.
Monitoring (HMI display)	Provisioning of IP based monitoring Fault signals - Temp/ Humidity, WLD, smoke, UPS and Automatic rear Door Kit, Door access.
Monitoring Technical specifications	Monitoring unit should be an intelligent monitoring system with an Ethernet 10BaseT network connection. The basis of the monitoring unit should be the processing unit (PU unit). Several input/output units (I/O unit) should be connected to one processing unit via a patch cable. This/these function module(s) should connect to the sensors via a standard plug connector. The sensors should be coded so that the function blocks recognise automatically which sensors are connected. Network interface: IEEE 802.3 10/100BaseT Full Duplex Basic protocols: TCP/IP, SNMP V1.0, Telnet, FTP, http Additional features: NTP, SSH, SSL, DHCP
Smoke detection and Suppression system	Smart rack should be fitted with smoke detection and suppression system. Cylinder for fire suppression medium should be mount outside the smart rack. Medium NOVEC 1230 or better eco friendly.

Specification of Smart Racks: Smart Rack Solutions have a minimum 1 No. rack with 7 kW cooling system with redundancy (N+N) and UPS System 10 kVA with 10 minutes backup.	
UPS System	Single 10 KVA UPS system rack mount with 10 minutes backup. UPS and batteries should mount in smart rack. Second source of UPS supply will be provided by end customer.
Services	The Rack, smoke detection, Cooling system, IPDU, Front Door access, Rear auto door opening, WLD, Monitoring system should be from one OEM for better SLA. OEM should have at least seven-year experience of smart rack in PSU/ Govt organisations.
Certification	Regulatory Standard, ISO 9001, 14001, 45001 and UL2416, ROHS, REACH
Installation & Training	Installation of smart rack and the relevant components has to be carried out by qualified technicians/OEM engineer. 01 days onsite training to the user will be given by the vendor.
Warranty	Smart rack with one year warranty.

3.6 Programmable Logic Controller (PLC)

3.6.1 Introduction

This Specification covers the minimum requirements of PLC as per the proposed/preferred vendor list which shall be used to monitor and control Wet utilities

3.6.2 Scope of Works

a) The Contractor shall provide all assets associated with the programmable logic controller. This shall include all hardware and software items, including (but not limited to):

b) All hardware including equipment racks, central processor units, I/O cards, communications modules, and programming cables.

c) All software including PC based configuration software (to include any “dongle”, license or other such software protection device required to utilize the software), fully documented and commented source code files.

d) All programming platforms (Development and Monitoring) and software for HMI, PLC, and SCADA are to be provided with a laptop for the same purpose.

e) The PLC shall be provided with sufficient communication ports to enable the laptop to be connected without a requirement to disconnect remote monitoring devices or any SCADA / HMI / programmable operator terminal units installed.

3.6.3 PLC Hardware Specifications

a) The PLC system shall comprise of a central processing unit, input/output modules and serial interface modules. The PLC shall be of modular construction with plug-in I/O cards and a facility to install expansion racks/modules when necessary. The system shall include 20% spare capacity in hardware and memory for future modifications in addition to the I/O signals for future pumps.

b) PLC shall have a dual redundant processor configuration. Over and above this, redundancies will be incorporated for input/output, power supply, communication network etc. Redundant I/O cards shall be used for closed loops, any other critical loop, shutdown and fire and gas loops.

c) The equipment shall accept discrete and analogue (4-20mA) signals from both field and panel mounted instruments. Analogue inputs shall be scanned into a 12-bit binary (minimum) analogue to digital converter with buffered inputs.

d) The PLC power supply shall be 230 VAC +/- 2% and 50 +/- 1% Hz UPS supply. The equipment shall be maintained in operation during a period of mains failure drawing power from the UPS system for a minimum back-up time of 3 hours. The UPS system shall include diagnostic and automatic self-test routines with volt-free contacts to initiate an alarm in the event of a malfunction.

e) The PLC controller family shall have a high degree of interchange capability. The power supply, battery and EEPROM Chips should all operate equally well regardless of the CPU being used.

f) It should be possible that all assemblies and sub-assemblies performing similar functions shall be interchangeable.

g) The system design shall accommodate the replacement of assemblies without having to disconnect field wiring; removable connectors shall be used to connect field wiring to the individual circuit board assemblies.

