

OFFICE OF
THE PROJECT DIRECTOR
PROJECT IMPLEMENTATION UNIT
JICA ASSISTED GUWAHATI WATER SUPPLY PROJECT
1ST FLOOR, TRIPTI TOWER, GANESHGURI
G. S. ROAD, GUWAHATI-781005

No: PIU/JICA/GHTY/80/2022/140

Date: 31/05/2023

Addendum No-2

IFB No: GWSP/LCB/C-9/2023-24/03 dated 28.04.23

"Central Water Management Centre CWMC – SCADA & Instrumentation with Comprehensive maintenance for a period of 5 years

Amendments in Volume to be referred as under:

Sl. No	Tender Reference	Tender Document	Amendment to Tender Document
1	Section III, Evaluation and Qualification Criteria 1.1.3 Equipment	1.1.3 Equipment – The bidder must demonstrate that it has key equipment listed hereafter	1.1.3 Equipment – Bidder/OEM must demonstrate that it has the key equipment listed hereafter either own or access to the facilities during the execution period.
2	Section III, Evaluation and Qualification Criteria 2.4 Experience 2.4.3 Cyber Security Solution Provider	2.4 Experience: 2.4.3 Cyber Security Solution Provider The System Protection appliance should come from firewall appliance family which has more than 10 years of ICSA labs certification and OEM should be ISO 9001-2015 & ISO 27001:2013 Certified Cyber Security Solution provider appointed by the lead bidder should have past experience of supplying Cyber Security Solution and Network Management Software of similar value to State/ Central / PSU Projects in last 3 years.- Must meet Requirement	Cyber Security requirement can be submitted by the bidder as specialized subcontractor/ vendor along with his bid submission / or during the detailed design period post award. The System Protection appliance should come from firewall appliance family which has more than 10 years of ICSA labs certification and OEM should be ISO 9001-2015 & ISO 27001:2013 Certified Cyber Security Solution provider appointed by the lead bidder should have past experience of supplying Cyber Security Solution and Network Management Software of similar value to State/ Central / PSU Projects in last 3 Years. — Cyber Security requirement can be submitted by the bidder as specialized subcontractor/ vendor along with his bid submission / or during the detailed design period post award.

3	Section III, Evaluation and Qualification Criteria 2.4 Experience 2.4.2 ISO 9001-2015 Certification	Shall have ISO 9001-2015 certification for Engineering, Design, Manufacturing, Installation and commissioning of electrical and automation systems.	Shall have ISO 9001-2015 certification for Engineering, Design, Manufacturing, Installation and commissioning of electrical and automation systems" Or ISO 9001 -2015 certification for engineering services, execution, SCADA solutions"
4	Section III, Evaluation and Qualification Criteria 2.4 Experience 2.4.5 Specific Construction Experience	Shall have experience in supply & installation of process instruments from NABL certified [testing & calibration lab- as per ISO/IEC 17025 for flow /pressure transmitter, etc.,] supplier shall have experience of integration of process instruments with SCADA.	Shall have experience in supply & installation of process instruments from NABL certified [testing & calibration lab- as per ISO/IEC 17025 for flow /pressure transmitter, etc.,] bidder shall have experience of integration of process instruments with SCADA"
5	Section III, Evaluation and Qualification Criteria 2.4 Experience Notes for Bidder	The Bidder shall be essentially an Original Equipment Manufacturer [OEM] for SCADA software & automation [PLC] hardware or shall be an authorized system integrator/ authorized specialist sub-contractor for the OEM for a minimum continuous period of for last 10 years.	The Bidder shall be essentially an Original Equipment Manufacturer [OEM] for SCADA software & automation [PLC] hardware or shall be an authorized system integrator/ authorized specialist sub-contractor for the OEM for a minimum continuous period of for last 5 years.
6	BF- Tech -4	Technical proposal	Include as below: Addendum-2 , Part-2 General Requirements, Bid Drawings & Technical Documentation Required to Be Submitted for Technical Qualification
7	BF-Tech-7	Mobilization Schedule	Include as below: As per Addendum-2 , Part-2 General Requirements, Clause 2.8 Milestones

8	BF-Tech-8	Implementation Schedule	Include as below: As per Addendum-2, Part-2 General Requirements, Clause 2.8 Milestones
9	BF-Tech-9	Preliminary Design	Include as below: Addendum-2, Part-2 General Requirements, Bid Drawings & Technical Documentation Required to Be Submitted for Technical Qualification
10	BF-Tech-10	Safety plan	Include as below: Addendum-2, Technical Schedules
11	BF-Tech-11	Annual maintenance	Include as below: As per Addendum-2, Part-13 Comprehensive Operation and maintenance
12	<p>Section VI-Employers Requirements</p> <p>Sub Section 1 SCADA and Instrumentation-General</p> <p>Sub section 2 Documentation</p> <p>Sub section 3 Data Administration</p> <p>Sub section 5 SCADA at CWMC</p> <p>Sub section 6 RTU and process Instrument</p> <p>Sub section 7 Security system for CWMC-SCADA</p>	<p>1.1 Scope of work</p> <p>1.2 Operation strategy</p> <p>1.3 Documentation of CWMC-SCADA</p> <p>1.4 Reference standards</p> <p>1.5 CWMC-SCADA system overview</p> <p>1.6 General requirements</p> <p>1.7 Contractor's responsibility</p> <p>1.8 General design requirements</p> <p>1.9 Communications</p> <p>1.10 Testing & communications</p> <p>2.1 Submissions by contractor</p> <p>2.2 Software documentation</p> <p>2.3 Operation and maintenance manual</p> <p>3.1 Database management system</p> <p>3.2 Energy management</p> <p>3.3 Historical data management</p>	<p>For better clarity on the scope of work and technical specifications for each equipment, inspection and testing requirements, functionality of the CWMC-Centralized SCADA center</p> <p>Include as below: Shall be provided as per Addendum-2</p> <ol style="list-style-type: none"> 1. Project requirements 2. General Requirements 3. Qualification requirements for vendors 4. Contractor documents required for approval 5. Particular requirements-Instrumentation control and Automation 6. Data communication equipment requirements 7. General electrical requirements 8. General Instrumentation & control requirements 9. Particular SCADA and Centralized SCADA control center requirements 10. Particular electrical plant requirements 11. Inspection and testing requirements

			12. Training requirements
13	Section VI-Employers Requirements Sub Section 4 Maintenance Contract	4.1 scope of agreement 4.2 scope of work 4.3 exclusions	For better clarity on the scope of work and technical specifications for each equipment, responsibilities during comprehensive operation and maintenance period and handing over requirements at the end of 5 years Include as below: Shall be provided as per Addendum-2 13. Comprehensive operation and maintenance requirements 14. Handing over requirements
14	BOQ Schedule II -RTU	Sl. No.1 to 5 RTU	Include as RTU/PLC as required under the specifications as per Addendum-2 wireless communication equipment with Sim cards, IP-68 rated panel enclosures, and all other ancillary equipment and works to be carried out as required under the specifications as per Addendum-2.
15	BOQ Schedule II -RTU	Sl. No. 6 RTU	Include as providing new enclosure as extension of existing 15 locations where the PLC/RTU is being provided under this tender. Modification of existing enclosures by attaching the new enclosures and wire up of all the items. Rest all the panels having sufficient space to accommodate all the items. Raw power supply 230VAC will be available in all the panels.
16	BOQ Schedule I -CWMC	A 1	Replace /include with rack mountable redundant NAS servers for SCADA, as per addendum-2.
17	BOQ Schedule I -CWMC	A 2	Replace/include with rack mountable redundant servers for SCADA, redundant front end integration servers, rack cabinet, rack monitoring systems inclusive of 22" LED monitor, as per addendum-2.
18	BOQ	A 4, A5	Include 16 GB RAM instead of 8 GB

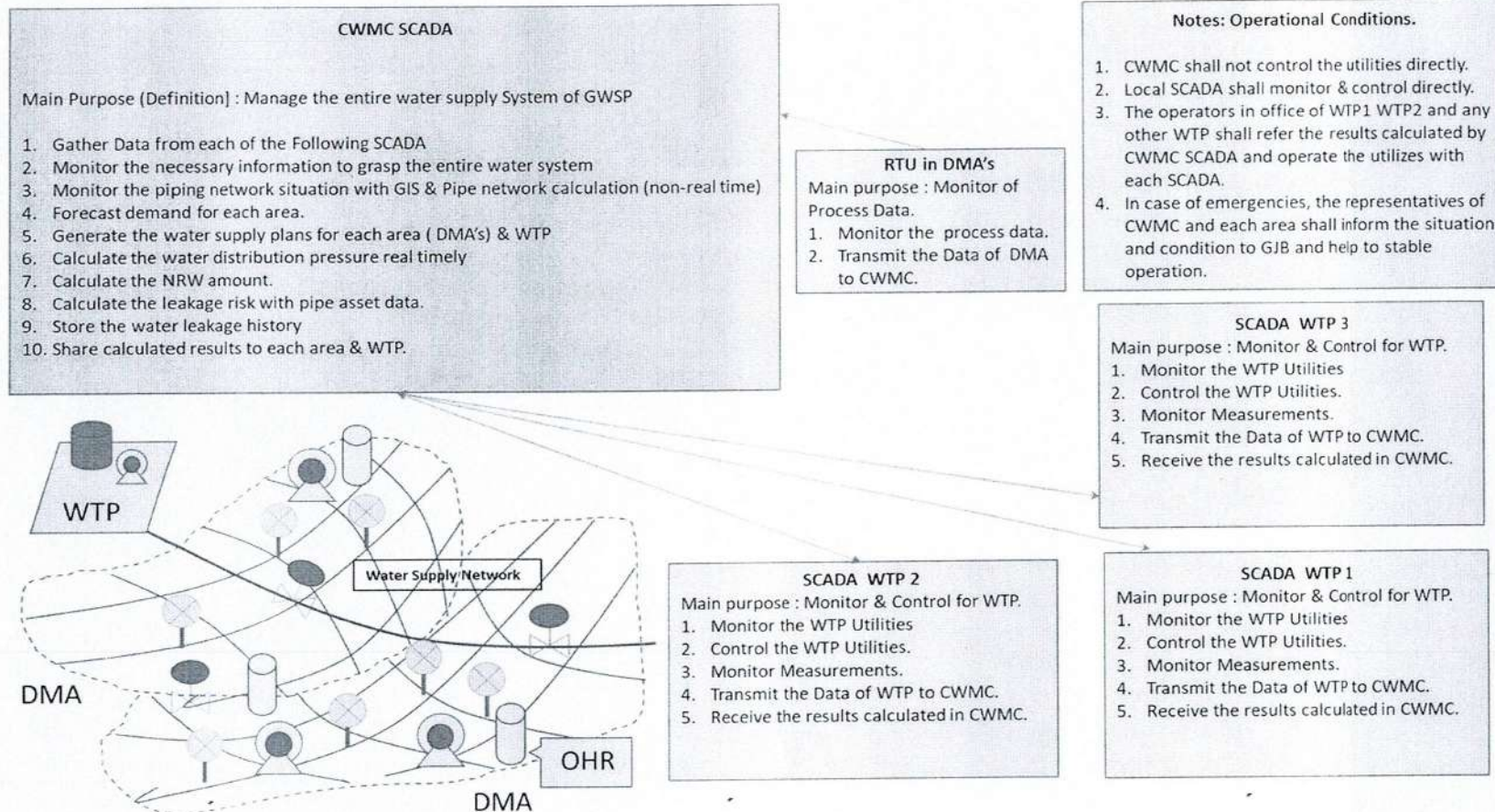
	Schedule I -CWMC		
19	BOQ Schedule I -CWMC	A 7	Include as per specifications in addendum-2, consider 55" instead of 42".
20	BOQ Schedule I -CWMC	A 14	Include as per specifications in addendum-2, consider 32" LED instead of 22 TFT.
21	BOQ Schedule I -CWMC	A 15	Shall also include the cost as per specifications as per addendum-1 for control desk, interiors for the control center and all other ancillaries including electrical equipment to be provided as per requirement and specifications in Addendum-1 for the equipment to be provided at CWMC-Centralized SCADA center for complete functioning.
22	BOQ Schedule I -CWMC	B 6	Shall be provided as per specifications in addendum-2.
23	BOQ Schedule I -CWMC	C	Shall include testing and commissioning of the entire CWMC-Centralized SCADA center for a period of 2 months (10 months for execution + 2 months for testing & commissioning)
24	BOQ Schedule I -CWMC	D	Shall include only as per specifications as per addendum-2
25	BOQ Schedule IV -O&M	Sl. No 1	Description shall be amended as following for each year of operation & maintenance period: Man Power as per specifications + manpower for carrying out repair works/replacement works(inclusive of all incidentals, travel & boarding cost) +manpower as required for integration of new and all other facilities that shall be made available for integration with the SCADA center along with SCADA screen mimics, reports as required, Data Communication cost between various remote sites with centralized SCADS, inclusive of leased line and related costs ,high speed broadband

			<p>internet charges, All software licensing, regular software patch upgrade for all software as and when made available by OEM with time stamping, applicable for all machines installed in the control center, servers, server components, cyber security audit, etc. plus all other software's licensing and related incidental cost , All required consumables for all water quality monitoring instruments inclusive of required chemicals, reagents, printer cartridges, fuel expenses, data loggers plus all other consumables costs , Operation & maintenance of the SCADA software modules inclusive of mathematical water demand & consumption modules, Historian software & hardware systems & antivirus protection for all components, Software programming & integration of newly added plants/locations with all field data to be integrated to the SCADA system as applicable with SCADA mimics, interoperability test procedures, communication checks with all remote sites at regular intervals, Comprehensive Operation & maintenance of all equipment(hardware, software, instrumentation, all control center equipment & associated systems) installed under this contract with preventive and predictive maintenance including replacement & repair.</p>
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Palau (S) No
31.5.23

Project Director
PIU, JICA Assisted Guwahati Water Supply Project

System Architecture:



**JICA assisted
Guwahati Water Supply Project**

**Contract Package No. 9
Central Water Management Centre CWMC – SCADA & Instrumentation
with Comprehensive maintenance for a period of 5 years**

**PART 1
PROJECT REQUIREMENTS**

Addendum 2 (Technical Specification)

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PART 1

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PART -1

PROJECT REQUIREMENTS

1.1 Description and Scope of Work

The central Water Management Center shall essentially be a centralized SCADA center which shall primarily integrate with all remote facilities that shall be made available during the contract period. The CWMC or Centralized SCADA centre shall provide GJB with a virtual mathematical model that shall utilize the operational data to run simulations zone wise and benchmark performance using the SCADA software and the Water demand & forecasting module of the SCADA software and leak detection/water loss information, allowing GJB engineers and field operators to pinpoint where efficiency gains can be made in the water distribution network. The complete data interfaced to the centralized SCADA system shall provide analysis of data and monitoring of systems which can identify performance optimization actions and actively provide information/data problems before they occur, preventing downtime and developing new efficiency opportunities for GJB.

The consolidated solution of interfacing/integration of water treatment & distribution system shall provide data, which will be analysed at each point/node integrated with the centralized SCADA system, which shall help in determining water demand, actual consumption, water pressure & velocity in each zone of the water distribution network. This consolidated data being made available from the centralized SCADA system shall facilitate & assist in contingency planning, allowing GJB to recover faster from any performance & maintenance issues, and help in providing an efficient water supply to the citizens of Guwahati city.

The minimum Scope of work under this contract shall comprise of design, supply, installation, testing, commissioning and comprehensive Operation and maintenance for a period of Five years with all required spares for all equipment, replacement of equipment, software & hardware and as required under these specifications. The following shall be provided on a minimum but not limited to:

- 1) Online Quality Analyser in Reservoirs & Flow /pressure monitoring equipment which shall be installed at key locations in the water transmission & distribution network shall also be integrated with the water SCADA server to provide data in real time. Note: The contractor during detailed engineering shall co-ordinate with GJB and finalize the list of locations in the water distribution network.
- 2) The Water SCADA server shall provide GJB engineers with the water supply, consumption data, water loss data and water demand data for zone wise, Reservoir command area, each division & sub division wise).
- 3) The water SCADA software shall be designed and implemented in the following manner:

- i. Generate charts, reports, dashboards with significant flexibility and high degree of situational awareness. The above shall lead to actionable and informed decisions.
- ii. System shall generate forecasts and predictive insights based on historical analysis, mathematical modelling of current data
- iii. Water supply pattern mapping with network visualization shall be incorporated which shall also depict the water availability, water demand, water consumption, water loss, area of high supply, moderate supply, low supply and no data available, etc.
- iv. Water SCADA shall provide GJB engineers and operators with data such as
 - Treatment plant viz water quality report
 - Pumping station viz water supply report
 - GLR/Reservoir viz water supply & water quality report
 - Network viz water supply report
 - Network viz water quality report with zone wise, division wise & sub division viz with population being served based on the KPI's.
 - Predictive maintenance alerts
 - Differential parameters monitoring for actual water supply monitoring in real time w.r.t Input parameters (command population, actual water flow, average flow, sanctioned quantity) V/s output parameters (LPCD), Flow rate monitoring in real time w.r.t Input parameters (instantaneous flow rate, optimum flow rate) V/s output parameters, etc.
- v. System operators for water SCADA shall be provided facility to view and download any historical data stored on the server (i.e., water quality readings, flow readings, pressure readings alert data, breakdown logs, laboratory data, water demand, consumption, etc.) in a given custom date range

Features which shall be available across all pages / views are as follows:

- ▶ Network visualization – shall include both Geographic view and schematic view
- ▶ Date range filters – shall provide date range selectors 1 day/ 7 days/ 30 days/ 365 days, and also custom date range selection as per operator user input
- ▶ Drilldown and drill-up – shall provide options for all charts with temporal data to adjust granularity of displayed data. Thus, if the control center operator requires day to day data granularity to be plotted, drilldown option may be used.
- ▶ Date and time stamp on each page / chart / view
- ▶ Data sharing – Shall provide capability for printing charts / reports / dashboards, export to pdf/ spreadsheet/csv file/ other data interoperability option

- ▶ All devices shall be provided with a unique ID in the Central Monitoring system for better accounting & tracking
- vi. The water SCADA software shall provide the following data on a minimum: -
 - Flow Information with daily flow (over last 24 hours), average flow (over last 30 days), Peak flow (over last 30 days)
 - Flowmeter status
 - Water supplied to various consumers segments (domestic, commercial, industries (if any), etc
 - Data shall be segregated w.r.t zone wise, division wise & sub division wise with population being served
 - The water distribution network map shall have details of flowmeter, water quality instrument, network lines overlaid with Google map having Zoom in, zoom out, scrolling features. Specific information pertaining to each flow meter shall be present on the pop-up / tool-tip window
 - Water flow diagram shall be implemented and the same shall indicate the line losses if any. Water loss for any selected segment shall be analysed and measured.
 - On selection of one location of flowmeter, flow diagram should represent flow starting from its preceding station/s and all its child locations
 - Dashboard to indicate and monitor locations with most days of non supply of water, Highest water loss(monthly), Most days of water supply(monthly), lowest water loss(monthly), Most no of water quality noncompliant reports(weekly), Most no of water quality compliant reports(weekly)
 - Dashboard to indicate instrument condition monitoring (all instrument), status, etc
 - Service level agreement monitoring & Penalty calculation for equipment breakdown to enable GJB to monitor the comprehensive O&M period in a graded manner. The SCADA software shall be designed to calculate such penalties on basis of contract requirements and incidence log maintained in the SCADA software.
- 4) Design, supply, installation, testing and commissioning of complete Centralized SCADA Center-CWMC/ Water SCADA equipment inclusive of redundant Front end Integration servers, redundant SCADA servers, Historian server, SCADA server stations, Engineering & Operator work stations with dual monitors ,Desktop work stations for GJB engineers at the SCADA center, rack cabinets inclusive of rack monitoring system and all other licensed software, hardware, networking equipment, anti-virus, etc as required under the specifications to have a fully functional CWMC/ centralized SCADA center.

- 5) Design, supply, installation, testing and commissioning of complete Centralized SCADA Center-Water SCADA software inclusive of Water demand & forecasting module as an integral part of software, with minimum 50,000 tags, Historian software with minimum 50,000 tags and all other software as required under the specifications to have a fully functional centralized SCADA center.
- 6) Design, supply, installation, testing and commissioning of complete Centralized SCADA Center-Water SCADA LED Video wall system with required video controller system, all required accessories, mounting accessories, and complete functionality as required under the specifications. The video wall shall be integrated with the water SCADA servers, engineering & operator work stations
- 7) Design, supply, installation, testing and commissioning of complete Centralized SCADA Center- Redundant GPRS Wireless communication Module to receive and transmit data to/from various remote locations at the CSC Water SCADA server
- 8) Design, supply, installation, testing and commissioning of complete Centralized SCADA Center- Internet broad band connection with required Routers (Broadband high speed) and all other required hardware, accessories for Internet access for control center-applicable for water SCADA systems and all other systems in the control center.
- 9) Design, supply, installation, testing and commissioning of complete Centralized SCADA Center -Bio-Metric Access Control system (complete with finger print ,PIN & EM proximity card reader/software, required hardware) for the control center. Entry to the control center ,server room, control room area and other facilities shall be via bio metric access control system to prevent any un-authorised entry to the control center and to maintain a log for every entry to the control center and other areas.
- 10) Design, supply, installation, testing and commissioning, implementation of Hardware based Firewall + software firewalls with complete cyber security solution , web security audit ,for the complete centralized SCADA center. The provided solution shall be Fully scalable without any limitations on the number of clients
- 11) Design, supply, Development & Implementation of Andriod & IOS application for accessing the Water centralized SCADA data, demand as per zone, Zone wise water consumption, online water quality parameters, GLR levels, water quality, flow & pressure data, etc as per specifications. The App shall be designed in such a way as to provide specific data to specific users only with user authentication and various security levels.
- 12) Design, supply, installation, testing and commissioning of EPABX system for complete Control center
- 13) Design, supply, installation, testing and commissioning of Overhead projector system with screen, conference table with ergonomic designed chairs, other required ancillaries for the

conference room to be set up at the control center. All other facilities in the control center as required under the specification.

- 14) Design, supply, installation ,commissioning of all necessary civil works, expansion of the control center ,floor tiling, sanitary fittings, etc. and interior architecture including false ceilings and false flooring, removal of existing walls to expand the control center and merge with existing rooms, refurbishment of existing washrooms inclusive of fittings, installation of new washrooms, and other facilities, as per design and approval of the engineer, Water proofing of terrace as required, painting, etc ,and all other works as required under specifications
- 15) Interior Designing, supply and installation of all required furniture inclusive of system consoles required to house the servers, monitors etc,
- 16) Design, supply installation, testing and commissioning of Industrial type Control system consoles for main control room area of Water SCADA control center, Ergonomic chairs, Work desks, tables, furniture to augment control room design presentation room facilities, cabinets etc as per requirements & specifications
- 17) Design, supply installation, testing and commissioning of precision air-conditioning systems for Server Room and centralized air conditioning system for rest of the rooms, etc. Design, supply/laying/terminations of all types of Cables on as required basis, bio-metric as well as card access control systems, Close circuit television (CCTV) systems for the control center covering all areas of the control center, and any other hardware/equipment as necessary and to the approval of the engineer.
- 18) Design, supply installation, testing and commissioning of Fire Alarm system :- Fire Detection, Fire alarm & Gas suppression system ,Aspiration system, addressable fire alarm system, Fire extinguishers, etc for the entire Centralized SCADA center along with central control panel and integration with SCADA system for monitoring.
- 19) Design, supply installation, testing and commissioning of UPS System - 2x 60 KVA, Parallel Redundant, Three phase,415V,50Hz, Standalone, Online, microprocessor based UPS System with SMF batteries for 120 minutes backup with accessories. The above sizing is the minimum to be provided. The contractor shall size the UPS to cater to all equipment in the control center.
- 20) Design, supply installation, testing and commissioning of Wireless Integration panel comprising of Redundant GPRS communication network to be provided at the remote locations as required under this contract and to transmit the complete plant operational data to the CSC
- 21) Design, supply installation, testing and commissioning of GLR Instrumentation and automation equipment comprising of level transmitters, and online real-time multi-parameter water quality parameters measuring instruments. Transmission of the above instruments data to the centralized SCADA control center in real time for real time monitoring of the data. The data

shall be communicated via integration panel consisting of standalone PLC with wireless GPRS communication panel. The system shall be designed & implemented for two way communication, i.e the GLR system shall transmit data at predefined intervals and also as and when requested from the centralized SCADA center.

- 22) Design, supply installation, testing and commissioning of Real time Flow & Pressure along with RTU/PLC at DMA locations in the Water Distribution Network and data transmission to Centralized SCADA Center, comprising of flow and pressure measurement. Associated required civil work, works required for tapping to pipeline, for installation of panel and construction of access chamber on site, with all required works, excavation, filling up, road restoration at the location where the equipment has been installed, etc as required under the specification. The location where the equipment shall be installed shall be reinstated to perfect new condition, all other requirements as required under the specification
- 23) The contractor shall conduct training for GJB engineers as per contract requirements.
- 24) Integration of the stations /plants other than those mentioned in this document to Water SCADA servers which will be available for integration during the five (5) years of comprehensive operation and maintenance period. The contractor shall be entirely responsible for integration of data from future stations/plants which will be available during the comprehensive operation and maintenance period. The contractor shall co-ordinate with the respective contractor and carryout interoperability tests with other contractor to ensure data is received at the control center/CWMC.
- 25) The contractor shall be responsible for complete comprehensive operation & maintenance of the centralized SCADA center and installed software and hardware, electrical equipment & accessories, UPS, LED video wall, Precision air-conditioning systems and any other equipment installed under this contract with all required spares ,software licensing and update, , all manpower (at centralized SCADA center and various locations as per contract requirements for a period of five (5) years inclusive of predictive maintenance and requires spares, replacement of equipment, software & hardware as required by the engineer.
- 26) The contractor during the last year of comprehensive operation and maintenance period, all software licensing, SCADA software, Historian software, all servers, desktops, engineering & operator machines, shall be replaced to new latest available hardware & software, replacement of data loggers, batteries for field instrumentation (if any), UPS batteries. wireless communication equipment for data communication shall be replaced. All IT hardware and software shall be updated with latest versions and latest version of the software inclusive of cyber security software & hardware. Data migration from existing system to new replaced system shall be carried out in the presence of the engineer and all tests required for regular and smooth functioning of control center as per project requirements with all interoperability tests shall be carried out by the contractor.

27) The contractor shall develop a web-based application through which the GJB engineers shall be able to view the control center data in real time. The web-based portal shall be integrated with the control center to provide latest real time data to GJB engineers, through access certified login. The web-based portal shall include the following on a minimum but not limited to:

1. Plant operational data (WTP, WPS, etc)
2. Laboratory data (WTP)
3. Water treatment data starting from each WTP's and distribution data from each pumping stations. Incoming flow at each GLR/reservoir and corresponding outflow from each GLR/reservoir to different distribution zones which are fed by the GLR/reservoir.
4. Water quality data at each GLR/reservoir and at key strategic locations in the water distribution network.
5. Flow & pressure data at DMA locations in the water distribution network.
6. Any other information as required by the engineer.

The application shall be designed in such a way as to provide specific data to specific users only with user authentication and various security levels. The application shall be updated regularly with all software & patch updates as and when they are available, inclusive of the comprehensive operation & maintenance period of five years.

1.2 Reservoirs to be integrated with Centralized SCADA Center

The contractor shall integrate the following equipment at each of the Ground level reservoir (GLR) locations (as indicated below):

Online real time water quality parameter monitoring instrumentation to measure pH, TDS, Turbidity & Total Residual Chlorine. The output of the same shall be connected to the PLC system for onward data transmission in real-time to the CWMC SCADA system.

The Reservoir Level, outlet flow from reservoir to be integrated with the CWMC SCADA.

The status of Booster Pumping stations (2 BPS, 1W+1S/ BPS)/ valves are to be integrated with the CWMC SCADA.

1.3 Online Realtime Flow & Pressure Measurement at DMA Locations in The Water Distribution Network

The contractor shall provide the following equipment at each of the locations identified by GJB (as indicated below):

1. Provide, install and commission pressure transmitter at each of the DMA locations
2. Integrate the electromagnetic flowmeter, pressure transmitter data to the PLC/RTU and communicate data to CWMC in real time.
3. IP-68 rated enclosure shall be provided to house the PLC/RTU, HMI and wireless communication devices. The enclosure shall be equipped with locking facility, limit switch contact for door (on opening of the same, the signal shall be initiated as door Open/Close) with wireless GPRS communication to centralized SCADA center.
4. Rigid wrought iron fence with painting, GJB logo engraved & locking facility, the size of the fence shall be suited to encircle the enclosure/panel completely to prevent any break of the panel. The positioning of the enclosure and fence shall be ensured to avoid any obstruction to pedestrians and vehicles and ensure smooth flow of both pedestrian and vehicle movement.
5. Associated required minor civil work for installation of panel and construction of chamber for the equipment.
6. The contractor during the works, the pavement/road is damaged/excavated/dug up, the same shall be made good new condition.

Online Booster Pumping Stations (23 locations) under DMAs in distribution network: The pumps (2W+1S)/pumping station are to be integrated with CWMC SCADA to get the status.

The locations in the water distribution network which are to be provided with the above-mentioned instrumentation, control & automation equipment and integrated with centralized SCADA center shall be decided during detailed design engineering in consultation with GJB engineers.

1.4 Staffing Requirements

The contractor shall provide all the necessary operating staff and maintenance personnel to operate the Works for a total period of 60 months from the start of the operating and maintenance period.

The Contractor shall provide a detailed proposed staffing schedule for 60 months before the anticipated start of the 30 day operation period for each of the sections of the Works. The schedule shall cover all categories of staff, including adequate numbers of maintenance staff.

The staffing schedule shall be prepared for operating the centralized SCADA center on a 24 hour per day basis with two equal shifts during the complete 60 month comprehensive O&M contract period.

1.5 Material of Construction

For any proprietary or generic design the Material of Construction shall be as per the tender document – (e.g. Instrumentation, panel, enclosures, etc)

1.6 Works Life Expectancy

The Contractor shall design the Works for a life expectancy as follows:

- concrete structures 100 years;

- mechanical plant 20 years;
- electrical plant 20 years;
- buried earth electrode systems 50 years;
- control panels 20 years;
- external instrumentation systems 15 years;
- computer systems 10 years.

1.7 Access for Other Contractors

The Contractor shall allow reasonable access to other contractors engaged on the Site or on areas adjoining the Site to carry out their work.

In the event of a dispute over access or priority between contractors, the Engineer shall be informed in writing. The Engineer shall inform all parties concerned in writing of his decision.

Where any part of the Works is associated with or in physical contact with plant supplied under a separate contract, the Contractor shall satisfy himself that the work carried out by the other contractor is consistent with the correct operation of the Plant. In the event of the Contractor considering any work being carried out or any work already completed to be detrimental to the ultimate operation of the Plant, he shall report the matter at once to the Engineer.

If the work of the Contractor is delayed because of any acts or omissions of any other contractor, the Contractor shall have no claim against the Employer on that account other than for an extension of time.

1.8 Interface with Other Contracts

The Works will physically interface with all contract packages and all other existing facilities of GJB, which form the scope of work under this contract.

End of Part-1

PART 2
GENERAL REQUIREMENTS

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GENERAL REQUIREMENTS

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PART - 2

GENERAL REQUIREMENTS

2.1. Documentation Requirements

2.1.1 Obligation to Provide Documentation

The contractor shall, as an integral part of the contract, supply detailed documentation and working drawings of the equipment / items to be supplied by him and to provide the Employer with copies within the specified period and further to provide and assist the Employer or his Engineer with any design calculation, other information on data relating to design or supply of the process or the mechanical or electrical plant.

The contractor shall supply all the documentation and drawings asked for or implied in the section or elsewhere in the specification.

Approval by the Employer or his Engineer of the contractor's design, drawings, calculations or Equipment shall not relieve the contractor of any of his contractual responsibilities or obligations.

2.1.2 Specifications

The contractor shall submit with his bid a detailed and substantive specification of all equipment (in six copies) and shall also give full particulars of the spare parts of the proposed plants & equipment, electric equipment, instruments and other appurtenant.

The final choice of make of any equipment shall be of Employer or his Engineer. The Contractor shall provide the list of makes along with the bid as per the approved makes listed in the bid.

The particulars together with these specifications will be binding upon the contractor and must not be departed from without the written permission of the Employer or his Engineer. For some specific reasons, if the contractor wishes to omit any specified items of plant or if the plant offered does not comply with the specified requirements or design or construction, special departures from this specification may be permitted provided it is included in the contractor's bid submission and in this instance the contractor shall fully justify the departure quoting the relevant clause in each case. Manufacturer's standard general specifications may be submitted in this regard but such specification will not be accepted as justification or in lieu of the schedule above mentioned in respect of any departures from this specification.

Unless specifically mentioned in the contractor's bid specification, items of plant and equipment omitted in the Bidder's specification, but required by this specification shall be provided by the contractor at his own expense.

If any item so omitted is subsequently found to be required for satisfactory operation or performance during the testing or commissioning or operation of the works; the contractor shall provide the item or rectify the deficiency at his own expense.

The bidder's specification shall be fully comprehensive and shall describe and specify in full each individual item of plant and equipment offered. It shall state the function of each unit, the duty required, describe the ability of the unit, to satisfy their requirement, the materials of construction and the speeds, powers, quality, finishes etc. and performance. It shall include the electrical plant, the cabling and instrumentation.

2.1.3 Schedule for Plants

The contractor shall prepare and submit a comprehensive set of performance and technical details. Individual technical data shall also be provided for all equipment. A schedule showing the manufactures of such component shall also be provided.

2.2. Drawing Sheet Format

All drawings provided by the Contractor shall be on standard size sheets, in the form of black or blue lines on a white background and shall show the following particulars in a title block located in the lower right hand corner, in addition to the name of Contractor and equipment manufacturer, date, scale, drawing number, revision number (R0 for drawings submitted initially, R1, R2, etc. for drawings submitted subsequently) and title :-

Guwahati Water Supply Project
JBIC Loan No. : ID-P201, Contract No.CP-09
Central Water Management Centre CWMC-Centralized SCADA Center

A blank space of 90 mm x 100 mm shall be provided for the Employer's approval stamp and provision shall be made for details of revisions to be recorded.

All drawings submitted by the Bidder/Contractor shall use the English language and preferably SI units. All drawings shall be clearly and fully cross referenced to the other drawings as relevant.

2.3. Bid Drawings & Technical Documentation Required To Be Submitted for Technical Qualification

Note-1: Documents & Drawings submitted by the Bidder with his Bid shall be listed in the index

Note-2: In addition to the each of the below information to be submitted without fail in full with complete details, the technical schedule shall be completed in full with all details as indicated for technical bid qualification. Bidder to note the importance of this requirement.

1. Provide a system architecture diagram of the proposed system showing all components and their interconnections and interrelationships. Label each diagram and indicate all external power and communications interfaces. The system configuration shall be complete in all aspects and depict the entire scope of the Central Water Management Centre CWMC centralized SCADA system along with its ancillary system.
2. Details including with a block diagram for proposed telemetry architecture between remote Stations, and Central SCADA center. The Routers, VPN or private / closed Network arrangement and connectivity scheme, mechanism for one to many (rather than point to point) links, proposed means for by passing or alternate arrangement in case of breakdown of communication at a specific remote Station, etc. shall be explained and illustrated.
3. Provide a written detailed overview of the proposed centralized SCADA system describing the principal functions and capabilities of the entire system (with all ancillaries system), system communications, Software & hardware ,servers, integration and general system capabilities as required under the water SCADA, etc.
4. Design of the proposed centralized SCADA center with layout plan with 3D model view of the proposed center with complete details. The control room layout shall depict the following on a minimum: Fire alarm panel/detector layout based on NFPA standards, CCTV layout, typical GA/IA of proposed control consoles, central air conditioning typical drawings.
5. Interior design proposed for the control center with complete details for every equipment, to cater to control room design and standards as per the bid requirements.
6. The contractor shall submit the organization chart, mobilization schedule, construction & implementation schedule, safety plan, Environment management plan.
7. Provide the proposed civil design for the following:
 - Details on interior design for the control center.
8. Provide details on the Water SCADA software with complete details on mathematical modelling to provide forecasts and predictive insights based on historical analysis, mathematical modelling of current data. Water supply pattern mapping with network visualization shall be incorporated which shall also depict the water availability, water demand, water consumption, water loss, area of high supply, moderate supply, low supply and no data available, etc. Details shall include with complete descriptive literature, SCADA screens, SCADA screens for Service level agreement monitoring & Penalty calculation for equipment breakdown to enable end user/utility to monitor the comprehensive O&M period in a graded manner. Bidder shall provide complete and comprehensive details as indicated above.
9. Name of SCADA package, number of clients/licenses, any limitations for Tags/IO's for the licenses for clients, Basic and other features on the offered Package vis-à-vis specifications mentioned in this document. Submit product datasheets, catalogues and other required documentation to justify the same.
10. The proposal should include a section that describes the development practices and standards applied to Vendor-written control system software (including firmware) used to ensure a high level of defense against unauthorized access. Responses should also discuss assurances that source code is developed and supported within trustworthy countries and

not circulating in unstable foreign areas. The Vendor shall disclose all the countries in which the source code has been distributed. All critical control system software should be developed by the supplier in a contained environment with development and maintenance staff having undergone the required background checks. Outsourcing of development to off- shore entities with unproven security track records will not be accepted. Contractor shall submit documentation to verify the same.

11. SCADA Implementation at Central Water Management Centre CWMC / Centralized SCADA Center: Details must include network architecture at the CSC, fire-wall and security aspects, Data backup, mirroring and redundancy proposed, types of dashboards and reports proposed, block diagram of proposed scheme/ architecture, connectivity method to GJB portal or GJB network for access to SCADA Network from outside (e.g. Internet) for the authorized Engineers, etc. The number of authorized users (if there are any limitations) to be mentioned in the write-up
12. Information is required regarding features such as OPC for data sharing, driver software and compatibility to proposed integration panel.
13. Describe in detail the interoperability test procedures and format to be employed. Provide details on the software to be used employed for interoperability tests.
14. Submit sample report format for Water SCADA as required under this contract, Shall include as per the functionality of the Water SCADA requirements of the bid.
15. Provide details on proposed Historian software for SCADA. Describe the complete functionality of the software .
16. Submit proposed SCADA screens, report dumps ,alarm and trends
17. Contractor to confirm and provide details that his offered SCADA System conforms to the following points. Contractor to provide details on each of the following implementation details:
 - Include all salient features of the software such as, graphical user interfaces, analytics provided as required under this specification and trend- charts, alarms, reporting, etc.
 - Whether the offered SCADA prompts live monitoring of information by authorized engineers on web- browser (local and remote).
 - Communication by 4G or higher than 1 Gbps bandwidth is offered.
18. Information from SCADA OEM shall be provided as per the following:
 - The SCADA software shall demonstrate a strong history of upgrade-ability from one version of their software to another with virtually no reconfiguration or engineering effort required to migrate functionality to new versions. A demonstrated track record of upgrades between versions of at least 3 years, with a preference for 5 years, must be shown. If reconfiguration or manual intervention has been required between any versions in the last 5 years, the vendor shall provide detailed documentation of the steps required to achieve the upgrade. If functionality has been removed when upgrading to a new version at any time in the last five years, the vendor shall provide a list of removed items.
19. Provide detailed calculations for sizing of Historian servers.

20. Submit complete design of the server blade system, Front end processor server, SCADA operator and engineering systems, networking, Historian system , precision cooling system for the servers, data architecture, etc as per the system architecture required under this contract.
21. Provide details on the wireless GPRS gateway modules, router with product brochures and detailed writeup.
22. Describe the wireless GPRS communication network proposed with complete details, details on the equipment proposed for Water SCADA communication network.
23. Provide the following details

Contractor to mention the Communication method, Service Provider, whether 4G, HSPA+, broadband, or other equivalent. Also mention the guaranteed band width/ speed for the network, availability of contiguous IP addresses, leased line etc. Contractor is required to positively mention the Name and address of the Service Provider whose telecommunication/ cellular network is being proposed for the telemetry(wireless GPRS Communication & leased line).

Note : The contractor as well as the Service Provider has to commit 24x7 availability of network at the highest signal strength as applicable for 4G at each of the Remote sites round the year, with guaranteed operation even during monsoons. The confirmation letter from the bidder shall be submitted as part of bid submission.

24. Provide details on the LED video wall system for Water SCADA complete with its integration with the Water SCADA server. Describe the functionality of the video wall and how the data shall be represented. Describe the functionality of the video wall controller. Include also the proposed system product brochures.
25. Provide details on the proposed Cyber security solution for centralized SCADA center with Software firewall & hardware firewall details, design levels of security, configuration, web security audit methodology to be adopted.
26. Provide details on the android/IOS app proposed to be developed.
27. Provide proposed single line diagram for the centralized SCADA center.
28. Provide details on the un-interruptible power supply proposed at centralized SCADA center. Detailed UPS load calculation and battery sizing shall be submitted.
29. Provide letter of conformance as required under Interior works for control center.
30. Bidder to provide Instrumentation schedule to be connected to the RTU/PLC with complete details of all instruments.
31. Include complete details on the real time water quality Instrumentation along with product brochure.
32. Interconnection schedule for instruments and control cables between instrument control panel and integration panel and onward communication to the centralized SCADA center.
33. Provide an equipment list with descriptive literature for the proposed system. Included on the list shall be all hardware & software items. List shall include as a minimum, the manufacturer, the quantity provided, and model numbers for each. Technical schedules for all instruments, RTU/PLC & SCADA, and all other equipment shall be duly filled with all relevant details without any deviations with the bid requirements. The technical

-
- schedule shall be completed in full for technical bid qualification. Bidder to note the importance of this requirement.
34. Provide an operating system and software applications list with descriptive literature for the proposed system. Include all software items, supplier name, quantity, and model numbers.
 35. Indicate whether any proposed software is proprietary and would not be turned over to the owner.
Note: Proprietary software will not be accepted and shall lead to technical disqualification.
 36. Provide written description of the Fire alarm, detection and suppression system and its integration with the SCADA system.
 37. Provide undertaking from the equipment manufacturer (PLC/RTU, SCADA, UPS, Fire alarm system, etc..) for maintenance support for minimum of Five years excluding IT hardware. Maintenance support for IT hardware to be confirmed for minimum 5 years by the bidder.
 38. Technical details are required for the following without any deviation as per bid requirements:
 1. Name and version of the proposed SCADA software Package with mathematical modelling, analytics module/business intelligence analytics for water demand & consumption modelling.
 2. Name and version of the RTU/PLC on-line/off-line programming software
 3. Name and version of the RTU/PLC,
 4. Name and version of the RTU/PLC I/O Modules,
 5. Name and version of Historian software
 6. Name and version of any required communications software, firmware, etc.
 7. Name and version of the specified report application software,
 8. Name and version of cybersecurity solution being provided.
 9. Name & version of all ancillary system to be provided at the centralized SCADA center, inclusive of all IT hardware, software, servers, networking equipment, etc
 10. Provide a description of any non-resident software required to program, troubleshoot or diagnose any devices in the system.
 39. Provide a tentative construction schedule for completion of the project within the specified Contract period. Indicate the following activities with milestones: Mobilization, FDS Submission, equipment procurement, system configuration and programming, factory testing, system delivery, system installation, start up, field testing and training, and post acceptance routine service intervals.
 40. Above documents shall be submitted in proper bounded form and indexed with page numbering for easy referencing. All catalogs and literature (including sub-suppliers' catalogs), datasheets, Instrument list, etc. shall be bounded together in indexed volumes. The Contractor shall submit all the documents with indexing with page numbering for easy reference
 41. The Contractor shall provide all of the above required details, documents, drawings, calculations as technical qualification criteria during the bid submission as a mandatory requirements. Failure to do so/in-complete submission will be treated as a technical non-

responsive bid and lead to technical disqualification. The Contractor should note the importance of this obligation.

2.4. Submission and Approval of Drawings and Documents

i. The following shall be the procedure for submission and approval of drawings/documents:

The Construction Documents are certified drawings submitted by the Contractor to the Employer or his Engineer during the course of the Contract for information or approval. The Contractor shall supply the first submittal to the Engineer in 4 (Four) hard copies duly signed and soft copy, with initial design calculations for the process and sizing of all components of the System including architectural, structural, electrical and instrumentation equipment, supported by design calculation (computer input and output files), flow diagrams and general arrangement drawings for approval. It is a matter of high priority that the Contractor ensures the submission and finalization of such designs and drawings in the stipulated time schedules as elaborated elsewhere in the bid document. It is the intention of the Employer to ensure that the approval of such submissions is made expeditiously and in time. The Contractor is therefore required to setup his project office at Guwahati within one month of contract award (fully equipped and staffed) to enable continuous submission, interaction and timely clearances..

The Employer shall arrange to send observations if necessary within 15 (Fifteen) days of submission of the design and drawings for modifications to the Contractor. The Contractor shall incorporate all necessary comments of the Engineer in the above design and drawings, if any, and shall re-submit further 6 (Six) copies each of the revised design and drawings within 10 (Ten) days for final approval of the Engineer. The Contractor shall thereafter submit 6 (Six) copies each of the approved design and 6 (Six) copies each of the approved drawings together with one copy and editable soft copy in a CD. The Engineer will return 1 (one) approved copies to the contractor and retain 5 (Five) for the Engineer's office and field use.

If the submissions require more than one round of revision on account of incomplete compliance from Contractor, the delay will be on account of the Contractor. If new observations are given by the Engineer, the Contractor will be entitled to take an additional 10 (ten) days period for compliance. Further design calculations and drawings shall be submitted in sequence as per a schedule to be drawn and agreed upon mutually, immediately after submission of the general arrangement drawings.

A blank space 90 x 50 mm shall be provided immediately above the title block for the approval stamp. If required in the document elsewhere, the detailed design and the execution drawings shall be submitted only after verification by an institute approved by the Employer. The Contractor shall be responsible for preparation of working drawings and the construction documents for works, as specified in the Contract.

The Engineer may require the Contractor to submit for approval additional drawings if they are necessary to enable him to satisfy himself that the items are well designed, that they comply with the Employer's Requirements and that they are suitable for their intended purpose. These drawings shall form the agreed basis for the execution of the Works. If an approved drawing is revised, revised copies shall be submitted

for approval as above and no such revised drawing shall be used for the purposes of the Contract until it has been approved in place of the earlier issue of the drawing.

Approval of drawings/documents by the Employer shall not relieve the Contractor of his responsibility of the works and their structural stability and performance.

The Engineer will not permit construction to start on a part or section of the Works unless Construction Documents for that part or section have been approved.

ii. As-Built Drawings

These drawings shall be compiled by the Contractor and shall constitute a permanent record of the Works as executed. These shall include all such drawings, schedules, documentation and calculations as necessary for a complete understanding of the works design, operation and maintenance.

Draft As-Built Drawings shall be submitted 56 calendar days prior to the commencement of Tests on completion. The Engineer will signify his approval or disapproval of the As-Built Drawings within 28 calendar days of submission.

The Contractor shall supply to the Engineer 5 (Five) copies of the As-Built drawings. The Contractor shall incorporate all necessary comments of the Engineer in the above drawings, if any, and shall re-submit further 5 (five) copies each of the revised drawing within 10 (Ten) days for final approval of the Engineer. The Contractor shall thereafter submit 8 (Eight) copies each of the approved As-built drawing with one copy each of the reproducible tracings. The Engineer will return 2 (two) approved copies to the contractor and retain 6 (six) for the Engineer's office.