h) All major assemblies and sub-assemblies, circuit boards, and devices shall be identified using permanent labels or markings each of which indicates the manufacturer’s catalogue number and item description.

i) The power supply unit shall be modular in design, compatible with the main CPU and expansion racks allowing easy on-site replacement in the unlikely event of failure.

j) The power supply unit shall contain a battery compartment for installing a long-life Lithium battery to protect programming CMOS RAM memory. The battery power transfer shall be bump less.

k) The battery shall be capable of supporting the memory for a period of a minimum one year without having power applied to the system. The low battery condition shall be alarmed.

l) This battery shall be replaceable while power is applied to the PLC.

m) The user application program shall be stored in Random Access Memory (RAM) or a combination of RAM and Electronically Erasable and Programmable Read Only Memory (EEPROM).

n) The user application program scan time, on average, shall be no greater than 50ms for logic and integer processing. Where three terms control (PID) and Floating-point data processing is required, the application scan time shall be no greater than 100ms.

o) RS232 Serial/Ethernet communication ports shall be provided to facilitate the following:

p) Connect the laptop for PC compatible programming software.

q) Connect the Hand-Held Programmer to the PLC

r) Connect to one of the wide varieties of third-party operator interfaces utilizing an open architecture software protocol.

s) Provide RS-422 signals with RS-485 compatibility. The characteristics of this port shall be software configurable and shall be modem compatible.

t) When an I/O fault occurs, the processor shall report the location of the fault, the condition, the address, and the circuit number If appropriate.

u) All digital input units shall be capable of accepting, a volt-free contact signal, the source voltage shall be regulated 24VDC and shall be derived from the PLC panel.

v) Where the input from an external source is not volt-free then suitable isolation devices shall be provided in order to prevent cross-connection of different supplies. This device may be e.g. interposing relay or optical isolator. For frequencies of operation greater than 30 operations/hour, the use of electromechanical devices shall not be permitted. All interface/isolation devices shall provide visual indication of Signal State.

w) Inputs signals from 'DUTY' equipment shall not be allocated to the same input module as signals from 'STANDBY' equipment performing the same function.

x) Digital outputs used for AC inductive loads shall be fitted with arc suppression devices as close to the load as is practicable.

y) Provide hardware watchdog relays driven by digital outputs from the PLC to detect major PLC processor fault, I/O error, and low battery fault.

z) PLC's to include facilities to retain the last state of the output modules at the time of the PLC failure. This shall be achieved by means of hardware or software.

aa) The power (AC and DC) for I/O shall be distributed by the use of suitably rated MCB's. Separate MCB shall be provided for the followings:

bb) PLC and I/O rack power supplies.

cc) External networking or communication if any.

dd) Analogue DC power supplies.

ee) Digital 24VDC power supplies.

ff) Digital 230 VAC.

gg) The CPU shall have a memory protect key switch together with passwords to provide different levels of access privilege for the PLC when the programmer is in On-line.

hh) Indication of status of digital I/O shall be provided by LEDs on the face of the I/O module.

ii) The processor unit shall have a real time clock with battery backup. A “battery low” indication lamp shall be provided to monitor battery status.

3.6.4 PLC Software Specifications

a) PLC Software shall be developed within the BS EN 61131-3 environment. Application program shall be developed by using software package that only conform to BS EN 61131-3 requirements.

b) Standard IEC libraries of Functions and Function Blocks shall be used when writing application software.

c) All software shall be suitably documented to include the following as a minimum:

i. Suitable comments

ii. Function description

iii. Descriptions of all constants

iv. List of cross-references

d) On-line and off-line, CPU and I/O configuration and application program development shall be achieved with a PC compatible computer and programming and documentation software.

e) The WINDOWS/ Windows NT Platform compatible software shall provide the capability of reading, writing, and verifying the configuration and program with a diskette / suitable backup arrangement.

f) The software shall provide on-line help information throughout its execution paths.

g) The software shall allow development of programming, storing the program to the PLC, monitor program and references address status while the PLC is in Run or Stop mode.

h) The software shall be user friendly to generate printout of the program for documentation purposes selectable to print various options e.g. printing of complete program with instruction for each rung, the reference list, reference description, reference address and tables.

i) The software shall have provisions for importing and exporting tag names, comments, and descriptions in an .xls format.

j) The programming language shall be BS EN 61131-3 compliant.

k) The CPU shall be capable of solving an application program whose source format shall be relay ladder diagram. The language shall support relay, timers and counters, arithmetic, relational, bit operation, data move, conversion, and control functions.

l) The CPU shall be capable of solving an application program whose main program format is in Sequential Function CHART (SFC) with underlying code in relay ladder diagram.

m) Control functions shall be provided to limit program execution, an immediate I/O update of all or a portion of the inputs or outputs for one scan while the program is running, or to update I/O during the program in addition to the normal I/O scan.

n) Additionally, the function shall provide a mean to read inputs into memory auxiliary to the true input table and execute outputs from discrete memory alternate to the true output table.

o) A method for structuring the ladder program shall be provided with the use of a JUMP Function. This will cause the program execution to jump to a specified location in the logic targeted by the location of the LABEL function.

p) Diagnostic and fault detection requirements shall typically include I/O data corruption, single bit RAM failures, power supply failures, processor failures, and I/O bus failures.

q) All PLC's shall be designed as hot standby and shall detect and report failures of all critical components so that appropriate control actions may be taken. All components that acquire or distribute I/O data or that are involved in execution of the control logic solution are considered critical components. A fault in the active unit shall cause a switch of control to the backup unit.

3.6.5 Alarm System

a) The alarm system is part of the control system functions. The alarm systems shall contain all alarms for a safe and reliable operation of the pumping station. Alarms shall be generated when important operating data exceed their limits or when abnormal operating conditions occur in the pumping station. An accumulation of alarms, e.g. in case of system trips, must not cause any loss of alarms.

b) Alarms shall be initiated by means of position or limit switches, protection relays, fuses and miniature circuit-breakers, auxiliary contacts of switchgear, breakers, etc., or generated by the programmed digital system itself.

c) Tripping and auto-change over of motors, trip of circuit-breakers, status of isolation device, etc. shall be announced by flashing of the symbol on the HMI/SCADA operator station mimic diagram and on any related screen representation. Such trips shall also be announced on the alarm summary screen. In case of alarm, an acoustic signal shall be given. It can be cancelled by a horn-off acknowledgement pushbutton. The alarm acknowledgement pushbutton shall be different from horn acknowledgement.

3.6.6 PLC Standards

a) PLC programming shall follow industry best practice. Software development shall be carried out in accordance with the methodologies described in BS EN 61508, BS EN 61511, and IEC 61131. Standard IEC libraries of Functions and Function Blocks shall be used when writing application software.

b)	BS 7671	16th Edition IEE Regulations for Electrical Installations
c)	BS EN 60204	Safety of machinery
d)	BS EN 61000	Electro-magnetic compatibility
e)	BS EN 61131	Programmable Controllers
f)	BS EN 50170	General purpose field communication system
g)	ISBN 0 86341 233 5	IEE Guidelines for the documentation of computer soft ware for real time and interactive systems
h)	ISBN 0 11 883906 3	HSE Programmable Electronic Systems in safety related applications
i)	BS EN	Equivalent Standard to BS/EN, please refer to Division 6 Section 06200 Standards and Regulations (Guidelines)

3.6.7 Documents and Drawings

On contract stage and before handing over, the contractor shall submit comprehensive documentation (ISSUED FOR APPROVAL) including but not limited to:

a) PLC Program in hard copy as well soft copy.

b) Technical data sheets for PLC hardware.

c) Formal inspection and Functional test procedures

d) O&M manual and installation instruction.

e) I/O list.

f) Automation System Architecture.

g) GA drawing with BOM

h) Loop drawing

i) Heat load calculation.

j) Power distribution

k) Wiring diagram

l) FAT / SAT Procedure

3.6.8 Spare Parts

Spare parts shall be provided as recommended by equipment manufacturers which shall be subject to review and approval by the Owner and Engineer.

3.6.9 Installation and Commissioning

The Contractor shall install and commission the supplied PLC. The Contactor shall provide the following:

a) Commissioning Plan

b) Commissioning Manual

c) Commissioning Log Test

d) Documentation, schedules, logs and final status report.

3.6.10 Training

Training shall be provided at site for the Owner's O&M personnel for a week, either directly by manufacturer of various instruments and control systems or through their suppliers on operation, monitoring and control, maintenance of ICA equipment.

3.7 SCADA and HMI

3.7.1 Introduction

This Specification covers minimum requirements of SCADA & HMI used to monitor and control utilities.