A3 and smaller sized As-Built Drawings shall be provided on durable paper for reproduction by photocopier. As-Built Drawings larger than A3 shall be provided as a paper copy and also produced in the form of black lines on a durable translucent film from which further paper prints can be taken by others as required. In addition drawings shall be provided as an AutoCAD Revision (latest version) software copy (Editable).

Text shall be provided in an industry standard word processing, spreadsheet or database format as appropriate (Editable with formulas).

iii. Construction Drawings

Construction drawings will be prepared by the Contractor during the progress of work and approved by the Engineer before releasing for Construction. "Released for Construction" drawings will progressively be released during the construction, broadly conforming to the basic scheme indicated in the Specification drawings.

The Contractor shall be furnished, free of charge, two certified true copies of the Contract Documents and all further drawings which may be issued during the progress of work as aforesaid. He shall keep one

copy of these documents on the Site in good order and the same shall at all reasonable times be available for inspection and use by the Engineer, his representative, or other inspecting officers.

None of these documents shall be used by the Contractor for any purpose other than that of the contract.

The documents and drawings released by the contractor as above remain the property of the Board.

iv. Calculation

Six copies of calculations for all the plants and equipment shall be submitted before approval of design of equipment. They shall fully embrace the range of flow rates and water conditions that are likely to occur on site.

Six Copies of Calculations for CWMS-Centralized SCADA system as indicated under control & automation system shall be submitted for approval. They shall be based on relevant latest codes, standards, design guide lines and Project Information – control & automation

Six Copies of Calculations for Instrumentation as indicated under instrumentation system shall be submitted for approval. They shall be based on relevant latest codes, standards, design guide lines and Project Information –Instrumentation.

Six Copies of Calculations for electrical works as indicated under electrical system shall be submitted for approval. They shall be based on relevant latest codes ,standards ,design guide lines and Project Information – Electrical.

Similarly, six copies of calculations for all structural and civil works shall be submitted for approval. They shall fully embrace relevant latest codal provisions, design guidelines, assumptions made, and shall be as per requirements of the Employer.

2.5. Operation and Maintenance Manuals

The operation and maintenance manuals shall be arranged to provide separate volumes for each principal section of the Works and they shall relate to as-built conditions and shall include all necessary drawings and diagrams for a proper understanding of the Works.

The operation and maintenance manual shall be approved in draft form initially prior to commencement of erection by the Engineer and shall cover all items of the Works. For this purpose, three draft copies shall be submitted to the Engineer. A mere collection of manufacturers' descriptive leaflets will not be acceptable in satisfaction of this Clause. The operation and maintenance manual shall comprise both operating instructions and maintenance instructions.

The manuals shall include, but not be limited to the following information:

- (a) Descriptive overview of the whole of the Works.

- (b) Descriptions of all systems installed, including IT systems, cyber security systems, electrical, instrumentation, control systems with relevant design and operating parameters.
- (c) Descriptions of all equipment supplied including manufacturer's leaflets, which shall be scheduled for easy reference.
- (d) Schedules and manufacturer's catalogues for all equipment supplied, giving duties, electrical load, etc.
- (e) As built drawings of all structures including details of designs.
- (f) Schedules of all equipment suppliers (and their local agents) including names, addresses, telephone, fax and e-mail numbers.
- (g) Start-up, operation and shut-down instructions for all parts of the Works. These shall include step by step directions on setting the Plant to work listing all adjustments and settings necessary for the current functioning of the Plant.
- (h) Instructions on monitoring of centralized SCADA center and its ancillaries system inclusive of all field instrumentation, online analyzers performance and sample log sheets for each Plant item, to be filled by operators on a routine basis.
- (i) "Dos" and "Don'ts" in centralized SCADA center operation. Operator's attention shall be drawn to all operations considered to be dangerous to operators or likely to cause damage to the Plant.
- (j) Procedures to deal with breakdown, Trouble shooting and emergencies.
- (k) Safety requirements.
- (l) Checking, testing and replacement procedures to be carried out on all plant items on a daily weekly and monthly basis or at longer intervals to ensure trouble free operation. Full maintenance instructions for all equipment and civil works including planned maintenance schedules or charts giving daily, weekly, monthly, quarterly, half yearly, annual and overhaul instructions, together with recommended lubricants and spares. These shall also include details of routine maintenance work that will be within the competence of the normal maintenance staff and notification of maintenance work that will have to be done by the manufacturer, his agent or other specialist operator.
- (m) Fault locations and remedy charts to facilitate tracing the cause of malfunctions or breakdown and correcting faults.

-
- (n) Complete list of recommended lubricants and lubrications charts.
 - (o) A 'spares schedule' which shall consist of a complete list of item wise spares for all Plant items with ordering references and part numbers.
 - (p) A complete list of manufacturer's instructions for operation and maintenance of all bought out equipment. The list shall be tabulated in alphabetical order giving the name of supplier/manufacture, identification of the Plant item giving the model number and the literature provided including instruction leaflets and drawing numbers.
 - (q) Step by step procedure for the dismantling, repair and re-assembly of all items of equipment.
 - (r) Part-list and drawings or exploded diagrams for each item of Plant with construction particulars, materials of construction, mating components, clearances and tolerances, maximum wear permitted before replacements are to be done, etc
 - (s) Record drawings of all systems installed, including general arrangements, conduit and wiring trunking systems, wiring diagrams, control schematics and valve charts, etc., to a reduced scale.
 - (t) Certified suppliers' drawings of all equipment supplied, which shall be scheduled for easy reference.
 - (u) Site test reports for all centralized SCADA equipment including IT hardware, cyber security, material & document management system,etc, electrical and instrumentation systems. Site test process reports for proving tests, commissioning reports, and supplier's test certificates.
 - (v) Copies of Operation and Maintenance Manual.

The Contractor shall furnish 8 copies of the Operation and Maintenance Manual for each location. Each volume shall be durable and permanently bound within a stiff binder of a design to be approved by the Employer. They shall permit the subsequent incorporation of revisions to be necessary during the Defect Liability Period.

- (w) Copies of Operation and Maintenance Manual at the time of Handing Over at the end of Operation and Maintenance period

The Contractor shall furnish 8 copies of the Operation and Maintenance Manual for each location. Each volume shall be durable and permanently bound within a stiff binder of a design to be approved by the Employer. They shall permit the subsequent incorporation of revisions to be necessary during the five years of comprehensive Operation & maintenance period.

2.6. Contractor's Organisation and Administration of the Contract

The Bidder shall submit with his Bid a diagram showing the structure of the organisation for his administration of the Contract. The structure shall include a Project Team consisting of Project Manager and Project Employees. The Project Manager and his site team shall be stationed in Guwahati full time for the entire duration of the contract. He shall represent the Contractor in all discussion corresponding and matters relating to the Works. The Project Manager shall have authority and powers to take decision on the spot and/or incur expenditure(s) in the interest of the Works whenever required by the Employer. The duties of the Project Manager shall also include responsibility for :

- (a) Monitoring of progress and submission of monthly progress reports.
- (b) Coordinating the supply, erection, testing and commissioning of all equipment and related civil works as applicable).
- (c) Ensuring that all codes, standards and any other technical requirements of the Contract are complied.

All correspondence and communication between the Employer and the Contractor including the Contractor's sub-Contractors shall be directed through the Project Manager. At the discretion of the Employer, regular meeting shall be called at which the Project Manager shall give full account of the Contract progress and programme.

The sub-Contractors proposed by the Contractor shall be subject to the approval of the Employer.

2.7. Programme Details

The Bidder shall along with the Bid submit a Network based on principles of PERT/CPM. The Network should be detailed covering entire scope of the Contract showing all the activities, their durations, proposed start and finish dates their inter-relationships and planned deployment of various categories of labour for each activity/group of activities. No activity should be of a duration of greater than 3 months; milestones and prerequisites should also be highlighted along with broad estimates for major resources like procurement of main components, preparation of drawings and erection etc. The Bidder shall also specify the minimum resources he will exclusively use for this Project. This will include all equipment and all classes of labour.

No extension of time will be granted by the Employer in respect of inclement weather or its effects (such as floods or droughts), fire or industrial disputes, unless such events could not reasonably have been foreseen by an experienced Contractor. All allowances to guard against such delays shall be clearly indicated in his programme.

On award of the Contract, the Contractor shall finalize the Network to the satisfaction of the Employer. This Network would be more detailed with a fixed project start and finish dates. Milestones would be determined such that :

At least 10% of the events are milestones, and no two successive milestones are more than three months apart.

The Network should be drawn to the complete satisfaction of the Employer. Any payment payable under any of the Contract clauses shall only be paid after the Network is finally approved by the Employer.

This finalised Network would form a part of the Contract may be amended from time to time, if felt necessary by the Employer and within the limitations of the time imposed in the Contract.

In addition to the requirements of the Contractor’s programme the Contractor shall provide to the Employer 14 days before commencement of the particular operation or work, a detailed method statement of any operation or work which affects the operation of existing works or requires extensive interfacing with other agencies. Each method statement shall comprise a step by step schedule of specific operations and activities with descriptions, dates, times and durations for each step. It shall highlight specific points in the programme, and include contingency plans for emergency reinstatement of the Plant including “point of no return” and “earliest start time” of modified or new Plant. The statement shall clearly state who and what organisation will carry out work and precisely when and what support or provision are to be provided by others outside the Contract. The statement shall be supported by sketches, diagrams or other supportive detail to enable a clear understanding of the method and significance of each step of work or operation. No work which affects the operation of existing works shall be carried out until a method statement has been submitted to and approved by the Employer.

2.8. Milestones

The Employer wishes to ensure consistent prorata progress on all components of the Contract during the entire Contract period. The key milestones set out in Table 2.1, or such other Milestones as may be proposed by the Contractor and agreed by the Employer at the time of bidding, are proposed to be adopted for periodic review of the progress of various components. These milestones will be the stages when the decisions regarding any delay in the implementation will be taken with a view towards the application of the provisions of the Conditions of Contract.

Table 2.1: Key Milestones to be met by Contractor

Sl.No	Work Description		Time from Date of Notice to Proceed (Months)
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		1 months	2 months	4 months	6 months	8 Months	10 months	12 months
1	Mobilization							
1.1	Establish site offices	100%						
1.2	Site surveys and investigations	100%						
1.3	Finalization of Construction Programme	100%						
2	CWMC-Centralized SCADA Center							
2.1	Mobilize construction equipment		100%					
2.2	Place orders for plant and equipment		50 %	100%				
	Civil works:							
2.3	Obtain design approvals		50 %	100%				
2.4	Interior Works & setting up of complete CSC		Start	50%	100%			
2.5	Painting		Start	100%				
4	Control center Ancillary systems							
4.1	vendor credentials ,Obtain design approvals,		Start	50%	100%			
4.2	Mobilize construction equipment			100%				
4.3	Air conditioning systems & precision air conditioning systems			50%	100%			
4.4	Fire Alarm system			50%	100%			
4.5	CCTV system			50%	100%			
4.6	UPS System			50%	100%			
4.7	LED Videowall			50%	100%			
4.9	Electrical systems including lighting			50%	100%			
4.10	All other systems(EPBAX, Access control system, routers, Wireless communication			50%	100%			

Sl.No	Work Description	Time from Date of Notice to Proceed (Months)						
		1 months	2 months	4 months	6 months	8 Months	10 months	12 months
	equipment, etc)							
4.11	Cyber Security Solutions inclusive of Hardware & software, antivirus, firewall, etc)		Start	50%	100%			
4.12	Trial run, Testing and commissioning			Start	50%	100%		
5	Water SCADA (Hardware & Software)-							
5.1	vendor credentials ,Obtain design approvals,	Start	75%	100%				
5.2	Place orders for plant and equipment (Software & Hardware)	Start	75%	100%				
5.3	Receipt of plant and Equipment's		Start	75%	100%			
5.4	Erection/Installation of plant and equipment			Start	75%	100%		
5.5	Trial run, Testing and commissioning				Start	75%	100%	
10	Reservoir- Instrumentation & Automation & Integration							
10.1	Vendor credentials, Obtain design approvals		Start	100%				
10.2	Mobilize construction equipment			Start	100%			
10.3	Place orders for equipment			Start	100%			
10.4	Receive materials				50%	100%		
10.5	Erect and install (Inclusive of all required civil works)				Start	50%	100%	
10.6	Integration				Start	50%	100%	
10.7	Trial run, Testing and commissioning					Start	100%	
11	Pressure monitoring							

Sl.No	Work Description	Time from Date of Notice to Proceed (Months)						
		1 months	2 months	4 months	6 months	8 Months	10 months	12 months
	equipment, Online Real time Water Quality Multi parameter Instrumentation in Distribution network, PLC/RTU to transmit the data to CWMC.							
11.1	Vendor credentials, Obtain design approvals		Start	100%				
11.2	Mobilize construction equipment			Start	100%			
11.3	Place orders for equipment			Start	100%			
11.4	Receive materials				50%	100%		
11.5	Erect and install (Inclusive of all required civil works, road/pavement restoration, fencing- Note: Road/pavement restoration to new condition shall be completed in maximum 3 days on installation of equipment/sensor/panel inclusive of final grading and finishing)				50%	100%		
11.6	Integration				Start	50%	100%	
11.7	Trial run, Testing and commissioning					Start	100%	

2.9. Contract Management

The Contractor shall be responsible for administration of the Contract from award of Contract through design, manufacture, inspection at manufacturer's works & factory testing of equipment where the equipment has been manufactured, and delivery of Plant to Site, installation, testing, Commissioning and performance testing to final take over. For this purpose he shall nominate a Contractor's Representative in

accordance with Conditions of Contract who shall be fully responsible for and undertake this administration.

Specific responsibilities of the Contractor's Representative shall be:

- (a) The sole representation on behalf of the Contractor in all discussion, correspondence and matters relating to the Works.
- (b) The co-ordination and monitoring of Contract progress, which shall include the preparation of the Contract programme, monitoring of progress and submission of monthly progress reports. At the discretion of the Engineer, regular meetings shall be called at which the Contractor's Representative shall give a full account of the Contract progress and programme.
- (c) Site records, daily & monthly Progress reports shall be submitted and maintained along with day to day photographs of each site on daily basis. He should maintain the construction milestone in MS project office. And shall discuss with the Engineer in charge day to day basis as indicated in MS project office.
- (d) The co-ordination and checking of designs, drawings and submissions. The Contractor's Representative shall be responsible for co-ordinating the design, technical information and data between sub-contractors. All calculations, drawings and information submitted to the Engineer shall be checked by the Contractor's Representative and certified as having been checked before submission.
- (e) Contract communication between the Engineer and the Contractor. The Contractor's Representative shall attend all meetings involving the Contractor and the Engineer
- (f) The co-ordination and programming of manufacturer's works tests and the submission of test certificates.
- (g) The co-ordination and programming of Plant delivery.
- (h) The co-ordination and programming of the installation of Plant on the Site, site tests and take over trials. The Contractor's Representative, although not necessarily based at the Site, shall be responsible for the various sub-contractors. At the discretion of the Engineer regular site meetings will be held during which the Contractor's Representative shall give full account of site progress and programme.
- (i) The Contractor's Representative shall also be responsible for producing in advance of the work being undertaken, detailed method statements of any work, which involves or affects the performance of existing equipment, processes, or disruption to existing water supplies, disruption to traffic while carrying out works, etc
- (j) The co-ordination and preparation of As-Built Drawings and operating and maintenance manuals.
- (k) Soft copies (design calculations and drawings) of all submissions should be in editable form.
- (l) The preparation and co-ordination of training.
- (m) The submission of applications for payment.

2.10. Meetings

From time to time the Engineer will call meetings in his office or at the Contractor's office, or at the Site, as he deems necessary, to discuss progress and any technical points requiring settlement. The Contractor's Representative or responsible representative shall attend such meetings.

The Contractor shall prepare and submit to the Engineer a daily activity report summarizing the main activities undertaken each day.

2.11. Photographs

In accordance with the requirements of the Conditions of Contract the Contractor shall supply negatives of photographs and unmounted positive colour prints not less than 250 x 200 mm of such portions of the Works, in progress and completed, as may be directed by the Engineer and specified herein. The negatives and prints shall not be retouched. The negative of each photograph shall be the property of the Employer and shall be delivered to the Engineer with the prints. No prints of these negatives shall be supplied to any other person without the written permission of the Engineer.

The photographs shall be of two categories:

- progress photographs
- record photographs.
- video Recording

Both categories of photographs shall be properly referenced to the approval of the Engineer, and on the back of each print shall be recorded the date and time of the photograph, the direction in which the camera was facing, an identifying description of the subject and the reference.

Photographs taken for record purposes as ordered by the Engineer or as specified herein shall be supplied with three prints, having the reverse of one subscribed with the signatures of the Contractor and the Engineer (or their authorized representatives) for the purpose of attestation. If required, the Contractor may at his own expense have an additional print similarly attested for his retention.

The Contractor shall supply one negative and three prints of each progress photograph ordered by the Engineer. The Contractor shall supply two additional prints of progress photographs selected by the Engineer for incorporation in albums. The Contractor shall supply two sets of albums, mount the prints, and title the prints and albums all to the approval of the Engineer.

The taking of photographs of the Works by the Contractor for any other purpose whether for use in India or in any other country shall not be carried out without written approval from the Engineer.

2.12. Site Labour and Supervision

The Contractor shall provide all the skilled and unskilled labour required, and all necessary tools and equipments for execution of the Works within the period agreed in the programme.

The Contractor shall not remove any supervisory staff or skilled labour from the Site without the Employer's prior approval.

2.13. Sub-letting

The Contractor shall not sub-let the whole of the Works or part of the works. Where any part of the Works is sub-let(on approval of GJB), the Contractor shall not be relieved of his obligation under the Contract. The Contractor shall be responsible for the acts, defaults and neglect acts in the Works of any sub-contractor, as if they were his own.

Where the Employer has consented to sub-contractors proposed by the Contractor, such manufacturers or sub-contractors shall not be changed without the prior approval in writing of the Employer.

A copy of every sub-order shall be sent to the Employer at the time the order is placed each clearly marked with the title of the Contract and the Contract number.

2.14. Languages

All drawings, instructions, signs, notices, name-plates, etc. for use in the Works shall be in English.

All site sign boards and warning signs shall be in Assamese and English.

2.15. Notice of Operations

The Contractor shall give full and complete written notice of all important operations to the Employer sufficiently in advance to enable the Employer to make such arrangements as the Employer may consider necessary for inspection and for any other purpose. The Contractor shall not start any important operation without the written approval of the Employer.

2.16. Protection of Existing Installations

The Contractor shall apply to the Employer in writing at least 28 days before starting any work that involves interference with existing structures, equipment, etc. The Contractor shall not execute such work until he has received permission to proceed in writing from the Employer.

The Contractor shall ensure that no earth, debris or rock is deposited on public or private roads or rights of way as a result of the Works and all vehicles leaving the Site shall be cleaned accordingly. All work sites in the water distribution network when is work is carried out shall be secured with safety barricades, lighting, reflective signs and safety signs. safety signs shall be placed at the work site and at sufficient regular distance's before the work site to inform and warn the public on the work being carried out and to exercise extreme caution.

2.17. Fencing, watching and lighting

The Contractor shall provide and maintain at his own expense all lights, guards, fencing and watching when and where necessary or as required by the Employer for the safety and conveniences of those employed on the works or the public. Safety signs shall be placed at the work site and at sufficient regular distance's before the work site to inform and warn the public on the work being carried out and to exercise extreme caution.

2.18. Protection of Existing Public and Private Services

The Contractor shall notify all public authorities, utility companies and private owners of proposed works that will affect them not less than two weeks before commencing the works.

The Contractor shall adequately protect, uphold, maintain and prevent damage to all services and shall not interfere with their operation without the prior consent of the public authorities, utility companies, private owners, or the Employer as appropriate. If any damage to services results from the execution of the Works, the Contractor shall immediately:

- (a) Notify the Employer and appropriate public authority, utility company or private owner.
- (b) Make arrangements for the damage to be made good without delay to the satisfaction of the public authorities, utility company or private owner as appropriate. The Contractor shall be liable for all costs for making good such damage.

The Employer may issue instructions or make other such arrangements as he deems necessary, to repair rapidly any essential services damaged during the execution of the Contract. Such arrangements shall not affect any liability to pay for making good the damage.

2.19. The Site

1.9 2.19.1 Maintenance of the Site

The Contractor shall allow for maintaining the accommodation, Construction equipment, Manpower, and related services until expiry of the Contract period or until such time as the aforementioned facilities are, with the permission of the Engineer in writing on day-to-day basis. The mobilization and demobilization of manpower, construction & office equipment and any facilities shall be intimated to the Engineer in writing.

The contractor shall first take over the site for construction activity, clearing/demolishing the existing required structures along with prior approval of the Engineer in charge.

1.10 2.19.3 Road Works

The Contractor shall obtain all permits required for carrying out works such as excavation on public roads and shall liaise with the appropriate authorities with regard to the timing and execution of the road works.

The Contractor shall be responsible for establishing and maintaining temporary road diversions for the duration of the road works. The road shall be kept open at all times during the road works period, and the

work shall be carried out in such a manner as to minimize the disruption to traffic. Safety signs shall be placed at the work site and at sufficient regular distance's all along the route before the work site to inform and warn the public on the work being carried out and to exercise extreme caution.

1.11 2.19.5 Clearance of the Site

The Contractor shall clear the Site to the extent required by the Engineer for checking the setting-out. Clearance of the Site shall also include the demolition and removal of all articles, existing buildings, objects and obstructions which are expressly required to be cleared.

The Contractor shall ensure that the parts of the Site to be occupied by the Permanent Works are clear, and shall maintain the remainder of the Site as may be required for access and Temporary Works areas.

The Contractor shall remove the material arising from such clearance and dispose of it in a manner and at a location, on or off the Site, to the approval of the Engineer.

The Contractor shall fill and make good with appropriate materials those cavities and losses of soil which result from clearing the parts of the Site not subsequently to be occupied by the Works.

The Contractor shall not clear the Site of any structure without the prior written permission of the Engineer.

1.12 Compressed Air Use on Site

The Contractor shall provide the necessary compressed air plant and equipment required for construction of the Works.

Electrically driven compressors connected to the site electricity supply shall not be used. Diesel engine driven compressors shall not be sited within buildings or in a location that may cause a health hazard to personnel owing to exhaust fumes or noise.

1.13 Site Records

The Contractor shall make records of the position and extent in the excavations of every type of service, stratum and obstruction encountered during the construction of the Works.

Access for the Employer and Engineer

The Contractor shall permit the Employer and the Employer and any person authorized by the Employer or the Employer including workmen of the Employer, other contractors or utility undertakings access for the purposes of the Contract to all areas of the Site and to any additional accommodation or temporary way leave for the duration of the Contract period.

2.20. Contractor's Office and Stores

The Contractor shall make his own arrangements for installation of telephones at his Site-office.

The Contractor shall depute an authorized person who shall always be present at the Site-office on all working days upon whom any notice from the Employer may be served. Service of any such notice left with aforesaid person or at the Site-office shall be deemed good service upon the Contractor.

The Contractor shall be responsible for the provision and sufficiency thereof of his Site-office and storage facilities as would be necessary throughout the execution of the Works.

2.21. Protection and Packing for Transportation

Before any Plant is dispatched from manufacturer's Works it shall be properly prepared and packed and the Contractor shall give the Employer at least 07 days' notice that these preparations are to commence.

Prior to dispatch, the Plant shall be adequately protected by painting or by other approved means for the whole period of transit, storage and erection, against corrosion and incidental damage, including the effects of vermin, sunlight rain, high temperatures and humid atmospheres. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and piping sealed with suitable devices to protect them from damage. The Contractor shall be responsible for the Plant being so packed and/or protected as to ensure that it reaches the Site intact and undamaged. The Plant shall be packed to withstand rough handling in transit and all packages shall be suitable for storage including possible delays in transit.

The Contractor shall be deemed to have included in the schedule of prices for all materials and packing cases necessary for the safe package, conveyance and delivery and storage of the Plant with all protective and preservation measures.

Cases containing rubber rings, bolts and other small items shall not normally weigh more than 50 kg gross per case. No one package or bundle shall contain items of Plant intended for incorporation in more than one section of the Works. All items of Plant shall be clearly marked for identification against the packing list.

Eye bolts, lifting hooks and brackets shall be provided for lifting the boxes, crates and packages. Every crate or package shall contain a packing list in a waterproof envelope. A duplicate copy of

the packing list shall be sent by post to the Engineer at Site. Consignments imported by ocean freight, shall be packed and preserved as stipulated above.

All crates, packages, etc. shall be clearly marked with a waterproof material to show the weight and where the slings should be attached, and shall also have an indelible identification mark relating them to the packing lists. Packing cases shall be non-returnable. Contractor shall have to clear the Site including packing material.

Electrical & instrumentation equipment shall be enclosed in sealed air tight package with hygroscopic material, before being placed in packing cases on shock absorbent materials and secured by means of battens.

2.22. Transportation of Materials and Equipment

The contract, wherever applicable shall, after proper painting, pack and crate all equipment's for sea/air shipment in a manner suitable for export to a tropical, humid climate region in accordance with the internationally accepted export practices and in such a manner as to protect them from damage and deterioration in transit by road, rail and/ or sea and during storage at the site till time of erection. The contractor shall be held responsible for all damages due to improper packing.

The contractor shall give complete shipping information concerning the weight, size, content of each package including any other information the owner may require.

When materials are to be supplied in bundles, the weight of each bundle should not exceed 1.5 tones.

The contractor shall prepare detailed packing list of all packages and containers, bundles and loose materials forming each and every consignment dispatched to site. The contractor shall further be responsible for making all necessary arrangements for loading, unloading and other handling right from his works till the site and also till the equipment is erected, testes and commissioned. He shall be solely responsible for proper storage and safe custody of all equipment's.

All demurrage, wastage and other expenses incurred due to delayed clearance of material or any other reasons shall be to the account of the contractor.

2.23. Delivery, Loading, Unloading and Storing at Site

The Contractor shall be responsible for checking all materials delivered to Site and shall keep the Engineer fully informed of the state of deliveries. The Contractor shall carry out, at his cost, all instructions of Employer or his Engineer for proper unloading, preservation, maintenance, storage and security of materials delivered to Site until he fulfils all his obligations under the Contract.

The following instructions shall also be ensured by the contractor:

(a) Arrival Check at site

- i. When all equipment to be installed arrives at site, the quality and quantity are checked by the packing list and the inspection sheets as well as taking photographs as the evidence of condition of equipment at site.

When the package is opened, the following must be checked at site.

- Confirm whether all accessories are packed or not.
- Confirm that any damage during the transportation.

- ii. The Contractor shall submit all of document and results of examination sheets with photographs for the Engineer's approval.
- iii. If there are any discrepancies or damaged, it should be dealt with by the Contractor appropriately and immediately so that it does not cause in delay of the schedule of process work.

(b) In-loading and un-loading

- Take care to avoid any deformation or damage as well as getting accident or injury.
- The equipment should not be piled up, and must be stocked and protected in room or appropriate covering material for keeping away from development of rust and /or spoil during storage, caused by getting wet, rain, wind, dust, sunlight, before assembly at site.
- Special attention should be given to bearings, gear teeth face, etc.
- Standard practice is for electrical motors, diesel engines and other electrical equipment, which should be stored indoor.

- Construction material except cement shall be stock at site in appropriate protection against rust, spoil, damage during storage. The cement shall be stock in door with wet protection and limited pile up for storage.

- Keep a high security system against property loss.
- In loading and unloading measuring, all equipment including instruments, operation panels, etc. care should be taken not to drop them or not to impact. Careful handling is required with proper platform.

(c) Handling of heavy materials

The loading and unloading of heavy materials and equipment can be dangerous when the work is operated wrongly.

- Hoist should be operated by qualified person to avoid getting any accident during the work, and the hoist should be checked safety of the hoist performance before start work.
- The position of the center of gravity of lifting equipment should be determined and use four wires at a position not to lose the lifting balance to proper installation and/or unloading at site.
- When wire rope is used, proper attention must be given to rope wear, deformation, safe load, slinging angle, etc.

The Contractor shall erect and maintain on the Site any temporary storage facility as required and approved by the Employer. If built up shed or area is provided by the Employer depending upon availability, the Contractor shall have to pay rent as finalised by the Employer.

Multiple handling and movement of materials during storage and retrieval shall be avoided.

2.24. Spare Parts

Spare Parts required after the taking over the Plant shall be provided by the contractor. Spares during pre-commissioning trials, commissioning tests/maintenance, guarantee etc. shall be provided by the Contractor. The spares also include the consumable such as bulbs, fuses, wires, lubricating oil, gaskets, packing seals etc. The necessary spares shall be brought by the Contractor prior to the pre-commissioning test so as to avoid the downtime of equipment due to non-availability of them. All these spares have to be provided as required, by Contractor free of cost.

All spare parts shall be of new, original manufacturer's spares and strictly interchangeable with the parts for which they are intended to be replacements and shall be treated and packed for long storage under the climatic conditions prevailing at the Site. Each spare part shall be clearly marked or labeled on the outside of its packing with its description, number and purpose. When more than one spare is packed in a single case or other container, a general description of its contents shall be shown on the outside of such case or container and a detailed list enclosed. All cases, containers and other packages shall be marked and numbered in an approved manner for the purpose of identification. Spares shall be delivered to Site after the completion of erection but before start of commissioning of Plant along with technical leaflets and details. Spare parts shall be indicated in the assembly drawing showing clearly the part numbers.

All cases, containers or other packages are liable to be opened for such examination as the Engineer may require and packing shall be designed to facilitate opening and therefore repacking. In the event of the some specific spares offered in the Contract being withdrawn from manufacture owing to changes in design of equipment or similar reasons viz., model being obsolete etc., the Contractor shall inform the Employer before such withdrawal so that the Employer can take timely alternative steps.

2.25. Tools

The specified tools shall not be used for the erection of the Plant being supplied and except that the Employer may call upon the Contractor to demonstrate their use or effectiveness, they must be handed over to the Employer in a completely new and unused condition. Should the Contractor require any such tools at site for erection, he shall provide his own.

The test equipment shall include special purpose items essential to the testing or recalibration of related items of Facilities.

2.26. Special Tools and Appliances

Deleted

2.27. Works to be Kept Clear of Water

The Contractor shall keep the Works well drained until the Employer certifies that the whole of the Works is substantially complete and shall ensure that so far as is practicable Work is carried out in the dry conditions. Excavated areas shall be kept well drained and free from standing water.

No separate payment will be made for any dewatering Works/measures. Prices quoted by the Bidder in the Schedules shall be deemed to have covered expenses for such dewatering measures.

Notwithstanding any approval by the Employer of the Contractor's arrangements for the exclusion of water, the Contractor shall be responsible for the sufficiency thereof and for keeping the Works safe at all times, particularly during any floods and for making good at his own expense any damage to the Works, including any that may be attributable to floods. Any loss of production or additional costs of any kind may that result from floods shall be at the Contractor's own risk.

2.28. Assistance for the Employer's Staff

The Contractor shall provide all necessary assistance to the Employer and his staff in carrying out their duties of checking the setting out, inspecting and measuring the Works. The Contractor shall provide staffmen, office attendants and labourers as may be needed from time to time by the Employer.

The Contractor shall provide the Employer and his staff with such protective clothing, safety helmets and rubber boots of suitable sizes, hand lamps and the like as may reasonably be required by them. These articles shall remain the property of the Contractor. No separate payment shall be made on this account.

2.29. Software

For all goods and services supplied and testing carried out under this contract, the Contractor shall warrant that they are Year 2022 complaint. The following rule shall also be complied with:

- (a) Where any date element is represented without a century, the correct century shall be unambiguous for all manipulations involving that element.
- (b) The component come from other sources, the Contractor shall use all reasonable endeavours to contact the manufacturers or suppliers of all elements of the [System/Software/Product/Services Data] whose performance or functionality may be

adversely affected by any date prior to, during and after the Year 2022, and the Contractor shall make requests to the appropriate third parties and shall use all reasonable endeavours to obtain and provide the Employer with sufficient information to enable the Employer to form a decision on a suitable action plan for the avoidance of any disruption to the Services. Without prejudice to the foregoing, the Contractor warrants that neither the performance nor the functionality of the [Contractor's System/Software/Product/Services Data] shall be adversely affected by any date prior to, during and after the Year 2022.

2.30. Camp and Office Facilities

The Contractor shall provide the following personnel & equipment, fittings supplied shall be new items of approved make. The personnel & equipment shall include.

The contractor shall appoint a coordinator (counterpart staff), who shall co-ordinate with GJB on a daily basis . The coordinator shall be based out of Guwahati. The contractor shall employ the personnel for daily co-ordination with GJB throughout the execution (from the start of design & execution period and operation and maintenance period of five years).The salary for the coordinator to be borne by the contractor and should be deemed to be included in the quoted contract price.

2.31. Water Supply and Disposal of Waste Water on Site

Water shall be provided to Contractor for the purposes of constructing the Works and testing at commercial rates as mentioned in Appendix to Bid. The distribution system from the point of supply shall be the responsibility of the Contractor and he shall ensure that quality of the water remains suitable for the purpose for which it is intended.

Wastewater shall be disposed off clear of the Site to the satisfaction of the Employer so as to cause no damage or complaint.

2.32. Sanitary and Washing Facilities

Throughout the period of construction of the Works the Contractor shall provide, maintain and cleanse suitable and sufficient latrines and washing facilities for use by his employees separate for men and women. He shall ensure that his employees do not foul the Site but make proper use of the latrines.

2.33. Electricity for Contractor's Use on Site

The Contractor shall be responsible for the provision and distribution of electrical supply for the purpose of constructing the Works.

The installation shall comply with all the relevant regulations, Indian Standards and Codes of Practice, and Health and Safety requirements, etc. The Contractor must take every possible precaution to ensure that his installation is safe and injury to personnel or damage to plant and buildings is avoided. The Contractor shall be fully responsible for all safety aspects.

The Contractor shall test the temporary site electric distribution system every 2 months for compliance with the relevant standards.

2.34. Works in the vicinity of Electrical Equipment

Any permanent fencing or other safeguards required to be erected around electrical equipment shall be completed as far as practicable before connection is made to the electricity supply.

Where this is not practicable, the Employer may permit the use of temporary fencing or other safeguards.

2.35. Health, Hygiene and Contamination of Water Supplies

The Site shall be an area of 'restricted operation'. Exemptions may be granted at the discretion of the Engineer for short term operations involving no risk of contamination.

- All personnel shall be medically accepted.
- **Strict discipline shall be maintained concerning personal hygiene.**
- Vehicles, plant, tools and protective clothing shall be kept clean and may require regular disinfection.

To obtain medical acceptance, the Contractor shall require his employees and those of his sub-contractors to undergo medical screening, to ensure that they are not harbouring waterborne pathogenic organisms, before commencing 'restricted operations'. It will be necessary for all potential employees and supervisors who may have contact with the 'restricted operations' to take a copy of the completed questionnaire together with two colour passport size photographs to the Medical Officer for Environmental Health of the District Health Authority where the person resides. The Medical Officer shall consult the person and return the questionnaire to the Contractor. The Contractor shall then forward the questionnaires and photographs of those he wishes to employ to the Engineer for approval. Approval in the form of a blue identity card shall be issued in the approved case cases. The card is valid for the duration of the Contract or one year whichever is the lesser. Contracts of duration greater than one year of 'restricted operations' carried out in the maintenance period will require reassessment of employees.

Should an employee contract any illness, looseness of bowels or gastric disorder he must immediately cease work on 'restricted operations', return his identity card, avoid contact with other employees, undergo medical screening and gain fresh approval before continuing work on the 'restricted operations' site.

Works involving both 'restricted' and non-restricted operations shall either require (1) all employees to be medically accepted or (2) separate messing facilities, storage for protective clothing, tools, vehicles and plant for the two types of employees.

2.36. Safety and Security on Site

The Contractor shall at all times maintain a safe system of working and shall comply with all enactments, regulations and working rules relating to safety, security, health and welfare of all persons who may be affected by his work.

In particular he shall ensure that only persons who are properly trained for their duties are employed, and that the correct tools and procedures are used.

Nothing which has been written into or omitted from this requirement shall be taken to relieve the Contractor from his obligations under this safety clause. Exemptory clause in this requirement shall prevent the Contractor from drawing the attention of the Engineer to any feature of the Works which is not consistent with normal safety practices nor prevent him putting forward proposals at any time which would increase the safety of the installations.

Not later than one weeks before work commences on the Site, the Contractor shall submit to the Engineer his comprehensive proposals relating to the safety, health and welfare of all his personnel on the Site.

The Contractor shall appoint a suitably qualified representative as Safety Officer/accident prevention officer who shall be responsible for the implementation of site procedures as per relevant standards which shall include but not be limited to:

- safety;
- working in hazardous areas;
- permit to work;
- fire and smoking regulations;
- first aid;
- warning signs;
- trenching scaffolding and other construction structures;
- safety barriers;
- protective clothing and equipment;
- safety training;
- safety meetings and inspections;
- health and welfare.
- Check up for equipment & Construction Machinery
- Web Cameras at appropriate locations.

The proposals shall be appropriate for all grades of labour and personnel who will work on or visit the Site on behalf of the Employer, Engineer or Contractor.

The Engineer shall have the power to stop any activity or work in any area where there is a breach of the published site safety rules such that health or life is put at risk.

The Contractor shall, in addition, comply with the Safety Policy of the Employer, copies of which are available on request from the Engineer.

The Contractor shall ensure that all other contractors working on the Site are not working in an unsafe manner so as to endanger themselves, the Contractors personnel, other personnel or the Plant. The Contractor shall bring any violation of Site safety rules by others to the attention of Engineer in writing.

2.37. First Aid and Life-saving Apparatus on Site

The Contractor shall provide on the Site such life-saving apparatus as may be appropriate and an adequate and easily accessible first aid outfit or such outfits as may be required in any government ordinances, factories acts, etc, published and subsequently amended from time to time. In addition, an adequate number of persons permanently on the Site shall be instructed in their use, and the persons so designated shall be made known to all employees by the posting of their names and designations in a prominent position on Site.

2.38. Electrical Safety on Site

The Contractor shall be responsible for the electrical safety of all Plant supplied and installed. Whilst any equipment is being installed or tested, the Contractor shall ensure that all necessary precautions are taken to safeguard personnel working on site. If necessary, this shall include fencing off areas which are considered to pose a risk, and erecting warning notices.

The Contractor shall be responsible for ensuring that the electrical installation is carried out by suitably trained competent personnel and that the work is carried out in a safe manner.

The Contractor shall be responsible for the operation on the Site of a permit to work system during the period of electrical equipment installation and testing. This system shall regulate the installation, the energisation and the use of electrical Plant installed and the method of work adopted.

2.39. Refuse Disposal on Site

Refuse and rubbish of every kind shall be removed from the Site and disposed off by the Contractor at his own expense, frequently and regularly so as to keep the Site in an approved wholesome and tidy condition to the satisfaction of the Employer.

2.40. Noise

The Contractor shall ensure that the operations entailed in the construction of the Works do not cause annoyance to others working on the Site or to persons living adjacent to the Site.

2.41. Site Working Hours

The site work shall be carried out at normal working hours from 8.00AM to 6.00PM. In case, any additional working permission shall be notified by the Contractor for Employer's approval. The Contractor shall not vary or increase the working hours without the prior approval of the Employer.

2.42. Setting out the Works

The Employer shall approve dimensioned drawings prepared by the Contractor, supply levels and other information necessary to enable the Contractor to set out the Works, at his own cost, such as levelling instruments in good working condition, all pegs, ranging rods, long measuring rods, marked meters and decimeters and each meter and decimeter numbered, posts and sight-rails, boning rods, moulds, template etc., together with any reasonable number of labourers that may be required and set out the Works and be responsible for the accuracy of the same. The Contractor shall amend at his own cost and to the satisfaction of the Employer any error found at any stage which may arise through inaccurate setting out unless such error is based on incorrect data furnished in writing by the Employer, in which case the cost of rectification shall be borne by the Board. The Contractor shall protect and preserve all benchmarks used in setting out the Works till the end of the Defects Liability Period unless the Employer directs its early removal. The Contractor should also keep the levelling instruments in good working condition throughout the period of construction work on site. The checking of any setting out or of any line or level by the Employer shall not in any way relieve the Contractor of his responsibility for the correctness thereof.

No separate payment will be made for setting out the Works as required. Rates quoted by the Contractor for all items will be deemed to have covered the expenses for such setting out.

2.43. Preservation of Vegetation

The Contractor shall ensure that his employees, sub-contractors (and also their employees) shall not fetch firewood from the trees around the Site. The Contractor shall be liable for any penalties levied by the concerned authorities for infringement of this regulation.

2.44. Precautions for works in Thoroughfares

While the execution of any work is in progress in any street or thoroughfare, the Contractor at his own cost shall have adequate provision for the passage of traffic, for securing safe access to all premises approached from such street or thoroughfare, and for any drainage, water supply, or means of lighting or any other utility service which may be interrupted to reason of execution of the Work. Whenever it may be necessary to stop the traffic in any street or thoroughfare, permission must first be obtained from the Employer and the Contractor shall then put up such barriers and adopt such other measures or take precautions as may be necessary or as the Employer may direct for regulation of traffic. The work shall in such cases be prosecuted night and day or for as long a period as practicable if so ordered by the Employer, and with such speed and vigour as he may require, so that the traffic may be impeded for as short a time as possible. The Contractor shall remove the barriers as soon as the necessity for them has ceased. Care shall be taken by the Contractor to cause the least possible obstruction traffic during the progress of the work.

2.45. Maintenance of underground utility services

All the underground utility services such as water pipes, gas pipes, drains, sewers, cable etc., which may be met up in or about any excavation, shall if the Employer deem it practicable, be properly maintained and protected by the Contractor himself or through other agency by means of shoring, strutting, planking over, padding or otherwise as directed by Employer during the progress of the work without claiming any extra charge. Any damage to these underground utility services shall be immediately remedied by the Contractor or by the agency at his own cost, failing which the Employer may with or without notice adopt such measures as he may deem necessary at the risk and cost of the Contractor.

If on the other hand, the Employer considered impracticable for the Contractor to maintain any such underground utility services and that the exigencies of the work necessitate the breaking down, removal or diversion of the said services the cost of such breaking down, removal or diversion including that of rebuilding, replacing, diverting and reinstating of any such utility service shall be paid to the Contractor, if done by him. However, the cost of provisions, pumps, chutes or other appliances as the Employer may direct for the raising or temporary passage of the water or sewage and the cost of pumping out or removing as often as the Employer may direct, water or sewage which may escape from any such underground utility service, shall be borne by the Contractor.

2.46. Contractor to preserve peace

The Contractor shall at all times during the progress of the work take all requisite precaution and use his best endeavours for preventing any riotous or unlawful behaviour by or amongst the workers and others employed on the Works and for the preservation of peace and protection of the inhabitants and the security of property in the neighborhood of the Works.

He shall also pay the charges of such special police (if any) as the Employer may deem necessary.

2.47. Connections to Existing Pipelines

The Contractor shall carry out all works connected with items like road surface / pavement breaking, excavation, diverting the road where necessary, cutting, grinding, filling, introducing appurtenances, major or minor fixtures, laying pipelines, welding, concreting, backfilling and consolidating, restoring the road / pavement, removing diversion etc., and any other connected items required for this, though not specifically mentioned herein. The Contractor shall arrange at his own cost ,all construction equipment, tools, tackles, cranes, diesel generators and / or diesel driven equipment and standby equipment to ensure meeting the scheduled program. The Contractor shall prepare his program for this work and submit it for Employer's review and approval.

2.48. Interface between Contracts

The interface between various contracts linked with this contract has been described in elsewhere in this document. The Contractor shall coordinate fully with the relevant activities of the other Contractors as specified by the Employer.

2.49. Contractor's office near the works

The Contractor shall have an office near the Works at which notice from the Employer may be served, and shall between the hours of sunrise and sunset on all working days have a clerk or some other authorised person always present at such office upon whom such notices may be served and service of any notices left with such clerk or any authorised person or at such office shall be deemed good upon the Contractor.

2.50. Lightning

The contractor shall ensure that any structure or installation provided by him is adequately designed to minimize damage to the works from lightning. Lightning Protection shall be designed & provided in accordance with the latest edition or the appropriate Indian standard code of practice.

2.51. Quality Assurance

a. Policy

In accordance with Volume I of the Conditions of Contract the Contractor shall apply the formal requirements of Quality Assurance to the design, supply, construction and maintenance of the Works. This shall be achieved through the implementation of a Quality System compliant with the requirements of BS 5750 or an equivalent International Standard.

Positive commitment to Quality Assurance shall be expressed in a formal policy statement given in the Contractor's Quality Manual.

b. Objectives

It shall be the stated aim of the Contractor to achieve and demonstrate the achievement of quality as expressed by 'due care and diligence' of the design, supply, construction and maintenance of the Works as defined by the Employer's Requirements.

The criteria to define 'due care and diligence' shall be explained in the Contractor's Quality Plan and shall embody all of the design, supply, construction and maintenance requirements of the Works.

c. Quality System

The Quality System shall be fully integrated for all of the Works.

This system will be defined by the organisational structure, responsibilities, activities, resources, and events that together demonstrate the capability of the Contractor to meet the stated quality requirements.

The Contractor shall ensure that all sub-contractors and sub-consultants establish quality systems and shall supply to the Employer such evidence as is necessary to demonstrate the effective implementation of a quality system in each sub-contractor or sub-consultant organisation.

The Quality System of the Contractor and of his sub-contractor and sub-consultants will be subject to periodic audits undertaken by the Engineer. The Engineer will give two weeks' notice of such audits that will involve a full assessment of the performance and efficiency of the Quality System and will include review of the feedback and records derived from the Contractor's monitoring and internal reviews.

On a day-to-day basis the Contractor shall afford reasonable availability of staff and documentation for the Engineer to assess the implementation of the Quality System. The Contractor shall ensure that all relevant personnel and documentation are available for such audits.

d. Quality Plan

The implementation of the Quality System shall be through the establishment of a comprehensive Quality Plan issued to and approved by the Engineer.

The documented procedures shall include but not be limited to:

- Management Procedures;
- Design;
- Supply/Procurement;
- Construction;
- Putting to work/Commissioning/Reliability Trial/Performance Test;
- Operator Training and Maintenance;
- Interface Control;
- Quality Performance, Monitoring and Review.

There shall be procedures to control transmission of information across all interfaces both internally (that is, within the Contractor's Quality System) and externally. Those of the latter shall include all Statutory Bodies, Authorities and the Engineer.

Formal assessment of any non-compliance with the Quality Plan shall be achieved through periodic reviews undertaken by a team appointed by the Contractor. All deficiencies shall be recorded and appropriate corrective measures shall be assessed, within an appropriate timescale, through subsequent formal reviews undertaken by the Contractor.

e. Quality Feedback

The system shall include for the reporting back, recording and incorporation into the system of deficiencies and remedial measures to correct them noted during the control of the project.

2.52. Environmental Protection

The Contractor shall minimize, as far as is practically possible, the effects of all his and his Subcontractors' activities upon the environment and shall implement and monitor measures to prevent:

- (a) Contamination of surfaces, ground, groundwater, surface water and rivers,
- (b) Emissions to air, including smells, gases, smoke, and dust.
- (c) Unsanitary or unsafe storage or discharge to drain, sewer and surface waters,
- (d) Unsanitary or unsafe storage or discharge of solid wastes,
- (e) Noise,
- (f) Visual intrusion, and
- (g) Excessive energy and water consumption.