3.7.2 Scope of Works

a) flow metering, valve , Analysers, Field Instruments and the lifting stations shall be monitored and controlled by SCADA system located at control room at common utility area.

b) The layout of the SCADA control room shall be proposed by the contractor for the Owner/Client's approval.

c) The Contractor shall provide all assets associated with the SCADA & HMI. This shall include all hardware and software items, including (but not limited to):

d) All hardware including operator and engineering workstations, printers, servers, communication hardware and cables.

e) All software including PC based configuration software (to include any "dongle", license or other such software protection device required to utilize the software), fully documented and commented source code files.

f) All programming platforms (Development and Monitoring) and software for HMI, PLC and SCADA to be provided with a laptop for the same purpose.

g) SCADA System shall be installed in temperature controlled RCC Room with all the required furniture and filing cabinet. The operator workstation VDUs shall be located on the operator desk console.

h) To ensure high system availability, the SCADA equipment shall be configured in a dual redundant system configuration. The configuration of all proposed computers shall be of the latest revision at the time of the equipment supply and to the approval of the Employer's Representative.

i) One printer shall be colour laser A3 printer provided for creating hard copies of workstation VDU. Other printer shall be a Dot Matrix type printer for Alarm/Event recording and for continuous logging of all pumping stations and entire plant data.

j) The SCADA software running on windows platform or latest industry proven version of Windows is preferred. The SCADA software shall have 'open system' client/server architecture allowing operation on and interfacing with a choice of hardware platforms. The SCADA software package shall be proven for similar application in India.

3.7.3 Standards

The following list of standards indicates the minimum requirements:

a)	IEC 60654	Operating conditions for industrial process measurement and control equipment
b)	IEC 60625	Interface system for programmable measuring instruments
c)	IEC 60902	Industrial process measurement and control – terms and definitions
d)	IEC 60839	Alarm and warning systems
e)	EN 50228	Instrumentation cables
f)	ISO 3511/1	Process measurement control functions and instrumentation symbolic representation
g)	BS 6739	Instrument loop checkouts

3.7.4 SCADA Computers

a) The SCADA computers shall provide the required power, flexibility, and scalability for the required application under a true multi-user, multi-tasking environment, and shall comprise servers and operator workstations. The specifications defined below are minimum, but the configurations to be provided by contractor to be latest at any stage.

b) Workstations and servers shall be suitable and proven for the application.

c) Minimum two computers shall be used as workstations and shall be provided with Network Management software and industrial automation process software, to ensure high system availability. The SCADA computers shall be configured as fault tolerant dual redundant hot standby and shall be connected to the PLC system via dual communication sub-system.

d) Archiving system shall be provided which shall be based on magneto-optical storage technology. At least two archiving systems shall be provided, one for each workstation. In case one system failure, the other shall be capable of completely taking over the archiving function. Diagnostic software and historical file management, archival and retrieval shall be included.

e) The workstations shall have a screen diagonal measurement of at least 36" with a minimum resolution of 1600 x 1280 pixels and shall include tilt and swivel facilities. A full function industrial Modem Fax 65KB, keyboard and mouse/track ball unit shall be provided with each computer. Each workstation on every control desk shall have both Engineering cum Operator station, along with one Engineering laptop consol. There shall be minimum two numbers of workstations in every control desk for each utility individually, in addition to local control panel minimum 17" screens, like for pump houses, if any.

f) The computer hardware (RAID 1) proposed shall be from industry standard manufacturers, having permanent technical back-up and service facility available in INDIA, and shall be subjected to approval.

g) The SCADA computers shall be designed for non-obsolescence by allowing for sufficient future expansions, upgrades and enhancement in hardware and software including CPU, memory, hard disk, I/O hardware, and peripherals. The contractor shall provide the details of the expandability and upgrade path together with their tender proposal.

3.7.5 SCADA Printers

Printers shall conform to the following specifications. Manufacturer and type shall be best in the industry and shall be subject to approval.

3.7.6 Page Printer

Information that is required on a page basis only, such as workstation colour graphical information and documents (but not for event-based information where each line represents an element of information) shall be printed using printers that print a page at a time. The printer shall have sufficient resolution to clearly print the smallest graphical and alphanumeric characters on A3/A4 paper format. Paper shall be hopper loaded.

Page printers shall be Colour Ink jet type and shall have the following minimum performance characteristics:

a) Throughput rate: six pages per minute (5% image area, text mode).

b) Printing resolution: 1440 dots per inch (dpi) at highest resolution (text and graphics mode).

c) Paper type: A4 and A3, plain paper, recycled quality or better.

d) Paper reserve capacity: 100 sheets minimum with manual-single-sheet feed facility.

e) Operating power requirements: 230V AC mains voltage/UPS.

f) Interval between services: 100,000 pages.

g) Data interfaces: Bi-directional Parallel Centronics (IEEE – 1284)

h) Print colour: Multi colour.

i. Fonts: Adobe postscript fonts, and graphics and true type fonts.

ii. Minimum range of fonts: CG Times; Times New Roman; Courier

iii. Printing styles: Regular, bold, italic, underline, subscript/ superscript

3.7.7 Dot Matrix Printer

The Dot Matrix printer shall have the following minimum specification:

a) Bi-directional serial impact dot matrix printer.

b) 24 pin printing head, 80 or 136 column width depending on requirements.

c) Printing speed: 350 cps min in draft mode.

d) Paper handling: Plain paper, fan fold paper.

e) Paper feeding: Friction and fan fold paper tractor.

f) Interface: Bi-directional parallel Centronics (IEEE – 1284).

g) MTBF: 1000 hours minimum.

3.7.8 HMI Specification

a) Human Machine Interface Unit shall be provided for each local control panel/station.

b) HMI units shall have a backlit display with minimum display area of 15” with a minimum resolution of 256 pixels x 128 pixels and a wide viewing angle. Colour displays only acceptable. The unit shall incorporate touch VDU. Touch screens shall be divided into touch cells, with each cell rated for a minimum of 1,000,000 presses or more.

c) HMI units shall be powered by either a 230VAC or 24 VDC supply and shall have a power consumption of no greater than 100VA.

3.7.9 SCADA/HMI Design Concept

a) SCADA/HMI units shall be configured to display data in a logically ordered format allowing quick and easy access to measured variables. Where displaying all data in one view would result in a cluttered or confusing display or where viewing and entry of control set points is possible from the SCADA/HMI, there will be a requirement for a number of views. Where data is split up across a number of views in this manner, data shall be displayed and accessed in a clear and logical way. The method used to switch between views shall be simple and intuitive. Periodic automatic scrolling of screens may be offered as an option, but it shall be possible to disable this mode if desired.

b) The SCADA/HMI unit shall store its view configuration in non-volatile memory to enable normal operation to resume without operator intervention on resumption of power supply following an outage. A battery backed real-time clock shall be provided.

c) SCADA/HMIs shall be provided with a communication port to enable connection to the PLC for operational use.

d) Where the SCADA/HMI is used to view and enter control set points, it shall be necessary to enter a password via the numeric membrane keypad or via a touch screen representation of a numeric keypad (depending on hardware configuration). When the password is correctly entered, the new set point value may be entered. The entered value will be error checked to ensure that the entered value is within the acceptable range. If the value entered is acceptable, the operator shall be alerted that the set point has been accepted and the entered value shall be written to the relevant PLC register. If the value is outside the acceptable limits, the operator shall be alerted that the entered value is outside acceptable limits, the entered set point shall not be written to the PLC and the existing set point data shall be used.

e) Where a SCADA/HMI is supplied, the contractor shall provide all assets associated with the device. This shall include all hardware and software items, including (but not limited to):

f) All hardware including communications modules and programming cables.

g) All software including PC based configuration software (to include any “dongle”, license or other such software protection device required to utilize the software), fully documented and commented source code files.

3.7.10 SCADA/HMI Interfaces Central Monitoring and Control Room (At respective Water Utility Control Room)

This project involves implementing a comprehensive SCADA system across Water Pumping stations, Control with integration into a centralized location viz ICCC (by others) The system will feature redundant SCADA for each Scada System and a web-based centralized SCADA for unified monitoring, control, data Logging and reporting.

Main Station SCADA Systems (Operation and Monitoring) – Redundance Server and Software SCADA system capable of

Monitoring of Transformers, Panels of Pump Houses.

Interfacing with power relays and energy meters.

Monitoring and controlling Water pumps.

Monitoring of Flow meters, water Level Tanks.

Monitoring of water meters IOT based communicating on GSM/LoRaWan.