These requirements shall be met through the constant and careful attention of the Contractor's management of all Site and off-site activities, and by instruction to all staff and labour in these matters.

The Contractor shall submit and adhere to the Environmental Management Plan and ensuring its implementation by the Contractor after obtaining approval of the Engineer.

Implementation shall include for monitoring and reporting on the results of the above measures. Monitoring reports shall be in writing and submitted on a monthly basis as part of the monthly report referred to above. The report shall include a listing and summary of daily monitoring results on all aspects listed above.

All potentially affected areas of the Site, other areas used for or affected by the works and all adjacent or affected waterways shall be monitored and where instructed by the Engineer tested.

The Environmental Management Plan (EMP) shall identify the potential environmental impacts from the various construction and operations and maintenance activities to be undertaken in the Contract and set out in detail the approach he will adopt in mitigating these environmental impacts to ensure that the residual impacts are minor and confined to a short period.

The EMP shall consider but not be limited to the following:

The methods of materials delivery, storage, usage and disposal; equipment usage; and site activities to ensure they have minimal impact on the environment,

Only environmentally safe products and practices shall be adopted in performing his works, and

The Contractor shall comply with all of the statutes regarding environmental effects.

The EMP shall provide separate descriptions of its proposals for minimizing any adverse environmental impacts/effects during the construction phase and the subsequent operations and maintenance phase.

The EMP shall be provided in draft form within 15 days from the Notice to Commence, and shall be updated from time to time by the Contractor as agreed or required by the Engineer to ensure the objectives of environmental protection are fully met.

2.53. Safety

The Contractor shall prepare a Safety Plan and submit the same to the Engineer for approval within 15 days of receiving the Notice to Commence.

The Safety Plan shall be followed at all times by the Contractor and shall contain adequate control measures, in accordance with the relevant protection of property and local laws and regulations as well as internationally accepted good practice, for the prevention of accidents, fires and public nuisance.

The Safety Plan shall be implemented properly and diligently throughout the execution of the Works and during the operations and maintenance period.

The Contractor's Safety Plan shall make safety provision for, among other things:

- Deep excavations and collapsing sides in trench excavations,
- Scaffolds and overhead working,
- Working in confined spaces,
- Working in water,
- Contractor's Equipment, especially cranes,
- Hand held power tools,
- Electrical equipment,
- Hazardous chemicals, gases and fuels,
- The use of protective clothing, and
- The provision of first aid facilities.

The Safety Plan shall be developed to ensure zero fatal accidents and zero hazardous incidents/occurrences in all construction works. The Safety Plan shall include descriptions of the company's standard policies and procedures regarding its site organization and procedures,

methods and frequency of conducting safety audits at the Site(s), record keeping and reporting, providing safety training for its personnel (including subcontractors), issue and mandatory use of safety equipment, and details of the qualifications and experience of the Bidder's proposed safety officers to be deployed at the Site(s). The Contractor shall provide separate descriptions in its Safety Plan covering the construction phase and the subsequent operations and maintenance phase.

The Contractor shall appoint a Full Time English speaking Safety Manager for the Works having experience in this field, who shall be responsible for implementing the Safety Plan. He shall be supported by at least two safety officers who are qualified for such safety works.

The Contractor shall ensure that his staff and labour and his Subcontractors are all fully trained in and aware of good and safe working practices.

The Contractor shall ensure that all precautions are taken to safeguard the general public and construction/operating staff from any danger.

All temporary and partially completed works shall be protected by way of barriers, lights, notices and the like.

All excavations and the like are to be protected by safety barriers at all times and adequately illuminated at night.

Warning and diversion signs concerning roadwork shall be suitably placed to give motorists ample warning. During the movement of heavy vehicles across roads or onto roads, men, bearing red flags, shall be in attendance to warn other road users and to generally control traffic in a safe manner.

The Safety Plan shall also consider requirements for warning and protection for other risks including overhead and underground cables, pipes or obstructions, or voids, openings, pits and trenches. The Contractor shall ensure that all appropriate measures are implemented.

The Safety Plan shall include a policy statement signed by the CEO or equivalent authority of the Organization declaring that safety and loss prevention shall be given the highest practicable priority in all aspects of the Contract. The Safety Plan shall be updated as necessary to cover the activities to be undertaken for operations and maintenance.

2.54. Reinstatement and Compensation for Damage to Persons or Property

The Contractor shall reinstate all properties whether public or private which are damaged in consequence of the construction and maintenance of the Works to a condition as specified and at least equal to that obtaining before his first entry on them.

If in the opinion of the Engineer the Contractor shall have failed to take reasonable and prompt action to discharge his obligations in the matter of reinstatement, the Engineer will inform the

Contractor in writing of his opinion, in which circumstances the Employer reserves the right to employ others to do the necessary work of reinstatement and to deduct the cost thereof as certified by the Engineer from any money due or which shall become due from the Employer to the Contractor.

The Contractor shall refer to the Employer without delay all claims, which may be considered to fall within the exceptions listed in the Conditions of Contract.

2.55. Safety and Security on Site

The Contractor shall at all times maintain safe work methods and procedures and shall comply with all enactments, regulations and working rules relating to safety, security, health and welfare of all persons who may be affected by his work.

In particular he shall ensure that only persons who are properly trained for their duties are employed, and that appropriate, approved tools, safety equipment, and procedures are used.

Nothing which has been written into or omitted from the Employer's Requirements shall be taken to relieve the Contractor from his obligations under this clause. No clause in the Employer's Requirements shall prevent the Contractor from drawing the attention of the Engineer to any feature of the Works which is not consistent with normal safety practices nor prevent him from putting forward proposals at any time which would increase the safety of the installations.

Not later than four weeks before work commences on the Site, the Contractor shall submit to the Engineer his comprehensive plans and proposals relating to the all aspects of health and safety on the Site. The proposals shall be appropriate for all grades of labour and personnel who will work on or visit the Site on behalf of the Employer, Engineer or Contractor.

The Contractor shall appoint a suitably qualified representative as Safety Officer who shall be responsible for the implementation of site procedures as per relevant standards. The Safety Officer's responsibilities shall include but not be limited to:

- safety;
- working in hazardous areas;
- permit to work;
- fire and smoking regulations;
- first aid;
- warning signs;
- trenching scaffolding and other construction structures;
- safety barriers;
- protective clothing and equipment;
- safety training;
- safety meetings and inspections;
- health and welfare.

The Engineer shall have the power to stop any activity or work in any area where there is a breach of the published site safety rules or health and safety is otherwise endangered.

The Contractor shall ensure that all other Contractors working on the Site also follow established health and safety procedures. The Contractor shall bring any violation of Site safety rules by others to the attention of the Engineer in writing.

2.56. Protection from Weather and Storage

An area and/or building on the Site for use by the Contractor for storage of Plant prior to erection will be subject to the approval of the Engineer.

The Contractor shall provide all other facilities for the safe and proper storage of Plant, as recommended by the manufacturers, with particular consideration being given to temperature, rain, sunlight, wind and ground conditions.

The Contractor shall remain responsible to the Employer for the care and insurance of the Plant and the provisions of this Clause shall not relieve the Contractor of any of his liabilities under the Contract.

Stored Plant items shall be laid out with their name, manufacture date cost with GST by the Contractor to facilitate their retrieval for use in the programmed order.

Stacked Plant items shall be protected from damage by spacers on load distributing supports and shall be safely arranged. No metalwork shall be stored directly on the ground.

Small Plant items shall be held in suitable bins, boxes or racks and be clearly labelled.

Items of Plant shall be handled and stored so that they are not subjected to excessive stresses and so that protective coatings are not damaged.

The Contractor shall comply with the manufacturer's package and plant markings concerning the use and location of lifting slings, chains and hooks.

2.57. Warning and Safety Signs

During the entire duration of construction of the Works, statutory safety signs, safety barricades shall be adequately provided throughout the Works, both indoors and outdoors. These safety signs shall cover mandatory, prohibition, warning, emergency, fire-fighting and general notices. All signs shall be positioned around the Works at highly visible points. Provision of signs and the positions of signs shall be subject to the Engineers approval. Special attention shall be given to areas designated hazardous.

2.58. Delivery to Site

The Contractor shall be responsible for the transporting and handling of all the Plant. The storage of all Plant at the Site shall be the Contractor's responsibility. The Contractor shall check all items against packing lists immediately on delivery to the Site and shall also inspect for damage and shortages. Damages and shortages shall be remedied with the minimum of delay.

The Contractor may with the prior approval of the Engineer and at no extra cost to the Employer, make arrangements for any other contractor or agent to take delivery of, unload and store the Plant on the Site on behalf of the Contractor.

All deliveries shall take place during the Contractor's normal working hours.

2.59. Contract Signboards

The Contractor shall supply and erect signboards at locations to be specified by the Engineer. The layout and dimensions of the signboards and their construction shall be to the approval of the Engineer and the lettering in Assamese, Hindi and English Languages shall be black on a white background.

2.60. Advertising

The Contractor shall not use any part of the Site for any form of advertising without the prior written approval of the Engineer.

End of Part-2

PART-3

VENDOR QUALIFICATION CRITERIA FOR VENDOR/SUB CONTRACTOR/SYSTEM INTEGRATOR

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Part 3

Qualification Requirements for Vendors/Sub Contractors/System Integrator

3.1 Vendor Qualification Criteria

The contractor shall submit the following documentation for review and approval, as part of vendor credentials submissions of the agency, for design, supply, program, execute and commission the works to the Employer Representative, before commencing any design, supply or associated works. Only on the approval of the same, the contractor shall commence the design and other associated works. Contractor shall note the importance of this clause.

Note-1: The contractor shall note that the approved vendor list indicated elsewhere in the specification, is only for the product make indicated. The contractor shall submit the credentials of the agency which shall be supplying & executing (design, supply, program ,execute and commission) the work for review and approval as per qualification criteria indicated below. The agency/OEM for design, supply, program, execute and commissioning the works, shall comply in all aspects with the qualification criteria as indicated below on a minimum.

Note-2: The contractor shall note that the approved vendor list indicated in particular requirements elsewhere in the specification, is only for the product make indicated. The contractor shall ensure that the make meets the technical specifications as specified in the technical specifications.

Note-3: The contractor shall submit the following documentation for review and approval, as part of credentials submissions of the agency, for design, supply, program, execute and commission the works to the Employer Representative, before commencing any design ,supply or associated works. Only on the approval of the same, the contractor shall commence the design and other associated works. Contractor shall note the importance of this clause.

3.2 Instrumentation (Level Instrumentation-Reservoir/)-System Integrator

The agency on a minimum shall be operating under an accredited ISO 9001:2015 systems.

The agency should have minimum 10 years of experience in India in the field of instruments supply, installation, testing & commissioning and operation and maintenance of instruments in plants as required under this contract, within 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. The agency shall be an authorized channel partner for the instrumentation equipment for minimum two years. Verification certificates signed not less than the country head of OEM shall be submitted as part of vendor credentials submission.

The agency shall have executed & completed at least ten individual project's with minimum all of the instruments (Ultrasonic level Transmitter, etc) for reservoir or water distribution network within India or outside India during the last five years period, inclusive of supply, installation, testing & commissioning and operation and maintenance period of minimum 1 year within India or outside India with any government organization/utility .

The agency shall demonstrate that it has service and calibration facility with trained service engineers (minimum 10 Engineers trained by OEM)available and are full time employees of the agency.

The agency shall furnish a brief write-up, backed with adequate data, explaining its available capacity and experience (both technical and commercial) for the execution of the proposed scope of work within the specified time of completion after the meeting all their current commitments. The agency shall provide letter from a reputed bank stating the availability of liquid assets and credit facilities of the not less than Thirty Million INR. Agency shall also submit bank solvency Certificate of not less than Thirty Million INR issued by Nationalized bank.

3.3 Instrumentation (Flowmeters & pressure data Integration –Distribution Network)- System Integrator

The agency on a minimum shall be operating under an accredited ISO 9001:2015 systems.

The agency should have minimum 15 years of experience in India in the field of instruments data integration, installation, testing & commissioning and operation and maintenance of communication equipment in plants as required under this contract, within 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.

The agency shall have executed & completed at least five individual project's with minimum all of the instruments (Electro-magnetic flowmeter with data logger, Pressure Transmitter, Wireless communication network) for water distribution network within India or outside India during the last five years period, inclusive of supply, installation, testing & commissioning and operation and maintenance period of minimum 1 year within India with any government organization/utility .

The agency shall furnish a brief write-up, backed with adequate data, explaining its available capacity and experience (both technical and commercial) for the execution of the proposed scope of work within the specified time of completion after the meeting all their current commitments. The agency shall provide letter from a reputed bank stating the availability of liquid assets and credit facilities of the not less than Thirty Million INR. Agency shall also submit bank solvency Certificate of not less than Thirty Million INR issued by Nationalized bank.

3.4 Fire Detection, Alarm & Suppression System Integrator:

The agency on a minimum shall be operating under an accredited ISO 9001:2015 systems.

The agency should have minimum 10 years of experience in India in the field of Fire alarm ,detection and suppression equipment for control center as required under this contract for supply, installation, commissioning and operation and maintenance of the same as required under this contract, within India or outside India and shall demonstrate capability and resources for integrating/interfacing the fire alarm systems from different manufacturers as well as coordination with multiple agencies for contract execution.

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The agency shall be an authorized channel partner for the Fire detection, alarm and suppression system proposed for minimum three years from the date of bid.

The system integrator/firm must submit evidence that they employ in excess of 25 personnel, including no less than 15 technical staff to include engineers, and qualified field technicians.

The agency shall demonstrate that it has service facility with trained service engineers available and are full time employees of the agency.

The agency shall furnish a brief write-up, backed with adequate data, explaining its available capacity and experience (both technical and commercial) for the execution of the proposed scope of work within the specified time of completion after the meeting all their current commitments. The agency shall provide letter from a reputed bank stating the availability of liquid assets and credit facilities of the not less than Five Million INR. Agency shall also submit bank solvency Certificate of not less than Five Million INR issued by Nationalized bank

3.5 Interior Design Works for Centralized SCADA Center

The contractor shall appoint an agency to carry out all interior design, modification works for the centralized SCADA center as per the requirements of the specification.

The agency on a minimum shall be operating under an accredited ISO 9001:2015 systems.

The agency should have minimum 5 years of experience in India or outside India in the field of interior design works for control center's required under this contract for supply, installation, commissioning and operation and maintenance of the same and shall demonstrate capability and resources for integrating/interfaces the systems from different manufacturers as well as coordination with multiple agencies for contract execution.

The agency shall have completed at least five interior design and upgrade works for large control center in the last five years.

The system design firm must submit evidence that they employ in excess of 25 personnel, including no less than 15 technical staff to include engineers, designers and qualified field technicians.

The agency shall demonstrate that it has service facility with trained service engineers available and are full time employees of the agency.

The agency shall furnish a brief write-up, backed with adequate data, explaining its available capacity and experience (both technical and commercial) for the execution of the proposed scope of work within the specified time of completion after the meeting all their current commitments. The agency shall provide letter from a reputed bank stating the availability of liquid assets and credit facilities of the not less than Ten Million INR. Agency shall also submit bank solvency Certificate of not less than Ten Million INR issued by Nationalized bank

3.6 Cyber security of the centralized SCADA center with Software firewall & hardware firewall

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The agency on a minimum shall be operating under an accredited ISO 9001:2015 , 27001:2015 systems.

The agency should have minimum 10 years of experience in India in the field of providing Cyber security implementation both IT and OT which shall include supply, installation, commissioning and operation and maintenance of the same for control center's as required under this contract, within India or outside India and shall demonstrate capability and resources for integrating/interfacing the cyber security system with all systems which are connected(both IT and hardware equipment on field) from different manufacturers as well as coordination with multiple agencies for contract execution.

The Agency on a minimum , shall have executed & completed at least two individual contracts of cyber security solution for control center's for a city wide projects , within India or outside India, during the last five years period. Verification end user performance certificates shall be submitted for the same.

Note: In the event, if the OEM intends to execute (design, supply, program, execute and commission) the works, the OEM shall comply in full to the qualification criteria as required in this clause & specification.

The agency shall demonstrate that it has service facility with trained service engineers available and are full time employees of the agency.

The agency shall furnish a brief write-up, backed with adequate data, explaining its available capacity and experience (both technical and commercial) for the execution of the proposed scope of work within the specified time of completion after the meeting all their current commitments. The agency shall provide letter from a reputed bank stating the availability of liquid assets and credit facilities of the not less than Ten Million INR. Agency shall also submit bank solvency Certificate of not less than Ten Million INR issued by Nationalized bank

3.7 LED Video wall Display System for Water SCADA

The agency on a minimum shall be operating under an accredited ISO 9001:2015 systems.

The agency should have minimum Five years of experience in India in the field of providing Videowall for large control center's which shall include supply, installation, commissioning and operation and maintenance of the same , as required under this contract, within India and shall demonstrate capability and resources for integrating/interfacing the videowall system with the control and automation system from different manufacturers as well as coordination with multiple agencies for contract execution.

The agency shall be an authorized channel partner for the Videowall system proposed for minimum three years from the date of bid. Verification certificates signed not less than the country head of OEM shall be submitted.

Contract Package No. 9

The Agency on a minimum, shall have executed & completed at least three individual contracts, within India, during the last Five years period . Verification end user performance certificates shall be submitted for the same.

Note: In the event, if the OEM intends to execute (design, supply, program, execute and commission) the works, the OEM shall comply in full to the qualification criteria as required in this clause & specification.

The agency shall demonstrate that it has service facility with trained service engineers (minimum 15 numbers who are trained from the OEM)available and are full time employees of the agency. The agency shall furnish a brief write-up, backed with adequate data, explaining its available capacity and experience (both technical and commercial) for the execution of the proposed scope of work within the specified time of completion after the meeting all their current commitments. The agency shall provide letter from a reputed bank stating the availability of liquid assets and credit facilities of the not less than Twenty Million INR. Agency shall also submit bank solvency Certificate of not less than Twenty Million INR issued by Nationalized bank.

End of Part-3

PART 4
DOCUMENTATION REQUIRED FOR APPROVAL

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Part 4

Documentation Required for Approval

4.1 Contractor Submission:

Contractor shall provide documentation specified or otherwise required to fulfil the intent of specification and to integrate into a fully functional CWMC-Centralized SCADA control center with Instrumentation and Control system, other ancillaries as required under the specifications ensuring operability, maintainability and reliability and durability for comprehensive operation & maintenance period of five (5) years described in this specification.

4.2 Documentation required -Basic Methodology

During the initial execution phase of the project, the Contractor shall provide the following documentation for review and approval on a minimum but not limited to:

- a) The Contractor shall make submissions to the Employer Representative of all design drawings, schedules, datasheets, and Inspection plan, Quality assurance and Quality control (QA/QC) procedures as per bid requirements, and complete documentation on spare parts relating to CWMC Centralized SCADA equipment, instrumentation and control equipment and systems provided under this Contract.
- b) Construction programme with detailed project schedule in Microsoft schedule/equivalent with clearly identifying the milestones. The same shall include detailed project execution plan /method statement for all components.
- c) Master list of Documentation covering all documentation as required under this bid, and to also include any documentation w.r.t regulatory approvals required during the execution of this project

4.3 Vendor Credentials for Agency and Alternate Make Approval.

The contractor shall submit the documentation for review and approval, as part of vendor credentials submissions of the agency, for design, supply, program, execute and commission the works to GJB and employers representative, before commencing any design, supply or associated works. Only on the approval of the same, the contractor shall commence the design and other associated works. Contractor shall note the importance of this clause.

The contractor shall further note that the approved vendor list indicated in elsewhere in the specification, is only for the product make & model (if indicated).The Model of the equipment proposed shall comply with complete technical specifications as specified.The

contractor shall submit the credentials of the agency which shall be supplying & executing (design, supply, program ,execute and commission) the work for review and approval as per qualification criteria indicated in the specification. The agency/OEM for design, supply, program, execute and commissioning the works, shall comply in all aspects with the qualification criteria as indicated.

If the contractor wishes to submit any alternate make for approval, the contractor shall submit the vendor credentials for the Make & model as per the requirements as stipulated elsewhere in the specifications.

The contractor shall submit System Integrator vendor credentials for approval of GJB as per contract requirements for every equipment, software, hardware. On approval of the same by GJB, the contractor shall submit the design data for review and approval of GJB. Note: The contractor shall ensure that the vendors proposed shall meet all technical specifications as stipulated in the specifications.

4.4 Contractor Design Submissions:

Design submissions shall include, the following:

- Instrument Schedule
- Functional design specification (FDS). The functional design specification shall be submitted for the following:
- Specific design & Drawings inclusive of schedules
- Civil design & Drawings
- Electrical design & Drawings

A. Instrumentation

The FDS shall include on a minimum, but not limited to:

- 1) Instrument Datasheets, OEM product brochure, Instrument hook up diagrams and quality Assurance plan for inspection at manufacturer test and quality facility where the equipment has been manufactured.
- 2) Instrument Location Layouts
- 3) Instrument hook up drawings -General arrangement drawings of field-mounted instruments showing installation details.
- 4) 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.
- 5) Layout drawings of panel fascias showing instruments, controls and details of all labels.
- 6) Internal circuit and wiring diagrams for instrument and control panels.
- 7) Schematic control diagrams.
- 8) Instrument loop diagrams.
- 9) Instrument wiring and piping diagrams.

- 10) Interconnection wiring diagrams.
- 11) Cable block diagrams, drawings and schedules.
- 12) Instrument system and panel power distribution diagrams.
- 13) The FDS shall describe control actions taken and monitoring functions which remain available during a power failure, and any automatic controls or sequencing which take place during system start-up and shut-down.
- 14) The FDS shall be presented in a clear and precise manner and shall include figures or drawings where appropriate.
- 15) Comprehensive testing schedules for all off-site, on-site, pre-commissioning and commissioning tests and take-over tests.

B. CWMC-Centralized SCADA System-Water SCADA

- 1) FDS shall comprise an overall description of the centralized SCADA center with water SCADA systems, its functioning and control, and a detailed description of each section of the server system covering modes of operation, manual overrides, set-point and parameter selection and adjustment. The detailed description shall include a step-by-step control description which defines the function of each piece of equipment and each control action and interlock, including details of the program in each programmable item. Flow charts shall be used to depict the control philosophy along with the write up for the same.
- 2) Integration with existing server systems/systems and its implementation with the CWMC-centralized SCADA system and its implementation in the network to provide complete information on water treatment, distribution and consumption up to end consumer.
- 3) Internet policy
- 4) Guideline & Calculations for water demand & water consumption
- 5) Water demand and water consumption reports, SCADA screen shots, alerts, etc as specified in the scope of work
- 6) Proposed CWMC-centralized SCADA screens for water SCADA, set point schedules, shall be an integral part of the FDS submissions.
- 7) Reports format
- 8) All other documentation as per scope of work
- 9) The FDS shall describe the 'fail-safe' features incorporated into the design for the event of failure of a plant item or system, or loss of an input signal.
- 10) The FDS shall describe control actions taken and monitoring functions which remain available during a power failure, and any automatic controls or sequencing which take place during system start-up and shut-down.
- 11) Control room, RIO Room interior design layouts, interior design diagrams, control room wiring layout, access control point diagrams, etc.
- 12) The FDS shall be presented in a clear and precise manner and shall include figures or drawings where appropriate.

C. Cyber Security Policy at CWMC-centralized SCADA Center and all Remote Sites

- 1) FDS shall comprise detailed information and methodology on the Cyber security solution for centralized SCADA center with Software firewall & hardware firewall details, design levels of security, configuration, web security audit methodology to be adopted, to achieve complete security for the SCADA centre.
- 2) FDS shall describe the intrusion prevention methods to be employed and submit sample screens, reports, alerts for the same.
- 3) The FDS shall describe the 'fail-safe' features incorporated into the design for the event of failure of a plant item or system, or loss of an input signal.
- 4) The FDS shall describe control actions taken and monitoring functions which remain available during a power failure, and any automatic controls or sequencing which take place during system start-up and shut-down.
- 5) The FDS shall be presented in a clear and precise manner and shall include figures or drawings where appropriate.
- 6) Comprehensive testing schedules for all off-site, on-site, pre-commissioning and commissioning tests and take-over tests.

D. Specific Design & Drawings inclusive of schedules

- 1) General arrangement drawings of field-mounted instruments showing installation details.
- 2) 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.
- 3) Layout drawings of panel fascias showing instruments, controls and details of all labels.
- 4) Layout drawings of panel interior showing equipment, terminal blocks and cable ways.
- 5) Internal circuit and wiring diagrams for instrument and control panels.
- 6) Schematic control diagrams.
- 7) Instrument loop diagrams.
- 8) Instrument wiring and piping diagrams.
- 9) Interconnection wiring diagrams.
- 10) Cable block diagrams, drawings and schedules.
- 11) Instrument system and panel power distribution diagrams.
- 12) Programmable-device functional design specifications which shall include hardware details, logic flow charts, ladder diagrams and program listings.
- 13) Schedules of inputs to and outputs from programmable controllers and telemetry outstations.
- 14) Labelling & tag schedules.
- 15) Comprehensive testing schedules for all off-site, on-site, pre-commissioning and commissioning tests and take-over tests.

E. Civil Design & Drawings

- a) CWMC-Centralized SCADA control center layout
- b) Ergonomic design, lighting and air conditioning calculations for the entire control center
- c) Fire Alarm panel, detector layout of control room
- d) CCTV layout diagram
- e) Interior Design & Drawings, all other civil related drawings for Control center modification as per project specifications
- f) Road restoration work design & drawings, method statement at all locations where the equipment is going to be installed.
- g) Fencing, Foundation & chamber drawings for installation of realtime water quality equipment in the distribution network

F. Electrical Design & Drawings

- a) SLD for centralized SCADA control center
- b) Electrical design & drawings for control center, earthing calculations, etc as required under the specification
- c) UPS system
- d) Electrical design & drawings at reservoir locations
- e) Electrical design & drawings at Water quality Multiparameter equipment locations
- f) Grounding scheme for the centralized SCADA center, all other locations in this contract
- g) Any other document, drawings as required under General & Particular Electrical requirements.

G. Interoperability test procedure:

- a) for integration with existing system-For each location
- b) Centralized SCADA interoperability test & guideline document for integration of future plants with centralized SCADA center

H. Database & Reports Format

- a) Reports format for Water SCADA
- b) Master database for Water SCADA

I. Equipment Datasheets & other drawings as per Price Schedule

- a) Equipment datasheet and other design documents as specified in the price schedule/BOQ.

- b) All other drawings necessary for the provision of ducts, openings, trenches, fixing holes for panels and the like and for the complete understanding of the operation, maintenance and extension of the system including any required for the Purchaser to dismantle, repair, maintain, modify or extend the Plant.
- c) Data and calculations
 - a) Manufacturers' catalogues and data sheets.
 - b) Calculations to support control system design.
 - c) Specification for protective coatings and painting.

J. Test Documentation & Certificates:

- a) Manufacturers' works tests.
- b) Pre-installation checks.
- c) Pressure-testing schedules.
- d) Instrument loop test check sheets.
- e) Installed instrument performance tests.
- f) System tests.
- g) Statutory certificates of compliance (such as hazardous area equipment).
- h) Factory acceptance test procedures
- i) Factory acceptance test documentation
- j) Site acceptance test procedures
- k) Site acceptance test documentation

K. Training documentation & manuals

L. As-built documentation & drawings

M. Handing over documentation

N. Asset replacement schedule

O. Operation & maintenance manuals

**P. Standard operating procedures for each equipment, during O&M period,
during asset replacement**

End of Part-4

PART 5

PARTICULAR REQUIREMENTS INSTRUMENTATION AND CONTROL WORKS

Content

PART 5

PARTICULAR REQUIREMENTS INSTRUMENTATION AND CONTROL WORKS

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PART 5

PARTICULAR REQUIREMENTS INSTRUMENTATION AND CONTROL WORKS

1.1 Introduction

This part covers the particular requirements for the design, engineering, supply, Factory inspection and testing, Field testing & calibration, installation & commissioning of the instrumentation, Control and Automation (Centralized SCADA, local remote stations inclusive of wireless communication system) and associated plants and materials for successful operation.

1.2 General

This section outlines the particular requirements for the instrumentation, control & automation works. This section shall be referred in conjunction to the general requirements for instrumentation, control and automation works specified in this document. Unless specified in this section to the contrary, the system provided by the Contractor and workmanship shall comply with the General Chapters of these Requirements.

The scope of instrumentation, control and automation (ICA) works for Centralized SCADA center and its ancillaries, Reservoir (Field instrumentation, Online real time Water quality monitoring instrumentation & Automation), and instrumentation in the water distribution network (Online real time Water quality monitoring instrumentation at key DMA locations in the water distribution network, Flow and pressure monitoring at key locations in the water distribution network, etc as required under this contract) under this contract shall comprise of the design, manufacture, supply, programming and configuration, off site testing, delivery to site, installation and erection, testing, commissioning, setting to work and provision of documentation for a complete instrumentation, control and automation system including the interfaces required to provide monitoring and control for a safe and efficient operation of the plant locally as well as remote monitoring from the CWMC-centralized SCADA Center.

The Contractor shall submit and obtain approval for all equipment from the Employer's Representative before beginning the Instrumentation and control system design and design submissions. Refer approved vendor list for instruments and automation. Additionally, the contractor shall note that the approved vendor list indicated in particular requirements is only for the product and not for executing agency to execute the work. The contractor shall submit the credentials of the agency which shall be executing the work for review and approval as per qualification criteria indicated in the Part-3 Qualification Requirements for Vendor and sub-contractors before commencing any works. Only on the approval of the same, the contractor shall commence works for instrumentation, control and automation works required under this contract.

CONTROL SYSTEM – DESIGN

The PLCs and Input/output modules used for the Works shall be from the same manufacturer and series and shall as far as be practical allow for the interchange of plug-in parts.

The control systems shall recover fully to a normal operational state on restoration of the power (either from the mains or the generator) after a power failure without manual intervention. (i. e. to remove doubt this requirement refers to a real failure of power to the control system such as would be experienced if the control system UPS s were not present).

The control system must be state-of-the-art in terms of structure and function as a process information and control system and its hardware and software must be future-oriented. The control system should be a modern system with an appealing user interface, open to the office and process world, with sophisticated and reliable functions, efficient to configure and scalable for simple and complex tasks.

The communication channels modules for the connection to the Programmable logical controllers/RTU via various communications media must be included in the scope of delivery of the control system, the same applies to drivers for simple types of coupling such as point-to-point via the MPI interface. In addition, it should be possible to establish the coupling to other devices and applications from various manufacturers via the standardized software interface OPC.

The site instrumentation shall also form an integral part of the control system.

Voltages

The following control voltages shall be used:

Item	Voltage
1. within starter enclosures	240 V AC
2. instrumentation power supplies	240 V AC / 24 V DC
3. PLC inputs cards	24 V DC
4. PLC outputs	24 V DC

Control System Protection

1. Short Circuit

All circuits shall be protected against short circuit by the provision of adequate numbers of fuses or miniature circuit breakers.

For ease of maintenance and system security power supplies to each instrument loop and each PLC output shall be protected with an individual fuse (terminal type).

2. Surge Protection

Surge protection devices (SPDs) shall be provided at the control panel end of all instrumentation and control cables which run for distances in excess of 50 m outside the confines of the building in which the CP is housed. The SPD s shall be grouped in a specific area within the CP to ensure 'dirty' signal cables do not come into direct contact with 'clean' signal cables.

1.3 Data Interface to Centralized SCADA center.

(a) Water SCADA

The Water SCADA server to be established at the CWMC-centralized SCADA center shall be integrated with the Data from current Water Treatment facilities and Water pumping stations. The Water SCADA server shall also be integrated with reservoirs with level, incoming flow and outgoing flow, real time water quality data via multi-parameter measuring instruments).The water SCADA server shall also be integrated with the real time water quality data at key strategic locations in the water distribution network to enable GJB to monitor water contamination at key locations in the distribution network. All the above instrumentation shall be programmed to transmit data to the centralized SCADA via wireless GPRS communication network at regular pre-defined intervals and as required by the operator at the CWMC-

centralized SCADA center (On-Demand data transfer).Note: Due to power failure/communication network failure, the system shall be designed to transmit the data to the centralized SCADA center on resumption of power/communication network. The water SCADA server provide a complete comprehensive view of the water data (treatment, pumping to Guwahati city, distribution, along with water quality data, water consumption, water demand for each zone, division and sub-division as required by GJB .

The centralized SCADA center shall monitor the following data on a minimum but not limited to:

S. No	Water Facilities	Data to be Monitored at Centralized SCADA Center
1	Water Treatment Facilities	Raw Water Quality parameters Treated Water Quality Parameters WTP Plant operational data Maintenance data Entire plant mimics shall be replicated at centralized SCADA end Functional guarantees parameters of these plants
2	Water Pumping Facilities	Reservoir level Pump operational status Pump Efficiency data Total Supplied Flow Maintenance data Entire plant mimics for each location shall be replicated at centralized SCADA end Functional guarantees parameters of these plants
3	Water Distribution Network	treated water discharge flow ,Water consumption & demand forecast modelling for each zone, division, sub division etc.. Flow measurement & pressure measurement at key strategic locations in distribution network. Online real time water quality monitoring(Residual Chlorine, pH, TDS, Turbidity etc..) At strategic locations .Functional guarantees parameters of these equipment's
4	Reservoirs	Incoming & discharge flow, real time water quality monitoring (Residual Chlorine, pH, TDS, Turbidity, etc..), reservoir level

Note-1: The water SCADA server shall also be integrated with other facilities that shall be established by GJB during the five (5) years of comprehensive operation and maintenance period. The contractor shall be responsible for integrating the data from these facilities and shall co-ordinate with the contractor of these facilities to enable seamless integration. All plant operational mimics and other data as indicated above shall be designed, programmed and integrated to enable GJB to have a complete comprehensive view of the entire water network.

Note-2: The integration communication network shall be part of those individual contracts and the scope of work for the centralized SCADA shall be only data integration, SCADA mimics to be replicated.

(b) Interoperability Test & Integration co-ordination:

The contractor shall conduct a interoperability test to confirm & demonstrate that the local control system data can be read & written by the centralized SCADA, using appropriate OPC server & client software via the interface panel and local PLC/SCADA. The test shall be carried out in presence & co-ordination with the local system (Plant contractor/system integrator).

The contractor shall co-ordinate fully with the local system (Plant contractor/system integrator) contractor for integration tests. The contractor shall be fully responsible for data to be made available at all times, which is connected the integration system.

1.4 System Completeness

This section of specifications defines the particular requirements of instrumentation, control & automation works.

Irrespective of the detailed specifications of the respective items detailed in the various chapters of the specification, the Contractor shall be required to provide all the equipment, accessories, cabling, earthing, providing necessary transducers/sensors, system hardware/software, programming logic, interlocks, cabinets, panels etc. to achieve the functional requirements described in the Document. The System completeness shall be the Contractor's responsibility.

Note: In FAT, all the field instruments shall be tested for functionality as per contract requirements at the manufacturers work location where the equipment is manufactured. Quality assurance plan (QAP) shall be submitted along with the datasheets for review and approval before any inspections call is initiated.

1.5 Field Instrumentation and Control

Each field instrument shall be operable in local mode and have display functions in SCADA. The Contractor shall be responsible for providing the appropriate signals at the locations required to provide the specified control and monitoring functions.

The Contractor shall ensure that field measuring systems shall respond quickly to any changes of the measured process variables.

All field instruments shall, as far as practicable, be mounted in a location that shall be free of vibration and shall be powered from the instrument control system.

24V dc power wiring for field instruments shall be individually fused and provided with a means of disconnecting the power without disturbing terminated wiring (e.g. knife-switch-type terminal blocks). Visual indication of a blown fuse condition shall be provided.

All field instrument components shall be of a proven and reliable design and shall have a high degree of uniformity and shall, wherever possible, be interchangeable. The design shall facilitate easy maintenance and repair, taking into account the availability of access routes through plant and structures generally.

Field Instruments shall perform sensing, indicating, transmitting and controlling. The devices shall generally interface with the SCADA, either directly or indirectly. The materials of those parts of the field instruments, including piping material, which are exposed to the measured media shall be compatible with the conditions of the respective media and of the ambient fluid and atmospheric conditions.

All field instruments shall be mounted within enclosures that are corrosion proof, dust proof and waterproof to provide a minimum protection specified in elsewhere in this Specification. The enclosure shall be rated to minimum IP 65. The enclosure design shall be submitted along with the instrument datasheet for review and approval before any design of the same.

All field instruments, including the components, shall be tropicalized and designed for the ambient conditions detailed elsewhere in this Specification. Lightning protection barriers shall be used for protecting transmitters and receiving instruments from the surge voltage due to lightning strike. Lightning protection barriers shall be supplied at both receiving and sending ends for all signals from outside building and those installed between the buildings.

1.6 Instrumentation Design Criteria

The design criteria to be applied to instrumentation systems shall be as follows:

- 1) all instruments shall be suitable for continuous operation;
- 2) all transmitting instruments shall have a 4 - 20 mA HART linear output;
- 3) all digital outputs shall be volt free;
- 4) all instruments shall be designed for the ambient conditions of temperature and humidity;
- 5) all wetted parts of instruments sensors shall be non-corrosive and suitable for use with sewage;
- 6) all instrumentation systems for use out of doors shall be protected to IP 65;
- 7) all analogue displays shall be of the digital type with no moving parts utilising back lit liquid crystal diode LED technology;
- 8) instrumentation shall utilise solid state electronic technology and avoid the use where practical of any moving parts;
- 9) minimum maintenance requirement;
- 10) Instrumentation shall resume operation automatically on the application of power following a power failure.

Instrumentation systems shall be provided as detailed in the Employer's Requirements and as necessary.

Instrumentation sensors shall be suitable for the environment in which they are expected to work. Sensor located in hazardous (flammable) or potentially hazardous atmospheres shall be certified for use in these areas.

All Sensors should be of self-cleaning type.

Instrumentation shall be selected and installed in accordance with the manufacturer's instructions. Wherever practical components of similar systems shall be interchangeable.

1.7 Pressure Instrumentation

Pressure Gauges:

- 1) Pressure gauges shall comply with BS EN 837- Parts 1, 2 and 3. Pressure Gauges shall have over range protection up to 1.5 times the maximum anticipated line pressure.
- 2) Internal parts shall be of stainless steel, bronze or other corrosion resistant material.
- 3) All Pressure Gauges shall be supplied complete with isolating valves and calibration points to enable calibration or removal without loss of fluid.
- 4) Where compensation of more than 2% of the instrument span is needed for the difference in level between the instrument and the tapping point, the reading shall be suitably adjusted and the amount of compensation marked upon the dial.
- 5) Pressure monitoring shall be by a sensor suitable for the medium and pressure/level range.
- 6) The sensor shall be selected to provide adequate sensitivity over the working range and be capable of sustaining a 400% overpressure without damage. The sensor shall be suitable for either free wire suspension in the medium or fitted remotely and provided with threaded sockets to permit connection of pressure pipe work.

Pressure Transmitters:

Pressure measuring system shall consist of pressure transmitter and digital pressure indicator and any other items required to complete the pressure measuring system. Pressure transmitter shall be rugged in construction and shall be suitable for continuous operation. Pressure transmitters shall be designed for operation over 130% of full range. It should have EEPROM for storing of history data.

Pressure transmitter shall be suitable for field mounting. They shall provide 4-20 mA Current output proportional to pressure. Transmitter output shall be isolated and shall be suitable for transmitting over long distance. Pressure transmitters shall have high degree of weatherproof protection as specified in technical particular. Pressure transmitters shall have LCD display to indicate pressure.

The Contractor shall mark the exact location of pressure measuring point on the pipe line. The contractor shall provide all the hardware items including manifolds, nuts, bolts, pipes, valves, gaskets etc. required for the work.

Sr. No.	Pressure Transmitters	
1	Specifications	Pressure Range 0 to 10 /20/50/ 100 Kg/cm ² g
2	Process Temperature range	-20 to +125 deg.C.
3	Output Signal	4 to 20 mA with superimposed digital communication protocol HART 6.0, 2-wire
4	Signal range –	4 to 20 mA HART 3.8 to 20.5 mA
5	Signal on alarm	As per NAMUR NE 43 • 4 to 20 mA HART
6	Resolution	Current output: 1 micro Amp
7	Response time	<250 ms
8	Damping	required
9	Supply voltage	11.5 to 45 V DC
10	Reference accuracy	± 0.1%

Sr. No.	Pressure Transmitters	
11	Housing	Die Cast Alu. Housing
12	Diaphragm Material	Ceramic
13	Long Term Stability	± 0.25% URL/year
14	Turn Down	10: 1

1.8 Online Real time Water Quality Multi Parameter Instrumentation

The contractor under this contract shall be responsible to provide Online Real time Water Quality Multi Parameter monitoring instrument at the following locations:

1. At all Ground Level Reservoirs which shall be integrated with the automation system with wireless GPRS communication system to transmit the data to Centralized SCADA system
2. At key strategic locations in the water distribution network (DMA Locations) to monitor water contamination.

Note: The contractor shall note that the locations indicated in the specifications are tentative and are subject to change during detailed engineering stage. The locations shall be finalized with GJB zonal engineer’s in-charge of operation & maintenance.

The contractor shall provide the Online multi-parametric pH, TDS, Turbidity & Total Residual Chlorine as single system for all four parameters i.e. measurement mechanism for all parameters are integral part of the single system only. Individual analysers shall not be accepted.

The contractor shall provide complete analyser with the Sample Handling system, Pump, Sample Tubing & other necessary accessories as required to achieve the complete measurement as a single unit.

The Multi parameter instrument shall be with efficient integrated automatic cleaning facility. All required mechanism for automatic cleaning shall be an integral part of the scope of work.

Analyzer should have USB port for download stored measurement data along with diagnostic files for easy troubleshooting.

S.No	Description	Specification
1	Multi-Parameter Single Unit Analyzer	
1.1	Analyser Type	Cabinet Type / Flow through Type, Multipara meter type
1.2	Operating Temperature	Sample temperature: 0 °C to 80 °C
1.3	Operating Flow	Vendor to specify
1.4	Enclosure protection	IP65, stainless steel with epoxy coating
1.5	Communication	- RS232 output -USB port required for USB/ pen drive connection
1.6	Memory	Instrument Minimum Memory with minimum 5000 records with Date and time
1.7	Display	Color TFT LCD, resolution: 320 x 240 pixels with

		LED backlight.
1.8	Measuring Cycle	Continuous or User Adjustable
1.9	Cleaning method	Analyzer should have facility to start cleaning cycle automatically as per user defined time interval.
1.10	Certifications	CE, EN 61010-1, EN 61326
2	Total Residual Chlorine	
2.1	Measuring Principle	Colorimetric, DPD Method as per US-EPA 330.5
2.2	Measuring Range	0 – 10 mg/l
2.3	Accuracy	± 0.01 mg/l or ± 5% whichever is greater
2.4	Repeatability	± 0.05 mg/l
2.5	Cleaning	In-built Automatic cleaning
2.6	Measuring Time	3 to 4 mins.
2.7	Reagents	Contractor shall ensure that the required reagents shall be non-proprietary. (Reagent should be prepared through open Chemistry)
3	Turbidity	
3.1	Measuring Principle	Nephelometric (90° scattered light detector)
3.2	Measuring Range	0 – 100 NTU
3.3	Accuracy	± 0.01 NTU or ± 5% whichever is greater
3.4	Repeatability	± 0.1 NTU
3.5	Light Source	Visible laser diode
3.6	Cleaning	In-built Automatic cleaning
4	Total Dissolved Solids (TDS)	
4.1	Measuring Principle	Electrochemical Method
4.2	Measuring Range	0 – 1000 mg/L
4.3	Accuracy	± 1 mg/L or ± 5% whichever is higher
4.4	Integral Sensor cable Length	6 meter
4.5	Body Material	Polypropylene
4.6	Temperature Compensation	Automatic
4.7	Temperature Element	Pt-100 Ohm RTD
4.8	Maximum Operating Pressure	100 psi
4.9	Cleaning	In-built Automatic cleaning
5	pH	
5.1	Measuring Principle	Electrochemical Method
5.2	Sensor Type	Convertible style Combination pH Sensor

5.3	Body Material	Ryton
5.4	Reference Junction	Double Junction with porous Teflon
5.5	Measuring Range	0 – 14 pH
5.6	Accuracy	± 0.01 pH or ± 5% whichever is greater
5.7	Repeatability	± 0.01 pH
5.8	Integral Sensor cable Length	6 meter
5.9	Temperature Compensation	Automatic
5.10	Temperature Element	Pt-100 Ohm RTD
5.11	Maximum Operating Pressure	100 psi
5.12	Cleaning	In-built Automatic cleaning

1.9 Closed Circuit Television (CCTV) System

Design, supply, install, test and commission CCTV system including its interface with SCADA system;

The contractor shall be responsible for the detailed design, supply, installation, testing and commissioning and training of Employer’s staff of Closed Circuit Television (CCTV) system to be installed in the SCADA control room , storage facilities and other areas of the center. The CCTV system shall be designed to have complete coverage of the control center.

The scope shall include all necessary cabling, indoor & outdoor cameras and lenses, camera housing, TV monitor, control and interface units, coaxial cable transmission, video switching unit, time-lapse video recorders and tapes, junction boxes, power supplies, mounting brackets, etc, as required to provide a cost effective and reliable and fully operational CCTV system complying with the specification and to the approval of the Employer’s Representative.

The CCTV system shall incorporate all equipment necessary to enable all areas to be viewed from the CCTV station monitor. The CCTV monitoring system shall be of latest design incorporating all the power and signal wiring as per manufacturer’s standard. The system shall be complete package of one supplier of equipment, fixings, wiring conducting and all items necessary for a complete installation.

Materials

Cameras

Cameras shall be digital high resolution colour cameras having 1/3 inch CCD 450 TV lines with lens and an interlace of 2:1 in the scanning system of high excellent quality and performance utilising latest digital technology of super colour reproduction with low light high sensitivity down to 5 lux with electronic shutter speeds 1/50 to 1/30000 seconds .

Cameras shall be provided with a 14mm automatic lens with/without “drive” (amplifier) for 1/2” sensors, F1.4 CS mount, 22° angle shot and a composite video output at 75 ohms lines and the useful illumination range shall be 1.5 lux. The camera lens shall be of the auto iris zoom type with spot filter providing

automatic control throughout the iris range from fully open F1.4, the lens shall incorporate a shutdown mechanism to protect the camera from high light level during periods of not in use. A neutral density filter designed to maintain image detail and contrast shall be incorporated in the lens. The output signal shall be of PAL. The Camera shall be suitable for the specified environmental conditions.

The camera shall be provided complete with all accessories required. The camera shall have the following features.

1. Program modes 1.5, 3, 6 minutes;
2. Variable scan speed between 1.40° per second;
3. Programmable limit stops for auto/random/frame scan modes;
4. Series protocols BS-422 'P' series and 'D' series;
5. Built-in menu system;
6. Pan movement – 360° continuous pan rotation;
7. Vertical tilt - Unobstructed +2 to +92°;
8. Variable pan/tilt speed controller;
9. Preset speeds:
Pan – 250°/sec
Tilt – 100°/sec
10. Electrical input – 24V AC.