Monitoring and controlling of Water Solenoid Valve.

Graphics implementation.

Displaying real-time data, alarms, and historical trends.

Programming, Configuration, and Testing of PLCs/Controllers.

Programming of Water Scada,:

Monitoring and controlling RMU panels, Relays, Energy Meters, Water meters, Water Pumping Stations, Solenoid Valves, Pump Houses Street Lights, Flow Meters, Water Tanks, etc.

Data acquisition from energy meters and relays.

Implementation of IEC 60851/61850 protocols.

Functional testing to ensure seamless data communication and control.

SCADA System Development.

Substation and Main Station SCADA:

Single-line diagrams for RMU panels, Transformers, Relays, Energy Meters, Water meters, Water Pumps Stations, Solenoid Valves, Pump houses Street Lights, Flow Meters, Water Tanks.

Real-time data visualization.

Graphics Implementations.

Alarm/event handling and historical trends.

3.7.11 Command Control Center SCADA (ICCC)

Web-based interface design with features:

Dashboard for comprehensive monitoring of all stations.

Consolidated alarms, events, and reports.

User role management for secure access.

Alarms and Notifications

Alarm prioritization and notifications for:

Faults Alarms

Email alerts for critical events.

Historical Data and Reporting

Local and centralized data logging for:

Energy consumption, fault analysis, and operational efficiency.

IEC 60851-compliant reporting with customizable formats.

Communication protocol for third party data:

RMU panels to Pump house substation Scada System on Modbus TCP IP.

Power relays and Energy meters to main Scada System on Modbus TCP IP.

Water pumps to main Scada System on Modbus TCP IP.

Flow meters, water Level Tanks to main Scada System on Modbus TCP IP.

Water meters and Solenoid Valves panels to main Scada System on GSM/Lora (IOT Based).

Pump Houses Street Light Control Panels to main Scada System on Modbus TCP IP.

3.7.12 Power Scada for Pump House, Water utility Sub Stations SCADA Systems

Redundance Server and Software SCADA systems capable of:

i. Monitoring and controlling RMU panels, Transformers.
ii. Interfacing with power relays and energy meters.
iii. Graphics implementation.
iv. Displaying real-time data, alarms, and historical trends.
v. Programming, Configuration, and Testing Controllers- Programming of Power Scada for:
vi. Monitoring and controlling RMU panels, Transformers, Relays, Energy Meters.
vii. Data acquisition from energy meters and relays.
viii. Implementation of IEC 60851/61850 protocols.
ix. Functional testing to ensure seamless data communication and control.
x. SCADA System Development Substation and Main Station SCADA:
xi. Single-line diagrams for RMU panels, Transformers, Relays, Energy Meters.
xii. Real-time data visualization.
xiii. Graphics Implementations.
xiv. Alarm/event handling and historical trends

3.7.13 Water Station SCADA Systems Monitoring and controlling of Water pumps.

Redundance Server and Software SCADA systems capable of:

i. Monitoring of Flow meters, water meters, Level Tanks.
ii. Monitoring and controlling Water Solenoid Valve.
iii. Graphics implementation.
iv. Displaying real-time data, alarms, and historical trends.
v. Programming, Configuration, and Testing Controllers.
vi. Programming of Water Scada for:
vii. Monitoring and controlling Water Pumps Stations, Solenoid Valves, Flow Meters, Water meters, Water Tanks.
viii. Data acquisition from energy meters and relays.
ix. Implementation of IEC 60851/61850 protocols.
x. Functional testing to ensure seamless data communication and control.
xi. SCADA System Development

xii. Substation and Main Station SCADA Development of screens for:

xiii. Single-line diagrams for Water Pumps Stations, Solenoid Valves, Flow Meters, Water Tanks.

xiv. Real-time data visualization.

xv. Graphics Implementations.

xvi. Alarm/event handling and historical trends.

xvii. Key benefits of the redundant SCADA system should include:

xviii. System Reliability: Guarantees continuous operation of the pump houses streetlight automation system without interruptions.

xix. Data Integrity: Ensures all energy, runtime, stop time, and fault data are consistently logged and available for reporting.

xx. Operational Security: Prevents single points of failure, minimizing the risk of system outages.

xxi. This robust architecture underpins a resilient and efficient water utilities streetlight management system, ideal for critical infrastructure applications

3.7.14 OFC Communication Network

Redundant communication system for Each Sub Stations and main Sub Station for Water Scada, wherever applicable 24 core Single Mode OFC cable shall be used for the network connectivity for Water SCADA, Pump Station, Armond cable having three different tubes of 8 core fiber and MITL logo shall be printed of OFC cable. Three different tubes shall be used for different network like Water SCADA, Streetlight SCADA and Power SCADA.

a) All substation shall be connected in ring topologies.

b) All end devices switches shall be connected in ring topology and dual homing.

c) Industrial grade managed switch with SPF module.

d) Fully loaded LIU's, patch cords with accessories

e) Outdoor Racks with patch panels.

3.7.15 Network Management software with server.

a) All end device node shall be configured in the NMS software

b) Failure notification shall be triggered

c) Contractor shall provide the NMS report at the time of O&M Payment

3.7.16 SCADA/HMI Security System

a) Comprehensive security system shall be configured to ensure over all integrity of the control system. Three levels of security to be configured for the following persons:

b) Operator (default)

c) Supervisor

d) Engineer

e) The system shall boot-up with operator security level. The following table shows the access of security groups.

Table 3-2: The Access of Security Groups

Name	Group 1	Group 2	Group 3
	Engineer	Supervisor	Operator
Default Password	ENGR	SUP	OPERATOR
View	□	□	□
Application Shut down	□		
Historical Trend	□	□	□
System Configu-ration	□		
Security	□		
Alarm Summary Display	□	□	□
Tag Group Editor	□	□	
Security Areas/ Function	□		
Main Menu	□	□	□
Control Override	□	□	
□ - Access Allowed			

3.7.17 SCADA/HMI Graphic Screens

a) Each graphic screen should have as a minimum following property:

b) Header Section

c) Common top header on every screen shall provide access to the following:

i. Main screen tab: shall open screen showing main sections of the pump station.

ii. Alarm Summary

iii. Log In

iv. Log Out

v. Screen Selection Tab: shall open a pop-up screen showing a list of screens. Operator can click on any button to display the relevant screen.

vi. Screen description title.

vii. Date and Time

d) Footer Section

e) Common bottom footer on every screen shall provide access to the following:

i. Alarm Acknowledge: By clicking on alarm acknowledge button from any screen, selected alarm should be acknowledged.

ii. Alarm Reset: By clicking on alarm reset button from any screen selected alarm should be reset when only it is physically removed.

iii. One-line alarm banner shall display the most recent alarm. If two alarms are raised simultaneously the alarm with higher priority should be displayed first.

3.7.18 Alarms Management System

All alarms shall be displayed / logged as a clear message indicating condition, time and date stamped.

Alarm Summary Screen: All alarms shall automatically send to the alarm summary page. Each alarm shall be time and date stamped. Colour coding shall be used to distinguish between (Alarm in alarm, and Alarm has been acknowledged).

3.7.19 Documents and Drawings

On contract stage and before handing over, the contractor shall submit comprehensive documentation (ISSUED FOR APPROVAL) including but not limited to:

a) Coloured hard copy of graphic screens.

b) Technical data sheets for SCADA/HMI hardware including servers & data loggers.

c) Alarm List.

3.7.20 Spares

Spares shall be provided as recommended by equipment manufacturer and it shall be submitted for review and approval by Owner and Engineer.

3.7.21 Installation and Commissioning

The Contractor shall install and commission the supplied SCADA/HMI system. The Contactor shall provide the following:

a) Commissioning Plan

b) Commissioning Manual

c) Commissioning Log

d) Test Documentation, schedules, logs and final status report.

3.7.22 Training

Training shall be provided at site for the Owner's O&M personnel for a week, either directly by manufacturer of various instruments and control systems or through their suppliers on operation, monitoring and control, maintenance of ICA equipment.

Advanced Software based Process Monitoring and advisory Control (PMAC for wastewater and Water Supply system:

Also, equipment control and secure communication with the local PLC-SCADA system to be incorporated. The process operator and technologist shall follow the process using a clean web-based user interface. It shall provide a schematic overview of the plant with control panels for each controller, adjustable settings, clear trends, and insightful dashboards. APC shall deliver optimal processes using minimal resources.