Monitor

The monitor shall be of high-resolution type suitable for CCTV system and shall comply with the following:

1. LED Screen: 32" Monitor;
2. Power Supply: 240V, 50Hz;
3. Resolution: 420 lines;
4. Bandwidth: 5 MHz (± 3 dB);
5. Video Input: 1 Vpp 75ohm;
6. Input/Output: BNC Video connector;
7. Front Controls: Power ON/OFF;
8. Brightness Control;
9. Contrast Control;
10. Colour Control.

Matrix Switcher

The matrix switcher shall be micro-processor based and provide switching and control for 16 video inputs and up to 4 monitor outputs from any one keyboard. The unit shall be remotely operated by desk-top key boards or external computer systems. The switcher shall have on-screen menu programming. The switcher shall support two system macros or salvo sequences to allow quick call-up of up to four cameras to four monitors simultaneously.

The salient features of the switcher shall be as follows:

1. 16 video inputs; 2 or 4 video outputs;
2. 20-character camera title;
3. Time (24-hour or AM/PM formats), Date (4 formats);

4. Video inputs individually detectable for terminating or looping;
5. Individual monitor sequential switching with preset cell;
6. Compatible with RS 422 protocol;
7. Camera control selection;
8. Full duplex RS485 keyboard communications;
9. Selectable data port – RS 232/RS 422/RS 425;
10. Password protected menu programming;
11. User partitioning to prevent un authorised viewing.

Receiver

The receiver shall operate on the principle of transmitting of transferring control information and video data on the same line. Standard control features shall include pan/tilt control, camera power, zoom lens control (zoom, iris, and focus with adjustable speed).The receiver shall be compatible with control systems utilizing standard 15-bit command protocols. Auto random scan capability or preset positioning shall be possible.

The test local control module shall allow on-site testing of system functions.

The salient features of the receiver shall be as follows:

1. Input power – 240V 50Hz AC;
2. Control method – 15 pulse train superimposed on the video signal;
3. Pulse amplitude – approximately 1 Vp-p added to video signal, 333kHz nominal;
4. Connectors – two BNC connector for video input and output one 37pin Amp CPC for control output;
5. Input video level – 1 Vp-p nominal, 2 Vp-p maximum;
6. System band width – Less than 2dB down at 10 MHz;
7. Fuse protection – 3 AG type;
8. Power chord – 3 wire grounded 18 AWG;
9. Operating distance – RG 11 at 1828 m;
10. Ambient temperature –20 to + 60°C.

The receiver shall be UL listed and shall comply with NEMA 4X and be CE compliant.

Amplifier

The video amplifier shall be of solid state circuitry and is meant for post equalization application only. The amplifier shall provide effective means of maintaining CCTV picture quality with RG11 coaxial cable.

The general construction of the amplifier shall consist of cover, chassis and panel.

The salient features of amplifier shall be as follows:

1. Input voltage – 240V AC;
2. Power transformer – 1.5VA (1.25 AMP) at 12 ±15% volts, 50Hz;
3. Input – Single BNC internally terminate in 75ohms;
4. Outputs – Single BNC source terminated;
5. Gain – Adjustable form 1 to 8dB;
6. Frequency response – Adjustable form flat (±1dB) at 12 MHz, greater than 18dB of boost at 12 MHz;
7. Output dynamic range – Up to 2 volts p-p at 50% APL;
Up to 1.5 volts p-p at 90% APL.
8. Cable length – RG 11 – 1828.8M;
9. Ambient temperature – 0° to 48.89°C at 0 - 90% RH.

The amplifier shall be UL listed to standard 2044 and comply with NEMA 1 and be CE compliant.

Time Lapse Video Cassette Recorder or Disk recorder

The time-lapse VCR/disk recorder shall be designed to suit multiple use. The recording capability shall enable continuous coverage over a long period of time with minimum tape changes.

Recording mode shall include standard VHS2 and 6-hour real time modes in addition to high density 18-hour linear real time recording. SP and EP recording modes shall make increase field recoding rate using standard high quality T120 VHS tapes.

The programming menu shall appear on the monitor output to provide easy setup of any programme feature. A lock mode shall disable all front panel controls presenting all changes to the unit's programming or operation. Playback features shall include speed search and reverse play back. Automatic alarm search feature shall allow the operator to go to a specific alarm index.

The salient features of disk recorder shall be as follows:

1. Standard VHS 2/6 hour recording mode;
2. 18/24/218/72/96/120/168 hour VHS compatible time-lapse modes;
3. Internal / short recording mode;
4. 24 hours real time recording mode;
5. High density record mode – triple speed time lapse recording;
6. Audio recording up to 24 hours;
7. Alarm index search;
8. Jog/shuttle for easy forward and reverse field playback and search;
9. On-screen menu programming;
10. Eight daily/weekly reading schedules.

CCTV Integration

A Close Circuit Television Camera's (CCTV) based on IP standard should be amenable to be integrated with the SCADA system. The camera integration feature should be a standard feature of SCADA in following ways -

Web Services

Video Viewer - ActiveX Control

PTZ Control (Pan, Tilt, Zoom) - ActiveX Control

Camera Manager

Add / Edit / Remove cameras in runtime environment

Camera configuration stored in DBF files

Pre-built Displays:

1 Up

2 Up

4 Up

9 Up

Additional features such as pop-up displays for motion/intrusion detection and linking of events with video functions should be made available.

1.10 Approved Vendor/Manufacturer/Make List-Instrumentation

The naming of a manufacturer in this specification is not intended to eliminate competition or prohibit qualified manufacturers from offering equipment. Rather, the intent is to establish a standard of excellence for the material used, and to indicate a principle of operation desired.

Sr. No.	Description	Vendor/Manufacturer/Make
1	LEVEL INDICATOR TRANSMITTER	M/S ABB-GERMANY M/S ENDRESS+HAUSER M/S SIEMENS-GERMANY M/S ROYCE INSTRUMENTS M/S HITACHI HIGH-TECH
2	PRESSURE INDICATOR TRANSMITTER	M/S EMERSON-USA M/S ENDRESS+HAUSER M/S SIEMENS M/S YOKOGAWA M/S FUJI ELECTRIC M/S ABB-GERMANY
3	ONLINE REAL TIME WATER QUALITY MONITORING INSTRUMENT SYSTEM	M/S TETHYS INSTRUMENTS-(FRANCE) M/S DKK (JAPAN) M/S IN SITU-(USA) M/S AQUALABO-FRANCE
4	CCTV	M/S SONY M/s HITACHI M/s AV SYSTEMS M/S AVTECH M/S BOSCH M/S HONEYWELL
5	UN-INTERRUPTIBLE POWER SUPPLY SYSTEMS	M/S EATON M/S FUJI ELECTRIC M/S HITACHI HIREL M/S TOSHIBA M/S ABB M/s DELTA M/S EMERSON ELECTRIC CO
6	BATTERIES	M/S SANKEN ELECTRIC M/S AMCO M/S EXIDE M/S SEC M/S FURUKAWA BATTERY M/S AMAR RAJA
7	PANELS/ENCLOSURES	M/S RITTAL M/S ELDON M/S CEPL M/S HOFFMAN M/S BCH

Sr. No.	Description	Vendor/Manufacturer/Make
8	CABLES	M/S UNIVERSAL CABLES M/S HAVELL'S M/S CCI M/S FINOLEX M/S NICCO M/S DELTON CABLES LIMITED
11	SMART MANAGED ETHERNET SWITCHES	M/S DIGISOL M/S/ D-LINK M/S TP-LINK

Note-1: In order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer's service, like items of equipment provided hereunder shall be the end products of one (1) manufacturer.

Note-2: All products shall be completely manufactured in the country of Origin as indicated. Assembled products shall not be accepted.

Note-3: In the event that the contractor wishes to propose alternate makes for the equipment mentioned above, he shall submit the following during detailed engineering:

- 1) Demonstrate that the proposed makes are “equivalent ” to the approved makes. The contractor shall ensure that alternate makes proposed, shall comply completely to the tender specifications, before the same is submitted for approval.
- 2) Submit ISO certificates for the OEM and CE certificates for the equipment.
- 3) Submit quality certificates that the equipment adheres to, as required under this contract.
- 4) Submit product brochures for the proposed equipment.
- 5) Submit documentation that the OEM facility where the equipment is manufactured has a full-fledged testing facility on the same premises ,where the proposed equipment will be inspected.
- 6) Manufacturer involved in manufacture of specified equipment for at least 10 years before bid date
- 7) End user performance certificates for minimum 10 successful individual installations of similar size , similar application as per this contract with the proposed equipment and model no, commissioned in last 5 years before bid date and satisfactorily operating for at least five years before bid date. Contractor to submit end user reference certificates for each of the installations referenced.
- 8) Manufacturer to provide full contact information for each reference as part of credentials submission.

1.11 Control Room Furniture:

In addition to the SCADA system equipment, the Contractor shall provide industrial grade system consoles to complement or match both the colour and styling of the equipment. The Control room Furniture shall comply with relevant IEC standards for ergonomic design. System console shall be so designed to house all servers, workstations. Monitors, interface equipment with cables having back entry. Details and design of system consoles shall be submitted to the Engineer for approval. The system console shall be as per the approved vendor list provided elsewhere in this specification.

Typically, The Contractor shall provide twenty five ergonomically designed swivel-type adjustable arm chairs with casters, ten lockable cupboard with glass doors , ten lockable File cabinets to store reports, storage of operating and maintenance manuals, drawings, logger paper, charts, disks and the like.

1.12 Large Video Wall for Water SCADA

A. General:

The video wall shall be positioned in the SCADA control room to provide the plant operators and visitors a complete view of the plant processes and CCTV feeds. The SCADA servers shall be interfaced with the video wall to enable the SCADA screens and all workstations including the historian station to be displayed in real time. The SCADA control room design shall cater to the video wall design such that the operator viewing angle is maintained at all time and the minimum distances between the video wall and operator is maintained as per OEM recommendation.

B. Operating Temperature in Control Room:

The SCADA control room air conditioning system shall be sized to provide adequate cooling, i.e., maintain 22Deg C at all times with the video wall in operation.

C. Water SCADA LED Video wall:

The Active LED video wall shall have display area of 55” with 2x5 configuration having display resolution of 7200 x 2430 pixels. The configuration shall have required AVoIP Encoders and Decoders with control Management Software. The Control Management Software shall be able to make complete video wall display behave as one logical area. It shall be possible to display any or all the inputs on the video wall in any desired configuration. It shall be possible to increase the no. of inputs if desired at a later stage.

D. LED Video wall (Active):

The system provided by the contractor shall meet the following parameters.

Sr. No	Description	Parameters
1	Pixel Configuration	Professional Grade 3 – in -1 SMD
2	Pixel Density	640000 pixels /sqmt. or better
3	Pixel Pitch	1.25 mm or less
4	Tile resolution	480 x 270 pixels
5	Brightness	800 nits Minimum
6	Contrast Ratio	5000:1 @ 1Lux 2000:1 @ 10Lux
7	Viewing angle - horizontal / vertical, degree	160°H / 160°V
8	Scan rate	1/45
9	Display colors	4.39 trillion (14-bit)
10	Cabinet Aspect Ratio	16:9
11	Color space	97% NTSC coverage
12	Refresh Rate	3840Hz or better
13	LED lifespan (50% brightness)	Minimum 100000 hrs
14	Environment	To be installed Indoor at control center premises
15	Processing	12 Bit or Higher
16	Power consumption per tile/ cabinet	Contractor to Specify Typical and maximum
17	Heat output per tile	Contractor to Specify Typical and maximum
18	Color Temperature range	2700-9600K
19	Runtime	24/7

20	Installation options	Flat, Concave
21	Direct mount system	Contractor to Include which shall be ADA-compliant
22	Maintenance Access	To be provided in Front
23	Power input rating	Contractor to Specify Typical and maximum
24	Operational Temperature Range F / C	Contractor to Specify Typical and maximum
25	Operational Humidity range	Contractor to Specify Typical and maximum
26	Storage temperature - degrees F / C	Contractor to Specify Typical and maximum
27	Cabinet IP rating	IP 30 or better
28	Certifications	CE (includes EMC), FCC, IC; CB, cULus/cCSAus/cETLus/cTUVus, RCM (1), BIS

E. LED Video wall controller:

Sr. No	Description	Parameters
1	LED Controller	LED Controller shall be with powerful video signal receivers, splicing and processing capacities, and support multiple signal inputs
2	Input port	Single-link DVI (HDCP compatible), HDMI 1.4a (HDCP compatible), 3G-SDI BNC
3	Input Resolution	1920 × 1080, 3840 x 2160 @60Hz
7	Output	6 × Gigabit Ethernet port, 2 × 10G optical port 3G-SDI LOOP, HDMI LOOP, DVI LOOP
8	Control	Ethernet, USB in, USB out, 1 x HDMI local monitor
9	HDCP	Support HDCP 2.2
10	Transmission Distance	CAT5≤140M; CAT6 170M; optical Fiber; No limitation
11	Peripherals	Multifunctional Card, Optical Fiber transceivers, gigabit switcher
12	Size	2U Standard Box
13	LAN	Network control (communication with PC, or access network) shall be provided
14	USB IN	USB input, which connects with PC to configure parameters shall be provided
15	USB OUT	USB output, cascading with the next controller shall be provided
16	Genlock	BNC in, BNC loop

17	Genlock Loop	Genlock synchronous signal loop output
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F. V- Over- IP- Receiver/Decoder Fiber-HDMI :

The device shall be built-in receiving an AV-stream including the control commands from an uncompressed or latency-free transmission with a resolution of up to 4K (60Hz, 4:4:4) in a standard 10 Gbit-Ethernet-Network and outputting audio and video signals via HDMI. The stream shall include the full resolution of the source up to 4k, the PreView stream sent by the encoder for preview in the management system and the information about the calculated resolution of the transmitted image or video signal for a multiwall display or supplement.

The system shall support Simplified device setup, deployment, and control through the management platform and its graphical user interface (GUI). Simplified setup of a large flexible AV-Network using the manufacturer's platform and complementary encoders and decoders shall be provided.

Specifications:

- HDCP 2.2 compatible (pass-through)
 - AES-128 encryption
 - EDID and CEC management
 - SDVoE compatibility
 - support video wall display over max. 15x15 displays, without external device
 - support multiview display of up to 19 sources, without external device
 - forwarding of control commands to ext. devices via Ethernetport
 - support multimode fiber (300m), singlemode fiber (10km)
 - support audio technologies and systems such as HDR10, HDR10 +, Dolby Vision®
- other supported resolutions: VGA: 640x480; SXGA: 1280x1024; 1080p/i: 1920x1080; SVGA: 800x600; WXGA: 1366x768; QXGA: 2048x1536; XGA: 1024x768; SXGA+: 1440x1080; UHD: 3840x2160; HDTV: 1280x720; UXGA: 1600x1200; 4K: 4096x2160, in 24bit, 30bit, 36bit or 48bit respectively

Connections:

- Audio/Video output: HDMI 2.0; TypeA incl. audio digital
- Analog audio output: sym. 3.5mm jack
- Control ext. devices: RJ45
- Streaming input 10Gb: MM or SM built-in module; SFP+
- USB: Single USB 2.0 TypeA
- Rx/Tx control
- without integrated fans
- networkable configuration and update possibility
- Basic software tools, diagnostic tool and drivers installed and on disk, current software updates as of delivery date shall be provided ,All manual shall be provided in English

G. AV- Over- IP- Transmitter/Encoder HDMI-Fiber:

The device shall be a compact device for feeding audio and video signal via an HDMI interface and outputting an AV stream including control commands for uncompressed or latency-free transmission with a resolution of up to 4K (60Hz, 4:4:4) in a standard 10 Gbit Ethernet network. The stream shall include

the full resolution of the source up to 4k, the Pre-View stream, sent by the encoder, for any preview in the management system and the information about the calculated resolution of the transmitted image or video signal for a multi-wall representation.

The system shall support simplified setup, implementation and control of the device through the management platform and its graphical user interface (GUI). Simpler Construction of an extensive flexible AV network with the manufacturer platform and complementary decoders and decoders shall be provided.

Specifications:

- HDCP 2.2-compatible (pass-through)
- AES-128 encryption
- EDID- und CEC-Management
- SDVoE compatibility
- support a video wall display via a maximum of 15x15 displays, without external device
- support a multi-view display of up to 19 sources, without external device
- Forwarding control commands to ext. Devices via Ethernet port
- supports audio technologies and systems such as HDR10, HDR10+, Dolby-Vision®
- Other supported resolutions:
VGA: 640x480; SXGA: 1280x1024; 1080p/i: 1920x1080; SVGA: 800x600;
WXGA: 1366x768; QXGA: 2048x1536; XGA: 1024x768; SXGA+: 1440x1080;
UHD: 3840x2160; HDTV: 1280x720; UXGA: 1600x1200; 4K: 4096x2160 , with
24bit,30bit,36bit or 48bit respectively
- **Connections:**

Audio/video input: HDMI 2.0; TypA incl. Audio digital
Analog Audio (I/O): sym. 3.5mm jack
Control ext. Devices: RJ45
Streaming output10Gb: MM or SM built-in module; SFP+
USB: Single USB 2.0 Type Mini-B
- Rx/Tx control
- without integrated fans
- network-capable configuration and update capability
- Basic software tools, diagnostic tool and drivers installed and on disk, current software updates as of delivery date shall be provided ,All manual shall be provided in English

H. Multi-Codec Management Platform: With Unlimited end-points License

Simplified Configuration and Control

Shall be Designed for the 4K (SDVoE, uncompressed 4K, 10 Gbps) AVoIP encoders and decoders; the multi-codec management platform shall enable source content to be simply dragged and dropped onto displays and video walls via an intuitive on-screen interface.

Easy Configuration: The Multi-Codec Management Platform auto discovery of all 4K endpoints shall allow the user to easily configure and manage the AV system.

Create Multi-views with up to 19 Sources: Graphical user interface shall provide common templates to easily create an unlimited number of multi-view configurations with up to 19 source images per display.

Hardware Specifications:

CPU	Intel® Pentium® Processor J5005
Operating System	Linux Ubuntu 16.04
Internal Storage	1 TB SSD
Graphics	Intel® HD Graphics 600
LAN	Gigabit LAN
Internal Memory	32 GB DDR4

I. Network Switch:

The network switch provided shall be compliant with major L3 Protocols and shall enable Zero-Touch install of SDVoE Video-over-IP .It shall streamline AV-over-IP SDVoE solutions, The switch shall be of Plug and play type and shall be able to grow as per requirements

1.13 Uninterruptible Power Supply (UPS)

The UPS shall be floor mounted; self-contained and metal clad and shall be suitable for supplying a non-linear load. It shall be possible to open the enclosure front door when the unit is in use without exposing any live contact to touch.

The UPS shall be an on-line type incorporating a six pulse rectifier and pulse width modulation inverter technology with microprocessor control. It shall incorporate a static bypass switch which shall operate in the event of UPS failure, overload or manual initiation in order to transfer the output supply to mains without disturbance to the output supply.

The UPS shall incorporate a dc under voltage trip circuit to electronically trip the UPS output in order to protect the batteries.

The noise level of the unit shall not exceed 60dB(A) at 1 m from the UPS cabinet.

The output of the inverter shall be a sine wave having less than 2% THD for linear loads and less than 4% for 50% non-linear load. It shall be suitable for load power factors 0.7 lag to 0.9 lead.

The unit shall have a dynamic response such that a 100% step load causes an output voltage transient of less than $\pm 4\%$ with a recovery time of less than 4 ms.

For three phase output units the output voltage shall not vary by more than $\pm 1\%$ for an unbalance of 10%.

The load crest factor shall not be less than 3:1.

The efficiency at full load and 0.8 power factor shall be greater than 88%.

The UPS System shall communicate the following status data to the centralized SCADA system to monitor: (Note: To be demonstrated during FAT)

- UPS status
- UPS alarm conditions
- Battery capacity

- Bypass status
- Fault

The UPS shall provide a volt free contact output to indicate:

- warning, i.e. low battery capacity
- fault
- static bypass in use.

The UPS shall have an overload capacity of 150% for 30 seconds and shall be protected in the event of a short circuit of the output.

The batteries shall be housed, either within the UPS enclosure or within a separate matching battery cubicle suitable for location adjacent to the UPS. The UPS battery shall be located in a well-ventilated area and the main enclosure shall be designed accordingly.

a) Technical Particulars:

Each UPS shall have the following features:

- The UPS shall be stand alone, true on line, based on advanced IGBT PWM technology with microprocessor-based control, monitoring and fault diagnostics, static by pass switch and front access-oriented layout.
- Main Parameters:

1	Input Voltage	415V +10% -15 % A.C. Three phase 4 wires with Solidly earthed Neutral.
2	Symmetrical Short circuit level. Frequency	25kA 50Hz ± 5%
3	Output Voltage	240 ± 1% A.C, Three Phase 4 wire with Solidly Earthed Neutral.
4	Frequency Wave form	50Hz ± 5% True Sine Wave
5	Isolation	True on line with complete galvanic Isolation
6	Total harmonic Distribution	< 2% for linear load, < 3% for non-linear load
7	Over load Capacity	125% for 10min 150% for 10Sec
8	Transient Response	Remain within ± 1% and recover to 100% within ¼ Cycle
9	Crest factor	3 : 1
10	Duty	Continuous
11	Static by pass	to be provided
12	Efficiency Converter	> 94%

	Inverter Overall	> 93% > 87%
13	Max Ambient Temp and Relative Humidity	45°C & 100%
14	Cooling	Forced air
15	Acoustic Noise Level	<60db at 1.5m

- c) The UPS shall be complete with Isolation transformer, Converter cum Charger, inverter, protections, indications, programming, microprocessor-based monitoring and fault diagnostic system, communication facilities, redundant control power supplies, SMF battery, accessories and interconnecting Cables.
- d) Constructional Features: The UPS shall be high quality CRCA sheet steel enclosed suitable for floor mounting. The sheet steel shall be of 2mm thick. All sheet parts shall undergo phosphating process to ensure anti rust conditioning and superior finish. Premier quality powder coating shall be applied. The degree of protection shall be IP 54. The UPS panel shall be provided with two earthing terminals. The final finish shall be Light Grey Semi Glossy Shade 631 of IS 5.

Converter cum Charger:

When normal AC supply is available, DC power for the inverter is fully supplied by the converter and the battery is kept under float charge. On main supply failure, the battery shall be automatically connected to the Inverter without interrupting the output voltage for critical load. Similarly on normalization of AC power, the DC load shall be transferred to the converter and battery shall be put on float charge without interruption at output side. The converter cum charger shall be designed to deliver the full load DC required by the inverter and charging of the battery. Battery charging shall be with float & boost mode selection with current limit.

1) Inverter:

The static inverter shall convert the power from the converter/battery into stable AC power which is supplied to load. The inverter shall be with the latest IGBT PWM technology with specially designed output transformer.

2) Battery Bank:

Batteries shall be 12V, SMF (sealed maintenance free) type. The Qty & AH of batteries shall be suitable for backup period of 60 minutes for full load.

The battery shall be rated to provide full load power for required backup time on AC power failure. After delivering this amount of power, the battery shall be suitable for recharging through converter cum charger on AC power restoration. The battery shall be mounted on a separate rack. The battery bank shall be complete with battery stand, interlinks and UPS to battery interconnecting cable.

3) Other features:

The other features of UPS shall be as follows:

- i) Microprocessor based Control, monitoring and fault diagnostics.
- ii) Comprehensive LED mimic and LED display with keypad Control to enable the following:
 - a) Date-time stamped event recording and logging in a non-volatile memory
 - b) Programming and Monitoring of various system parameters
 - c) Status indications and number of LCD digital meters.
- iii) 100% Nonlinear local handling Capability with low distortion of less than 5% and high crest factor of 3:1
- iv) RS 232c/ RS 485 interface port.
- v) Front access layout.
- vi) Inbuilt line chokes for main power supply.
- vii) Indications:
 - Mains 'ON'
 - Converter 'ON'
 - Inverter 'ON'
 - Battery Low
 - Over load
 - Inverter Trip
 - Charger Trip
 - Output 'ON'
- viii) Protections:
 - Incomer MCCB with Overload & Short circuit releases
 - Outgoing MCCB with Overload & Short circuit releases
 - Battery MCCB with Overload & Short circuit releases
 - Input under/over voltage
 - Converter over voltage
 - Battery Low
 - Battery charging current limit
 - Output under voltage
 - Output over voltage
 - Output over load
 - Output short circuit
 - Inverter over temp
 - Single phase prevention

Alarm and trip conditions shall be separately enunciated.

The backup period shall be minimum 1 hr on full load.

Testing Requirements

The Contractor shall carry out specified tests as follows in addition to any tests stated or implied by the foregoing sections of this clause.

The tests shall be carried out on the fully assembled unit utilising the batteries that are to be supplied with the unit.

The Contractor shall demonstrate the following on a minimum:

- change-over from full load with mains present to full load on battery supply;
- carry out a discharge test on the system at full load and for the specified duty bridging time period;
- carry out recharge test after operation for the specified duty bridging time at full load. The UPS shall supply the full load during the recharge cycle.
- Demonstrate the full functioning of the field system while running on UPS power.
- All Routine/acceptance tests as per relevant Indian / International standards shall be carried out in the presence of Employer / his Employer Representative

Quality Assurance/Quality Control (QA/QC)

QA/QVC shall comply with the Contract, with particular requirements specific to the equipment or service being provided as outlined below for systems and other equipment that shall comprise the instrumentation and automation system under this contract. The quality assurance/control procedures shall include, but not be limited to the following:

- Continuity and Wiring tests;
- Insulation and High Potential Testing;
- Complete functional test inclusive of calibration;
- Packaging and Shipping;
- Welding;
- Cleaning and Painting.

The quality assurance/quality control documentation shall include, but not be limited to the following:

- Material Certifications;
- Shop Test Reports;
- All other documentation required by applicable codes and standards.
- Calibration test
- Functional test of complete equipment inclusive of calibration test

1.14 SCADA Control Room design

Design Considerations

An ergonomic approach to the design of centralized SCADA monitoring center workstations and the layout of the control room shall contribute to achieving safety and performance objectives set for the centralized SCADA room.

Effective control room design shall consider safety and performance / aesthetic objectives and function to create workspaces that facilitate the complex interaction between operators, technology and the environment. Raised flooring, acoustic concerns, indirect lighting and the wellbeing, health and safety of each operator shall need to be addressed.

Operators in the control room shall work 24 hours a day, 7 days a week.

Control room design shall take into consideration room size, number of operators, viewing requirements and equipment. Operators shall be able to communicate with each other as well as have easy access to essential equipment. The height of the console shall be calculated so the shortest operator can see over the

top of any workstation mounted electronics to remote monitor walls, control panels or displays and the clearance underneath the work surface should allow for the tallest operator to sit comfortably.

When designing the control room to address these and other concerns, the following steps shall be taken to ensure operator comfort and minimize fatigue:

- Test console layout with operators for “human tasks” including sequential task simulations.
- Develop workstation layouts designed around acceptable reach zones and visual limitations.
- Take into account maintenance requirements and removal of equipment from both the rear and front of the workstation.
- Provide ergonomic footrests where appropriate.
- Provide 24/7 chairs with full adjustment capabilities.
- Reduce excess heat and noise by locating electronics in an equipment room.
- In workstation dimensions, consider the full height and size range of the operators, utilizing height adjustable work surfaces where appropriate.

The SCADA control room shall be constructed to a high standard to provide a high profile feature and focal point for visitors.

SCADA control room and associated areas shall be equipped with false flooring & false ceiling. The entire control room and associated areas shall be provided with air-conditioning systems (at least six nos of 2 tonne air conditioners in the main control room & server area).

No UPS system shall be installed in the control room. A separate UPS room ,separate battery room shall be provided in the administration building for the purpose.

The SCADA control room shall be equipped with false flooring to provide access for all cables. No cables shall be installed over the control room floor.

The SCADA control room shall be provided with air conditioning system .The temperature in any area of the control room shall not exceed 22deg C

1. Electrical & Earthing Requirements for SCADA control Room

SCADA Control room Power distribution system shall have redundancy at two levels. The electrical system shall be designed to incorporate spare capacity (Minimum 20%) at each distribution level. All wiring up to the SCADA Control room shall be laid in powder coated MS conduits / Aluminum raceway.

All power cables up to the SCADA Control room shall be PVC insulated type. All cables shall be armored cable type except where flexibility required does not permit use of armored cable.

Earthing system shall be as per IS – 3043.

Contractor shall design and implement anti- static EMI / RFI protection arrangement, wherever necessary.

The contractor shall design, engineer, supply/manufacture, test, erect, install, connect; commission and site test the Electrical Distribution System for any and all power requirements within the SCADA Control

room facility. This shall include, but not be limited to UPS, Lighting system, ACDB system and input power to various sub systems of the Server/SCADA Control room like cooling units, alarm systems etc.

Design, engineering, supply, section, wiring, commissioning and testing of all systems are in the contractor scope. Contractor shall design, engineer, supply, commission and test the electrical system considering the various loads it has to cater to.

The technical specifications and the scope for various items provided herein need to be verified by the Contractor. Contractor's scope shall include end to end system that is designed and implemented according to various applicable standards / regulations and meets total requirement for the Server/SCADA Control room Facility.

Copper earth pit station as per IS - 3043 using 600 X 600 X 3 mm copper earth plate complete with accessories and hinged cover shall be provided by the Contractor. Another earthing system shall be extended for equipment body earthing of SCADA control room, using 25 X 3 mmGI strip. Two Earthing pits shall be provided for UPS Earthing, which will be interconnected, and same grid will join the building-earthing grid at only one point. Earthing System shall be designed & maintained considering personnel safety and noise-resistant electronic environments by providing equi-potential bonding with earth resistance of less than 3 ohm. Contractor shall design, supply and implement the most efficient and safe earthing system considering the types of load, fault conditions, cross current circulation, spikes, circulating current due to potential differences, etc.

The earthing system implemented shall ensure safety of people and systems under all conditions. Earth fault protection shall be designed and implemented by the Contractor for all loads.

2. Fire Alarm System

The contractor scope of work shall include on a minimum, design, engineering, supply and installation & commissioning of Fire Alarm System suitable for control room and all ancillary facilities area.

Fire Alarm System (FAS) shall be designed to detect & suppress the incipient fires and generates audio/visual alarms in case of fire. The system shall consist of automatic fire detectors and manual call point & break glass units. Automatic fire detector shall work on principle of sensing the smoke, heat or infrared rays.

Detector shall be provided in control room and various location in the administration building. Manual call point shall be provided at exit doors/ routes of control room. Number of detectors and manual call point shall be decided as per guideline and codes.

Fire alarm system shall be microprocessor based fire alarm system and shall have addressable type field devices. It shall comprise following equipment's used in conjunction with addressable automatic detectors & and addressable MCPs.

1. Multi loop Data Gathering Fire Alarm Panel (DGFAPs).
2. Sirens & Starters, Hooters, exit signs.
3. Interface with other systems thru Dual redundant data highway with complete network hardware.

System shall be modular and facilitate future extension up to 20%. Redundancy shall be provided at Processor, communication, power supply level. Fire alarm logic shall be programmable type. Minimum number of detectors/ MCPs/ addressable devices in single loop shall be 60 nos. Conductor size of loop cable shall be 1.5 sq. mm copper. All field devices like detectors, MCP shall be addressable type. Fire alarm system shall be interfaced with Fire extinguishing system.

3. Fire Extinguishing System

The contractor shall supply on a minimum 10 Nos of fire extinguishers to be installed at the control room to cover all areas.

4. False flooring:

Finished height of Access floor up to 450mm Raised flooring shall be provided.

- a. The raised floor must be capable of withstanding a uniform load of 1,220 kg/m² with a maximum deflection of 2.5 mm.
- b. The recommended panel size for the raised floor is 610 mm square. These panels must be easily removable to facilitate access to the under-floor area. Special weather coating on back side of the tiles to be provided.
- c. The raised floor must be level within +3.2 mm overall and within +1.6 mm in any 3.05 m (10 ft) distance.
- d. Fire resistance of floor material must comply with more stringent, local regulations. It should be totally fire proof.
- e. The metallic structure of the raised floor must be electrically bonded to the ground to minimize static buildup. The floor panels must have conductive contact with either the framing, the pedestals, or both for positive electrical grounding.
- f. Panel surfaces must be high-pressure laminate. Do not use carpeting. Use material that is both dust and crack resistant. The material must withstand movement of heavy equipment on casters and must resist the buildup of static electricity. Cleaning products containing ammonia must not be used.
- g. All cable openings in floor panels must have plastic edging to prevent damage to cables
- h. Provide adequate drainage to ensure that no moisture accumulates in the recessed area.

Following provisions for the computer system between the raised floor and the primary floor: shall be provided:

- AC power distribution for the computer system
- Input/output cables.
- Air ducts or passages for cooling air
- Cable ducts

Clearance between the raised floor and the primary floor is 450 mm.

- i. The cables are to be routed along the under floor and brought up to the cabinet locations prior to placing the cabinets.
- j. Ensure that at least 102 mm (4 in.) of free space exists between the top of the under-floor cables and the raised floor. Route the cables so that excessive buildup does not occur in any local area. Cables routed under the floor that are to connect to electronic equipment must be routed so that excessive strain does not occur on the connector due to inadequate space for bent radius of the cable. In the case

of the large diameter input/output cables for peripheral equipment, provide a minimum bend radius of 212 mm (6 in.). All cables are to be routed at 90 degree angles. Power and signal cables must be separated by 150 to 300 mm to minimize noise interference.

- k. Matching/approved profiles to be provided.

1. Industrial system console for SCADA control room:

The Industrial system console solution shall be capable of performing 24X7 operations under the specified environmental condition. It shall conform to high standard of engineering as mentioned in the document; meeting the specified codes, designs and standards. All the certificates and reports mentioned below shall be submitted as part of datasheet submission. Entire system console shall be Green guard Gold and UL certified. The system console shall be sized to accommodate the complete SCADA system and its ancillaries inclusive of but not limited to the following:

1. Redundant SCADA servers
2. Operator and engineering work stations
3. Historian stations
4. CCTV stations
5. Managed Ethernet switches
6. Online printers
7. Other ancillaries

The entire Industrial system consoles shall be warranted for minimum five years against any manufacturing defect.

The Color scheme of the system console shall be as per GJB requirements and shall be decided during detailed engineering.

Hardware: - All bolts shall be of SS material to avoid rust due to environment. Remaining hardware shall be Nickel Plated with RoHS certificate.

1.15 Inspection & Testing Requirements for Instrumentation, Control and Automation equipment, other related equipment as required under specifications:

A. Inspection and Testing Requirements for Instrumentation works

1. Inspection, Testing and Setting to Work — General

Each item of plant shall be subjected to the manufacturer's own tests which shall be certified. Each item of plant and its installation shall be subject to inspection and testing at the place of manufacture. The Contractor shall be responsible for the provision of all necessary test equipment. The Contractor shall demonstrate to the Engineer, the correct operation of any item of plant and the Engineer may witness any test. Tests which, in the opinion of the Engineer, were failed or not performed correctly shall be repeated.

Before any test is made, the Contractor shall submit to the Engineer a full list of test equipment to be used. Each item of test equipment shall have a standard of accuracy better than that stated by the manufacturer of the item to be tested. The Contractor shall provide evidence of the condition and performance of any item of test equipment, in the form of test certificates issued by an appropriate authority independent of

the Contractor and manufacturer, or as otherwise directed by the Engineer. Test equipment shall be checked frequently during the period of the tests.

The Contractor's staff responsible for supervising and carrying out tests shall be fully conversant with the various items of equipment of other manufacturers and if necessary the Contractor shall arrange for his personnel to attend suitable training courses on his own expense. The contractor has to get approval from the client's representative for the training personnel to be employed by the contractor.

Any fault or shortcoming found during any inspection or test shall be rectified to the satisfaction of the Engineer before proceeding with further inspection or testing of that item. Any circuit previously tested, which may have been affected by the rectification work, shall be re-tested.

2. Preliminary Inspection and Testing at the Place of Manufacture

Field Instruments and Analytical Instruments

After the successful completion of the manufacturer's own inspection and testing of instruments to be supplied under the Contract, complete functional tests inclusive of calibration checks shall be carried out in the presence of the Engineer, engineer's representative and the Contractor at the manufacturer's factory where the instruments have been manufactured. Such tests shall include a demonstration that an increase or decrease of the measured value at several points over the full range of the instrument produces a corresponding increase or decrease in the instrument output signal. These tests shall include checks on the specified accuracy of the instrument at all points.

3. Instrument panels, enclosures and mounting boards

The manufacturer shall not present instrument panels, enclosures, junction boxes and mounting boards (assemblies) for inspection and testing until the manufacturer's own tests and inspection has been completed. A preliminary inspection and test of these assemblies shall then be witnessed by the Engineer, engineer's representative. The Contractor shall give not less than 15 days' notice in writing that he has completed his tests and inspection and is ready for the witnessed tests and inspection. Where this notice period is different in the Conditions of Contract this shall take precedent.

The witnessed inspection and testing shall include the following on a minimum:

- a. Complete functional testing of the instrument inclusive of calibration and sampling system
- b. A visual inspection of the panel assembly to show that the design, construction and finish are satisfactory and in accordance with the Specification;
- c. A check that equipment is securely mounted, accessible for removal or calibration without damage to or undue disturbance of other components, wiring or piping;
- d. That all engraving and labels are correctly positioned, fixed and designated in accordance with the Specification;
- e. Panel power-distribution circuits have the correct breaker/fuse rating coordination and designation;
- f. Power-isolation facilities meet the Specification;
- g. The main incoming supply voltage, frequency and/or pneumatic supply pressure is within the required limits, these being checked at the beginning and end of the test and the results recorded on test certificates;
- h. The output of all power supply units again at the beginning and end of the testing with results being recorded;

- i. The power supply voltage or air pressure of all component instruments of the assembly(s), these voltages/pressures being recorded on the test certificate;
- j. The insulation resistance of all circuits except sensitive electronic equipment which is liable to damage by application of the test voltage, such circuits being disconnected before making the insulation resistance tests and these tests being carried out in accordance with IEE Wiring Regulations;
- k. That the clean earth bar is isolated from main frame of the panel. Internal lighting and anti-condensation heaters and associated thermostats, isolators, limit switches and wiring shall be checked for compliance with the Specification. Spare capacity within the panel(s) shall be checked to see that it complies with the Specification. This shall include future equipment space, spare terminals, space in wiring trunking and provision for additional cable entry.

4. Functional Testing at the OEM factory where the equipment has been manufactured

General requirements

Once the preliminary inspection and testing is complete to the satisfaction of the Engineer, functional testing shall commence in the presence of the employer and employer's representative for 100% quantity of all equipment. The purpose of the functional tests are to demonstrate that all instruments and analytical instruments, LED screen display system, wireless communication equipment, etc, covering all instruments and related equipment (Junction box, local control panels, all cables, cable trays), panels' enclosures and mounting boards (assemblies), sampling system conform to requirements of the Specification. Functional testing on a minimum shall include, calibration check as per established international standards, transmitter function check, error reporting, alarm functions, communication check with external third party devices, etc.

Not less than 30 days before the commencement of functional tests, the Contractor shall submit to the Engineer, for approval, two copies of comprehensive test procedural documents detailing each test to be carried out. The document shall include results forms on which the results of each test will be entered. The forms shall include spaces for numerical values, where necessary, and witness signatures. All applicable drawings and data shall be provided at the place of inspection by the Contractor.

The Contractor shall provide all test instruments and equipment necessary to test the assemblies in their entirety.

The following is a typical list of the equipment required:

- Switch boxes;
- Indicator light boxes;
- Analogue signal sources;
- Dummy loads;
- Meters;
- Simulators;
- Desk-top computers;
- Programmers for PLC /RTU or outstations;
- Insulation test equipment.

5. Quality Assurance/Quality Control (QA/QC/QAP)

The quality assurance/control procedures shall include, but not be limited to the following:

- Continuity and Wiring tests;

- Calibration check;
- complete functional testing of equipment along with sampling system(as applicable);
- Insulation and High Potential Testing;
- Packaging and Shipping;
- Welding;
- Cleaning and Painting.

The quality assurance/quality control documentation shall include, but not be limited to the following:

- Material Certifications;
- Shop Test Reports;

All other documentation required by applicable codes and standards.

B. Inspection and Testing Requirements for Control & Automation works

a) Factory Acceptance Test (FAT)

The Contractor shall conduct a full programme of tests of the RTU/PLC & SCADA system at the Contractor's testing facility in the presence of the Engineer to verify that all features of the system have been provided, are operating correctly and are in full compliance with the Specification. Unless otherwise specified or agreed by the Engineer, the entire RTU/PLC & SCADA system shall be assembled and tested together as an integrated system, including all master station equipment, all operators' consoles, all outstations and telemetry equipment all instrumentation panels and uninterruptible power supplies included in this Specification. The scheduled date for the factory acceptance test shall be as agreed by the Contractor and the Engineer at least four weeks before the test.

The RTU/PLC and SCADA system shall be conducted as one complete system FAT only. No separate FAT for RTU/PLC and separate FAT for SCADA system shall be conducted. Contractor to note the importance of this clause.

Not less than one month before the scheduled factory acceptance test, the Contractor shall submit to the Engineer for approval two copies of a comprehensive manual detailing each test to be conducted. The manual shall include a results form on which the results of each test will be entered, including spaces for numerical values where appropriate and witness signatures.

Not less than 21 days before the scheduled factory acceptance test, the Contractor shall submit the internal completed FAT test reports to the Engineer as per contract requirements, which has been witnessed and signed by the contractor representative and that, in the opinion of the Contractor, the system exhibits stable operation and is ready for the formal factory acceptance test by the employer and the employer's representative.

The factory acceptance test will be considered successfully completed only when the system has successfully passed all factory tests as detailed in the FAT procedure and Functional design specifications. The system shall not be delivered to Site until the successful completion of the factory acceptance test is certified by the Engineer. Delay in the delivery of the system due to failure of the factory acceptance test shall not constitute an unavoidable delay. If the system fails the factory acceptance test, the test shall be extended or rescheduled at the discretion of the Engineer.

All hardware to be used in the testing of the system shall have passed an agreed preliminary hardware performance test to ensure known hardware operability before software testing begins.

After successful completion of the factory acceptance test, no software changes shall be made to the system without written authorisation by the Engineer. Any changes to the system which effect the system software documentation, such as input scale modifications or changes to the control logic, shall be entered into the system documentation before delivery of the system to Site.

The entire cost of the complete FAT and any other required testing(interoperability, site visits etc..), including reasonable per diem expenses to cover meals, lodging, transport and similar expenses for all GJB & employers representative personnel attending the tests, shall be the responsibility of the Contractor/ system supplier and shall be included in the contract price.

b) Factory Acceptance Test Procedures

1) General

The scope of the tests shall include the proving of every aspect of hardware and software operation and functions as detailed below.

2) Hardware tests

- (a) Verify the correct inventory of hardware including cables and printed circuit boards;
- (b) Demonstrate that all spare-memory, disk-capacity and system-expansion requirements have been met;
- (c) Demonstrate all hardware and software diagnostics;
- (d) Verify all power supply voltages are within tolerance;
- (e) Verify proper earth connections and isolation of instrumentation earth for all equipment;
- (f) Demonstrate operation of test simulation and indication equipment and its Suitability for adequate functional testing of all system functions.

3) Software tests

- (a) Demonstrate the editing of all system parameters including set-points, timers and the like;
- (b) Demonstrate system configuration capabilities including the addition and deletion of input and output points, outstations, and all data base parameters;
- (c) Demonstrate the addition, deletion and modification of mimic displays and report formats;
- (d) Complete control philosophy with all interlocks shall be demonstrated
- (e) Historian data check.

4) Functional tests

The functional tests shall verify proper operation of every specified system function as an integrated system. These tests shall be conducted in conjunction with functional tests of instrumentation and control panels as specified elsewhere. All failures or discrepancies found shall be documented in the test manual.

Following a failure of any functional test, should software or hardware modifications be required it shall be the decision of the Engineer whether the factory acceptance test is to continue, re-start or be aborted. If testing is allowed to continue, any changes which are required shall be described in a system modification document, signed by both Contractor and Engineer and be incorporated into the final factory acceptance test documentation. The failed test shall be re-conducted and the Engineer may require the retest of functions which may be affected by the modification.

The functional tests shall include, as a minimum, the following:

- (a) Demonstration that the system meets the requirements of the Specification for response time and speed of screen update
- (b) Verification of the accuracy of all analogue input points in the system. The procedure shall include applying the appropriate signal to each analogue input at a minimum of three points within the range of the input, checking for expected numerical results, and verifying appropriate update of related mimic displays. Proper sensing and action by the system to high and low out-of-range inputs shall also be verified
- (c) Verification of the proper logic sense, pulse accumulation and rate computation where appropriate, of all digital inputs and verifying appropriate update of related mimic displays;
- (e) Verification of all control and sequencing operations and proper operation of all digital and analogue outputs. The procedure shall include simulation of all related process variables for both normal and abnormal conditions, including instrument and component failure, and demonstration of fail-safe response of the system. System outputs shall be indicated with appropriate lamps and indicators;
- (f) Simulation of outstation communications errors and failures and demonstration of error detection and handling, failure detection and handling, and appropriate changes to control actions as designed and specified;
- (g) Verification of fault detection and diagnostics by inducing a sufficient variety of fault conditions in the system to ensure that detection processes and fail-safe operation are adequately tested;
- (h) Demonstration of proper operation of all mimic displays, help pages, reports, operator procedures and historical data accumulation;
- (j) Demonstration of proper operation of all outstations following a simulated master station central processor failure;
- (k) Demonstration of proper operation of all equipment during both a system wide or isolated power failure, and following power restoration. The procedure shall include the demonstration of battery backup of both master station and outstation for the full length of time specified, and proper operation of power fail, low voltage warning and all associated alarms.

5) Reliability test

After successful completion of the functional tests a 48-hour continuous run of the system shall be performed. The test shall be passed if no system function is lost or no hardware or software failure occurs. Hardware failure is defined for this test as the loss of a major component such as the computer, an outstation, a VDU or a peripheral device. Non-repetitive mechanical failures of loggers, push-buttons and the like are excluded.

During this test, the system shall be exercised with simulated inputs and conditions in a manner which approximates the on-site operational environment. Unstructured testing by the Engineer shall be included during this test. Upon any system failure during this period, it shall be the decision of the Engineer whether the reliability test is to continue or be aborted. If testing is allowed to continue any changes to the system which are required shall be described in a system-modification document, signed by both Contractor and Engineer and the document shall be incorporated into the final factory acceptance test documentation.

e) Factory acceptance test documentation

As a minimum, the following information shall be included in the factory Acceptance test manual for each test:

- Test identification number;

- Test name and description;
- List of all equipment to be tested including any special test equipment required;
- Description of the test procedure broken down into logical steps, complete control philosophy check;
- Description of the expected system response verifying the completion of each logical step;
- Space for recording the results of the test and the time and date of the test;
- Space for signatures of the Contractor and the Engineer.

In addition, the Contractor shall provide a method for recording and tracing all problems, discrepancies, queries and suggestions regarding the system and software, and for formalised control of any modifications to the system.

d) Pre-commissioning tests

The Contractor shall perform pre-commissioning, or preliminary, testing of the CWMC SCADA system in accordance with that specified for instrumentation. The purpose of pre-commissioning tests is to confirm readiness of the system for commissioning.

The scope of pre-commissioning tests shall be generally as specified for factory acceptance tests but real field inputs and final control elements shall be used wherever practical to provide inputs to the system and to confirm proper outputs.

Where this is impractical, simulation signals shall be injected as near as possible to their ultimate sources so as to include in the tests as much of the cabling system as possible.

Each process system shall be set to work under manual control and the system tested to confirm proper operation. After proper operation of manual control mode has been verified, tests of automatic controls of each process system shall be conducted wherever practical.

e) Site Acceptance Tests (SAT)

The Contractor shall submit all relevant draft operating manuals for the complete System to the Engineer for approval prior to commissioning tests. Any faults or failures of the system detected during the previous tests shall be noted and corrected to the satisfaction of the Engineer before commissioning is allowed to commence.

As part of commissioning of the system (complete Centralized SCADA system inclusive of Water SCADA system inclusive of analytics module for water demand and consumption functionality, , Historian systems, , Cyber security systems, Antivirus systems, LED video walls and controllers, Field instrumentation , Analytical instrumentation, Water quality multi parameters instrumentation, LED screen display system, wireless communication equipment, UPS systems, etc, covering all instruments and related equipment (Junction box, local control panels, etc) shall be tested for availability for a continuous period of sixty days. During this period, the system will perform the normal functions according to the procedures described in the SAT documentation approved by the Engineer.

The system shall have passed the SAT if all components have been free from fault or failure and exhibit full error-free functionality for 100 % of the total duration of the test. Components include all master station equipment, outstations, communications facilities and instrument panel components, excluding push-buttons, switches and lamps and any equipment not supplied by the Contractor. If the system fails to

meet the above criteria, the SAT period shall be reinitiated further for a period of thirty days, till such time the complete system exhibit full error-free functionality for 100 % of the total duration of the test.

During SAT, no modifications to the system shall be made by the Contractor without the written approval of the Engineer. Erroneous functioning which requires software modifications or re-configuration to correct, other than set-point or parameter changes, shall constitute a failure of the availability test. Any changes to the system which are required and approved shall be described in a system-modification document, signed by both Contractor and Engineer and the document shall be incorporated into the final test documentation. The test shall be restarted after corrections have been made.

1.16 Training Requirements

A. Before Conduction of Site Acceptance Test(SAT)

The system supplier shall conduct training courses for personnel selected by GJB. Training shall be conducted by personnel employed by the Contractor/ system supplier familiar with the system supplied and who have experience and training in developing and implementing instructional courses.

Training shall be conducted for a minimum period of two (days) for at least fifteen GJB personnel on all site as applicable, by the system suppliers (complete Centralized SCADA system inclusive of Water SCADA system inclusive of analytics module for water demand and consumption functionality, , Historian systems, , Cyber security systems, Antivirus systems, LED video walls and controllers, Field instrumentation , Analytical instrumentation, Water quality multi parameters instrumentation, LED screen display system, wireless communication equipment, UPS systems, etc, covering all instruments and related equipment, etc

The entire cost of the complete training programme, including reasonable per diem expenses to cover meals, lodging, transport and similar expenses for all GJB personnel attending the training program, shall be the responsibility of the Contractor/ system supplier and shall be included in the contract price.

The Contractor/ system supplier shall submit information on the training programme for approval, 45 days prior to training program. This submittal shall include a course outline; time required, course schedule, sample workbook and instructor qualification information for each level.

The Contractor/ system supplier shall make a workbook on each course available to every person taking the courses listed herein. The workbook shall be of sufficient detail so that, at a later date, a trainee could review in detail the major topics of the course.

B. After Conduction of Site Acceptance Test(SAT)

Training shall be provided for ten (10) of the GJB personnel at the facility on operations and maintenance of all components. The training program shall be divided into two segments and shall consist of at least 5 (five) working days, each of 8 (eight) hours duration. This shall include (complete Centralized SCADA system inclusive of Water SCADA system inclusive of analytics module for water demand and consumption functionality, , Historian systems, , Cyber security systems, Antivirus systems, LED video walls and controllers, Field instrumentation , Analytical instrumentation, Water quality multi parameters instrumentation, LED screen display system, wireless communication equipment, UPS systems, etc, covering all instruments and related equipment,etc.

The maintenance training program shall be developed for personnel that have electronics maintenance and repair experience and a general knowledge of computer systems, but shall not assume any familiarity with the specific hardware furnished.

As a minimum, the following subjects shall be covered:

- System Architecture and Layout
- Hardware Components
- Module Switch Settings (Configuration Switches)
- I/O Modules
- Power Supplies
- Data Highway:
- Programmer connection
- IOP programming and diagnostic techniques
- Battery replacement and recharging
- PC and workstation familiarization and maintenance:
- Troubleshooting
- Disassembly
- Cleaning
- Component Replacement
- Re-assembly
- The operation training programme shall include the following topics:
- Power-up, bootstrapping and shutdown of all hardware devices
- Interpretation of all standard displays
- Appropriate actions for software and hardware error occurrences
- Use of operator interface displays and keyboards
- Use of printer including replenishment of supplies
- Manual data entries
- Creation and editing of graphic operator display screens.
- Loading of any required software into the system
- Data base creation and editing.

Note-1: In addition to the above, the contractor shall conduct training to AEE, EE and SE/ACE cadre of GJB to familiarize them to the functionality of the centralized SCADA systems and all its ancillary system. Separate training manuals shall be prepared for the above mentioned management staff of GJB, which shall help them to monitor the complete functioning of the centralized SCADA center and its ancillary systems. The training program shall be two days (2) period of 8 hour duration each, covering all the aspects of the CWMC-centralized SCADA center

Note-2 : Contractor shall additionally refer to Training & advisory requirements for complete training requirements.

End of PART 5

PART-06

DATA COMMUNICATION EQUIPMENT REQUIREMENTS

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Part-06

Data Communication Equipment Requirements

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Part-06
Data Communication Equipment Requirements

6.1 Introduction

The contractor under this contract package CP-09 is required to integrate remote stations with the centralized SCADA center for monitoring& control of the remote location data. The data transfer from each of the remote locations shall consist of complete plant operational data and other parameters as required by the centralized SCADA operator.

The data communication from remote stations to the centralized SCADA center shall be broadly classified in the following communication networks:

- 1) Wireless Communication Network

The contractor under this contract shall design, supply, test, install and commission the data communication network to achieve seamless integration with various remote locations such that data from these locations are integrated with the CWMC-centralized SCADA center in real time.

6.2 Wired Communication Network:

The wired communication network under this contract shall comprise of the following:

- 1) Leased Line services

6.3 Submissions by the Contractor

1) Scope of Submissions

The Contractor shall make submissions of all design drawings and data sheets relating to data communications systems and equipment (Functional Design Specifications-FDS). These submissions shall include, but not limited to, the following:

2) Statement of Compliance

The Contractor shall provide copies of the reference standards used and shall provide a compliance/non-compliance statement.

3) System Description

The Contractor shall submit a complete written system description (Functional design specification – FDS) for each telecommunications system for approval.

The system description(s) shall describe the "fail safe" features incorporated into the design in the event of a failure of a plant item or system, or loss of an input signal affecting a telecommunications system. The description shall also cover the consequences up on the power failure.

The description(s) shall be presented in a clear and precise manner and shall include figures or drawings where appropriate.

4) Design Documentation, Drawings and Data sheets as part of Functional Design Specifications-FDS

1. A list of the channel allocations;
2. A transmit/receive power budget for each application;
3. A reliability analysis for each system;
4. General schematic arrangement (block diagram), of each telecommunications system, showing cabling arrangements between receive/transmit points and the basic equipment mounted at each point;
5. General arrangement drawings of field-mounted telecommunications equipment showing installation details (including location drawings, mounting arrangements and housing details);
6. General arrangement drawings of telecommunication panels, fully dimensioned in plan and elevation views, showing foundation and fixing details, access doors, clearances, cable entry positions, weight and lifting arrangement;
7. Layout drawings of panel fascias showing controls and details of all labels;
8. Layout drawings of panel interior showing equipment, terminal blocks and cable ways;
9. Internal circuit and wiring diagrams for telecommunications panels;
10. Cable block diagrams;
11. Telecommunication systems and panel power distribution diagrams;
12. Labelling lists;
13. Comprehensive testing schedules for all off site, on site, pre-commissioning and commissioning tests and take over tests;
14. All other drawings necessary for the provision of ducts, openings, trenches, fixing holes for panels etc. and for the complete understanding of the operation, maintenance and extension of the system including any drawings required for the GJB to dismantle, repair, maintain, modify or extend the Plant.
15. Data and Calculations :
 1. Manufacturers' catalogues and data sheets;
 2. Calculations to support telecommunications system design;
 3. Specification for protective coatings and painting
 4. Certificates
16. Manufacturers' Works tests;
17. Pre-installation checks;
18. Telecommunications system test check sheets;
19. Installed telecommunications systems performance tests

5) Operation and Maintenance Instructions

1. Composite manual describing the function and operation of each piece of equipment;
2. Composite manual for testing and servicing every system and individual item.

6.4 Leased Line services:

The contractor shall provide redundant uncontended leased lines to communicate data to the centralized SCADA control center. The leased line shall be enterprise grade, high speed leased line that shall provide consistent performance, security and reliability between the connected sites. The

leased line network chosen shall be backed by state of art network operation center (NOC) and shall provide round the clock support function for all issues encountered in connectivity.

End to end enterprise SLA agreement for 100% shall be provided and submitted as per requirements of this contract. The leased line shall be provided with DDoS protection and mitigation measures for all type of attacks and managed firewall services. The leased line shall be with a dedicated speed of minimum 50 Gbps and shall be based on fibre network and premium DIA (direct Internet access) shall be provided under this contract.

6.5 GPRS Wireless Communication Equipment:

GPRS wireless mode of communication shall be the primary mode of communication between ground level reservoirs, Water quality multi-parameter instrumentation, Flow & pressure in the water distribution network with the CWMC-Centralized SCADA center.

6.6 Technical Specifications

Industrial Cellular 4G Gateway

Description/ Parameter	Specifications
Cellular Interface	
SIM	2 x Mini SIM (2FF)
Connector	SMA-K
Number of antennas	2 (MAIN + AUX)
Ethernet Interface	2 x 10/100 Mbps, 2 x LAN or 1 x LAN + 1 x WAN WAN port
Number of ports Supports	
Magnet isolation protection	1.5 KV
Wi-Fi Interface	2.4 GHz
Standards Frequency bands	
Security	WEP, WPA, WPA2
Encryption	64/128 AES, TKIP
Data speed	2 x 2 MIMO, 300 Mbps
Number of antennas	Two
Connector	RP-SMA-K
Serial Interface	
Type	RS232 or RS485 (software configurable)
Connector	1 x 3-pin 3.5 mm female socket
Signal definition	RS232: TXD, RXD, GND RS485:

		A, B
	Software (Basic features of OS)	
	Network protocols	PPP, PPPoE, TCP, UDP, DHCP, ICMP, NAT, HTTP, HTTPs, DNS, ARP, BGP, RIP, OSPF, NTP, SMTP, Telnet, VLAN, SSH2, DDNS, etc.
	VPN tunnel	DNP3, IPsec, OpenVPN, GRE, Wire Guard Modbus RTU Gateway
	Firewall	DMZ, anti-DoS, Filtering (IP/Domain name/ MAC address), Port Mapping, Access Control
	Remote management	Web, CLI, SMS
	Serial port	Transparent, TCP Client/Server, UDP, Modbus RTU Gateway
	SDK	
	Supported Programming Language	C, C++
	Flash available for SDK	16 MB
	RAM available for SDK	64 MB
	Power Supply	9-32 VDC
	Operating Temp	-20 to 65 Deg Cen
	RH	5 to 95%
	Others	
	Reset button	1 x RST
	LED indicators	1 x RUN, 1 x MDM, 1 x WIFI, 3 x RSSI
	Built-in	Watchdog, Timer

END OF PART-6

PART 7
GENERAL ELECTRICAL REQUIREMENTS
(DELETED)

End of Part-7

PART 8

GENERAL INSTRUMENTATION & CONTROL REQUIREMENTS

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PART 8

GENERAL INSTRUMENTATION & CONTROL REQUIREMENTS

8.1 Introduction

This part covers the general requirements for the design, supply, installation, inspection and testing of the Instrumentation, Control and Automation and associated plant and materials. On a minimum, under this contract shall be provided with the individual instrumentation, control and automation equipment as detailed under the general and particular requirements.

8.2 Reference Standards

Unless otherwise approved, all equipment shall comply with relevant quality standards test procedures and codes of practice collectively referred to as Reference Standards including those listed below in accordance with the requirements detailed elsewhere in this specification.

Generally, the following latest edition of codes and standards prevailing at the time of award of contract shall be applicable.

8.2.1 Temperature Measurement

- a) Instrument and apparatus for temperature measurement - ASME PTC 19.3 (1974).
- b) Temperature Measurement - Thermocouples - ANSI - MC 96.1 - 1982.
- c) Temperature Measurement by electrical resistance thermometers – IS : 2806
- d) Thermometer-element-Platinum resistance - IS: 2848 / DIN 43760

8.2.2 Pressure Measurement

- a) Instrument and apparatus for pressure measurement - ASME PTC 19.2 (1964).
- b) Bourdon tube pressure and vacuum gauges - IS: 3624/1996.

8.2.3 Flow Measurement

- a) Instruments and apparatus for flow measurement - ASME PTC 19.5 (1972) Interim supplement, Part-II
- b) Measurements of fluid flow in closed conduit - BS 1042.

8.2.4 Electronic Measuring Instruments and Control Hardware

- a) Automatic null balancing electrical measuring instruments -ANSI C 39.4 (Rev. 1973), IS 9319

- b) Safety requirements for electrical and electronic measuring and controlling instrumentation - ANSI C 39.5 / 1974.
- c) Compatibility of analog signals for electronic industrial process instruments - ISA-S 50.1: ANSI MC 12.1 / 1975.
- d) Dynamic response testing of process control instrumentation - ANSI MC 4.1 (1975) - ISA -S26 (1968).
- e) Surge withstand capability (SWC) tests - ANSI C 37.90A (1989), IEC-255.4.

8.2.5 Instrument Switches and Contacts

- a) Contact Rating - AC services NEMA ICS Part-2 125, A-600
- b) Contact Rating - DC services NEMA ICS Part-2 125, N-600

8.2.6 Enclosures

- a) Enclosures for Industrial Controls and Systems–NEMA ICS-6-110.15 through 110.22
- b) Racks, panels and associated equipment -EIA: RS-310-B-1983 (ANSI C83.9 - 1972).

8.2.7 Apparatus, Enclosures and Installation Practices in Hazardous Area

- a) Classification of hazardous area - NEMA Article 500, Volume-6, 1978.
- b) Electrical Instruments in hazardous dust locations - ISA-RP 12.11.
- c) Intrinsically safe apparatus - NFPA Article 493 Volume-4 1978.
- d) Purged and pressurized enclosure for electrical equipment in hazardous location
- e) - NF Article 496 Volume-4, 1978.

8.2.8 Sampling System

- a) Stainless Steel material of tubing and valves, for sampling system - ASTM A269-79 GRTO-316.
- b) Submerged helical coil heat exchangers for sample coolers -- ASTM D11-98.

8.2.9 Annunciators

- a) Specifications and guides for the use of general-purpose annunciators - ISA RP 18.1.
- b) Surge withstand capability tests -ANSI C37.90 a -1971 and IEEE Standard 472- 1974

8.2.10 Interlocks, Protections

- a) Relays and relay system associated with electric power apparatus - IEEE Standards 3.13.
- b) Surge withstand capability tests - ANSI C37.90 a - 1971 and IEEE Standard 472-1974.
- c) General requirements and tests for switching devices for control and auxiliary circuits including contactor relays - IS-6875 (Part-I)/1973.

8.2.11 UPS System

- a) Practice and requirements for semi-conductor power rectifiers - ANSI C34.2.
- b) Relays and relay systems associated with electrical power apparatus IEEE Standard - 3.13.
- c) Surge withstand capability tests - ANSI C 70.90 A/1971, IEC-255.4.

- d) Recommended practice for sizing large lead storage batteries for generating stations and sub-stations - IEEE-485.
- e) Ni-Cd Battery - IEEE Std. 1106 /IS 10918

8.2.12 Instrument Tubing

- a) Seamless Carbon Steel Pipe - ASTM-A-106.
- b) Forged carbon steel fittings - ASTM-A-105.
- c) Dimensions of fittings - ANSI-B16.11.
- d) Code for pressure piping, welding, hydrostatic testing - ANSI-B 31.1.
- e) Nomenclature for instrument tube fittings - ISA-RP 42.1 / 1982.
- f) Seamless Stainless Steel Tube ASTM A-213 TP 316 / ASTM A-269 TP 316
- g) Seamless Alloy Steel Pipe ASTM A 335 P22
- h) Seamless Stainless Steel Pipe ASTM A-312 TP 316

8.2.13 Cables

- a) Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy-IPCEA S-61-402
- b) Guide for design and installation of cable system in power generating station (insulation, jacket materials) - IEEE Standard 422.
- c) Requirements of vertical tray flame test - IEEE 383
- d) Standard specification for tinned soft or annealed copper wire for electrical purpose - ASTM B33.

8.2.14 Electronic Cards, Subassemblies and Components

a) Unpackaged

- i. Vibration : IEC-68.2.6
- ii. Shock : IEC-68.2.27
- iii. Drop & Topple : IEC-68.2.31

b) Packaged

Vibration, Drop & Static Compression - NSTA.

c) Electromagnetic Compatibility

- i. Electrical Fast Transient : IEC-801.4
- ii. Surge Withstand : IEC-255.4
- iii. Radiated Electromagnetic Field : IEC-801.3
- iv. Electrostatic Discharge : IEC-801.2
- v. Electromagnetic Emissions : VDE 0871, Class-B

8.2.15 Cable Trays, Conduits

- a) Guide for the design and installation of cable system in power generating station (cable trays, support systems, conduits) - IEEE Standard 422, NEMA VE-1, NEC-1981. Test Standards NEMA VE-1-1979.
- b) Galvanizing of carbon steel cable trays - ASTM A-386.

8.2.16 Characteristics

- 1) ISO 9000 and 09004 - Quality Systems

-
- | | | |
|-----------------------|---|--|
| 2) IEEE 587 | - | Power Supply Surge Protection\ |
| 3) IEC 61158-2 | - | Communication Protocols |
| 4) ISO 9075 (BS 6964) | - | Structured Query Language (SQL) |
| 5) BS 5515 | - | Documentation of Computer Based Systems |
| 6) BS 7165 | - | Recommendation for Achievement of Quality in Software |
| 7) BS EN 50081 | - | Electromagnetic Compatibility |
| 8) ISO 3511 | - | Process measurement control functions –
Instrumentation symbolic representation |
| 9) ISO-OSI | - | 7 Layer Communication Model |
| 10) IEEE 472-1974 | - | Surge protection. |

All standards which the Contractor intends to use but which are not part of the above Standards or other listed Reference Standards, shall be submitted to the Employer Representative for consent before any design against that standard proceeds.

8.3 Project Requirements

- 1) Contractor shall provide material, equipment & services specified or otherwise required to fulfill the intent of specification and to integrate into a fully functional Centralized SCADA system ensuring operability, maintainability and reliability and durability for comprehensive operation & maintenance period of seven (7) years described in this specification.
- 2) Contractor shall furnish their offer based on the requirements as described in the specification.
- 3) The scope of supply shall include but shall not be limited to the following:
 - a) Field instruments and sensors for remote measurement, Primary flow elements along with branch pipes, root valves, nipples, flanges, nuts, bolts, gaskets and accessories.
 - b) Instrumentation pair, triad & core cable, instrumentation power cable, optical fiber cable, special cable etc, cable trays. as required.
 - c) Control panel, panel instruments, field junction boxes, instrument enclosures accessories and furniture (system consoles), as required.
 - d) Required power supply
 - e) Supply of all start-up, commissioning and recommended spares in addition to the mandatory spares.
- 4) Ingress protection of panels shall be as per requirements mentioned in this document.
- 5) Local Panels, Gauge Boards and Transmitter Racks, stanchions, brackets etc. as required.
- 6) Process connection and piping materials including impulse pipes of different grades & stainless steel tubes, stub, bosses, root valves, isolation & drain valves, valve manifolds, gauge valves, condensate pot, fittings, stands, brackets etc. as applicable, for satisfactory installation of all field instruments and analysers.
- 7) Pneumatic tubing along with fittings and isolating cocks for air consumers.
- 8) Erection hardware including junction boxes, canopies, field enclosures for all instrumentation, structural steel items viz steel angles, channels, flats.

-
- 9) Complete cable accessories viz flexible conduits, sub-trays/perforated trays, pull boxes, inspection covers, bends, elbows, mounting brackets, clamps, nuts and bolts, glands, lugs, ferrules, connectors, markers, tray supports, rigid conduits, tie wraps etc.
 - 10) Complete optical fiber cable /special cables with accessories like optical fiber distribution box, patch cord / pigtail, converter, terminators, taps, heavy duty conduits etc. to make the system complete in all respect.
 - 11) Rating plates, Nameplates and Labels.
 - 12) Maintenance, calibration, commissioning, site testing and troubleshooting equipment.
 - 13) Fiber optic cable and accessories including tray /conduit for system data network and for data collection through Modbus, Ethernet or OPC connectivity, wherever required.
 - 14) Arranging all performance test instruments and equipment.
 - 15) Instrument control panels.
 - 16) Performing tests on all equipment as per Quality Plan prior to shipment.
 - 17) Contractor shall be responsible for software licensing, design, development, debugging, system engineering, customizing, installation, site modification, tuning, adjustments, commissioning and furnishing manuals, documentation etc.
 - 18) Drawings and Documents: Contractor shall furnish system description, operational write-up, bill of materials, drawings, data, information, technical catalogues, test certificates and other details to establish the provenness, capability and performance of the equipment and systems offered.
 - 19) Final Drawings
 - a) Contractor shall secure approval on the design drawings from Employer for the drawings identified as “Approved”, in writing. Any manufacture done prior to approval of the drawings shall be rectified in accordance with the approved drawings by Contractor at his own cost and time and the equipment shall be supplied within the stipulated period.
 - b) Contractor shall furnish final drawings and documents in multiple (3 sets) hard and soft copies. Contractor shall furnish instruction manuals containing various components, sub-assemblies, method of installation, check-ups and tests to be carried out during erection and commissioning of the equipment. The manual shall also include instruction for step checking, trouble shooting and fault rectification for different components and sub-assemblies.
 - c) Contractor shall incorporate all modifications in the drawings carried out at site during trial run, start-up performance and guarantee tests till hand over of the units to Employer and submit these final as-built drawings both in hard and soft copy.
 - d) Final documents shall be submitted in proper bounded form. All catalogs and literature (including sub-suppliers’ catalogs), datasheets, Instrument list, input output list, function control diagram, loop diagrams, configuration diagram etc. shall be bounded together in indexed volumes. All O&M manuals shall be in handy size and neatly bound for carrying it to the work place.
 - e) Contractor shall convert all drawings and documents, manuals under this contract in to PDF format and store it in operator work station at the SCADA control room.
 - f) Operation and maintenance instructions
 - 1) Composite manual describing the functional and operation of each piece of equipment.

- 2) Composite manual for testing and servicing every system and individual item.
 - g) Original manuals and CDs from OEMs.
 - h) Training material shall be provided which shall include the presentations used for trainings and also the required relevant documents for the topics.
-
- 1) The selected Contractor shall submit a complete set of
 - 2) Floor Layout Drawings,
 - 3) Single Line diagram.
 - 4) Complete cabling system layout (as installed), including cable routing.
 - 5) The layout shall detail locations of all components and indicate all wiring pathways.
 - i) The Contractor shall be responsible for preparing process documentation related to the operation and maintenance of each and every component of the Instrumentation, control & Automation system.
 - j) The prepared process document shall be formally signed off by end user before completion of final acceptance test.
 - k) The Contractor shall document all the installation and commissioning procedures and provide the same to end user, within one week of the commissioning of project along with final configuration dumps and implemented solution details.
 - l) The Contractor shall be responsible for documenting configuration of all devices and keeping back up of all configuration files, so as to enable quick recovery in case of failure of devices.

8.4 Design Requirements for Instrumentation, Control & Automation system

Minimum Design Consideration

The instrumentation, control & automation system shall fully comply with design standards, regulations and the material and workmanship requirements of the Specification.

The electrical plant installations associated instrumentation control and automation systems shall also comply with and be tested in accordance with the latest edition of BS 7671 or equivalent Indian standards.

All equipment and materials incorporated in the system shall be selected, designed and rated to operate under the defined performance duties and specified site conditions and to maintain a high level of operational reliability.

The instrumentation control and monitoring system equipment and materials shall have an operational life of not less than ten (10) years.

Instrumentation, Control, Automation system shall be designed, manufactured and installed to achieve the following basic requirements:

- to maintain the highest standards of availability, reliability and accuracy and to give clear warnings of any deterioration in performance;
- to suit the abilities of the staff who will:
 - use the systems;
 - service the systems;
- to measure, indicate, process, store and control the relevant parameters, as specified;
- to give clear warnings of dangerous and other abnormal conditions and to initiate plant safety procedures, shutdowns and corrective measures as specified to assure the safety of 'operations and maintenance' personnel and plant and to store and collate the data, as required;

- to derive, present and utilize, as required, such additional data as required to facilitate:
 - the most efficient operation of the plant;
 - the routine maintenance of the plant
- Equipment and system shall be designed and constructed to perform accurately and safely under the environmental and operating conditions described or implied in this specification without undue heating, vibration, wear, corrosion.

Equipment and systems shall be supplied as per the vendor list indicated in specification elsewhere.

The equipment, systems and accessories furnished shall be designed and constructed to meet the performance specification during the continuous service life of the plant.

Contractor shall indicate the year in which the offered models of the instruments and control system have been introduced and how long the commercial production of the same is expected to continue. In any case, Contractor shall ensure supply of spare parts for minimum period of ten years. In case if it is felt by Contractor that certain equipment/ component is likely to become obsolete, Contractor shall clearly bring it to the notice of Employer and indicate step proposed to deal with such obsolescence like maintaining “bonded spares” with the manufacturer/s.

Any part/ module of the C&I system which are not listed under recommended spares shall be deemed as having life expectancy not less than ten years.

Contractor shall supply proven latest version of hardware and software available at the time of system designing. In case of future up-gradation of software, Contractor shall remain committed to upgrade the supplied system at per with the new version within the warranty period and comprehensive O&M period and ensure successful integration of the system.

For the sake of completeness of the system and in order to ensure desired performance & safety measures, any hardware or software item felt required, shall be in the scope of Contractor irrespective of their explicit or implicit inclusion in the accompanying document.

Technical details furnished in the accompanying documents are subject to change in future within reasonable limits, which Contractor shall abide by.

8.5 General Technical Requirements

8.5.1 Local Instruments

Required local instruments including gauge boards, level indicators etc. shall be provided.

8.5.2 Cabling Concept

Instrumentation cables shall be copper, overall screened unless manufacturer’s recommendation dictates use of pair or triad shields apart from overall shield. All cables shall generally be armoured, other than short run cables which may be unarmoured. Unarmoured cables shall run through conduits.

Binary and analog signals shall not run through the same cable. Signals of different voltage levels shall not be routed through the same cable. The screen shall be grounded at the control room end only.

Conductor cross section for single pair or triad signal cables shall not have individual conductor cross section below 1.5 mm² and multi-pair or multi-triad cables shall not have individual conductor cross section below 0.5 mm². For solenoid valves, depending on pick-up VA, individual conductor cross

section shall not be below 2.5 mm². For interposing relay drive connection individual conductor cross section shall not be below 1.5 mm².

8.5.3 Design Criteria

This section lays down the general design criteria to be adapted in designing the instrumentation and control system

8.5.4 General Requirements

Instrumentation and control devices and accessories shall be designed with the following considerations:

- a) Stable in spite of temperature fluctuations.
- b) Able to withstand high humidity.
- c) Weather proof.
- d) Dust proof.
- e) Corrosion resistant.
- f) Erosion resistant.
- g) Able to withstand high vibration.
- h) Easily accessible for operation & maintenance.

Parts subject to high pressure, temperature or other severe duty shall be of materials and construction suitable for the service conditions and long operating life.

8.5.5 Instrument Accuracy, Standard Scales and Ranges

8.5.11.1. Instrument Accuracy

Instruments shall meet the following general requirements.

- a) Pressure measurement shall be linear with respect to the measured pressure.
- b) Flow meter shall meet the specified accuracy criteria when operating between 25 and 100 % of full-scale flow. The accuracy shall include the effect of errors in the differential head measuring device, square root converter and signal generator.
- c) Level measurement shall be linear with respect to the measured level based on a water specific gravity of 1.00.

8.5.11.2. Instrument Scale Displays

- a) All displays shall be in engineering units. Instrument scales displayed on screen will have graduations with scale divisions based on multiples of 10. The smallest division shall preferably be a whole number approximately 1% of the scale range if not otherwise impracticable.
- b) Pressure instrument shall have the unit suffixed with 'a' or 'g' to indicate absolute or gauge pressure, respectively.
- c) Scales and charts of all instruments shall have linear graduations

8.5.11.3. Instrument Ranges

Instrument range shall be selected to have the normal reading, preferably between 50% and 70% of full scale for linear parameters and 70% to 80% for flow measurements. Deviation indicators shall

have the null position at midscale. The normal operating parameter shall be identified with a clear green mark.

8.5.6 Established Reliability & Availability of individual instrument system

The target reliability of each component/module shall be established by taking into consideration its Mean time between failure (MTBF) and Mean time to repair (MTTR), so that availability of each system is assured for 100% of the time.

In order to establish the target reliability Contractor shall perform necessary availability tests. Surge protection for solid state systems, selection of proper materials, manufacturing processes, quality controlled components and parts, adequate derating of electronic components and parts shall be ensured to meet the reliability and life expectancy goals.

Continuous self-checking features shall be incorporated in system design with automatic transfer to healthy/redundant circuits to enhance the reliability of the complete system.

8.5.7 Measurement & Channel Redundancy

To meet the failure and self-checking criteria for the control system, measurement redundancy shall be provided for all the critical parameters. Throughout the control system, the security and validity of signals are to be ensured based on the following design principles.

- a) Where a plant measurement is to be duplicated or triplicated such signals shall be separately fed to the different input modules.
- b) Signals, after due security and validity checking by means of voting, averaging, median, difference monitoring or similar technique shall be used for control functions.
- c) Where duplicated measurements are used, provision shall be there for selecting any one as the duty signal. Continuous monitoring of difference between the signals shall be made.
- d) Signals shall be verified against cable failure.

8.5.8 Design of Enclosures

Design of outdoor enclosures shall be weather proof-(IP-67) and shall take into account the environmental conditions.

Enclosures shall be adequately sized so that the maximum permissible temperature rise above ambient is 10 °C (maximum).

Enclosures design shall also take into account greatest possible personnel safety.

All instrumentation, inclusive of the analytical instrumentation, shall be mounted inside the IP-67 rated enclosures, irrespective of the transmitter IP rating.

8.5.9 Electrical Noise Control

Equipment furnished by Contractor shall incorporate necessary techniques to eliminate problems caused by electrical noise interferences and power line borne surges encountered in power plant

environment. Equipment, which is vulnerable to electrical noise interference or surge, shall be suitably immunized to eliminate possible problems.

8.5.10 Surge-Protection for Solid State Equipment

All solid-state equipment shall be able to withstand the surges inherent in a working environment. Equipment shall be designed to successfully withstand surges without damage to components and/or wiring on application of surge wave whose shape and characteristics are defined in ANSI publication C37.90-a (IEEE-472-1974) entitled "Guide for Surge Withstand Capability (SWC) Tests".

To immunize the system against surge, coupling free-wheeling diodes, surge suppressors, optical / galvanic isolators shall be used as required.

8.5.11 Panels, Cubicles and Enclosures

8.5.11.1. General

- a) All panels, cubicles and enclosures shall be furnished complete with integral piping, internal wiring, convenience outlets, internal lighting, grounding, ventilation, space heating, vibration isolating pads and other accessories.
- b) Unless otherwise specified cable entry for panels / desks / cabinets shall be through bottom via glanding plate. Fireproof seal shall be used to seal the bottom to prevent entry of dust.
- c) Panels and cabinets shall be constructed from steel sheet reinforced as required to provide true surface and adequate support for devices mounted thereon. Thickness of the steel plate shall conform to the requirements of UL 50 or equivalent standard. Panels and cabinets shall be of adequate strength to support mounted components during shipment and to support a concentrated load of 100 Kilograms on their top after erection.
- d) Panel/ cabinet shall have eyebolt on top for lifting.

8.5.11.2. Surface Preparation and Painting

Sheet metal exterior steel surfaces shall be sand blasted, ground smooth and painted as specified below:

Suitable filler shall be applied to all pits, blemishes and voids in the surface. The filler shall be sanded so that surfaces are level and flat; corners are smooth and even. Exposed raw metal edges shall be ground burr-free. The entire surface shall be blast clean to remove rust and scale. Oil, grease and salts etc. shall be removed from by one or more solvent cleaning methods prior to blasting.

- a) Two spray coats of epoxy primer surfacer shall be applied to all exterior and interior surfaces, each coat of primer surfacer shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish color (Catalyzed epoxy or polyurethane) shall be applied to all surface of dry film thickness 2.0 Mil. The finish colors for exterior and interior surfaces shall conform to the following shades:
 - i. Exterior – RAL 7032
 - ii. Interior - Brilliant White.
- b) Paint films, which show sags, cheeks, blisters, teardrops, fat edges or other painting imperfections shall not be acceptable.

8.5.11.3. Wiring

Wiring within the panels shall conform to NEC standards and shall be factory installed and tested at the works. All interior wiring shall be installed neatly. Features shall not be limited to the following :

- a) All spare contacts of relays, switches and push buttons shall be wired up to the terminal blocks.
- b) Each wire shall be identified at both ends with wire designation as per approved wiring diagram. Heat shrinkable type ferrules with indelible computerized print shall be used with cross-identification.
- c) Wire termination shall be made with insulated sleeve and crimping type lugs. All external connections shall be made with one wire per terminal. Wire shall not be spliced or tapped between terminals. Open-ended terminal lugs shall not be used.
- d) Internal wiring should be terminated uniformly on one side of the terminal block leaving the other side available for termination of outgoing cables.
- e) Analyzer measuring lead wires, or any other lead wires carrying measuring signal of the order of low millivolt or micro volt shall be electrically and physically isolated from other AC and DC wiring.
- f) All low-level signal cables shall be separately bundled from control cable.
- g) Wires shall be dressed and run in troughs with clamp-on type covers. Wirings shall be neatly bunched in groups by non-metallic cleats or bands. Each group shall be adequately supported along its run to prevent sagging or strain on termination.
- h) Shield wires shall be terminated on separately.
- i) Common connections shall be limited to two wires per terminal.
- j) Wiring to door mounted devices shall be provided with multi-strand wires of (49 strands minimum) adequate loop lengths of hinge-wire so that multiple door openings will not cause fatigue to the conductor.
- k) Wiring shall be arranged to enable instruments or devices to be removed and/or serviced without disturbing the wiring. No wire shall be routed across the face or rear of any device in a manner, which will impede the opening of covers or obstruct access to leads, terminals or devices.
- l) Panel internal wiring shall follow distinct color-coding to segregate different voltage levels viz. 24V DC, 48V, 110V AC, 240V AC, 220V DC etc.
- m) Panels/ cabinets/ desks shall be provided with removable gasketed cable gland plates and cable glands. Split type grommets shall be used for prefab cables.
- n) Wire shall be multistranded annealed flexible high purity copper conductor with heat resistant FRLS PVC insulation and shall pass vertical flame test per IPCEAS-1981.
- o) Wire sizes used for internal wiring shall not be lower than the followings :
 - i. Control wiring : 1.5 Sq.mm
(switches, pushbuttons etc.)
 - ii. Power supply/ receptacle : 2.5 sq. mm or higher as per load.
illumination wiring
 - iii. 4-20mA DC current : 1 Sq. mm
and low voltage signal
up to 48V DC
- p) Identification of conductors shall be done by insulation color-coding identified on drawings or by printed wiring lists.
- q) All cables terminated in the terminal block (both signal cables and power cables) shall be ferruled. Ferruling shall be double cross ferruling, i.e., source and destination addresses shall be marked on both sides of the tube ferruling.

8.5.11.4. Grounding

- a) System cabinet AC and DC ground shall be electrically isolated from each other and also electrically isolated from the Instrumentation signal ground. All the above ground shall be individually connected to the single point on the ground pit. Dedicated redundant earth pit shall be provided which shall be away from the HV equipment. This earth pit shall not be shared with other electrical equipment ground and shall also be insulated from other electrical system ground to ensure single point grounding of the system. Grounding resistance shall be better than 1.0 ohm. IEEE guideline shall be followed while designing the grounding system.
- b) Panels and cabinets shall be provided with a continuous tinned copper ground bus bar of minimum 25 mm x 6 mm cross section, extending along the entire length of the panel / desk / cabinet assembly. The ground bus shall be bolted to the panel structure and effectively ground the entire structure.
- c) The panel/ desk/ enclosure/ JB ground shall have two (2) bolt drilling with GI bolts and nuts at each end to connect to GI/ copper flat ground riser by means of insulated copper ground cable of required cross section with lug.
- d) Circuits requiring grounding shall be individually and directly connected to the panel ground bus.
- e) For electronic system cabinets, the electronic system ground bus shall be similar but insulated from the cabinet and shall be separately connected to the system ground. Signal cable shields shall be grounded at the panel end only and shall not be left open. The ground in between panels of a shipping section shall be firmly looped.
- f) Electrical meters, relays, transmitters and switching devices, operating at a voltage less than 50V may be grounded through the steel structure.

8.5.11.5. Panel / Cabinet/ Desk/ Enclosures Environmental Protections

- a) Panels, cabinets, desks, distribution boxes, terminal boxes and all other field mounted equipment / enclosures shall suit the environmental condition of the area and shall not Be inferior to the requirement indicated in the following table:

Sr. No.	Location	Enclosure type
1.	Indoor type non- ventilated enclosure in non-hazardous area	IP-45
2.	Indoor type ventilated enclosure in non-hazardous area	IP -42
3.	Enclosure in Air conditioned area	IP-22 with suitable canopy at top to prevent ingress of dripping water.
4.	Outdoor type in non-hazardous areas	IP-67
6.	Outdoor in hazardous areas	As per requirements of the NEC / IS Code for the location

- b) The construction of electrical enclosures located in areas subject to conditions classified in the National Electrical Code (NEC)/IS Code as hazardous shall be of a type designated suitable for the environment in which they are located.

8.5.11.6. Terminal Blocks

- a) Terminals shall be chromated galvanized DIN rail mounted screwless cage clamp type. Terminals shall have screwed connection for conductor cross-section above 2.5 mm². Terminal blocks shall conform to IEC 947-7-1.
- b) The characteristics of the terminal blocks shall be as follows.
 - i. High contact force, independent of conductor cross-section and large contact surface area.
 - ii. Self-loosening protection.
 - iii. Resistant to thermal aging and vibration.
 - iv. Low and constant voltage drop
- c) Tension spring shall be made of high quality, non-rusting, acid-resistant steel. The current bar shall be of tin-lead plated copper or brass.
- d) Terminals shall be of non-flammable suitable thermoplastic material such as polyamide.
- e) Terminal blocks shall be mounted vertically in panels and cubicles with clearance for at least 100 mm between two sets and between wall and terminal block.
- f) Terminal blocks shall be provided with white marking strips / self-adhesive marker cards. Power terminals shall have protection covers.
- g) At least 30 percent spare unwired terminals shall be provided for all panels /cabinets /desks /junction box etc. This shall be in addition to 20% spare wired terminals of spare IO channels and 10% wired spare modules.
- h) Bottom of the terminal block shall be at least 200 mm above the cable gland plate for bottom entry type panels.
- i) For extending 24 V DC supply to panels, the size of the terminals shall be decided based on voltage drop and not based on current.
- j) Other requirements of the terminal blocks are as follows.
- k) The last block in a rail-mounted assembly shall be closed with an end plate and end bracket.
- l) For visual and electrical separation of terminal groups, partition plates shall be provided,
- m) which can be push fitted after forming an assembly.
- n) Design shall permit testing of incoming and outgoing signals by using suitable test plug and socket without disconnecting the cable connections.
- o) It shall be possible to use jumper plugs through the test plug socket to connect adjacent
- p) terminals.
- q) Where more than one connection to a terminal block is required, two tier terminals shall be used.
- r) Terminal blocks shall be of different colors depending on voltage levels.

8.5.11.7. Nameplates and Labels

- a) Each item shall have permanently attached to it, in a prominent position, a rating plate of non-corrosive material upon which is to be engraved the, equipment, type / model number, range, serial number, together with details of the loading conditions under which the item of plant in question has been designed to operate.
- b) Such nameplates or labels are to be of white non-hygroscopic material with engraved black lettering, or alternatively of transparent plastic material with suitably colored lettering engraved on the back.
- c) The nameplates shall be held by self-tapping screws. The size of nameplate shall be approximately 20 mm x 75 mm for equipment and 40 mm x 150 mm for the panels.
- d) Items of plant such as valves, which are subject to handling, are to be provided with an engraved chromium plated nameplate or label with engraving filled with enamel, suitably mounted or as fixed with strong rustproof chain.

e) All such nameplates, instruction plates, lubrication charts etc. shall be with English inscriptions.

8.6 Metering Bases and Chart Units

The following system of units shall be followed for various displays and scales unless otherwise mentioned:

- i) Pressure : Kg/cm²
- ii) Differential Pressure : mm of H₂O column / Kg/cm²
- iii) Draught : mm of H₂O column
- iv) Vacuum : Kg/cm² (abs)/ mm of Hg column
- v) Temperature : Degree Celsius (° C)
- vi) Flow (Water) : Tonnes / hr, M³/Hr
- vii) Flow (Oil) : M³ / Hr, Liter/ Hr
- viii) Flow Air : Tonnes / hr / M³ / Hr.
- ix) Density : gms / c.c.
- x) Level : Mm /%
- xi) Conductivity : Siemens / cm
- xii) Dissolved Oxygen / Silica / Sodium : ppm /ppb
- xiii) Turbidity : NTU
- xiv) Residual Chlorine : ppm
- xv) UV Transmittance : %

8.7 Process Connection & Instrument Hook Up

Instrument connection to the process system (piping, vessel etc.) shall be according to the process & piping specification up to and including the root valves. Root valves shall be installed as close as possible to the piping or vessel.

Each instrument shall have its own independent connection to the process except for instruments located on standpipe. Each instrument shall be connected independently to the standpipe through isolation valve.

Isolation and drain valves adequate for duty and capable of withstanding continuous design condition of main process shall be provided. For process pressure equal or above 40 kg/ sq.cm double blowdown valves shall be used connecting to blowdown header. Instrument manifold / gauge valve shall be installed close to the instrument.

Process connection for instruments lines and vessels shall be in accordance to standards such as ASME or other recognized international standards. Table below indicates the type of connection generally to be used.

Instruments	Equipment / Pipe Side	Instrument Side
Level Instruments		
Internal Displacer	4" - Flanged	4" - Flanged
External Displacer	2" - Flanged	2" - Flanged
Level gauge	¾" -Flanged	¾" - Flanged
DP Type	½" (min.)-welded	½"- NPT

Instruments	Equipment / Pipe Side	Instrument Side
External cage Level switch	1"- welded	1"- welded
Flow Instruments		
DP Type	½" - welded in general	½" - NPT
Pressure Instruments		
Conventional	½" (min.)-welded	½" - NPT
Diaphragm type- Fuel Oil application	3"- Flanged	3"- Flanged
Temperature Instruments		
Thermowell	Generally - M 33 X2 (M) 1½" Flanged- For air path application	½" NPT
Analyzer		
Liquid analyzer	½"- 1" - welded	½"

Separate stubs and take-off points with thermowell / root valves shall be provided for performance guarantee test.

Impulse pipes shall be clamped at suitable interval not exceeding 1.5 meter. Process pipe shall not be used for supporting the impulse pipe.

Fittings shall conform to ANSI B 16.11. Threads of piping component shall be of tapered construction.

Instrument blowdown header shall in no case be lower than the material grade ASTM A 106 Gr. C.

Impulse pipe shall be laid at least with slope of gradient 1:10 to avoid any air pocket or water accumulation.

Expansion loop shall be provided at the end of each termination.

Orientation of tappings shall be as follows:

- a) For liquid service within 45 ° at lower half of the pipe horizontal plane.
- b) For air service within 90 ° at upper half of the pipe horizontal plane.

As a rule tap orientation of high and low pressure side should be parallel and symmetrical.

Pressure & Differential pressure instruments in liquid services shall be located below the taps and the piping shall be sloped to avoid formation of air pocket.

Pressure & Differential pressure instruments in air service shall be located above the taps and the piping shall be sloped back to process to avoid formation of any liquid.

Impulse pipe including taps for coal mill application shall be provided with air purge connection. Differential instruments for such application shall have continuous and as well as intermittent purging. Whereas, pressure measurement shall have only intermittent purging.

Material of impulse pipe for the instruments mounted on rack and enclosure shall be same as that of main process pipe except stainless steel tube of Gr. 316H or better shall be provided for connection in between impulse pipe (from tee connection on impulse pipe) and instrument manifold valve & instruments. Impulse pipe, tubes, fittings and accessories shall have the same design pressure and temperature applicable for the related main pipe.

A. Site Conditions

- **Temperature and Humidity Range.** The equipment shall be installed in an environment having a temperature range of 0 °C to 55 °C and a maximum relative humidity of 100 % (noncondensing). The Contractor shall use, where required, fans, heaters, and air conditioning units to maintain a correct working temperature for his equipment. All Parts of the equipment shall be constructed of materials or treated to prevent the formation of mould, fungus or any corrosion over the temperature and relative humidity ranges specified.
- **EMI/RFI Noise Immunity.** The equipment to be provided shall be adequately protected against interference from the use of radio transmitters, at any point external to the equipment housings and no malfunction of the equipment shall result from this cause. Responsibility for the correct and reliable operation of the equipment shall rest with the Contractor, who must ensure that the equipment is adequately protected against the ingress of radiated, mains-borne signal-borne interference.
- **Generated Interference.** The Contractor shall ensure that the computer, instrumentation and communications equipment conforms to BS EN 50081-1 or equivalent Indian Standard for noise emissions.
- **Coordination.** The Contractor shall check with other trades to ensure that equipment and material can be installed in space provided. Provide other trades with information necessary for them to execute their work. Details on Drawings, which are specific regarding dimensions and locations, are for information purposes. Coordinate with other trades to ensure work can be installed as indicated.
- **Sequencing.** The Contractor shall make applications to the local telecommunications Service Provider for provision of communications and coordinate with the sub-contractor responsible for installation of power supply services under this contract. Applications shall be made in time to ensure services are available for installation and commissioning of the telemetry equipment.

B. Panel Details

I. Enclosures and mounting boards

Enclosures shall be any form of board, cabinet, panel, desk, box or case used to protect, contain or group instrumentation, telemetry or control equipment.

All equipment in or on enclosures shall be arranged logically and, as far as possible, symmetrically, with projections kept to a minimum. Each enclosure and board shall be designed on ergonomic principles and shall permit in-situ and safe access for any normal adjustment, maintenance and servicing. The tops of plant-mounted enclosures shall be sloped downwards from front to rear.