For Control, continuous systems and batch systems shall be adopted for the solution selection:

Continuous systems:

a) Aeration for optimal TOD removal: BOD, NKj with minimal aeration energy usage

b) Recirculation for optimal N and P regime with minimal recirculation energy usage

c) Return sludge RAS optimization reducing risk of sludge washout and saving energy.

d) Waste sludge WAS optimization reducing risk of too much endogenous respiration.

e) Dosing e.g. carbon source, phosphate removal with minimal dosing applied.

f) Dashboarding Total Dissolved Nitrogen, Specific Energy Usage Sludge Washout Risk

g) Batch systems:

h) SBR Controller with scheduling and clear phases for e.g. feeding, aerating, decanting.

i) Analytics

A cloud-based analytics environment to be provided in which operational support by anomaly + drift detection, performance indicators + soft sensors, including early warnings can be given.

j) Requirements

k) Online instrumentation shall be provided for flow and concentrations available (e.g. O2, NH4, NO3, PO4, MLSS).

l) Note: the necessary parameters highly depend on the desired controllers for implementation!

m) PA&ICT infrastructure installation should be ready for advanced process control (APC)

Additionally, operational support needs to be provided by experienced process technologists and their comprehensive domain knowledge.

For the process control over and above offered SCADA, a proven software platform powered by artificial intelligence for process automation and predictive analytics for the entire water cycle. The Product should be multipurpose consists of at least five products that are integrated in a single solution to provide clean water, treat wastewater, and optimise biosolids for potable water and wastewater.

For each stage of the water cycle, it should have a specific product within the process-based Software platform to address specific challenges. At the same time, data from all processes and points are connected, enabling you to get full visibility across complete water and wastewater network. This shall empower O&M engineer to make fact-based decisions quickly to improve processes and performance. This includes lowering operating costs, reducing capital investment and enabling proactive maintenance, warning of leaks, bursts, overflows, and pollution incidents.

Bidder to offer, Leak proof system as ultimate monitoring and control software platform for the water and wastewater system that combines supply and demand prediction software with smart automation controls. Accurate self-learning prediction of demand, flow & pressure to identify when leaks & bursts occur within the water supply network.

Once identified leaks & bursts are localised enabling reduced time to repair. It should be able to makes use of in-built proven prediction of flow, pressure & demand. The prediction is allocated to nodes within the network and compared with real-time data to highlight anomalies and identity leaks. Application should learn the variance at each node and uses this to develop a very accurate alarm threshold variance for each node. The real-time flow is compared instantaneously to the nodal prediction and to a rolling summation of flow to identify smaller leaks & bursts. The self-learning capability of the software should ensure all alarms are genuine alarms. Process based software should further enhances on It should alert's leak detection ability by localising new leaks and bursts. It should find uses real time feedback from network pressure sensors together with its nodal prediction of pressure to identify an area within the supply zone.

where the new leak & burst has occurred. Self-learning automated detection of leaks and bursts, Insightful interface, Reduced time to repair, Reduced leakage volume, Improved customer service Improved resilience, Reduced costs.

The software should further help move you towards a smart integrated and optimised sewer network. It should optimise sewage network and pumping stations. It translates real-time data from sewage pumping stations, providing valuable insights into the actual performance of the entire wastewater transport systems. It can actively control the sewage pumping stations, to optimise the total sewage system, including wastewater treatment plants, if any. It should offer overall control of your wastewater system, through the use of insightful dashboards and decision support tools. These include model-based monitoring, to predict sewage overflows, pipe friction loss, pump efficiency and energy consumption, and rain forecasts for peak flow reduction.

In case of Water Supply network, the software should offer advanced control of water supply system. It should optimise water abstraction and distribution, to provide a stable and efficient process performance, which leads to improved water quality and reduced levels of energy consumption.

This insightful and intuitive product should be self-learning, smart autopilot, which enables overall control of the water system. This allows for a constant production rate, leading to lower overall system pressure and lower peak factor production and

transportation. It should haves a pipe burst alert, which is triggered when there is a deviation in behaviour patterns.

3.8 Communication Network

3.8.1 Introduction

The communication between local ICA panels and SCADA shall be via Ethernet protocol self- healing, redundant Network. The control system shall continuously monitor LAN communications and raise an alarm at the central HMI located at SCADA Room. If communications should fail between the central HMI and a controlling PLC or between PLCs if inter-PLC communication is being used. A separate SCADA screen (mimic) showing the real time status of PLC's, I/O modules, LAN communication etc. is to be incorporated.