Enclosures mounted inside buildings shall have a minimum rating of protection to IP 45.

Enclosures for use outside buildings or in places where splashing may occur shall have a minimum rating of protection to IP 65 and have tops which project sufficiently to protect the vertical faces of the enclosure and any component mounted thereon from splashing, inclement weather and direct sunlight. Also, when enclosures for use outside buildings are located where exposure to direct sunlight will give rise to high top-panel surface temperatures such that the internal temperature rises above the manufacturer's recommendation (normally 40°C), the enclosure shall include a sun shield fitted to the top of the enclosure. The sun shield shall prevent direct sunlight from reaching the instrumentation for the full day throughout the year, and shall have louvered ventilation.

All instrumentation, inclusive of analytical instruments (Multi parameter online instruments, etc..) irrespective of the transmitter IP Rating shall be installed in IP-67 rated enclosures.

Fixing arrangements for surface-mounting enclosures shall be external to the enclosure and shall ensure that the rear face of the enclosure is not in contact with the surface to which it is fixed.

Enclosures shall have hinged access doors, fitted with recessed lockable handles.

Doors shall be of rigid construction and provided with close-fitting flexible seals in recesses to prevent the ingress of liquids, moisture, dust and vermin. Hinges shall be of the lift-off pattern and one hinge shall engage before the other for ease of fitting. Wherever necessary, removable access covers secured by quick-release fasteners shall be provided to ensure ease of maintenance for all installed apparatus.

Mounting plates, brackets and racks shall be provided for all other internal equipment which shall be hinged or otherwise arranged with quick-release fasteners or captive screws to give quick and easy access to equipment, securing screws, terminals and wiring.

Enclosures for two or more devices with electrical circuits shall have gland plates and terminal blocks as specified elsewhere.

Each enclosure shall be designed for the safe testing and servicing of equipment with the power on. Each part which may be live under any circumstances shall be so covered or shielded as to prevent inadvertent contact.

II. Panels - Major

Panels shall be constructed generally as specified in the preceding clause. Panel material shall be prime-quality, cold-rolled and annealed mild steel or zinc-coated mild steel sheet, suitably braced and stiffened as necessary with flat bar or angle to form a rigid structure.

Panel fronts shall be flat and free from bow or ripple. Exterior corners and edges shall be rounded or welded and ground to give a smooth overall appearance.

Flanged edges shall be straight and smooth.

Materials shall be chosen with due regard to the panel size, number of cut-outs, instrument weight and position of center of gravity and method of fabrication, with the following minimum thickness:

- instrument bearing surfaces, gland plates and pneumatic distribution plates, 3mm;

- internal mounting plates, 3mm;
- doors, covers and filler panels, 3mm as a minimum.

No design involving the use of externally-visible assembly or fixing bolts and screws or any design resulting in dust or water-collecting crevices will be accepted.

When a panel is constructed in sections, the sections shall be designed for ease of assembly during installation and, in any case, shall not exceed 2m in length. All panels shall have a minimum width of 900 mm and shall not exceed 2mtr in length in any case. All necessary nuts, bolts, washers and the like shall be supplied and included in the same shipment as the relevant sections. Sections exceeding 1m in length shall be provided with double doors.

Each panel shall be mounted on a self-draining base frame fabricated from 150mm deep, steel channel section which shall be drilled or provided with clamps for bolting to the floor. The base frame shall be set back from the panel front face to give a toe space of not less than 25mm. The outside of the base frame shall be covered with an approved kicking strip.

Ceiling and other filler panels shall be fabricated from sheet steel and adequately stiffened. Each section shall have 50mm returned edges along all four sides and shall be braced to the main steelwork of the panel.

A chequer- plate floor shall be provided inside and above the level of the base frame, having openings suitable for the bottom entry of cables when applicable.

Sufficient removable un-drilled gland plates, in sections convenient for handling, shall be fitted close to the appropriate terminal blocks and not less than 230mm above the panel floor or not less than 230mm below the panel top. The gland plates shall have removable side covers giving access to both sides of the gland plate and ensuring vermin-proof and dust-proof construction. Gland plates of a surface mounted enclosure may form a part of the base or top.

Panels containing instruments using a fluid as the transmission medium shall have distribution plates with bulkhead unions for the termination of internal and external pipework.

All doors shall open outwards and all doors in one panel assembly shall use the same lock and key combination.

Panel design shall ensure adequate ventilation and air circulation without permitting the entry of vermin or dust. Panels installed in control rooms or other clean condition areas shall have louvres to allow air circulation. Temporary closures shall be provided to prevent the entry of dust and vermin during transit and installation. After commissioning has been completed, all entries except air circulation louvres shall be sealed.

No equipment other than front-of-panel items shall be mounted on panel wall surfaces.

If electrical and non-electrical instruments are mounted in the same panel, the panel shall be subdivided internally to separate the electrical and non-electrical sections.

All connections shall be arranged to ensure that no accidental damage to cabling or electrical components can occur in the event of failure of any non-electrical component or connection.

Provision shall be made for safe and easy handling during transit and installation.

If lifting eyes are provided, they shall be reversible and panel tops shall be reinforced where necessary.

Where equipment is specified to be installed at a future date, space shall be allocated, and cut-outs with removable masking plates, brackets, supports, wiring, terminals and piping and the like shall be provided.

Panels shall be finish-coated at the place of manufacture before commencing the installation of apparatus and other fittings.

III. Panels – Minor

Panels for installation on the Plant which contain relatively few items of equipment, or where so specified elsewhere, shall be classed as minor panels and shall be constructed generally as specified in the preceding clause and comply with this Clause.

Panels shall be fabricated from sheet steel less than 3 mm thick suitably braced to form a robust and rigid structure. Exterior corners and edges shall be rounded to give a smooth overall appearance and assembly bolts, screws or rivets shall not be visible on the front face.

The design shall be such as to ensure adequate ventilation and air circulation where required, without permitting the entry of vermin. Openings for cables shall be made vermin-proof. Doors shall be hinged and shall be provided with close-fitting flexible seals in recesses to prevent the ingress of liquids, moisture, dust and vermin. Unless otherwise specified, panels shall be suitable for floor mounting and shall not exceed 2130mm in height. Where surface-mounted panels are provided, the fixing shall prevent the ingress of moisture and the rear of the enclosure shall be not less than 10mm from the wall.

Lifting eyebolts shall be removed, issued to the Purchaser and subsequently replaced with bolts after installation.

Panels shall be extensible, and symmetrically arranged as far as possible with projections kept to a minimum. Where two or more panels are fitted together, they shall form a flush-fronted continuous panel of uniform height. Front door and top cover dimensions shall match. Instruments, relays, and control devices shall be mounted at a height not more than 2000mm and not less than 300mm from floor level.

The arrangement of equipment within each enclosure shall be such as to permit easy access for installation and maintenance. No instruments, relays or other components shall be mounted on rear access doors or removable covers.

IV. Panel internal wiring

Panel circuits shall be segregated into the following categories:

Group 1: Power control and very-high-level signal wiring (above 50V):

- 1.1 ac power supplies;
- 1.2 dc power supplies;

- 1.3 ac current signals above 50mA (such as CT circuits);
- 1.4 ac voltage and control signals above 50V (such as PT circuits).

Group 2: High-level signal wiring (6V to 50Vdc):

- 2.1 signals from conventional electronic transmitters and controllers (such as digital or 4mA to 20mA);
- 2.2 circuits to alarm annunciators and other solid-state devices
- 2.3 digital signals;
- 2.4 emergency shut-down and tripping circuits;
- 2.5 on/off control circuits;
- 2.6 intrinsically safe circuits;

Group 3: Low-level signal wiring (5V dc and below):

- 3.1 signals from thermocouples;
- 3.2 signals from resistance thermometers and re-transmitting slide-wires;
- 3.3 signals from analytical equipment and strain gauges.

For Group 3 wiring, internal connections to the instruments shall be made by one of the following methods:

- (a) The twisted, screened conductors of the external cable shall be led direct to their appropriate instruments via ducting systems installed for this purpose during construction of the panel;
- (b) The conductors of the external cables shall be terminated on terminals segregated from all other categories and the connections to the appropriate instruments shall be made using twisted pairs with individual screening installed for this purpose during construction of the panel.

Internal wiring for all circuits in Group 2 except those sharing a common connection shall be multi-stranded, twisted pair, 0.75mm² minimum copper conductor with HPDE or PVC-insulated cable of adequate grade and rating.

Wiring for circuits in other Groups or sharing a common connection shall be run in stranded, 1.0mm² minimum copper conductor with 250V grade, PVC-insulated cable of adequate grade and rating.

Wiring sheath colors shall be black for ac circuits, and grey for dc circuits (excluding thermocouple circuits) and blue for Group 2.6 circuits. Circuits supplied at 240V, between 240V and 110V dc shall also be physically segregated from each other and from other circuits. Access to wiring and components of circuits having voltages exceeding 240V shall not be possible unless and until the circuit has been isolated.

Separate ducts, trunking, cable looms, tray work and the like shall be provided within the panel for each category with at least 150mm between parallel paths of Group 1 and those of any other Group. Intrinsically-safe circuits and their terminals shall be segregated from other circuits and terminals.

All wiring shall be neatly and securely fixed by insulated cleats, bunched and secured by approved insulated wiring trunking or non-corrodible flexible tubing. Not more than 75% of the capacity of trunking, ducts, looming, or tubing shall be used. Insulated earth wiring shall be so arranged that access to any equipment or connection point or the removal of any item of equipment is unimpeded.

Wiring for future equipment shall be secured and terminated on terminal blocks. Lacing for wiring looms shall be of rot-proof cord or plastic strips. Inter-section wiring in multi-section cabinets shall be via a terminal block in each section.

V. Panel wiring identification and termination

Identification ferrules shall be fitted at both ends of each wire. The numbers or letters used shall correspond with the appropriate wiring diagram. The ferrules shall be of plastic insulating material with permanent black characters on a color coded background for numbers and on a white background for letters, unaffected by oil or water. They shall be so arranged that they can be read logically from left to right when viewed normally.

The system of wire identification shall be such that wires in the same circuit on opposite sides of a terminal shall have the same reference, and this system shall be continued through all external cabling. Terminal ferrules (spade, tongue, crimped connections) shall be provided on each conductor.

VI. Panel Earthing

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. The cable gland-plates and the earth bar shall be provided with suitable brass terminals of not less than 6mm diameter for connecting the metal cladding or armoring of all incoming and outgoing cables to the station earthing system.

A second continuous copper earth bar of not less than 25mm x 6mm cross section, electrically isolated from the steelwork of the panel and metal cladding and armoring of cables, shall be provided for earthing the signal earth connection of each instrumentation and control device and the screen(s) of each instrument cable not earthed elsewhere to the station instrumentation earth plate. The earth bar shall have sufficient brass terminals as specified above for each instrumentation and control device and the screen of every shielded cable plus 25% spare terminals.

In multi-section panels, each earth bar shall be electrically bonded to the corresponding bars in the adjacent section(s).

The earth pit for instrumentation system shall be separate. Electric earth pit shall not be used for earthing of instrumentation equipment. All signal cable screens (analogue and digital) shall be terminated onto the instrument earth bar. Signal cable screens shall be earthed at the control panel end only. Screens at the field end shall be tied back and insulated.

SPD s associated with the control and instrumentation system shall be earthed to the instrument earth in accordance with the SPD manufacturer's recommendations.

VII. Panel lighting

Each panel shall be adequately illuminated internally, as evenly and as free from dazzle as possible, by fixed LED lighting controlled from totally-enclosed light switches and by totally-enclosed door-operated switches positioned so as not to interfere with access. The control switch for an inspection lamp shall form part of the lamp assembly. Lighting circuits shall be fused independently of any instrumentation and control circuit and designed to allow lamps to be replaced safely and shall be fed

from a distribution board and circuit breaker connected on the live side of the main panel ac supply circuit breaker.

VIII. Panel ventilation

Each panel shall be provided with ventilation fans to ensure that equipment within the panel is maintained within manufacturer's recommendations, with due regard to the environment in which the panel will be mounted. Fans shall be controlled by a suitably-labelled enclosed switch mounted internally in an accessible position.

Fans shall be mounted with their axes horizontal and shall be arranged to draw clean air into the panel. Air entries shall have filters which can be renewed from outside the panel and shall be designed to prevent the entry of rain, spray, injurious fluids, sand or dust.

IX. Panel labels

All control gear shall be fully labelled, identifying the equipment designation/function, all external and internal components, all rating data, detailed equipment operating data and for danger and hazard warning.

Labels shall be provided for every panel to describe the duty or otherwise identify the panel and its sections and every instrument, component and item of equipment mounted internally and externally. Where applicable, front-of-panel labels shall be as detailed in the Specification. Wording shall be clear, concise and unambiguous and shall be subject to review by the Employer Representative before manufacture. Each label shall be permanently secured to the surface near the item to which it refers. Externally-fitted labels shall be of Perspex or other approved transparent plastic, with letters and numbers rear-engraved and filled with black.

The rear surface of each Perspex label shall be finished with a coat of paint of the same colour as the panel external finish. Instrument duty labels fitted externally shall be below the item to which they refer. Embossed tape or similar adhesive labels will not be approved.

Rear-engraved and filled plastic shall be used for internally fitted labels, which shall be white with engraved black letters.

Labels conforming to the requirements of the preceding paragraphs or other approved means shall be provided:

- To describe or identify circuits or circuit components;
- To identify dc polarity;
- To warn or remind about dangerous or potentially-dangerous circumstances;
- Wherever elsewhere specified.

Unless otherwise specified, all engraving shall be in plain block letters, minimum 4mm high.

The minimum practicable number of different sizes shall be used.

Note: Contractor shall note that Manufacturers' nameplates shall not be fitted on panel external surfaces. Only equipment Tag I.D shall be located on the panel exterior surface. The same is applicable for filed junction boxes, panels, enclosures, etc.

X. Panel finish

All panels, desks and cubicles shall be hard, smooth, durable and finish free of blemishes, shall be provided. Before painting, all external welds and any rough areas shall be smoothed, and all surfaces shall be thoroughly cleaned and free from scale, contaminates, corrosion or grease. If rust-proof or Zintec steel has not been used in the construction, the panel shall be treated with a passivating agent such as phosphoric acid. All internal surfaces shall have a minimum of three coats of paint of which the first shall be an approved anti-rusting priming coat and the final coat shall be an opaque gloss white enamel. All external surfaces shall have not less than five coats of paint of which the first shall be an approved etch-priming coat, and the second and third suitable undercoats, all of which shall be rubbed smooth when dry before application of the next coat. The undercoats shall be easily distinguished in shade or colour from the priming and finishing coats. The two final coats shall be of stove enamel paint, gloss or semi-matt finish, to a colour and finish to be advised by the Employer Representative. Stoving shall be carried out in accordance with the recommendation of the paint manufacturer.

The overall dry film thickness (DFT) shall be between 85 and 120 microns.

Nuts, bolts, washers and other fixing devices which may have to be removed for transit or maintenance purposes shall be galvanized or otherwise finished to an approved standard.

C. Instruments and ancillaries

I. General

All instruments, gauges and control equipment which perform similar duties shall be of uniform type and manufacture throughout the Works in order to facilitate maintenance and the stocking of spare parts.

All equipment shall be fully tropicalized and suitable for the worst environmental operating conditions. Panel-mounted instruments shall be of the electrically operated flush mounted type and shall have damp-proof and dust-proof cases.

Instruments mounted outside instrument panels shall have weatherproof and dustproof cases. Instrument cases shall be of corrosion-resistant material or finish.

Instrument screws (unless forming part of a magnetic circuit) shall be of brass or bronze. Access to terminal compartments of instruments mounted outside panels or other enclosures shall not expose any working part. Moving parts and contacts shall be adequately protected from the ingress of dust. Where applicable instruments shall be easily withdrawable from its housing for maintenance without interrupting its signal.

Unless otherwise specified, instruments shall be finished in the manufacturer's standard colour. Instrument dials shall be of such material that no peeling or discolouration will take place with age under tropical conditions.

Plant-mounted indicators and gauges shall be sized to give full legibility when viewed from a position with convenient and easy access or from the point at which any operation requiring observation of the gauge is performed. The minimum diameter for any gauge shall be 100mm except where forming part of standard instruments and accessories such as air-sets.

Dials and bezels shall be of bronze and internal components shall be of stainless steel, bronze or other corrosion-resistant material.

Unless otherwise specified, all functions shall be transmitted electrically and all analogue signal-transmission systems shall be in accordance with BS 5863: Part 1 or equivalent and shall use a signal of digital or 4mA to 20mA dc. Where possible, measuring systems shall be designed so that any necessary power supply is taken from the appropriate instrument panel.

Transmitting devices shall have integral indicators to monitor the output signal or connections suitable for use with a portable test meter, and shall be capable of meeting the performance requirements specified in the appropriate part of BS EN 60770-1 or equivalent.

Equipment mounted in enclosures shall be suitable for continuous operation at the maximum internal temperature possible in service, due account being taken of internally-generated heat and heat dissipated by other plant. All components shall be rated adequately and circuits shall be designed so that change of component characteristics within the manufacturers' tolerances shall not affect the performance of plant. All equipment shall be designed to operate without forced (or fan) cooling.

Equipment provided with anti-condensation heaters shall be capable of operating without damage if the heaters are left on continuously. Unless provided with unalterable factory configured ranges, measuring instruments shall have zero and span adjustment.

Field mounted instruments shall be mounted such that they are easily viewable and easily accessible for maintenance. Access platform shall be provided for all instruments which shall be mounted at a height to enable plant operators to access the same for reading and maintenance purposes.

Instruments not mounted in panels shall be supplied complete with all brackets, stands, supporting steelwork and weatherproof IP-65 enclosures (separate from the instrument cases) necessary for securing them in their working positions and affording complete protection at all times including periods of servicing, adjustment, calibration and maintenance.

Each installation shall incorporate a valve and pipework for obtaining a sample representative of the fluid at the position of the permanent meter and drain. If the measuring and sampling points are remote from each other, the test and sample facilities shall be provided at both points.

In order that maintenance and inspection may be carried out safely and conveniently instruments mounted in elevated and open work areas shall be provided with safety ladders and a sufficiently sized working platform with sun shading.

II. Indicator Lights

Indicator lights shall be not less than 20 mm diameter and shall be panel mounted types with metal bodies adequately fastened so that the lamps shall be capable of replacement from the front of the apparatus without disturbance to the lamp holder or panel wiring. Lamp holders shall be keyed into panels to prevent rotation. Lens colours shall comply with BS EN 60037 as follows:

- power on - white*
- running - green
- tripped/alarm - red
- status (open, closed, etc.) - blue
- ready to start - blue
- warning (no imminent danger) - amber

Note: *white may be used where doubt exists as to which other colour to use.

The lights shall be under-run to give long life either by use of a resistor to limit voltage to 90% normal value or by using higher voltage lamps.

The indicating lamps on control panel shall be cluster of LED's.

III. Pushbuttons

Colours of pushbuttons shall generally comply with IS 6875, BSEN 60947, 60037 or IEC 60073 and in particular shall be as follows:

- stop, emergency stop - red
- start - green
- jogging/inching - black
- reset (when not also acting as a stop) - blue
- lamp test - blue
- override/alarm accept - yellow

D. Junction Boxes

I. Junction box (Instrument)

1	Construction	-	UV resistance plastic
2	Protection	-	IP 65
3	Paint and shade	-	
			Powder coated light grey as per
			Shade 631 of is:5
4	Terminal strip	-	Elmex type capable of
			Terminating 0.5 sqmm to 1.5 sqmm
			Cable din rail mounted
5	No of terminal strips	-	30/40/70

			Rating:600v 10 a ac
6	Conduit & cable entry	-	Bottom side
7	Gland plant thickness	-	3mm
8	Door of JB	-	Hinged with proper locking
			Arrangement to avoid entry of
			Dust & moisture the design of
			Fixing screws of the lids of the
			Junction box shall be such that
			They do not come out of the lids
			When completely unscrewed
			(captive screws)
9	Dimension	-	Vendor to provide most
			Economic dimension of JB based
			On the no of Terminal bases and cable
			Entry
10	Mounting	-	Frame mounted
11	Earthing	-	Two no of earthing bolts for JB
			Earthing separate instrument
			Earth bus on insulating clits to
			be provided
12	Name plates	-	To be provided material: white
			Engraved letters on black
			Anodized aluminum sheet
			Fixing: stainless steel screws
			Lettering:- black with white
			Engraved. Note: No vendor nameplate shall be affixed to the junction box(exterior, interior)

II. Junction box (power & control)

1	Construction	-	UV resistance plastic
2	Protection	-	IP 65
3	Paint and shade	-	Power coated light grey as per
			Shade 631 of IS:5
4	Terminal strip	-	Elmex type capable of
			Terminating 0.5 sqmm to 1.5 sqmm
			Cable din rail mounted
5	No of terminal strips	-	30/40/70
6	Conduit & cable entry	-	Lower side
7	Gland plate thickness	-	3mm
8	Door of JB	-	Hinged with proper locking

			Arrangement to avoid entry of
			Dust & moisture the design of
			Fixing screws of the lids of the
			Junction box shall be such that
			They do not come out of the lid
			When completely unscrewed
			(captive screws)
9	Dimension	-	Vendor to provide most
			Economic dimension of JB based
			On the no of Terminal bases and cable
			Entry clearly specifying GA
			Drawing
10	Mounting	-	Frame mounted
11	Earthing	-	Two no of earthing bolts for JB
			Earthing
12	Name plates	-	To be provided material: white
			Engraved letters on black
			Anodized aluminum sheet
			Fixing: stainless steel screws
			Lettering:- black with white
			Engraved. Note: No vendor nameplate shall be affixed to the junction box(exterior, interior)

E. Cabling

I. Instrumentation Cabling

Cables from conventional measuring transmitters and analogue process controllers, such as digital or 4mA to 20mA dc output from a constant-current source, (hereinafter referred to as high-level signals) shall be polyethylene or PVC insulated with stranded conductors. Each cable shall have an overall screen of braided copper or mylar backed aluminium foil giving a minimum coverage of 85%, a steel wire armouring insulated from the screen and from any ducting and an overall PVC sheath. For runs exceeding 30 metres or for all inputs to a data logger, computer or microprocessor, multi-core cables shall have an individual screen of braided copper or mylar-backed aluminium foil for each signal pair. The minimum conductor size shall be 24/0.2mm but shall be of greater cross-sectional area if required for the satisfactory operation of associated plant. Cables for intrinsically safe systems shall comply with BS 5308 and the relevant certificate.

Cables from strain gauges, analyzers and the like, such as 0 to 100mV (hereinafter referred to as low-level signals — see also below) shall be as specified above and shall have an individual screen for each signal pair.

Cables from indicating devices to alarm or tripping circuits shall be as specified above for high-level signals but shall use cables, cable trays, ducts and conduit separate from those for other high-level circuits.

Cables for high-level signals, low-level signals, resistance thermometers and thermocouples shall be segregated from each other and each shall be separated from cables for power, communications and

other electrical services. Other cables run in the vicinity of instrumentation cables shall be separated from instrumentation cables by a distance of not less than 300mm.

Initiating devices for plant protection and personnel safety shall be connected by individual cables direct to the tripping or safety device and shall not be routed via any intermediate junction, marshalling box, cabinet, relay or similar. The outer sheaths of such cables shall be coloured orange.

II. Cable Termination Boxes

Cable termination boxes shall have double-ended screw terminals with removable links to facilitate core isolation during testing. Each box shall contain sufficient terminals for every conductor plus 20% spare terminals. Cable termination boxes shall have cable sealing chambers and insulated glands with earthing terminals so that the armouring may be earthed or isolated from earth, as circumstances dictate.

Termination boxes for use within buildings shall be of sheet steel with hinged or removable front covers. All other termination boxes shall be cast steel or heavy gauge sheet steel construction giving protection to IP55. All termination boxes shall be hot-dip galvanised or approved equivalent finish. Each terminal box shall have a removable, un-drilled gland plate and the Contractor shall supply and fit the requisite number of cable glands.

At each cable termination box, each cable core (including spares) shall be identified by a numbered slip-over type collet. The numbering for a particular cable core shall be the same throughout its length.

Cable joints shall be at points approved by the engineer.

Each cable joint shall be of the straight-through type. The conductors shall be ferrule-jointed with the insulation maintained by heat-shrink sleeving. Joint closure shall be made with epoxy resin and the completed joint shall be impervious to water if submerged or in waterlogged ground. If cast iron joint boxes be used, they shall be provided with cable glands and, after installation and testing, shall be covered with Densomatic HD compound or equal; so that all sharp corners, bolts and projections are moulded to a smooth surface. Two lappings of Densopol grade ZN 50mm tape, or equal, shall then be applied overall. Jointing shall be carried out on each conductor, including any provided in excess of the minimum quantity specified. All materials and things of every kind required for the cabling jointing shall be provided by the Contractor.

III. Cable labelling

At each end of each cable, in a uniform and visible position, a label shall be fixed on the cable to indicate the site cable number and route, and the number and size of conductors. Labels shall be made of brass, aluminium, lead or copper strip, engraved and retained by suitable non-rusting or non-corrodible binding wire passing through two fixing holes, one at either end of the label. If the cable gland is not normally visible, then the label shall be fixed inside the panel by means of screws.

Three-phase power cable cores shall be identified A, B, C or colour-coded red, yellow, blue so that the correct three-phase sequence is preserved throughout the system. Single-phase power cable cores shall be colour-coded red and black.

Control cables shall have individual cores identified by means of suitable permanent ferrules bearing the same number at both ends. Core identification shall occur at every point of termination using an approved system of colour-coded ferrule markers. The size of these ferrule markers shall be such as to match the overall diameter of conductor plus insulation. Numbering shall read from the termination upwards on all cores.

Each cable and core shall bear the same number at both ends of the cable and core respectively.

- a) Power terminations - colour, number or letter.
- b) Control terminations - letter or number or both.

IV. Cable terminations

All PVC/SWAPVC, PVC/PVC and XLPE/SWAPVC cables shall be terminated with mechanical glands which shall comply with BS 6121. They shall seal the inner and outer cable sheaths against ingress of dirt and moisture and provide adequate mechanical support. Each cable gland shall be protected by corrosion-resistant molded PVC hoods, covering the entire assembly from the overall sheath to the gland neck.

Glands for armoured cables shall provide a positive armour clamp to the enclosure so that no tension is applied to the termination. The clamp shall also provide a high level of earth continuity and be of adequate size to withstand the full fault current of the system for one second.

All glands shall be provided with an earthing tag. For cables of 4mm² or less, a serrated washer may be used instead for earth continuity.

The cable termination and sealing equipment shall be obtained from the cable manufacturer, or other approved supplier, and shall be purpose-made for the type, size and grade of cable concerned. The application of these materials shall be strictly in accordance with the manufacturer's instructions.

Through joints shall be permitted only on long cable runs outside buildings. Where such joints are necessary; the cables shall be jointed with epoxy or acrylic resin Cold-setting compound which has been pre-measured and pre-packed ready for use.

The boxes shall be of a split moulded plastic type with filling vents for compound.

Bonding straps shall be fitted with armour clamps across the joint and inspected by the Employer Representative prior to filling the box with compound. Wrapped pressure type joints shall not be accepted.

Conductor cores shall be jointed number to number or color to color.

V. Cable installation-general

Cables which are to be run on walls, ceilings or other building structures shall, unless otherwise agreed by the Employer Representative, be secured on cable trays and ladders or enclosed in conduit or trunking.

Every cable shall be neatly run vertically or parallel to adjacent walls, beams or other structural members. Cables shall not be installed in areas of direct sunlight.

Where this is unavoidable, approved sun shields shall be supplied and installed.

Where the building structure incorporates purpose-built covered duct or trench systems for main cables, instrumentation cables shall be segregated and installed on tray work or otherwise secured to the sides of the duct or trench.

Where the structure incorporates general service ducts or trenches containing pipework, chemical lines and other services, all cabling shall be segregated from the other services and shall be run on the walls unless otherwise agreed by the Employer Representative.

Cables shall be spaced to prevent interference between power and signal cables, and to avoid unnecessary crossovers.

The spacing of clips, saddles and cleats shall prevent the sagging of the cables during their installed life. The method of fixing clips and the like shall be by means of non-corrodible screws inserted into approved wall fixings, such as rawplugs.

Cable hangers, cleats, saddles, brackets and similar supporting devices shall be of an approved type and of adequate strength for the cables they are supporting. They shall be treated to withstand Site conditions without corroding. Self-locking plastic buckle clips and strapping shall not be used. The arrangement and fixing of each cable shall permit the removal and replacement of any cable without disturbance to any other cable or the fixings thereof.

When cables are terminated in any particular item of equipment, special care shall be taken to ensure that the cables finally approach the equipment from a common direction and are individually terminated in an orderly and symmetrical fashion.

Submissions which the Contractor shall submit the following in relation to cable installations in addition to submissions detailed elsewhere in the Specification.

VI. Drawings and schedules:

- Block diagrams to show control cabling systems with each cable and terminal equipment being identified as in the cable schedules.
- Cable route and layout drawings. For those items which are underground, these drawings shall include the following:
 - Route plans and sectional views for all cable runs, cable trays, cable ducts and cable trenches;
 - The position of all marker posts, joints, draw pits and the like.
- Cable schedules shall detail the cable number, type, voltage, size, route length and number of cores or pairs. Control-cable schedules shall detail the connected and spare core numbers, diagram number for connected equipment, core ferrule and terminal reference number.

VII. Data and calculations:

Manufacturers' catalogues and data sheets for all cables and fittings. Cable sizing Calculations.

VIII. Test certificates:

Test certificates for all witnessed and routine tests carried out at the manufacturer's works and at Site (calibration).

IX. Cable trays and ladders

Cable tray, cable trays covers and cable-support ladders shall be of heavy-gauge galvanised steel and with an overall PVC coating when required to the approval of the engineer.

Cable tray and ladder systems shall be installed with joints and junction/bend pieces. Wherever tray and ladder sections are cut and shaped on Site, cut edges shall be dressed and painted with at least two coats of cold galvanising compound or lead-based anti-corrosive paint.

Ladder systems shall be secured to walls and ceilings by pre-formed galvanized interlocking channel.

All instrumentation cables shall be laid in separate cable tray with covers.

X. Flexible conduits

Flexible conduit shall be of the waterproof galvanised type of PVC wire-wound type with cadmium-plated mild steel couplings. Lengths of flexible conduit shall be sufficient to permit withdrawal, adjustment or movement of the equipment to which it is attached and shall have a minimum length of 300mm. Flexible conduit shall not be used as a means of providing earth continuity. A single earth conductor of adequate size shall be installed external to the conduit complete with earth terminations.

Where conversion from rigid conduit to flexible metallic conduit is to be made, the rigid conduit shall terminate in a trough-type box. The flexible conduit shall extend from this box to the equipment; the earth continuity cable shall be secured to the box and to the piece of equipment. The use of lid facing screws and the like will not be permitted. Adaptors shall incorporate a grub screw or a gland to prevent the flexible conduit becoming loose.

XI. PVC conduit

Where galvanised conduit would be liable to corrosion, PVC conduit shall be installed.

PVC conduit shall be of the oval or round high impact non-flame-propagating type as specified and self-extinguishing, to BS EN 61386-21. Surface and concealed installations shall be generally as described for steel conduit.

PVC conduit fittings shall comply with BS 4607. They shall all be white unless specified otherwise.

Jointing shall be carried out using PVC solvent and socketed accessories.

Expansion couplers shall be fitted in straight surface runs every 12m. The free end shall be sealed with non-setting mastic to form a waterproof seal.

Purpose-made bends may be used providing that the cable bending radius is maintained. Cracked or crinkled conduit will be rejected.

The conduit shall be suitable for use in ambient temperatures of between -5°C and $+60^{\circ}\text{C}$ and shall not be installed in areas that receive direct sunlight. A separate protective conductor (earth-continuity conductor) shall be installed.

Adaptable boxes and accessories shall be made from heat-resistant insulating material. The minimum wall thickness of boxes having a nominal internal depth of 16mm or less shall be 1.5mm. For deeper boxes, the minimum wall thickness shall be 2mm. All boxes which are intended to support luminaires or other heat sources shall have either external fixing lugs riveted to the metal inserts or utilize steel insert clips.

F. Cable installation methods

I. General

All cabling installation methods shall be subject to the approval of the Employer Representative.

II. Installation directly into the ground

Where cables are buried in the earth, the bottom of the excavated trenches shall be freed of sharp stones and other projections and covered with sand to a depth of 50mm.

Cables shall be unrolled from drums without loops and kinks, and care shall be taken when laying to avoid damage to the outer sheath by drawing over sharp projections.

Cables shall be snaked into the trenches to avoid tension in the cables during backfilling or from subsequent settlement. After laying, cables shall be covered to a minimum depth of 100mm of compacted sand and shall have a layer of protective interlocking concrete cable tiles. The tiles shall be overlaid with marker tape.

When cables of different voltages are laid together at the same depth, vertical cable tiles shall be used to segregate the cables.

ICA and communication cables shall be laid not closer than 1000mm to high voltage cables.

A sufficient number of rollers shall be provided so that the cable does not touch the ground or twist during pulling.

III. Installation in underground ducts

Underground ducts shall be constructed of impact-resistant uPVC and laid at a minimum depth of 500mm (to the duct centre), surrounded by at least 75mm of sieved sand. At road crossings, uPVC ducts of minimum diameter 100mm shall be laid at a minimum depth of 1000mm (to the duct centre). The ducts shall be encased by 150mm concrete on all sides.

When installing cables in ducts, the following measures shall be observed:

- Cables shall be pulled in a straight line;
- Rollers shall be positioned at the edges of draw pits both at the drawing-in and drawing-out points over which the cables shall be drawn;
- PVC pipes and cable sheaths shall be coated with an approved lubricant;

- Sufficient draw-in points shall be provided and adequate room allowed for installation of cables;
- The pulling rope shall be guided by rollers.

Whenever a duct is laid in the ground, a draw-wire shall be pulled through with at least 1000mm excess at each end and the draw-wire left in position if the duct is not to be used immediately.

8.8 Process Instrumentation

8.8.1. General

- Instrumentation system shall be designed, manufactured, installed and tested to ensure the high standards of operational reliability. All electronic components shall be adequately rated and circuits shall be designed so that change of component characteristics shall not affect plant operation.
- All instrumentation equipment shall be new, of proven design, reputed make, and shall be suitable for continuous operation. Unless otherwise specified, all instruments shall be tropicalized. The outdoor equipment shall be designed to withstand tropical rain. Wherever necessary space heaters, dust and water proof cabinets shall be provided. Instruments offered shall be complete with all the necessary mounting accessories.
- All instruments shall be from the country of origin as indicated in the vendor list elsewhere in this specification.
- All instruments ,inclusive of the field instrumentation,(Flow meters, pressure guages, transmitters,level instrumentation, analytical instrumentation analyzers (Multi parameters, etc) shall be offered for inspection & testing before dispatch, at Manufacturers Factory works where the instrument has been manufactured. The same shall be indicated in the QAP and submitted along with the equipment datasheet for review and approval.
- Electronic instruments shall utilise solid state electronic components, integrated circuits, microprocessors, etc., and shall be of proven design.
- No custom made hybrid type integrated circuits shall be used.
- Unless otherwise stated, overall accuracy of all measurement systems shall be $\pm 0.5\%$ of measured value, and repeatability shall be $\pm 0.5\%$.
- Unless otherwise specified, the normal working range of all indicating instruments shall be between 30% and 80% of the full scale range.
- On resumption of the supply following a power failure the instruments and associated equipment shall start working automatically.
- The instruments shall be designed to permit maximum interchangeability of parts and ease of access during inspection and maintenance.

- Unless otherwise stated, field mounted electrical and electronic instruments shall be weatherproof to IP-65.
- All outdoor instruments shall be fitted with IP67 enclosure to shield the instruments against the weather, irrespective of the IP rating of the instrument/transmitter. The enclosures shall be of lockable type.
- The instruments shall be designed to work at the ambient conditions of temperature, humidity, and chlorine contamination that may prevail but in any case not less stringent than those conditions detailed in the Project Requirements. Instruments shall be resistant to corrosion in the atmosphere in which they are expected to operate.
- All field instruments, and cabinets/panel mounted instruments shall have tag plates/name plates permanently attached to them. Details of proposed inscriptions shall be submitted to the Employer for approval before any labels are manufactured.
- All coated parts of sensors shall be made out of noncorrosive material capable of working with chlorine content of 5 ppm.
- For all instruments installed in the field, surge protection devices (SPD s) shall be provided at both ends of the connecting cable for protection against static discharges / lightning and electromagnetic interference.
- Individual pair screened, overall screened, armoured cables shall be used for analogue signals and armoured, overall screened cable shall be used for digital signal cables.

I.Level Measuring System

a) Ultrasonic Level Meters

Ultrasonic level measuring devices applied for liquid level measurement shall comprise a transducer, control unit and remote indicator.

The transducer shall be suitable for flange or bracket mounting as required and shall be environmentally protected to IP 67. It shall have ambient temperature compensation, adjustable datum setting facilities.

The accuracy of the sensor shall be $\pm 0.25\%$ or better.

It shall be programmable with an integral programming keyboard and provide a digital display of the measured variable. It shall be provided with diagnosis facilities and shall provide an isolated 4 to 20 mA dc output signal proportional to the range of measurement.

The design and application of ultrasonic level meters shall take into account the vessel or channel construction, the material, size, shape, environment, process fluid or material, the presence of foam, granules, size etc.

The installation shall avoid any degradation of performance from spurious reflections, absorption, sound velocity variations, sensor detection area, temperature fluctuations, specific gravity changes

and condensation. For applications where spurious reflections are unavoidable the control unit shall be provided with facilities for spurious reflection rejection.

If turbulence exists, shielding, stilling tubes or other measures shall be provided to avoid effects on the measurement.

All instruments shall be offered for inspection & testing before dispatch at Manufacturers Factory where the instrument has been manufactured. QAP shall be submitted which shall include functional testing and calibration at the manufacturer factory.

II. Pressure gauges, Switches and transmitters

Pressure gauges shall comply with BS EN 837- Parts 1, 2 and 3. Pressure gauges, transmitters and switches shall have over range protection up to 1.5 times the maximum anticipated line pressure and have concentric scales. For specially arduous duty where the gauge is subject to pressure pulsations and/or vibration, it shall be provided with a glycerine-filled dial and line snubbers shall be used. Bourdon-tube type differential-pressure gauges shall be capable of withstanding full line pressure on any side with the other side vented to atmosphere without damage to or effect on the calibration. No plastic material shall be used in their construction. Internal parts shall be of stainless steel, bronze or approved corrosion-resistant material.

The minimum diameter for round pressure gauges shall be 100mm unless specified otherwise or where the gauge forms part of a standard item of equipment.

Unless specified elsewhere the accuracy for pressure gauges shall be 1% of range, for diaphragm gauges 1% of range and for differential gauges 1.5% of range or better.

Where compensation of more than 2% of the instrument span is needed for the difference in level between the instrument and the tapping point, the reading shall be suitably adjusted and the amount of compensation shall be marked on the dial.

The zero and span of a pressure transmitter shall not change by more than 0.1% of the span per Celsius degree change in ambient temperature. After application for 10 minutes of pressure at 130% of maximum pressure, the change in zero and span shall not exceed 0.1% of the span.

Pressure transmitters/switches shall have an accuracy typically better than 0.1% of span, depending on the application and shall be protected to BS EN 60529: IP 65 standard or higher standard. For transmitters installed in meter chambers liable to flooding or underwater applications, they shall be to BS EN 60529: IP 68 standard and shall operate up to maximum submergence of 20 metres of water.

Pressure transmitters shall provide a digital or 4mA to 20mA dc output proportional to the pressure range.

Pressure gauges, switches 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.

Pressure and differential pressure switches shall have contacts with separate 'cut in' and 'cut out' pressure values.

The nominal pressure values at which pressure switches operate shall be fully adjustable over the whole range of the instrument and the set value(s) shall be clearly indicated by means of a scale and pointer.

Pressure monitoring shall be by a sensor suitable for the medium and pressure/level range.

The sensor shall be suitable for either free wire suspension in the medium or fitted remotely and provided with threaded sockets to permit connection of pressure pipework.

A transmitter shall be provided either integral with the transducer or separately mounted and converting the signals received from the transducer to a 4 to 20 mA signal proportional to the range specified.

The transmitter shall have provision for span and zero adjustment.

III. Strain-gauge pressure transducers and transmitters

Strain-gauge pressure transducers shall use thin film sensors without bonding.

Each instrument housing shall be of all-welded Grade X 4 CrNiMo 17 12 2 stainless steel or equivalent and hermetically sealed. Non-interacting, zero and span adjustments shall be provided on each transducer. The measuring diaphragm shall be isolated from the process fluid by a non-corrodible barrier diaphragm. The mean time between failure for any model of strain-gauge transducer shall be not less than 15 years, and the performance of the measurement system shall be as given below, or higher performance:

- accuracy: $\pm 0.1\%$ of calibrated span, including linearity hysteresis and repeatability;
- repeatability: $\pm 0.05\%$ at maximum span;
- stability: $\pm 0.1\%$ of upper range limit over 6-month period;
- over pressure: sustain a 400% over-pressure without damage;
- RFI / EMI effect: less than 1% of span with 500MHz at 5W direct contact;
- power supply variation effect: 0.01% per volt variation.
- load variation effect: $\pm 0.0002\%$ per ohm of loop-resistance variation.
- temperature: -29°C to $+82^{\circ}\text{C}$ range; total thermal error of $\pm 0.75\%$ of span over 0°C to 50°C ;
- protection: IP 65.

Strain-gauge transducers which do not have terminals for their cable connection, shall have integral sealed-cable assemblies, installed in conduit and terminated at weatherproof junction boxes, protected to IP 65 each mounted near to its associated process transmitter. A digital or 4mA to 20mA dc output signal proportional to the transducer range shall be provided.

Strain-gauge pressure transmitters shall be generally as the transducer except that it shall incorporate a waterproof pressure transmitter producing a digital or 4mA to 20mA output signal.

Provision for transducer venting shall be provided.

All instruments shall be offered for inspection & testing before dispatch at Manufacturers Factory where the instrument has been manufactured. QAP shall be submitted which shall include functional testing and calibration at the manufacturer factory.

IV. Analytical Instrumentation

In all cases, the location and housing of the monitor shall take into account the provision of a representative sample to the monitor sensor, the pre-conditioning if any, required prior to the sample's analysis, operator requirements for access, maintenance, calibration, repair and replacement of the monitor or its sensors.

8.9 Installation Requirements for Instruments

8.9.1. General

The contractor is responsible for coordinating the installation, testing and commissioning to assure proper interface and system integration. Services shall include, but not necessarily be limited to all labour, materials, tools, equipment, supplies and services and auxiliary devices including brackets and mounting hardware required to install the instrumentation.

8.9.2. The following general installation guidelines shall apply:

- Transmitters and transducers shall be mounted as near as practical to the measurement point. The transmitter shall be installed at a suitable location and height for the operator to view the transmitter display
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring. Provide a separate (independent) circuit for each analyser (note that control panels are powered by online UPS and supplied from the sites critical emergency power circuit).
- Unless otherwise shown or specified, all instruments shall be mounted 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount direct reading or electrical transmitters on process piping. Mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from ground elevation.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed at no charge to the contract.
- Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.

- Follow the Manufacturer's recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.
- Follow the Manufacturer's recommendations for surge suppression on inductive loads.
- Unless specifically instructed otherwise, ensure installations conform to the manufacturer's installation recommendations.

8.9.3. Analytical Instrumentation

- Physically locate the sample point so is does not contribute unnecessary dead time in the analysis. Take care to ensure the sample point is clean, thoroughly mixed, and representative of the process stream.
- Locate the analyzer next to a floor drain. Provide shutoff (block) and bleed valves: size valve and select type and material for the application.
- Provide flushing facilities for cleaning probes

8.9.4. Surge Protection Devices

Surge protection devices (SPDs) shall be suitable for withstanding the surge arising out of high energy static discharge / lightning strikes and protect the instrument to which it is connected against damage. SPDs shall provide protection through the use of quick acting semiconductors like Tran Zorb, Zener diodes, varistors and an automatic disconnect and reset circuit. SPDs shall be passive and shall require negligible power for operation. During the occurrence of a surge, it shall clamp on the allowable voltage and pass the excess voltage to the ground. The SPD shall be self- resetting to minimise the down time of the measurement loop.

SPD s shall be provided to protect devices transmitting and receiving analogue and digital signals derived from field devices located outdoors.

The surge protection device shall be rated for surge rating of 10 KA.

8.10 Control & Automation

8.10.1. Programmable Logic Controllers/Remote Terminal Units

In particular, there shall be a single vendor for all locations under this contract to ensure uniformity among equipment and spare holding.

In particular, the following configuration shall be applicable across each of the GLR location. Each GLR location shall be provided with integration panel consisting of standalone PLC/RTU. Wireless GPRS communication modules shall be utilized to communicate the GLR data to the centralized SCADA in real time. The standalone PLC/RTU shall be programmed to transmit the data at pre-defined intervals or at intervals as required at the centralized SCADA enter operator (On demand). The entire Instrumentation, control and communication system shall be provided with UPS system with a battery backup of minimum 30 mins on full load.

PLC/RTU shall have the following attributes as a standalone Controller.

- carry out sequential logic implementation for operations;
- carry out computation and interfacing for data acquisition, data storage and retrieval;
- it shall accept downloaded program from a programmer;
- it shall have different functional modules to perform the desired functions;
- it shall scan the inputs in time cycles and update the status of its outputs;

The PLC/RTU system shall be expandable DIN rail mounted, OPC Compatible and shall be modular in construction, so as to be capable of future expansion without hardware modifications. PLC/RTUs shall be microprocessor based. PLC/RTUs shall use standard known protocols and structures for communication outside the system. The communication protocol to be chosen adequately to avoid data loss in case network disruption or power failure, the data shall be automatically retrieve on restore of such disruption.

In case of system failure or power supply failure the outputs shall attain a predetermined fail-safe condition (this shall normally be 'off').

The PLC/RTU used shall have a proven record in the type of application concerned and in the prevailing environmental conditions.

The contractor shall submit the sizing calculations for the air conditioning system for review and approval. The contractor shall refer the approved vendor list for the PLC system and hardware, elsewhere in this document.

8.10.1.1. I/O Modules:

I/O Modules should be of the same series as the PLC/RTU CPU. Refer the approved vendor list for the PLC system and hardware, elsewhere in this document.

Field wiring shall be terminated in screwed terminal blocks and interconnected to the processor I/O system with prefabricated cables and plug in card type connectors. I/O Modules should be hot swappable. Provision shall be provided for future expansion of additional 20% extra I/O modules of the installed capacity in the panel.

I/O modules shall be as follows:

- a) Inputs shall be opto isolated;
- b) filters shall be provided for noise rejection;
- c) output status shall be indicated by an LED;
- d) all outputs shall be fuse protected and have fuse failure indication the fuses may be mounted externally from the output module;
- e) All the modules shall be of addressable type.

8.10.2. Ethernet Switches

The contractor shall only provide managed industrial grade Ethernet switches under this contract. Minimum 16 port managed Ethernet switch shall be provided.

8.10.3. PLC/RTU Programming

The Contractor shall supply, install, program and commission the PLC/RTU using the PLC/RTU manufacturers recommended windows-based PLC coding and documentation software. The PLC/RTU code shall be structured in the manner of the best industry standard and have comprehensive subroutine and rung annotation.

The logic shall be prepared using proprietary programming software and shall be comprehensively annotated with subroutine and rung comments to assist further development and maintenance.

The system shall support a simple programming of the application software comply with IEC 61131-3.

The system shall support a structured, modular programming. At least the following standard operations shall be applicable:

- 1) Logic functions (such as AND/OR/AND NOT etc.);
- 2) Timer functions (externally adjustable);
- 3) Counter functions;
- 4) Skip functions;
- 5) Comparison functions;
- 6) Limit value functions;
- 7) Arithmetic functions;
- 8) Physical unit functions;
- 9) Closed-loop functions such as P/PI/PID/etc.

The Contractor shall submit the logic diagrams for review & approval as an integral part of FDS submissions.

End of Part 8

PART-9
PARTICULAR SCADA AND CENTRALIZED SCADA CONTROL CENTER
REQUIREMENTS

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PART - 9

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PART - 9

Particular SCADA and Centralized SCADA Control Center Requirements

9.1 General

This part covers the Particular Requirements for the complete design, supply, installation, Inspection and testing of Centralized SCADA Centre (CSC) and associated plant and materials. Unless specified in this section to the contrary equipment provided by the Contractor and workmanship shall comply with the General Parts of these Requirements.

9.2 Introduction

The CWMC-centralized SCADA system shall provide a quick deployment platform that integrates all available plant, equipment's, instruments and energy data of water supply and waste water supply systems into a high performance, real-time, distributed platform. The CWMC-centralized SCADA shall include all the tools necessary to create and deliver rich visualization of actionable information, in real-time, anywhere, anyplace, and at any time.

9.3 Applicable Standards

All equipment shall comply with all applicable national and local laws regulations and standards, in addition to those listed below:

- | | | |
|------------------------------|---|---|
| 1. ISO 9000 and 09004 | - | Quality Systems |
| 2. IEEE 587 | - | Power Supply Surge Protection\ |
| 3. IEC 61158-2 | - | Communication Protocols |
| 4. ISO 9075 (BS 6964) | - | Structured Query Language (SQL) |
| 5. BS 5515 | - | Documentation of Computer Based Systems |
| 6. BS 7165 | - | Recommendation for Achievement of Quality of software. |
| 7. BS EN 50081 | - | Electromagnetic Compatibility |
| 8. ISO 3511 | - | Process measurement & control functions – Instrumentation symbolic representation |
| 9. ISO-OSI | - | 7 Layer Communication Model |
| 10. IEEE 472-1974 | - | Surge protection. |
| 11. EEMUA | - | Alarm rationalization and management |
| 12. DNP | - | Distributed Network Protocol |
| 13. UHF Radio/GPRS standards | - | |
| 14. Network standards | - | SNMP/SMTP |

9.4 Established Reliability & Availability

The target reliability of each component/module shall be established by taking into consideration its Mean time between failure (MTBF) and Mean time to repair (MTTR), so that availability of the complete system is assured for 99.9%. at all times.

In order to establish the target reliability Contractor shall perform necessary availability tests. Surge protection for solid state systems, selection of proper materials, manufacturing processes, and quality controlled components and parts, adequate derating of electronic components and parts shall be ensured to meet the reliability and life expectancy goals.

Continuous self-checking features shall be incorporated in system design with automatic transfer to healthy/redundant circuits to enhance the reliability of the complete system.

9.5 Control Center:

An ergonomic approach to the design of CWMC-centralized SCADA monitoring center (CSC) workstations and the layout of the SCADA monitoring center room, shall contribute to achieving safety and performance objectives, set for the CSC room.

The offered system shall have an inherent high level of scalability, flexibility & modular architecture for both hardware & software's to meet the future expansions. Effective SCADA monitoring center room design shall consider both form and function, to create workspaces that facilitate the complex interaction between operators, technology and the environment. Raised flooring, acoustic concerns, indirect lighting, the wellbeing, health and safety of each operator shall need to be provided.

Operators in the SCADA monitoring center room shall work 24 hours a day in two shifts, 7 days a week basis.

Centralized SCADA center room design shall take into consideration room size, number of operators, viewing requirements and equipment. Operators shall be able to communicate with each other as well as have easy access to essential equipment. The height of the console shall be calculated so the shortest operator can see over the top of any workstation mounted electronics to remote monitor, control panels or displays and the clearance underneath the work surface shall allow for the tallest operator to sit comfortably.

When designing the SCADA monitoring center room, to address these and other concerns, the following steps shall be taken to ensure operator comfort and minimize fatigue:

- Test console layout with operators for “human tasks” including sequential task simulations.
- Develop workstation layouts designed around acceptable reach zones and visual limitations.
- Take into account maintenance requirements and removal of equipment from both the rear and front of the workstation.
- Provide ergonomic footrests where appropriate.
- Provide ergonomic designed chairs with full adjustment capabilities.
- Reduce excess heat and noise by locating electronics in an equipment room.
- In workstation dimensions, consider the full height and size range of the operators, utilizing height adjustable work surfaces where appropriate.

9.6 CWMC-Centralized SCADA Center Minimum Requirements:

A space required for setting up the centralized SCADA center shall be made available by GJB at the GJB building at Kharguli.

Although the focus in a control room is normally on the equipment and computers, the amount of space for the operators shall also be maximized. The amount of desk space shall not be compromised. Space shall be allowed for manuals and other items to be left on the desk without unnecessary clutter. The control room shall be provided with false ceiling and false flooring, air conditioning, system console, ergonomically designed chairs and furniture. Access to the control room area shall be via access control system.

9.6.1 Control center shall include the following on a minimum but not be limited to:

- 1) Cabins for engineers-3 Nos
- 2) Main control rooms
- 3) LED Videowall system
- 4) Server room
- 5) Fire alarm ,detection and suppression systems for the entire centralized SCADA center
- 6) UPS room for all equipment
- 7) Electrical equipment room
- 8) Precision air-conditioning for control center server systems
- 9) Bio-metric & Card based access control system for the control center entrance, water SCADA server room, Water Control room, , UPS room, store room, etc.
- 10) Close circuit television(CCTV) system for entire centralized SCADA center and to cover all entry and exit points,
- 11) Store room for equipment
- 12) Electronic Rodent & pest control facilities
- 13) False flooring for the control center inclusive of server rooms, control room, other areas as required and applicable.
- 14) False ceiling for the entire control center

9.6.2 Main Control room :

The main control room area's shall be equipped with the following equipment on a minimum but not limited to:

- 1) SCADA Engineering & Operator work stations
- 2) Historian work station
- 3) Cyber security stations
- 4) Multi-function printer's
- 5) Fire alarm & suppression system monitoring system
- 6) 55" LED video wall display system integrated with the SCADA and CCTV system
- 7) Ergonomically designed System console

9.6.3 Engineer rooms/cabins:

The control center shall be provided with engineer rooms/cabins for GJB staff. Space shall also be provided for SCADA control manager. The cabin design shall be in sync with the control center design and shall include telephones, desks, file storage cabinets and desk top computer systems

with 32" LED monitor (three Nos). Each system shall be provided with licensed latest windows operating system with MS office system full version software and antivirus system and firewall system which are licensed.

9.6.4 Server room

The control center shall be provided with a server rooms. Server room shall house the redundant front end integration servers, SCADA server's & historian servers applications. In addition to the above, redundant GPRS wireless gateway equipment shall be located in the server room, any other system as required.

9.6.5 UPS room

The control center shall be provided a separate room for the online UPS system and the status and health shall be monitored on the SCADA system. The UPS system shall consist of redundant industrial grade online system along with required batteries in redundant configuration with 120 minutes backup on full load. The contractor shall submit the complete load list & calculations to cover all equipment, IT Hardware, Fire alarm monitoring system, CCTV system, etc. for review and approval.

9.6.6 Air-conditioning (including precision air-conditioning)

The control center shall be provided with air-conditioning (2 T). Precision air-conditioning shall be provided for server rooms.

Note:

Fire rated walls, glass partitions - All walls / partitions in centralized SCADA center shall be with 1 hr. fire rating.

Door to SCADA Control room shall be provisioned with security system (Access Control) and surveillance cameras

All entry to SCADA control room shall have provisions for dust proofing and there shall be provisions for shoe racks outside the server room. Anti-static Laminate covering on the floor duly laid with grounding grid. Floor Insulation of the wall in SCADA Control room with 9mm thick nitrile rubber.

9.6.7 Civil works & Interior works for CWMC-Centralized SCADA center

The contractor scope of work under this contract shall also include all required civil works to cater to the new centralized SCADA center.

The scope of works shall also include Interior design works for the entire centralized SCADA center to augment the entire control center as per control center standards to the approval of the Engineer, presentation room facilities, Glass partitions, fire rated glass partitions for Server room and control room area, false ceiling & false flooring for control center, GJB Logo stickers etc.as per specification requirements and to the approval of the Engineer.

All furniture and fixtures shall be termite resistant.

Illuminated signs with proper naming convention shall be installed in the Control room & CSC building

9.6.8 Room Lighting:

Lighting circuit wiring shall be laid in PVC conduit / Aluminum race ways concealed in brick wall / cleated on ceiling using 2 nos. 2.5 sq. mm. PVC copper wire & 1 no. 1.5 sq. mm PVC copper earth wire. The contractor shall carry out design, engineering, installation, wiring, connections, testing and commissioning of the lighting system. Lighting fixtures & Point wiring shall be supplied, erected, connected and tested as required in the entire Server/SCADA Control room Facility. Illumination level shall be maintained between 500 Lux in all Server & SCADA Control room and associated rooms, anti-glare ceiling/recessed mounted light fixtures shall be used for lighting. The luminaries shall be fixed overhead and provide direct lighting. Desk lighting shall be installed to provide localized lighting over the keyboard. An average reflectance level of 30 to 60% is recommended for the walls. The ceiling shall have a reflectance of at least 75% with floors an average of 40%.

9.6.9 Sound:

A maximum noise level of 54 to 59 dB(A) is recommended and shall not be exceeded at all times.

9.6.10 Ventilation:

The environment in which SCADA system is installed must be appropriate to the computer system and the associated electronics systems. The air temperature shall be between 20°C and 26°C with relative humidity range of 40to60%RH fresh air shall flow at the rate of 7 litres/sec on throughout the control room. All the necessary air-conditioning equipment shall be provided by the successful Contractor at no extra cost in addition to the air condition systems already specified(6 Nos).

9.6.11 Earthing:

Ensure that all hardware is securely earthed and that the earth electrode is the central point for all electrical equipment and AC power within the facility. Contractor shall make use the most appropriate size copper wire for the earth as specified in BS Standard.

9.7 Centralized SCADA Control center Interior works Requirements

9.7.1 Scope of work

The purpose of this document is to define the specifications of control room interiors & consoles for centralized SCADA control center.

As the Control room is a significant place where critical operations/monitoring takes place, it is imperative that it is designed properly in terms of aesthetics, safety, ergonomics and functionality. Various aspects shall be considered while designing control room area to create ideal workplace, considering physiological aspects such as line of sight and field of vision and cognitive factors such as concentration and perceptivity as per ISO 11064/equivalent BS standards.

The scope of the project includes designing; engineering, supply & installation of 24X7 mission control centre interiors. Being a project of international repute the state-of-the-art centralized

SCADA control center & all its components like ceiling, flooring, panelling/partition, glass partitions, control desks, ceiling light & luminaire's electrical etc. shall look integrated and therefore it shall be treated as a part of one single solution.

To ensure an integrated solution, to qualify as per the international control room design & safety norms; the contractor shall appoint one single professional control room interior solution provider as per the experience as specified in Part-3 Qualification Requirements for vendors and sub-contractors.

The contractor shall note that It is mandatory and essential that the control room interior solution agency supplies all elements & executes all the activities at control center like ceiling, flooring, panelling, partitions & illumination to avoid interface & quality related issues.

The control room interior solution agency scope of work and supply shall consist of the following parts on a minimum but not limited to:

- 1) Interior Design, engineering of Control room,
- 2) All related services for supply, installation & testing,
- 3) Ergonomic compliance report as per ISO 11064/ equivalent BS standards.

9.7.2 Conformance to be submitted along with Technical Bid

This contract project demands for a contemporary, aesthetically appealing, ergonomically designed, safe and 24X7 working facility. Conventional wooden cladding, Gypsum, Aluminium composite panels, Laminates, Fabric, Paint, Plaster of Paris (for Control room area) is prone to damages & ageing. These components shall not be used to ensure maintenance free working environment. The contractor shall submit undertaking to comply to the above requirements during technical bid for technical qualification.

9.7.3 Design Criteria

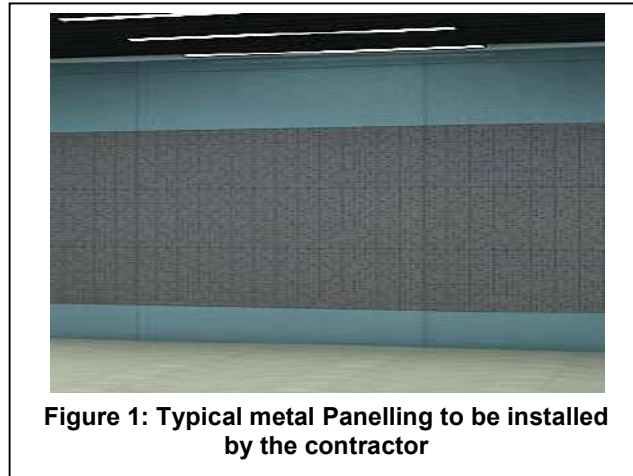
The metal ceiling, metal panelling and partition shall be of modular design, facilitating future equipment retrofits and full reconfigurations without requiring any major modification to the structure.

9.7.4 Quality Criteria

The critical components of the SCADA control room i.e., designer metal ceiling, carpet/laminated flooring, modular metal wall panelling/partitions shall not emit formaldehydes, TVOC beyond permissible limits i.e. $9 \mu\text{g}/\text{m}^3$, $0.22 \text{ mg}/\text{m}^3$ respectively. This shall ensure healthier air quality for the operators 24 x 7. Therefore, the control room interior shall be green guard gold certified (Modular metal ceiling, Acoustic flooring & Modular metal wall panelling) from UL/Intertek.

The Console (open plan) shall not emit TVOC (A), Formaldehyde, i.e. $152 \mu\text{g}/\text{m}^2\cdot\text{hr}$, $6.2 \mu\text{g}/\text{m}^2\cdot\text{hr}$ respectively. This is to ensure healthier air quality for the operators.

9.7.5 Technical Specification of Command Control Room Interior and Console



Modular rigid PVC metal panelling

Factory made removable type self inter lockable metal panels with front sheet of preformed textured hot dip galvanized sheet with rigid polyvinylchloride (PVC) film on one side and on the other side a coating to avoid rust (sheet thickness 0.6mm & PVC coating atleast 0.11mm). The back cover of the panel shall be made up of 0.6mm thick CRCA/GI sheet of approved colour. The panelling design shall comprise of specially designed combination of perforated and non-perforated panels through CNC laser cutting, bending & punching. Panels shall be designed to achieve shape and design as per the approved design from GJB and shall be fixed using GI/CRCA hook fitting on structure. Overall system thickness for panelling shall be 60mm to 90mm and for partition shall be 70mm to 120mm.

Panel shall comprise of perforation for making the cladding and partitions acoustically sound.

Tiles Perforation – To achieve acoustics without deteriorating the aesthetical appeal of the control room it is necessary that the wall panelling shall have micro-perforations (less than 1.6mm diameter each) all over the surface with a density of 5000 holes per square feet. The tile shall have 5000 holes per square feet on front side of the tile. Valid UL audit certificate to be submitted

As per design, panel shall comprise of perforation for making panelling and partitions acoustically sound. Acoustic grade fire retardant fabric (minimum 1mm thick) shall be fixed (on the back side of perforated tiles) at some parts of the control room facility.

There shall be possibility of wide variety of colours and images to be used on the wall elements to give the aesthetic and state of the art look to the control room interior.

Panel design to support proper integration of large video screen.

Gluing, screwing, ACP (Aluminium composite panels), Paint, Fabric, Gypsum, Wooden laminates shall be deemed unacceptable in control room interior. Contractor shall note the importance of this clause.

Structure shall allow uninterrupted flow of wires/cable/tubes of maximum diameter 25mm.

Panel shall be designed in such a manner that it takes care of undulation of walls and gives perfect flat surface finish and compile easy service & maintenance procedure.

To provide acoustically superior environment and ensure proper attenuation of airborne sound, it is necessary that the sound transmission class (STC) value of wall panelling and partition shall be 35 (According to IS: 9901 (Part III) – 1981, DIN 52210 Part I- 1989, ISO: 16283 (Part I) -2014).

The modular metal panelling shall comply to the lead-free directive to ensure restriction of hazardous substances so that the final product does not contaminate the environment. It is necessary that the modular metal panelling system shall be RoHS certified/tested (from UL / Intertek).

From fire safety point of view the metal wall panelling tiles shall be class A fire rated as per the norms of comparative measurements of surface flame spread and smoke density measurements with that of select grade red oak and fiber-cement board surfaces under the specific fire exposure conditions. The proposed wall panelling tiles shall be Class A certified/tested as per ASTM e84 (from UL/Intertek) for surface spread of flame and smoke generation. This is mandatory to ensure that the materials used in the interiors do not provoke fire.

Seismic safety of user & control room equipment shall be prime concern when designing the system. The metal panelling shall sustain the seismic vibrations as per design spectrum IS 1893 for zone 2 or better vibrations. The test shall be carried out by authorized government agency. Test Report to be submitted.

The wall panelling shall be robust & strong enough to sustain the routine loads/minor impacts of typical control room environment. The wall panelling/partition structure shall have UL audit certified feature of Load bearing capacity of 300 Kgs to hold any display unit on clamp having minimum length of 750mm. Valid UL audit certificate to be submitted.

As control room is a mission critical area and in an unlikely case of damage to the existing wall panelling tiles the same shall be replaceable within short time (1 day) and thereby preventing loss of time of operators and ongoing operations. UL audit certified feature of modular wall panelling tile having secure locking arrangement for equidistant mounting shall be submitted.

Design

The cladding panels shall be made up of combination of two sheets locked and riveted together and polystyrene shall be used as infill to achieve strength and acoustics. The front tile (PVC pre-coated metal sheet) shall be perforated/ non-perforated as per the design requirement and the back tile (Powder coated 0.6mm CRCA steel sheet and powder coating thickness 0.06mm to 0.09mm) shall be designed in such a manner that it fits on the back portion of the front tile. Once the tiles are assembled then these shall be riveted. These tiles shall be bent through CNC, machine punched & laser cut to achieve perfect accuracy.

Structure shall be made from modular, heavy-duty powder coated CRCA frame (minimum sheet thickness 1mm) and shall allow uninterrupted flow of wires/cable/tubes of maximum diameter 25mm.

Structure shall be securely connected from wall, roof and floor. It shall be made up of minimum 1mm thick vertical slotted rolled C sections (Upright) and horizontal rolled 'C' connectors. Grid of desired dimension shall be formed by vertical and horizontal sections having 20 to 50mm pitch.

Surface Finish

For panels

Front Panel: PVC pre-coated GI sheet (sheet thickness: 0.6mm and PVC coating: atleast 0.11mm)

Back Cover: Powder coated CRCA steel sheet. (sheet thickness: 0.6mm)

Rigid PVC / Panel material shall provide better thermal and electrical insulation. It shall be non-reflective/glare free.

For Structure

Powder coated CRCA steel sheet. (sheet thickness minimum 1.0mm with powder coating)

The metal sheet shall have possibility of being formed mechanically per the specific needs of the project.

Material Selection

Available Width- 100mm to 1200mm (in multiples of 100 & 150mm).

Available Height- 100mm to 750mm (in multiples of 100 & 150mm).

Thickness- minimum 10mm for perforated tiles with acoustic fleece without back cover.

Minimum 25mm for perforated/non-perforated tiles with back covers.

Material Testing/Certification:

PVC pre-coated sheet:

Fire rating and Low flame spread: EN ISO 11925-2, EN 13823 and ASTM e-84

Core material (compressed polystyrene):

Acoustic test: 9301/ ISO: 140/ASTM 413, ASTM C 578.

Powder coating

Adhesion test: EN ISO 2409 / ASTM: D 3359

Impact resistance test: ASTM D 2794 (5/9' ball)

Conical mandrel test: ASTM D522

Salt spray test: 1000 hours as per ASTM B117

Resistance to humid atmosphere test as per ISO 6270

Component Specification

Floor Mounting

'I' section made from pre-welded of minimum 2mm thick C channels; having minimum height of 150mm. This I section shall be firmly weld on 3mm thick grouting plate.

This assembly shall be grouted on the false floor with the help of M8/10 anchor fasteners.

These floor mountings shall be the base support to the vertical uprights spaced at a center-to-center distance of 1200mm maximum.

Contractor shall ensure proper marking and levelling before proceeding with any floor grouting.

C Section (Upright) fixing

58mm wide slotted rolled C section (UPRIGHT) (1 to 1.6 mm thick CRCA steel sheet). Maximum single piece length shall not exceed 2450mm.

All sections shall be dual slotted with 20 to 50 mm pitch.

These uprights shall be mounted over the floor mountings and shall be connected by C connectors made up of 1.0mm to 1.6mm thick CRCA steel sheet 'C' sections.

The installation to be carried out with Uprights spaced at 1200 mm (center to center) securely fixed to the false floor by means floor mountings.

The uprights shall be firmly held with L-shaped wall mounts made up of minimum 1.6mm thick CRCA steel sheet duly powder coated.

The L clamp and the upright shall be bolted together with M6 bolts

End Cap

0.75mm thick PVC coated GI tile; (similar to panel tile) shall be bolted on the extreme end-uprights, corners to hide the grid structure.

Panel

The panels shall be hooked on the uprights.

Panels shall have metal hooks

The hooks of the panels shall have a length of minimum 90mm (for the upper hook) and 80mm (for the bottom hook). So that these panels are firmly held on the uprights.

The panel shall have hook in arrangement (With gravity lock).

Door Profile

Door frame shall be fixed with these profiles only to have proper integration of doors with the overall system.

Feature

Raw material for tile & powder coating shall not affect environment.

Colour shall not fade over 10 years

No sagging

Easy and quick installation

Low cleaning effort

Vendor to demonstrate one portion at wall panelling & ceiling at their premises before dismantling & shipping to site. In short, a FAT (Factory acceptance test) to be carried out at vendors works for ceiling & panelling

100 % modular design. At site, no cutting, chipping work is allowed.

The tile shall be bend resistant.

Printed metal panelling

The printed panelling shall have the same technical specifications as that of modular rigid PVC metal panelling However, in addition to it, the front tile shall be digitally printed. Graphics shall be approved by GJB.

Digital printing shall be done on modular metal panelling. Pasting stickers/flex/vinyl on metal tile shall not be acceptable.

The structure shall be made from a modular, heavy-duty powder-coated CRCA frame (minimum sheet thickness 1mm) and shall allow an uninterrupted flow of wires/cable/tubes of maximum diameter 25mm.

The structure shall be securely connected from wall, roof and floor. It shall be made up of a minimum of 1mm thick vertical slotted rolled C sections (Upright) and horizontal rolled 'C' connectors. Grid of the desired dimension shall be formed by Vertical and horizontal sections having 20 to 50mm pitch.

For Structure: - Powder coated CRCA steel sheet. (Sheet thickness minimum 1.0mm with powder coating).

Curve Modular Rigid PVC Metal Panelling

The material of construction and technical specification shall remain the same as per modular rigid PVC metal panelling ,however, the shape shall be a perfect curve to provide more space for mounting of the LED. Panelling's curve shall be achieved by curved tiles only. Curvilinear arrangement using straight tiles shall be deemed unacceptable.

Factory made removable type self inter lockable metal panels with front sheet of preformed textured hot dip galvanized sheet with rigid polyvinylchloride (PVC) film on one side and on the other side a coating to avoid rust (sheet thickness 0.6mm & PVC coating atleast 0.11mm). The back cover of the panel shall be made up of 0.6mm thick CRCA/GI sheet of approved colour. The panelling design shall comprise of specially designed combination of perforated and non-perforated panels through CNC laser cutting, bending & punching. Panels shall be designed to achieve shape and design as per the design consultant and shall be fixed using GI/CRCA hook fitting on structure. Overall system thickness for panelling shall be 60mm to 90mm and for partition shall be 70mm to 120mm.

Structure shall allow uninterrupted flow of wires/cable/tubes of maximum diameter 25mm.

Panel shall be designed in such a manner that it takes care of undulation of walls and gives perfect flat surface finish and compile easy service & maintenance procedure.

The modular metal panelling shall comply to the lead-free directive to ensure restriction of hazardous substances so that the final product does not contaminate the environment. The final product i.e., modular metal panelling does not contain hazardous substances and we give a healthy life to our coming generations it is necessary that the modular metal panelling system shall be RoHS certified/tested (from UL / Intertek). Valid certificate/test report shall be submitted.

From fire safety point of view the metal wall panelling tiles shall be class A fire rated as per the norms of comparative measurements of surface flame spread and smoke density measurements with that of select grade red oak and fiber-cement board surfaces under the specific fire exposure conditions. The proposed wall panelling tiles shall be Class A certified/tested as per ASTM e84 (from UL/Intertek) for surface spread of flame and smoke generation. This is mandatory to ensure that the materials used in the interiors do not provoke fire. Valid certificate/test report shall be submitted .

Seismic safety of user & control room equipment is of prime concern. The metal panelling shall sustain the seismic vibrations as per design spectrum IS 1893 for zone 2 or better vibrations. The test shall be carried out by authorized government agency. Test Report to be submitted.

The wall panelling shall be robust & strong enough to sustain the routine loads/minor impacts of typical control room environment.

Structure shall be made from modular, heavy-duty powder coated CRCA frame (minimum sheet thickness 1mm) and shall allow uninterrupted flow of wires/cable/tubes of maximum diameter 25mm.

Doors

12mm thick Frameless tempered clear glass door with fittings (Single / Double Doors): - With door spring and locking arrangements and both way handle and patch fittings.

Ceiling Designer Acoustic Metal False ceiling with Planks



Factory

made acoustic modular metal false ceiling of powder coated panels. Make shall comprise of perforated and non-perforated metal panels made through CNC laser Cutting, bending & punching. Panel shall be of 0.6mm CRCA sheet of approved powder coating finish. Panels shall be designed to achieve shape and design as per the GJB requirements with the combination of acrylic panels with lights, designed to enhance visual feel, with provision for easy installation and maintenance, integrated lighting and scope for integration of building services like HVAC and fire detection/ fighting system. Metal modular false ceiling shall have noise absorption coefficient (NRC) value 0.60 according to IS:8225-1987, ISO: 354-1985 and ASTM 423-90. Test reports shall be to be submitted .

The proposed ceiling tiles shall be Class A certified/tested as per ASTM e84 (from UL / Intertek) for surface spread of flame and smoke generation. This is mandatory to ensure that the materials used in the interiors do not provoke fire. Valid certificate & report to be submitted.

To ensure restriction of hazardous substances; so that the final product does not contaminate the environment and we give a healthy life to our coming generations it is necessary that the modular metal ceiling system shall be RoHS certified/tested (from UL / Intertek). Valid certificate & report to be submitted.

To avoid dark spots/areas in the control room it is necessary that continuous linear lights are used across the width/length of the control room. UL audit certified design feature of integrated channel in ceiling for quick installation & replaceability of continuous linear light: The ceiling system having integrated inbuilt channel for installation of cove lights and shall permit quick and easy replacement of cove light without using any tools. Valid UL audit certificate shall be to be submitted.

Seismic safety of user & control room equipment is a prime concern area. The metal ceiling shall sustain the seismic vibrations as per design spectrum IS 1893 for zone 2 vibrations or better. Valid test report to be submitted .

Structure shall be made from heavy duty powder coated CRCA steel sheet (minimum sheet thickness 0.8 to 1.6mm). It shall be securely grouted from roof with help of anchor fastener and GI self-threaded rods. It shall be formed with the help of slotted rolled W sections (stiffener) and Master C section with help of M6 cage nut and bolts.

The ceiling system shall have double safety system to take care of seismic vibrations.

The ceiling planks shall have locking redundancy to enhance seismic impact resistance.

The powder coated metal sheet shall have possibility of being formed mechanically per the specific needs. The powder coating shall be able to undergo stretching up to 100% and therefor follow (adhere to) bend with the steel in all its deformation. The master section shall have laser cut

profile to enable fixing of perforated, non-Perforated & diffused continuous LED section with acrylic sheet.

Dimensional Details

Non- Perforated Tile: - Machine profiled CRCA Steel sheet of 290mm (Wide) available in various length of 600mm to 1800mm in multiple of 300mm

Perforated Tile: - Machine profiled CRCA Steel sheet with fleece of 146mm (Wide) in various length of 600mm to 1800mm in multiple of 300mm.

Type- Hook on with double locking arrangements. (Key requirement). Shall be easily openable to access above ceiling services. Special connection joineries to take care of seismic vibration.

Material Testing/Certification

Powder coating: shall qualify 1000 hours' salt spray test.

Component Specification

Master Section

1.2mm thick CRCA steel sheet section length 1200mm. the installation to be carried out with runner's spaces at 1200/1500/2100mm center to center securely fixed to the hanging W section by means at M6 Nut and bolts.

Hanging W Section

Specially machine profiled W section 65x15x0.8mm.the section shall be 2400 mm long & shall run across the length at the room.

Centre to Centre distance between W section shall be 1000mm.

These sections are securely fixed to the slab by means of Metal fastener and 08mm GI rod fully threaded (with hex nut for precision level adjustment)

The two-master section shall be attached to each other by means at fixing pate 45x34mm & M6 cage nut & bolts.

U Section

Machine profiled 'U' Section 150x77x0.6mm section to accommodate continues running light

It shall have provision for fixing acrylic sheet

This whole assembly shall be hung from roof slab with help of anchor fastener and full threaded GI rod.

Ceiling Plank

It shall have Laser cut holes/cut-outs for light fixing as per defined lux requirement and approved layout.

Non-perforated tile slots shall be punched to accommodate AC grills.

Designer calcium silicate ceiling

Plain calcium silicate acoustic boards for false ceiling with 08mm approximately thick, Structure for underside of suspended grid formed of GI perimeter channels. Wood screws and metal expansion raw plugs for fixing with wall. Plastic emulsion paint of approved make and shade for finishing surface of Calcium Silicate Boards.

Lighting and Illumination

Round LED Lights: - High performance LED downlighter with high system efficacy for good quality and uniform lighting. Shall conform to general lighting norms for office and other indoor applications.

Colour Temperature (K)- 3000 K / 4000 K / 5700K

LED Efficacy (lm/W) – 100 to 160

CRI >70

Power Consumption 6W to 24W

LED's life >25,000 hours @ L70

Wiring for ceiling lights

For ceiling wiring inter looping shall be done and switches shall be provided

The system of wiring shall consist of PVC insulated copper conductor stranded flexible FRLS wires of 1100 volts grade of insulation, in metallic conduits for all exposed wiring and PVC/ metallic conduits for all concealed wiring. Minimum size of copper conductor shall be 1.5 sq. mm for lighting and 2.5 sq.mm for power. Colour code shall be maintained for the entire wiring installation that is Red/Yellow/Blue (or as per Local Standards) for the all-single phases, Black for neutral and Green for earthing.

Appropriate ferrule shall be used in both the side (LDB Side & Switch's Side).

Note – Each Light Fixture shall have 3 Wires: Phase, Neutral & Earth individually.

Switches and Sockets

Compliance to stringent quality norms, Dual shutter mechanism for easy & better fitment Wide & flat switch knob for easy operation. FR grade polycarbonate with high impact resistance, shock proof & UV rays stabilized.

MCBs

For the control and protection of low voltage installations against overload and short circuits.

Ripping characteristic: C Curve – 5 to 10 x In

Rated at 25°C to -50°C

Isolation function

Double entry points, separate bus bar entry, open mouthed terminal and lift clamps.

9.8 Hardware and Other components of system

9.8.1 Servers & Hardware:

All Servers under this contract shall be of blade type with required blade enclosure and precision cooling systems.

Redundant Front end processor servers (FEP) shall receive the data from each of the remote locations and internally route the data to the SCADA Servers.

SCADA software servers, Front end processor (FEP) servers shall be provided in redundant configuration. This shall ensure that in the event of failure of any one server, the other server shall be able to handle the monitoring & control tasks without any interruption in operation

Hardware & Ancillary Requirements

The system shall support hardware and software interconnectivity to other networks generally in accordance with the ISO Open System Interconnect 7 layer reference model.

9.8.2 Servers & Work stations:

All servers under this contract (SCADA servers, front end integration/processor servers, historian NAS servers) shall be blade servers. Each of the above shall be assigned individual blade servers and shall together constitute a blade system. True redundancy shall be provided.

Front end integration servers shall receive the incoming data from various remote stations and communicate the same to the SCADA servers.

All workstations, servers, communications equipment and peripherals shall be from reputed manufacturers, suitable for continuous operation and shall be the most currently available models at the time of construction, subject to approval. Adequate spare capacity shall be included to meet the specified requirements and future expansions. The contractor shall refer to the approved Vendor list specified elsewhere in this document.

All work stations –SCADA, Fire alarm & CCTV, operator and engineering workstations shall be provided with 32” LED screen monitors. All the work stations shall be networked on local area network (LAN).

The following requirements shall be met on a minimum but not limited to the following. The contractor shall provide the complete system as required to meet the requirements of this contract.

9.8.3 Blade Server Requirements:

Blade Chassis	
Form Factor	6U-10U rack mountable Chasis to House at least 4 or more Blade Servers
Chasis	Shall be configured with 8 blades
Network	Dual end to end redundant Network connectivity for each blade
Power Redundancy	Each blade shall have dual redundant connectivity for Power from the Power supplies through the midplane
I/O Connectivity	Dual Redundant I/O Connectivity to each blade server
Blade Compatibility	Shall accommodate Intel, AMD/RISC/EPIC CPU Blades in the same Chassis
KVM Support	At least one IP Based KVM Switch or more in the chassis
Optical Drive Support	The Chassis shall have At least one DVD ROM drive or better which can be used by all the blade servers The optical drive shall be hot swappable
L2 Switch Support	2 redundant 1GB Ethernet switch to be provided in the chassis with Layer 2 features
Power Supply	Hotswap and redundant Power supplies shall be

	provided with full redundancy and all power modules shall be fully populated
Cooling Modules	Hot Swap and redundant cooling modules and all modules shall be fully populated
Alert Management	Pre failure alerts and error identification on Hard Disks, processor, memory, power Supplies, fans/blowers, switch modules, KVM management module shall be provided
System management	System management and deployment tools to aid configuring the Blade Servers and OS Deployment
Supporting Software	Software for Vulnerability assessment
Efficiency	The Blade servers shall have dual connectors on it to be connected to the midplane so as to provide dual path for I/O,N/W and power to each server for redundancy

Note: Latest version shall be supplied

9.8.4 Blade:

Item	Specifications
CPU	1 x Intel Xeon Quad Core E5-2603 80W 1.8GHz
Cache L3	15 MB of L3 Cache
Chipset	Intel Chipset
Memory	32GB Registered DDR-3 ECC Memory Upgradeable to 96 GB
Active Memory protection	Advanced Chipkill ECC memory protection support, memory mirroring and memory sparing
SCSI Controllers	Integrated Hardware Raid Controller to supports Hardware Raid 0,1
Disk Drives	3 x 300GB 2.5in SFF Slim-HS 10K 6Gbps SAS HDD
Graphics Controller	
16MB SDRAM Ethernet Adapter	Server shall be configured with four number of 1Gbps ethernet ports
Fiber Channel/SAS HBA Connectivity	Dual port SAS HBA for connecting to Internal/External Storage
I/O Expansions	2 x8 PCIe
Power Supply	From the Blade Chassis via Dual Redundant Power Connectors
Warranty	3 Years Onsite Comprehensive Warranty
Form Factor	Full Height Blade Servers
Failure Alerting Mechanism	The server shall be able to alert impending failures on maximum number of components. The components covered under alerting mechanism shall at least include Processor, memory, HDDs and expansion cards

Blade Form Factor	Full Height Blade Server with Dual Redundant I/O and Power Connectors
Systems management capabilities	Server shall support systems management capabilities like
Server Management Software	Shall be able to discover systems and other resources in a heterogeneous environment and Collect inventory data about hardware and software that is currently installed on systems
	Shall be able to view and manage the status, problems and events for discovered systems
	Shall be able to determine the health, compliance, and performance of managed systems by viewing detailed information about the problems by inspecting the event log
	Capable of automatically send the notifications for hardware events or when thresholds are exceeded
	<p>Capable of doing configuration management of other systems by Initially configuring one or more systems (hardware and operating systems). Automatically configure newly discovered systems</p> <p>Shall have feature like update manager for detecting and viewing out-of-date systems and also get a notification when systems are in need of updates and which updates are needed. Download, distribute and install available and requisite updates</p> <p>Shall be able to do the graphical remote control tools including VNC, RDP, and web-based remote control for AMM, ILO, IMM, and RSA</p> <p>Able to discover and Work with virtualized environments including Microsoft Virtual Server, VMware, and Xen. Capable of viewing topology that shows the connections between physical and virtual resources</p> <p>Create automation plans based on events from virtual and physical resources and automation actions such as relocating a virtual server based on critical hardware alerts</p> <p>Create, delete and manage virtual servers and virtual farms for several virtualization</p>

	<p>technologies</p> <p>Relocate virtual servers to alternate physical hosts</p> <p>Ability to discover network devices and review network device inventory . Able to Monitor the health and status of network devices. View network device configuration settings, and apply templates to configure devices</p>
OS Support	Server shall support latest version of Microsoft windows, Redhat, Novell and Vmware

9.8.5 Workstations:

Processor	Intel Xeon E3-1220 3.10 GHz v2
RAM	32 GB (1 X 6GB) Non-ECC configurable Up to 32 GB 1600 MHz DDR3
Storage	2TB SATA HDD
ODD	DVDRW
Graphics	NVIDIA Quadro 2000 1Gb graphics with Dual Display Port, Dual-link DVI and supporting maximum resolution of 2560x1600
Monitor	32" LED Monitor Multiple input options – DisplayPort, DVI-D and V, Wide viewing angle with native resolution of 1680 x 1050; 16:10 Aspect ratio; 5ms response time ,ENERGY STAR 5.1 compliant, TCO certified Edge 1.1, and Mercury/Arsenic free glass
Ports	(4) USB 3.0 (Rear);(2) USB 2.0 (Front)
Ethernet	Gigabit ethernet
OS	64-bit Latest OS professional version (Minimum)
Warranty	Three-year(Extendable to 5-years),next business day warranty including labor and parts, 24x7support

9.8.6 NAS Server (For Historian)

	Specification	Minimum Requirement
1	CPU	Dual-core Intel® 2.4 GHz Processor
2	Memory	System memory: 32GB DDR3 RAM
		Memory module pre- installed: 4 GB x1
		Total memory slots: 4

		Memory expandable up to: 32 GB (8GB x4)
3	Flash Memory	512MB DOM
4	Hard Drive	4 x 2 TB SATA 6Gb/s
5	Hard Drive Tray	8 x hot-swappable and lockable tray
6	LAN Port	2 x Gigabit RJ-45 Ethernet port (Expandable up to 6 x 1 Gb LAN or 4 x 10 Gb + 2 x 1 Gb LAN by installing optional dual-port 10 Gb and 1 Gb network card)
7	LED Indicators	Status, 10 GbE, LAN, Esata, hard drives
8	Form Factor	2U, Rackmount
9	Expansion Slot (PCI -E)	2

9.8.7 A3 Size All in One Printers:

	Specification	Requirement
1	Specifications	Print, Scan, Copy &Fax standalone scan-to email, photo card slots
2	Print – Duplex print Option - Print Speed - Print Resolution	Automatic 25ppm Upto 600 X 600dpi
3	Scan – Scan Type - Scan speed - Scan Resolution	Flat Bed ADF Normal, A4,A3 Size: Up to 14ppm(B&W),upto5ppm (colour) Hardware:Upto300x300dpi (colour and mono, ADF); Upto600x600dpi(colour,Upto1200x 1200 dpi(mono, Optical: Up to 300dpi(colour and mono, ADF); Up to 600dpi(colour, Up to 1200 dpi(mono, flatbed).
4	Copy – Copy speed - Copy resolution - Max no of copies - Copier resize	Up to 25 cpm black Black (text): Upto 600x600dpi; Black(graphics):Upto600x600dpi 99copies - 25 to400%

5	Fax – Fax speed	3 sec per page
	- Fax speed dialing(max nos)	Upto120 numbers(119groupdials)
5	- Fax resolution	Black(standard):203x98dpi;204 x 196 dpi; Black Photo Grayscale:300x300dpi(halftone enabled);300x300dpi(no halftone)
	- Fax features	Auto fax reduction support: Yes; Auto-Redialing: Yes; Fax delayed sending: Yes; Distinctive ring detection supported: Yes; Fax forwarding supported: Yes; Junk barrier supported:Yes;Maximumspeeddialingnumbers:Upto120numbers(119; PC interface supported: Yes
6	Memory	- 256MB(minimum)

9.8.8 Configuration & Remote Connect Client

CPU	Intel © Core™ i7, 3.40 GHz or higher
RAM	32 GB or more
HDD	Hard disk with a capacity of 2TB or more
ETHERNET ADAPTOR	Ethernet compatible network port
OPERATING SYSTEMS	Windows
GUI	F/T Configuration and Operator interface

Web-HMI Server hardware specifications

CPU	Intel © Core™ i7, 3.40 GHz
RAM	32 GB or more
HDD	Hard disk with a capacity of 2TB or more
ETHERNET ADAPTOR	Ethernet compatible network port
OPERATING SYSTEMS	Windows, Red Hat, CentOS, Unix

PLC/Remote telemetry Unit:

	Specification	Requirement
1	Dynamic memory (RAM) (program execution, dynamic variables and file system, etc.)	32 Megabytes or more
2	Program memory (Flash) (for Linux OS, program storage, and file system)	64 Megabytes or more
3	Real-time clock resolution	10Ms
4	Real-time clock accuracy	+/-15 seconds per month
5	Data log modes	Trending, alarm log, sequence of events, event initiated, client transfers, and others
6	IEC 61131programming	Yes

7	Language support	At least two or more from Ladder logic, function chart, function block, instruction list, structured text, and flowchart
8	Cycle time	10 ms minimum (user settable)
9	Communication capabilities	Master, slave, peer to peer, report on exception
10	Communication	6 Ethernet (TCP/IP) and RS485(MODBUS)
14	CPU watchdog	CPU shall automatically reset if error is detected; status LED shall flashes error code
15	Ethernet Port	Networkport:1 shielded RJ45connector with Isolation to1.5kVrms/ 1minute Message response time (typical) – 5ms Diagnostic LEDs–(speed and activity) Protocols supported–TCP/IP,ARP, UDP, ICMP,DHCP, Modbus/TCP

9.8.9 DC Power Supplies

	Specification	Requirement
1	Nominal input voltage	230VAC
2	Frequency	47 Hz to 63Hz
3	Input current	3.2 A typ. At 230VAC
4	Mains failure hold-up time	> 20 ms at 230VAC
5	Nominal output voltage	24VDC
6	Output current	10 A at 24VDC
7	Adjustment accuracy	1%
8	Degree of protection	IP20
9	Operational indication	LED green(24VDCo.k.),LED red(overload)
10	Type of mounting	DIN-rail mounting(DINEN50022)
11	Ambient	-10 °C to+70°C
12	Wire Connection	Cage Clamp
13	Type	SMPS, shielded metal case, with provision for earth

9.8.10 Surge Protection Barrier

	Specification	Requirement
1	Channels	1-Channel
2	Rated voltage Un	≤30V

3	Rated current I_n	$\leq 250\text{mA}$
4	Leakage current	$\leq 5\mu\text{A}$
5	On-state voltage	$\leq 45\text{V}$
6	Nominal discharge current(8/20) I_n	10kApercore,5kApercore(10x)
7	Max. surge current(8/20) I_{max}	20kApercore,10kApercore(1x)
8	Degree of protection	IEC60529
9	Ambient temperature	-30...80°C(-22...176°F)
10	Degree of protection	IP20
11	Mounting	DIN rail mount module
12	Group, category, type of protection, temperature class	Ex II 2(1)G Ex ia IICT6
13	Directive94/9/EC	EN60079-0:2006,EN60079-11:2007
14	IEC Ex approval	IECEx BAS14.0010X

9.8.11 ROUTER for 4G/5G

	Specification	Requirement
1	Important 4Gfeatures	<ul style="list-style-type: none"> • Auto-switch fail over between primary and backup link • Multichannel-interface-processor (MIP) profile configuration • Remotely initiated data call back using voice • Remotely initiated data call back using Short Message Service (SMS) • Remote firmware upgrade over 4G • Virtual diagnostic monitoring • Mobile Equipment Personalization (MEP) lock and unlock capabilities • SIM lock and unlock capabilities
2	Dual SIM support	<ul style="list-style-type: none"> • High reliability and cellular multi-homing support for HSPA and HSPA+ based networks • Dual SIM card socket; compliant with ISO-7816-2 (SIM mechanical) • Two Internal SIM Card Slots:
3	SMS	<ul style="list-style-type: none"> • Ability to send and receive SMS (maximum of 160 characters)
		<ul style="list-style-type: none"> • In-band and out-of-band management using Telnet (Cisco IOS Software command-line interface [CLI]) and

4	4G/5G network management and diagnostics	Industry-standard 4G diagnostics and monitoring tools (QUALCOMM CDMA Air Interface Tester [CAIT] and Spirent Universal Diagnostic Monitor [UDM])
5	Included antenna	Two multiband swivel-mount dipole antennae (4G) and one extender (4G-AE010-R) are included with all Cisco 819 Routers.
6	LED indicators	<ul style="list-style-type: none"> Received signal strength indication (RSSI) (green) • WLAN • WWAN • SIM status • 3G/4G service (green/amber) • SYS • ACT
7	IP and IP services features	<ul style="list-style-type: none"> Routing Information Protocol Versions 1 and 2 (RIPv1 and RIPv2) Generic routing encapsulation (GRE) and multipoint GRE (MGRE) Standard 802.1d Spanning Tree Protocol Layer 2 Tunneling Protocol (L2TP) Layer 2 Tunneling Protocol Version 3 (L2TPv3) • Network Address Translation Dynamic Host Configuration Protocol (DHCP) server, relay, and client Dynamic Domain Name System (DNS) • DNS Proxy • DNS Spoofing • Access control lists (ACLs) • Ipv4 and Ipv6 Multicast Open Shortest Path First (OSPF) • Border Gateway Protocol (BGP) • Performance Routing (PfR) Enhanced Interior Gateway Routing Protocol (EIGRP)

		Virtual Route Forwarding (VRF) Lite
		Next Hop Resolution Protocol (NHRP)
		Bidirectional Forwarding Detection (BFD)
		Web Cache Communication Protocol (WCCP)
8	Switch features	Auto Media Device In/Media Device Cross Over (MDI-MDX)
		• 8 802.1Q VLANs
		• MAC filtering
		• Switched Port Analyzer (SPAN)
		• Storm control
		• Smart ports
		• Secure MAC address
		Internet Group Management Protocol Version 3 (IGMPv3) snooping
• 802.1x		
9	Security features	Secure Sockets Layer (SSL) VPN for secure remote access
		Hardware-accelerated DES, 3DES, AES 128, AES 192, and AES 256
		Public-key-infrastructure (PKI) support
		• 20 Ipv6 tunnels
		Dynamic Multipoint VPN (DMVPN)
		Tunnel-less Group Encrypted Transport VPN
		• Ipv6 stateful failover
		• VRF-aware Ipv6
		• Ipv6 over Ipv6
		• Adaptive control technology
		Session Initiation Protocol (SIP) application layer gateway
		• Zone-Based Policy Firewall
Stateful inspection transparent firewall		

		Secure HTTP (HTTPS), FTP, and Telnet Authentication Proxy
		Dynamic and static port security
		Firewall stateful failover; VRF- aware firewall
		Content filtering:
		• Cisco IOS Software black and white lists
		Integrated threat control:
		• Intrusion prevention system (IPS)
		• Control Plane Policing
		• Flexible Packet Matching
		• Hierarchical QoS (HqoS)
10	Ipv6features	• Ipv6 addressing architecture
		• Ipv6 name resolution
		• Ipv6 statistics
		• Ipv6 translation: Transport packets between Ipv6-only and Ipv4-only endpoints (NAT-PT)
		• Internet Control Message Protocol Version 6 (ICMPv6)
		• IPv6 DHCP
11	Memory	
12	DRAM	At least 512MB
13	Flash memory	At least 256MB
14	Interface Support:	
15	Console or auxiliary port	RJ-45: Single dual-purpose port, which provides direct connection to a console or external modem for management or backup access point
16	Mini-USB port(RSVD)	Mini-USB port to support remote 3G diagnostics and monitoring tools (QUALCOMM CAIT and Spirent UDM)
17	WAN interfaces	• Wireless WAN with 3G, 3.5G and 3.7G speeds
		• 10/100/1000 Giga bit Ethernet port
		• Cisco Smart Serial Interface (sync/async/bisync)
18	LAN interfaces	• Four 10/100 Fast Ethernet ports

19	Standard safety certifications	<ul style="list-style-type: none"> UL 60950-1, 2nd edition
		<ul style="list-style-type: none"> CAN/CSA C22.2 No. 60950-1, 2nd edition
		<ul style="list-style-type: none"> EN 60950-1, 2nd edition
		<ul style="list-style-type: none"> CB to IEC 60950-1, 2nd edition with all group differences and national deviations
20	EMC immunity	EN55022/CISPR22, CFR 47 Part 15, ICES003, VCCI-V-3, AS/NZS CISPR22, CNS13438, EN300-386, EN61000-3-2, EN55024/CISPR24, (EN61000-4- 2, EN61000-4-3, EN61000-4-4, EN61000-4-5, EN61000-4-6, EN61000-4-11), and EN300-386
21	Radio Immunity	EN301 489-1, EN 301 489-7, and EN301 489-24
22	Cellular radio	EN 301 908-1, EN 301 908-2, EN 301 511, 47 CFR Part 22, and 47
		Cisco Smart Serial Interface (sync/async/bisync)
23	LAN interfaces	Four 10/100 Fast Ethernet ports
24	Standard safety certifications	<ul style="list-style-type: none"> UL 60950-1, 2nd edition
		<ul style="list-style-type: none"> CAN/CSA C22.2 No. 60950-1, 2nd edition
		<ul style="list-style-type: none"> EN 60950-1, 2nd edition
		<ul style="list-style-type: none"> CB to IEC 60950-1, 2nd edition with all group differences and national deviations
		EN55022/CISPR22, CFR 47 Part 15, ICES003, VCCI-V-3, AS/NZS CISPR22, CNS13438, EN300-386, EN61000-3-2,

9.8.12 19” Rack mount Gigabit Ethernet Switch

	Specification	Requirement
1	Standards and Protocols	IEEE802.3i,IEEE802.3u,IEEE802.3ab, IEEE802.3x
2	Interface	810/100/1000MbpsRJ45Ports(Auto Negotiation/Auto MDI/MDIX)
3	Network Media	10BASE-T:UTPcategory3,4,5cable (maximum100m)
		100BASE-TX/1000BASE-T: UTP category5,5eorabovecable(maximum100m)
4	Switching Capacity	16Gbps
5	MAC Address Table	8K
6	Buffer Memory	2Mb

7	Power Supply	Preferably built-in for direct 230VAC or with external power adapter.
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9.8.13 19" Rack mount Patch Panels

	Specification	Requirement
1	Panel	19"Rackmount
2	No. of RJ45Ports	24(1U)
3	RJ45Jack	Housing: ABS, UL94V-0 ContactBracket:PC,UL94V-2, Transparentcolor.
4	RJ45 Jack Contact	Material: Phosphor Bronze with Nickel Plated Finish:50micro-inchesGoldplated on plug contact area
5	Security	Hardware firewall
6	Connectors	CAT-6cable,CAT-6patch-cords,etc.,

9.8.14 Rack Enclosure

1	Size	Width 900 MM x Depth 630 MM x Height 2000 MM(minimum)
2	Material:	Enclosure, Door, Rear Panel: Stainless steel 1.4301(AISI304), 1.5 mm (minimum), exterior brushed Base: Stainless steel 1.4301 (AISI 304), 1.5 mm (min.) Mounting plate: Sheet steel 3.0 mm
3	Surface finish:	Enclosure, rear panel and door: Brushed, grain size 400 Mounting plate: Zinc-plated
4	Protection category IP	IP 66 (IEC 60 529), NEMA 4X
5	The Component Modules in the Rack / Enclosure to comprise of:	Enclosure, solid top and sides Door(s), with 180 degrees hinges (if available) Front-door with glass, rear steel door Mounting plate Base, solid; with gland-plate for cable-entry at top and bottom
6	Locks (front and rear)	Comfort handle for semi-cylinders and security lock
7	Equipment Mounting sections	Two482.6mm(19")mountingsectionsfrontandrear,variably mountedonsupportstripswithquick-releasefasteners
8	Earthing	Connection accessories for potential equalization with earthing point

9	Cage nuts, screw kits	50multi-toothscrewsM5,cagenutsM5,conductive(suppliedloose)
Note: Due to the hardness of the material, metal multi-tooth screws shall be used for the interior installation.		

9.8.15 Broadband Internet

Broadband internet services with high speed connectivity shall be supplied at the Centralized SCADA center for connectivity with remote sites and for web connectivity. The most suitable package of broadband internet service provided by an Internet Service Provider (ISP) which suits the Client’s requirement shall be utilized. The contractor shall enter in to SLA agreement to provide continuous fail safe services as required under this contract.

9.8.16 Fixed Line

For locations at where ISP is readily available, the technology which supports the broadband services shall be based on Digital Subscriber Line (DSL). The type of DSL utilized shall be of the Asymmetrical Digital Subscriber Line (ADSL) which shall allow simultaneous access to the net and usage of the telephone or fax line Certified ADSL modems shall be utilized. Splitter and micro filter shall be installed on the telephone or fax line to avoid interference.

9.9 Fire Alarm System

The contractor scope of work shall include on a minimum, design, engineering, supply and installation & commissioning of Fire Alarm , detection and suppression System suitable for control room and all ancillary facilities area.

Fire Alarm System (FAS) shall be designed to detect & suppress the incipient fires and generates audio/ visual alarms in case of fire. The system shall consist of automatic fire detectors and manual call point & break glass units. Automatic fire detector shall work on principle of sensing the smoke, heat or infrared rays.

Detector shall be provided in control room and various location in the control center. Manual call point shall be provided at exit doors/ routes of control room. Number of detectors and manual call point shall be decided as per guideline and codes.

Fire alarm system shall be microprocessor-based fire alarm system and shall have addressable type field devices. It shall comprise following equipment’s used in conjunction with addressable automatic detectors & and addressable MCPs.

1. Multi loop Data Gathering Fire Alarm Panel (DGFAPs).
2. Sirens & Starters, Hooters, exit signs.
3. Interface with other systems thru Dual redundant data highway with complete network hardware.

System shall be modular and facilitate future extension up to 30%. Redundancy shall be provided at Processor, communication, power supply level. Fire alarm logic shall be programmable type. Minimum number of detectors/ MCPs/ addressable devices in single loop shall be 60 nos.

Conductor size of loop cable shall be 1.5 sq. mm copper. All field devices like detectors, MCP shall be addressable type. Fire alarm system shall be interfaced with Fire extinguishing system.

9.9.1 Fire Extinguishing System

Design, engineering, supply and installation commissioning, puff test, guaranteeing of total flooding (above false flooring + control room + below false flooring) clean agent Fire Extinguishing system for Fire Protection. Clean agent to be considered is HFC227ea, HFC-125, IG-541, IG-100, , IG-55 and IG-01 as per NFPA-2001 for fire protection.

All equipment's shall be approved by UL/FM/Vds/ LPC and TAC accredited agency. Cylinders along with cylinder valve shall be seamless and PESO approved. Clean agent system to be provided shall meet the requirement of NFPA 2001 (Latest).

The system shall include electrically actuated automatic clean agent Fire extinguishing system complete with filled up clean agent cylinders, cylinder rack, manifold, pressure reducing devices, cylinder valves, directional valves, pipes, discharge nozzles, bracket supports, hangers and such other fittings necessary for complete installation of system including necessary civil and mechanical work to complete the above work.

System shall be in operation in following modes

2. Automatically due to fire detection in protected area.
3. Operation of manual release push button located adjacent to protected area.
4. By operating manual lever provided on electrical/ manual control head on pilot cylinder
5. By push button actuation at clean agent control panel.

The system shall include electrically actuated automatic clean agent Fire extinguishing system complete with filled up clean agent cylinders, cylinder rack, manifold, pressure reducing devices, cylinder valves, directional valves, pipes, discharge nozzles, bracket supports, hangers and such other fittings necessary for complete installation of system including necessary civil and mechanical work to complete the above work.

The clean agent shall be discharged / actuated automatically after an adjustable time delay based on the detection signal received. The delay shall be minimum 30 seconds; however, it shall be adjustable from 30 to 120 sec. Local control panel of control agent shall be equipped with Hooter. It shall operate once gas is released.

9.10 Particular SCADA Software Requirements

The SCADA software shall demonstrate a strong history of upgrade-ability from one version of their software to another with virtually no reconfiguration or engineering effort required to migrate functionality to new versions. A demonstrated track record of upgrades between versions of at least 3 years, with a preference for 5 years, must be shown. If reconfiguration or manual intervention has been required between any versions in the last 5 years, the vendor shall provide detailed documentation of the steps required to achieve the upgrade. If functionality has been removed when upgrading to a new version at any time in the last five years, the vendor shall provide a list of removed items. Any additional software required for meeting this specification, other than a standard Windows operating system and internet explorer shall be listed and included

within the contractor pricing proposal. Run time version & Engineering license shall not be separate. It shall subscribe to single licensing philosophy.

The SCADA software shall be fully OPC compliant and shall allow for seamless interoperability with any third-party software for integration of data from other SCADA software's. Contractor shall note the importance of this clause.

9.10.1 SCADA Software:

The Centralized SCADA center shall be equipped with the following software and hardware configuration on a minimum but not limited to:

The SCADA software shall be dual redundant type and shall be equipped with development and run time tag configuration and licensing. This feature shall allow the software tags to be configured for future expansion of I/Os for integration of facilities to be set up in the future, without any extra cost or licensing. The SCADA software shall be of 64 bit version and shall have web server functionality.

SCADA software offered shall not be restricted by number of SCADA screens, and the minimum number of tag license offered shall be of minimum Fifty thousand tags. Additionally, the contractor shall ensure that the tags shall be "4 times actually utilized tags" in SCADA package. The SCADA software shall be fully OPC compliant and shall allow for seamless interoperability with any third-party software for integration of data from other SCADA software's. Contractor shall note the importance of this clause

Historian Software: The historian software shall be equipped to store historical data received at the centralized SCADA center from all the remote stations. The Historian software shall be based on the above indicated SCADA packages and shall follow the same licensing. The historical data can be recalled for analysis using reports and trends as required by the top management.

Operator & Engineering Workstations & CCTV workstation: The CSC shall be equipped with engineering and operator work stations. The CSC administrator shall be able to program the SCADA system using the engineering work station with appropriate user login credentials and passwords. The CSC operators shall be able to monitor the remote stations and the data using the operator work stations.

Each operator and work stations shall be equipped with 32" LED Monitors to provide operator comfort and wide coverage area. One of the operator workstations shall be equipped to monitor the status of the fire alarm system to be installed in the control center. Workstation to monitor the CCTV feeds & fire alarm system in the control center shall be provided.

The software must be able to integrate the live feeds from the IP based cameras.

1) Scalability

The software shall be scalable such that the user can start with a small system, and expand the database to any size. No changes shall be required to commissioned stations, or to the project configuration, to support new ones.

2) Architecture

The SCADA software shall consist of an Operator Interface Subsystem(s) and various Server Subsystems for centralized processing including as a minimum:

- 1) I/O Communications Subsystem(s)
- 2) Monitoring, alerting, distribution and acknowledgement of alarms
- 3) Collection, storing and distribution of historical trends
- 4) Processing, storing and distribution of reports
- 5) Web browser based clients

Subsystems shall run as separate threads / processes such that a failure of one subsystem does not negatively impact the operation of any other subsystem, and the failed subsystem can be reset and recover without shutting down the SCADA application or the computer.

This is to provide high reliability as well as to reduce duplication of processing, network bandwidth and field device processing, as well as to achieve high performance. Finally it shall ensure that all historical data is retained in a centralized repository for ease of maintenance and backups. Additionally, each of these sub-systems shall be run as individual threads / processes and be capable of taking advantage of multi-CPU computers to load share across the CPUs and improve the overall performance of the system.

Configuration changes made to any server subsystem shall not require a restart of unrelated subsystems. Remote display clients shall not require restarting when configuration changes are made to the project, but shall be automatically updated as changes are deployed.

SCADA client stations shall contact the various server subsystems to acquire or write to data related to the appropriate subsystem. SCADA client stations shall act as clients for these tasks, rather than processing these items independently. Computers running the various server subsystems shall also be capable of acting as SCADA clients.

It shall be possible to perform any action in the SCADA software from any station on the network including development activities.

The SCADA software shall support development and runtime implementations on all of these operating systems simultaneously. Additionally, the system shall support casual web browser clients so that personnel on the WAN with the appropriate security settings can have access to the system. The web browser clients shall support view and control capabilities, controlled by both login security and license types. The web browser client shall provide identical functionality to the standard client software including but not limited to graphics displays, trend pages, alarm pages and system security. The web browser clients shall support view and control capabilities, controlled by both login security and license types. The web browser client shall not require any additional engineering or specialized software, nor the exporting of configuration. The standard graphics pages, alarm pages and trend pages used for operator client stations shall be available via the web browser clients without any additional development effort. Browser clients shall support page changes of average under 2 seconds.

The SCADA software shall be configurable as a single global database regardless of the number of stations in the system. It shall be possible to make configuration changes to the global database at any station on the system in a manner that is completely transparent to the user. Each SCADA

station shall have the option of either hosting the database locally to reduce network traffic or accessing the database remotely in a file serving environment on networks with high bandwidth capabilities.

The SCADA software shall be able to be configured as a series of projects for ease of maintenance and commissioning, and be easily linked together (or Included) to run as a single global database. All server based software tasks shall be treated as critical, such that each task has a primary and a secondary computer for processing. Further, the software shall support intelligent hot-redundancy. It shall be true hot-redundancy and not just duplication to ensure that there is continued seamless operation in the event of any single hardware or software failure in the Interface Subsystem, and that operator actions to one server are seamlessly replicated to the other server without requiring additional configuration or code.

To support system expansion, it shall be possible to link SCADA clients belonging to one set of SCADA Servers (a Cluster), to other Server Clusters with minimal engineering effort. SCADA clients shall be able to retrieve and display live data, historical data and alarm data from any Server Cluster on the network without requiring a restart, or operator intervention.

Further, Server Clusters shall be capable of cross-supporting each other such that one server may be the hot-standby server for many distributed local Servers, or any combination of Primary and hot-standby roles may be assigned to best suit the distributed network requirements.

The software shall be supplied as a complete package. No additional software shall be required to configure or run all the features of the system. All communication drivers available in the SCADA/historian software shall be included to cater for future expansion.

Configuration licenses are deemed to be included in the price to cater for current and future engineering & expansion requirements; Systems comprising a collection of software from various manufacturers (other than the computer operating system and network operating software) shall not be considered and technically rejected leading to technical disqualification.

3) Plant / Business Intelligence/Analytics

The contractor shall offer a SCADA solution, including hardware and software, able to deliver a set of network management functions described below: The solution shall provide the required advanced simulation capabilities and shall enhance the SCADA functions, by combining historical, real-time and forecast data within the SCADA interface, without any other middleware module. The SCADA solution shall be used to monitor and control the water supply and distribution network. Following are the minimum functions required in the solution:

Enhanced network monitoring: The system shall provide information about flow, pressure and water quality conditions in the water distribution network for all connected field sensors/devices.

Proposed SCADA system shall monitor, operate and control operations of all units/systems and associated equipment's/devices/instruments etc. at Water Treatment Plant, Clear Water gravity main pipeline, GLRs with Pump House at various locations Guwahati.

Proposed System shall be able to calculate water loss level across the entire water network.

It should also possible to combine with weather forecast data to predict future consumption – even during periods of changeable or extreme weather conditions.

It should be possible to simulate scenarios to see operation & maintenance impacts in advance, making easier to choose the best option for a smooth and risk less operation

It should be possible to monitor Water quality and early warning on pollution/bad quality cases to reduce health threatening events.

Real time monitoring of and streaming analytics-based event generation on turbidity, pH & chlorine levels at Reservoir / Junctions, flow rate and pressure monitoring Real time monitoring of chlorine level at strategic points

Timely trigger to plant personnel on how much local chlorine boosting to be done in case of chlorine decay during distribution Real time monitoring of cleaning up of reservoirs and alert in case of failure in cleaning Analysis of correlation between multiple water quality parameters.

Understand trends of water quality across the reservoir and analyse the effectiveness of corrective actions.

The software shall provide Advanced analytics and reporting capabilities that provide real-time feedback on the status of the water supply, enabling engineers to make timely modifications to the water distribution patterns, informed decision of future water planning through what if Analytics It should support investigation of outage, alarms and events as case management using network analytics and visualization which is interactive

To convert data into actionable insight through Business Analytics & Predictive Analytics Algorithms.

The contractor shall provide the complete details on the proposed module as part of technical bid qualification.

4) Process Data Interface

The software shall employ an I/O (Input/output) Server to read and write variables or tags in the I/O Device Subsystem(s). The I/O Servers shall manage the reading and writing of data from the I/O Device Subsystem and shall provide the data on request to any client on the Network.

The I/O Servers shall be able to read and write data when they are requested to by a client, or Server Subsystem on the Network, so as to reduce the traffic on the Network and the processing load on the field device(s). I/O Servers shall also have the option to read all data at predefined rate to allow for a background poll cycle.

All SCADA clients and Server Subsystems that acquire data shall access all discrete or analog field signals via the I/O Device Subsystem. Under healthy conditions communications shall be routed via a preferred path to each field controller on behalf of all stations in the SCADA software and only one SCADA station shall communicate directly with a field controller at any given time. Requests for common data from multiple stations shall result in a single request to the field device. Requests for recently acquired data shall not result in a request to the field device, but rather shall be serviced from a cache. The cache stale timeout shall be configurable per field device.

For appropriate protocols (eg. Telemetry systems (wired & wireless), the I/O Device Subsystem shall be capable of receiving data time-stamps from the field device, as well as historical data in the form of alarms and data log files. This information shall be automatically populated into the SCADA historical records without any user configuration or intervention.

5) **Integrated Automation Network Components**

The SCADA package shall be a single integrated SCADA software package from one vendor only to reduce support requirements. The contractor shall offer standard off the shelf software's, so that the end user is not locked down by single supplier for upgrade, maintenance etc. Contractor shall note the importance of this requirement. Core SCADA functionality offered, such as communications drivers, graphics capabilities, reporting, historical storage, trend, alarm displays and the development environment shall be offered as a single integrated software package. Water SCADA package offered shall not be restricted by number of SCADA screens, and the minimum number of tag license offered shall be Fifty Thousand tags. Additionally, the contractor shall ensure that the tags shall be "4 times actually utilized tags" in SCADA package.

The SCADA package shall be a single integrated **SCADA software package from one vendor only**. The SCADA software shall be of 64-bit advanced SCADA with Web server and browser functionality. Core SCADA functionality offered, such as communications drivers, graphics capabilities, reporting, historical storage, trend and alarm displays and the development environment shall be offered as a single integrated software package.

The SCADA software shall be constructed such that all subsystems are present, interoperable, and assessable via a system wide IP network, via OPEN Industrial/Commercial Certified protocols. The use of gateways or other protocol conversion devices are discouraged and shall not be allowed unless prior approval is provided. In addition, the SCADA software shall be interoperable with IT systems view SQL ODBC and Web Service Interfaces.

The SCADA software shall provide connectivity between and to any network device utilizing following minimum protocols.

Mode of Communication between CSC and remote locations (WTP, WPS, GLR, Flow, Pressure & water quality monitoring locations, etc.):

General Packet Radio Services (GPRS) (wireless communication is proposed to be mode of communication between the centralized SCADA monitoring center and the remote locations.

6) **Database Integration**

The SCADA software, or an integrated and bundled package, shall be capable of logging key SCADA data to a relational database including MS SQL server and Oracle. The software shall support logging of snapshot (real-time) data, historical data in tabular format, and alarm histories in list formats, to the database. Configuration of the logging shall be via point-and-click configuration and shall not require any scripting to achieve this functionality.

The destination database shall be a "full-license" version of the database and allow the end-user all normal data access, data manipulation and reporting options. Where redundant SCADA servers, or clustered SCADA servers shall exist, the database logging shall seamlessly collect data from the currently active servers as required to facilitate a successful transfer.

7) Web Browser Integration

The SCADA software shall be capable of publishing information to a standard web browser. Specifically, Microsoft Edge, Google Chrome, Mozilla Firefox shall be supported by the software. Published information shall include snapshot (real-time) data, historical data in both tabular and time-series graphical format, and alarm histories in list formats.

Additionally, data logged to a database in this way shall also be able to be published to the web browser in the same format as native SCADA data.

Data displays and favorites shall be integrated with the web browser login so that individual users shall have access to the data designated to them, and the ability to create favorite views and save them under their profile, which shall be accessible from any web client.

Further, as well as web-based reporting, the SCADA software itself shall be able to run within a web browser from a remote location, either on the intranet, or through firewalls and over the public internet (refer Web Browser below). The contractor shall document and include any firewall requirements needed to facilitate this functionality as an integral part of this contract.

8) Web Browser Clients

The SCADA software shall include all the necessary software including the internet server to provide full operator display functionality via the internet without any loss of functionality. It shall not be necessary to export, compile or recreate graphics specifically for the Web Clients. Instead they shall operate from the same project configuration as the rest of the SCADA system, minimizing maintenance overheads and version control risks. The web browser version shall be fully functional in all aspects, with the exception that 3rd party items such as ActiveX objects may need to be loaded on the client PCs.

Changes shall be automatically uploaded to the web browser user's PC only when the user accesses a display that has been modified so as to conserve bandwidth and optimize performance. The addition of new displays shall be treated as a change to the database and shall be provided to the user. The SCADA software shall operate in conjunction with firewalls and provide security to reduce the possibility of unauthorized access. It shall be possible to limit access to "view only" or provide full "read and write" access and web clients shall provide identical functionality to a workstation on the LAN. Assuming reasonable ISP performance, users accessing via the internet using modem access shall consistently obtain display refresh times on average of 1 to 5 seconds and page display times of on average less than 5 seconds.

If the resolution of the web browser client is lower than that of the SCADA system, the software shall have the ability to automatically rescale the application to fit within the client window. This functionality shall not require 3rd party thin client software to be loaded on the client PCs. Contractor shall take note on the importance of this clause and functionality to be provided.

9) OPC UA – (OPC Foundation Unified Architecture)

The SCADA software shall allow connectivity between any network devices using the OPC UA (Unified Architecture) protocol. Data shall be allowed to pass through firewalls or over the Internet via native OPC UA capability.

The SCADA software OPCUA Protocol shall support the following OPC-UA Discovery Services: Find Servers, Get Endpoints, Register Server

10) OPC Classic Protocol

The SCADA software shall allow connectivity between any network device using one or more of the following OPC Protocols. OPC DA; OPC A/E; OPC HDA. The system shall support OPC Data Access specifications version 1.0, 2.05 and 3.0 and OPC XML DA servers.

11) MODBUS IP

The MODBUS IP Protocol shall support one or more of the following MODBUS protocol types: Basic, Modicon 184,384,484,584,584L,884,984, Micros84, Quantum, ModDell.

12) SNMP (Simplified Network Management Protocol)

SNMP Devices shall support
SNMP V1 or V2

13) REST Web Services

The REST interface shall support multiple standard security protocols including OAuth, JSON Web Tokens, and NTLM for message authentication. The REST interface shall support a variety of standard REST methods for both inbound and outbound messaging. These shall include at a minimum:

- GET
- POST
- HEAD
- PUT
- DELETE
- OPTIONS
- PATCH
- MERGE

14) IOT – MQTT (Message queuing telemetry transport IEC 20922)

The SCADA Software shall support encryption with X.509 Certificates on all MQTT communication

The SCADA Software shall support MQTT over WebSocket's

The SCADA Software shall be capable of processing MQTT message payloads of JSON content.

15) DNP 3

SCADA software shall support DNP3.

16) WEB AND INTERNET CONNECTIVITY

The software shall provide a connection to a Web server integrated into the graphics module. It shall be possible to “publish” to a Web server using the graphics module. A user shall only require web browser to be installed on their machine (Thin Client) to access the system, with any “Plug-ins” automatically installed for them by the Server when they first access a graphic, trend, or alarm screen.

The software shall allow for “publishing” so that displays can be viewed on the most popular internet browsers including Microsoft Edge, Mozilla Firefox, Google Chrome and Apple Safari.

17) REDUNDANCY

The software shall support OPC HDA and A/E Redundancy, as well as provide support for trend and alarm server redundancy including Redundant Alarm Module AE Servers; and redundant logged data configurations (including Historical Alarm Data Loggers; and Feature for automatic database synchronization; Automatic failover between node pairs).

The software shall provide Store and Forward Technology for synchronizing node pairs and for synchronizing disconnected remote data servers including:

Alarm Logger Module Store and Forward; Trend Logger Module Store and Forward; and Global Diagnostics.

The SCADA software shall provide a global diagnostic interface displaying the status of redundant system to users across the HMI/SCADA network.

The software shall support Primary and Standby I/O Servers to provide automatic redundancy in the event of a Primary I/O Server failure without any user intervention or scripting required. This switch over from a Primary to a Standby I/O Server shall be accomplished in on average under 2 seconds when a communication failure is detected. Built-in Diagnostic Alarms shall be posted if either the Primary or Standby I/O Server communications to a field device fail. ie; The software shall monitor the health of communications for both the Primary and Standby I/O Servers at all times.

In addition, the I/O Servers shall support redundant I/O Device hardware and communication paths and provide automatic changeover in the event of a failure. Built-in Diagnostic Alarms shall be posted if the communications to either the Primary or Standby field device fails at any time. ie; The software shall monitor the health of communications to both the Primary and the Standby field devices.

In addition to Primary/Standby redundancy, the system shall support multi-tier automatic switching of I/O communications for at least 5 levels of redundant I/O servers for each field device.

The Primary I/O Server shall define a preferred communication path to the field device. In the event of a communications failure on the preferred path, a standby path shall be automatically used, with seamless transfer of functionality transparent to the rest of the SCADA network and stations. After a return to a healthy state, communications shall revert once again to the preferred communication path, via the preferred SCADA station. This ensures that all field device traffic is routed via the highest bandwidth path under normal conditions. Clients and other Server Sub-systems shall automatically revert to the Primary I/O Server to acquire their data once it returns to a healthy state.

To support this level of redundancy the software shall not require exact duplicates of projects or tag databases on both servers. Instead the I/O Device Subsystem shall deal with tags on an as-needed basis. This allows one server to be used to stage new developments while still providing full redundancy to the primary unit, as well as flexibility in deployments as mentioned earlier for various network topologies including 'domino' redundancy.

The software shall support communications to field controllers that have primary and standby processors. If a primary processor fails, the software shall automatically detect the failure and switch to communicating to the standby processor. The software shall be capable of writing data to both the primary and standby field devices simultaneously to ensure common tag values in both processors. This shall require no user intervention, special scripting nor use of redundant tags within the software.

All currently available drivers shall be included with the software and included in the price quoted by the contractor.

18) SECURITY

The software shall have mandatory driver signing to protect from 3rd party software interfering or replacing components. It shall be compatible with an operating system with protection from potentially malicious attacks via the Windows kernel (such as Kernel Patch Protection). In addition, it shall also be compatible with operating systems with protection from attacks originating from restricted or non-executable memory locations (software and hardware-based Data Execution Protection - DEP).

The software shall provide a configurable security component that can be used to restrict access, application navigation and configuration of databases or displays. It shall supports configuration of different sets (or policies) of individual users. It shall support categorization (grouping) of those users and assignment of users to more than one category.

The software shall provide a method of Automatic Login to allow users to specify a default user to login on start up. The software security component shall allow for the names and groups to be obtained from a domain server, active directory group or local users. Synchronization shall be supported for these users and the server, and the system shall automatically populate. It shall provide support for 256-bit encryption, as well as provide support for restricted user login access from any node on the system, including Remote, Networked, Web and Wireless nodes.

The software security component shall provide individual users with the following specifications (including, but not limited to): Name; Password; Locked/Unlocked; Account policy; Allowed actions (by module); Allowed operations for data, alarms, files, and login stations; Denied operations for data, alarms, files, and login stations; and Custom allow/deny operations configuration.

The software security component shall have a method to reserve users and/or usernames for use. These users shall always consume a user license but shall assure them that access shall not be denied due to user counts.

The software security component shall provide account policies with the following specifications (including, but not limited to): Name; Limits on password editing, expiration, time before password change and complexity; Limits on login failure such as login failure attempt counts,

locking, auto-logout; and Hours during days of the week the policy users are allowed to access stations

Security shall be fully integrated into the SCADA software to allow access to any individual part of the system only to users with appropriate security levels. Security must be checked on the server side and passwords must be encrypted.

The software shall support a large number of users. For each user, it shall be possible to define a password and the privilege level(s) and areas that are available to that user. Passwords shall be hidden both in the configuration and the runtime environment to ensure that other personnel cannot access another account.

The software shall support SCADA users that are defined in a Windows domain. SCADA users shall be able to be added, removed and granted access to existing SCADA roles via the Windows domain server without requiring changes to the SCADA configuration. Authenticated Windows user credentials shall be securely cached on the SCADA node to allow the user to be able to login to the SCADA node in the event the domain controller is unavailable. The current Windows user shall be able to be automatically logged in to the SCADA at startup of the SCADA so that the user does not have to re enter their credentials. The use of both internal SCADA users and Windows users shall be possible. The software shall not require additional SCADA individual object configuration to support Windows users, the setup of privilege levels for SCADA objects shall be common for both the internal SCADA users and Windows users.

The software shall monitor the actions of the user currently logged on at each station, and automatically log the user out of the SCADA software after an adjustable time period. Logging out a user shall not shut down the system; the system shall revert to a view only security status. It shall be possible to prevent access to the operating system by unauthorized personnel.

It shall be possible to disable Windows "hot" keys such as Ctrl Esc, Ctrl Alt Del etc to prevent operator access to unauthorized software.

The software shall monitor and log control actions of the users. This logging shall be able to incorporate operator control actions, including such as logging in and out of the system. The sequence of actions shall be viewable via an event viewer window within the SCADA software and also stored in an external open file format (such as txt, csv, dbf, sql) for later analysis.

19) OPERATING SYSTEM & DATABASE COMPATABILITY

The software shall be compatible and function fully with Microsoft Windows operating systems including the following:

Windows Server 2021 or latter

Windows 10 or latter

Also, software shall utilizes the following database technology for all configuration databases

Microsoft SQL Server 2019 or latter.

Enterprise Version

20) ASSET MANAGEMENT

The Software shall provide an asset management module where “assets” can be configured for any real-world object, equipment, or location as part of a hierarchical navigation tree. The hierarchical structure shall support enterprise organization as defined by the ISA 95 standard.

The Asset Management Module shall support the definition of unlimited “properties” associated with each asset. Properties of an asset can include real-time tags, expressions, constants, historical values, or aggregations.

The Asset Management Module shall support runtime changes. The software shall provide a tool for rapid bulk deployment of assets. The tool shall take an Excel spreadsheet as input and create the required assets, along with any required alarms and historical tags.

21) DASHBOARDS

The Dashboard shall allow the user to use a variety of symbols and controls in designing the dashboard and provides a navigable list of those symbols and controls to pick from when deciding how to represent any data values.

The Dashboard shall allow for the use of controls including but not limited to:

- Alarm Viewer
- Trend Viewer
- Pie charts
- Donut charts
- Categorical charts including
- Clustered Bar charts
- Stack Bar charts
- Stack 100 Bar charts
- Funnel charts
- Data Diagrams
- Tree maps
- Data grids
- Geospatial Maps
- Gauge

The Self-Service Dashboard shall allow for controls to be utilized which permit runtime filtering and drilldown within the datasets. These controls shall allow for filtering by the following:

- Time range
- Data value range
- Inclusion/exclusion of values within the set

The Self-Service Dashboard shall permit the user to create new dashboards, as well as to save and load dashboards for reuse.

22) Graphical Visualization

The number of graphic displays possible shall not be limited by the software. Graphic display pages shall be capable of a minimum of 2000 analogue tags, with updates of on average of two seconds (for all data to appear or change on the page).

Graphics pages shall support automatic re-sizing to match the screen resolution of the given computer, irrespective of the resolution the pages were developed in or configured for, and irrespective of whether vector or bitmap graphics are used on the page, without shutting down the SCADA software, without recompiling, and without having multiple copies of graphic pages for different resolutions. Additionally, the user shall be able to resize the Window hosting the

graphics page, and all components shall be automatically re-sized to match the new Window size.

The graphics system shall support a screen resolution of up to 4000 x 4000 pixel resolution and shall support multiple monitors on the one computer. This support shall include separate windows on each monitor, or a single window across multiple monitors.

The tags required by the SCADA software at any given point in time shall be scanned and displayed on any SCADA client in the system on average within 2 seconds. Fixed scan rates for each and every tag shall not be considered. It shall not be necessary to configure or fine tune each tag individually in order to meet system performance. The I/O Server shall read trend tags according to the configured trend period, alarms tags shall be scanned at a single pre-determined interval, and other information only on an as-needed basis (i.e. when the page is displayed) to minimize negative impact on the field controller processing rate.

The I/O Server shall perform read & write caching of data for a time configurable for each field device. This is to prevent data being read needlessly and therefore impact field device communication bandwidth, that is; only one read is needed if the same tag is needed for multiple clients and/or subsystems within the cache time.

It shall be possible to display other graphics pages by selecting screen targets, and to automatically display any screen based on the condition of a tag. e.g. automatically call a particular graphic display when an alarm occurs. It shall be possible to configure keyboard macros on a per graphic basis or global keyboard macros that apply to all displays.

When multiple objects on a page are configured for flashing then all objects shall flash synchronously.

The SCADA software shall have the capability to provide pop-up windows for trends, loops, device status pages or any other graphical display purpose. To minimize operator confusion, pop-up windows shall be capable of being configured so that multiple copies of the same popup cannot be opened on the same computer at the same time.

It shall be possible to group together dynamic graphic objects and then apply dynamic properties to the group as a whole, rather than each individual object. Individual objects within the group shall continue to support their own unique properties independently of the group. For example, articulated equipment may have on/off status for individual components, but be required to move around the screen as a group. It shall be possible to edit individual object properties within a group without ungrouping them.

Each display object shall support keyboard entry that shall allow adjustment of any tag in the system. When an operator wants to enter a value, the object shall be selected then the operator input shall be displayed as the input is typed (such as a tooltip adjacent to the object). The system shall check the value entered is in an approved range before sending it to the field device. The software shall support full screen, live camera video images and video from disk (MPEG, AVI, mp4, etc...) concurrently with screen displays with no interruption to data collection. Refresh rates of display windows shall not be affected.

If communications to a particular I/O tag fails for any reason, then wherever that data is displayed the software shall post a visual indication that the tag is not valid.

The software must be designed with the ability to make changes to the graphics while the system is running. Shutting down the system shall not be required to make these changes.

The SCADA software shall be an ActiveX container and allow for instantiation of ActiveX objects. It shall be possible for the SCADA software to interact with ActiveX objects in the following ways.

- Dynamically change properties of an ActiveX object via a Tag from an field device
- Dynamically change properties from SCADA software high level language.
- ActiveX object to trigger actions in the SCADA software based on events in the ActiveX Object.
- ActiveX property values can be read by the SCADA software.

The user shall be able to navigate around the graphics system utilizing a variety of navigation methods:

- Hot keys shall be available to provide quick links to specific graphics pages from the Windows keyboard.
- Windows style navigation menus shall be provided allowing access to any configured page in the system from any other page.
- The graphical displays shall be configured with “hot spots”, where as a user can click on the area and drill down into a detailed view (if available) of the plant area.

The Windows style navigation menus shall be configurable in runtime, and shall be saved and restored with the project backup/restore utility. Trend and Alarm grouping assignments shall be configurable in runtime, and shall be saved with the project configuration for inclusion with the Backup and Restore utilities.

The software shall provide multiple formats for viewing HMI screens including, but not limited to: Desktop; Web; Dashboard; and Mobile (smartphones and tablets).

23) Graphical Configuration – 2D Graphics

The scada software shall allow the following functions for a Picture: allow the image to be resized with or without maintaining the aspect ratio; support compression of files; allow embedded pictures or referenced pictures in displays; have an option to reset to the default image size and shape; allow replacement of an image with another; select a “transparent color” for an image (e.g., selecting blue would eliminate the display of that shade of blue within the image, thereby revealing any object behind the image; allow insertion of any of the following file types: Windows bitmaps (*.BMP), GIF (*.GIF), JPEG (*.JPG;*.JPEG), Icon (*.ICO), Portable Network Graphics (*.PNG), Tag Image File Format (*.TIF;*.TIFF), Microsoft Visio Files (*.EMF), Autodesk AutoCAD Files (*.DWG;*.DXF) Metafiles (*.WMF, *.EMF); Allow insertion of either .wmf or .emf metafiles shall allow resizing of metafiles with or without maintaining the aspect ratio; and allow a metafile to be converted to constituent shapes and grouped as a symbol.

24) Graphical Configuration – 3D Graphics

The software shall utilize a graphics package that offers an extensive 3D configuration environment, meant to allow users to configure complex 3D environments that accurately emulate real world conditions. It shall include the following 3D primitives: Sphere; Cube; Cone; Cylinder;

Pipes; Torus; Terrain; and 2D planes. A pipe primitive shall be able to be moved, extended, or changed by a simple user manipulation.

The SCADA software shall include Import functionality that can be implemented to include the following standard formats: *.DWG,*.DXF, *.3DS, *.DAE (COLLADA), *.OBJ, and *.XAML.

25) Animation Tools

The software shall include Animations, which are configurable with a point and click interface or “Browser”, which support local and network point configuration without additional user configuration. Animations shall be configurable with or without scripting.

26) GEO Spatial Mapping

The Software shall include a mapping module or integrated mapping within the graphics module. The mapping module shall be able to be placed in a display by use of a layer and shall be based on a tile system that can utilize multiple inputs.

The software shall use multiple tile systems provided by third parties (e.g., Microsoft Bing, Google,etc). The module shall be configurable in the live preview mode and operators shall be able to give the option to change the tile system dynamically.

To support for colour switching modes SCADA shall include a Global Colour Palette.

27) DATA HISTORIAN AND TRENDING

The Historian software shall have the powerful compression algorithms enabling to store years of data easily and securely on line, thereby enhancing the performance and reducing maintenance.

The software of modular design, with separate components for: Data Collection, Data Logging, Data Trending/Charting and Reporting. One or more instances of each component shall be installed on servers distributed across the network to facilitate distributed data collection and recording.

28) Historical Data Collection

The software shall support any number of distributed data collectors, each which can collect data from all configured points and forwarding to one or more loggers for archival. The Data Collectors shall support the ability to filter data that is to be logged. Filters can include: all samples (no filtering), Maximum, Minimum, Average, Standard Deviation, Totalizer, Running Maximum, Running Minimum, Running Average, Moving Maximum, Moving Minimum, Moving Average.

29) Historical Data Logging

The software shall support compression of all logged data. Compression options shall include swinging door, dead band, and summary aggregates.

The SCADA software Historical Data Logging shall start the logging process (collecting to RAM, applying filters, writing to disk, etc.) based on: Time Interval (range at least 1 second to 24 hours); Specific Time (e.g., every day at 8:30am); Condition/Event tied to an OPC Tag and/or an Expression (e.g., begin data monitoring/logging whenever the machine is turned on.); or as soon as the Historical System starts up.

30) Historical data logger to historical data logger

The software shall support logger to logger connectivity that allows an instance of a logger on one server, to aggregate and merge data from any number of additional loggers distributed throughout an enterprise network. This functionality enables the creation of corporate loggers that maintain copies of data, merged from any different location loggers or sites. Data exchanges shall be triggered automatically on a schedule or manually on demand.

31) Data Trending/Charting

The software shall include a Data Trending/Charting component (viewer) that shall be capable of being embedded within a graphic display file and configured through that graphic display to view data. The viewer shall contain multiple configurable charts or trends. The trend within the viewer shall be configurable as to the: Data Source; Colors and line thicknesses; Plot type; and Scale.

The chart within the viewer shall be configurable as to the: Data shown and order of the data; Legend; Time period; Easy access to change the Time Period; and Data collection and refresh rates.

The number of trends collected shall not be limited by the software. The software shall be capable of logging historical trend information at configurable sample periods from 1 Millisecond to 24 Hours. Trend data shall be stored in a circular file system with the number of files, the size of each file, the sample period, file location, privilege and area configurable for each Trend Tag. Storage file names and paths shall support file names up to 255 characters in length.

Each file shall contain up to one year of historical data at 2 second sample intervals. Files shall rollover to create a contiguous historical archive. The historical archive shall store a minimum of five years of data at an average of 10 second sample intervals.

Trend data shall be retrieved transparently from the historical archive, irrespective of the age of the data being retrieved, or which archive file the data is located in. The trends shall be maintained online for operator call back without the need to backup or restore history files.

It shall be possible to collect trend data on a periodic basis (one sample every sample period), or on an event basis (Sample is read each time a condition goes true). It shall also be possible to start and stop the storage of trend information based variety of conditions such as on a process condition, time, or manually by an operator.

Trend values shall be stored in floating point resolution, and not require rescaling for retrieval and display purposes.

The SCADA scripting language shall support interaction with the trend archive to both retrieve and write samples to the archive. Scripting access shall be transparent to the historical archive, irrespective of the age of the data being retrieved, or which archive file the data is located in. Scripting access shall not inhibit any other trend acquisition, storage or retrieval functions, nor shall it 'lock' a file, preventing access from other SCADA subsystems.

32) Trend Display

Trend displays shall comprise line graphs with time on a linear, continuous horizontal or vertical axis and the trended value on the vertical or horizontal axis. Resolution of each graph shall be to within 0.1% of full scale. Where more than one tag is graphed, the graph of each tag and associated information shall be displayed in a different color.

Trend displays shall support both analogue and digital pens on the same graph. Trend pen assignments shall be user definable and retrievable in runtime to allow easy creation and management of favorite trend groups. The graph shall be capable of viewing the entire archived trend history for a group of pens on a single display.

It shall be possible to trend multiple pens or multiple plots of the same pen over various time spans. Each pen shall display individual ranges and engineering units. Each pen shall be scalable for display purposes independently of other pens displayed on a page. The software shall include the capability to pan backward and forward within a selected time range to read the exact value of any displayed tag, by selecting a point on the graph or chart.

The system shall display historical information as far back in time as desired, with all information being displayed on average 1 second. The trend display shall have a slide wire that can be moved over the page that shall provide indication of the date, time and value at the intersection of the slide wire and the trend tags. The trend display shall be dynamic, scrolling through time, with the capability to 'replay' or scroll through historical time as well as current time. There shall also be the capability to stop the automatic scrolling of the trend for detailed analysis of a point in history. Pens on the same pane shall be able to be separated both in the time axis and the range axis.

The user shall be able to toggle the trend display between Local time and UTC time. The software shall provide "zoom" and "pan" facilities for both the trended tag range and the time axis range. The "zoom" facility shall allow an operator to compress or expand the axis range whilst the "pan" facility shall allow an operator to shift the origin of the axis. The software shall allow a user to define any zoom area by dragging a mouse across the trend.

The software shall provide Minimum, Maximum and Average summaries for all displayed analogue pens. Trends which are acquired and stored by events, rather than periodically, shall be viewable both on a timeline, and by event number.

The software shall be capable of displaying different (minimum 15) tags on a single trend display. The tags shall be distinguishable by different colors. It shall be possible to retrieve the raw data and time/date values for any single trend or group of trends from the display for further analysis.

The software shall make available trending data from the historical database for export to disk files or external databases. It shall be possible to define the section of the trend to be exported by clicking and dragging the mouse across the trend. Data shall be exported to csv, dbf or txt formatted files.

33) ALARM MONITORING

The number of Alarms supported shall not be limited by the software. Alarm events shall also be written to logging files and stored on a rolling file basis for archiving purposes. The software shall

be integrated such that an alarm acknowledged on one operator station shall be recognized on both the Primary and Standby servers, and shown as acknowledged on all client stations. This shall be configured as one common database, with no programming or scripting necessary to enable global acknowledgment of alarms from any PC on the network. The SCADA software shall monitor analog tags, discrete tags, and calculated conditions to determine alarm conditions.

For alarm events (both digital and analog) which are time-stamped by the field controller for increased accuracy, the SCADA software shall support using that time-stamp for the event rather than its own time-stamp. The SCADA software shall support millisecond precision for this time-stamp.

a. Analog Alarms

For each Analog Tag, an alarm shall be able to be configured with limits available for each of the following conditions:

LOW-LOW,
LOW,
HI,
HI-HI
Deviation LO
Deviation HI
Rate of Change

All Analog alarm limits shall be adjustable without shutting the system down. The system may be configured to support persisting those changes so that if the system is restarted then the Alarm Settings shall be correct. Analog alarms shall also support the use of a dead band value.

b. Digital Alarms

For each Discrete Tag, an alarm for each of the following conditions shall be assignable:-

Tag ON,
Tag OFF

Discrete alarms shall have facility for time stamping, to enable tracking to millisecond precision.

Multi-Digital Alarms

It shall be possible to configure alarms that are based on a combination of discrete tags and any state combination may be configured to be an alarm condition. In addition if the Multi-Digital Alarm is active in one alarm state and changes to another alarm state then it shall re-alarm.

c. Alarm Actions

It shall be possible to configure alarm actions that are unique to each individual alarm category group for when alarms within the group transition into and out of alarm state. These actions shall be capable of performing any macro or code function available in the SCADA system, including reading and writing to IO data, displaying graphics, sound annunciation, or running complex SCADA functions.

Alarm Display with appropriate privileges, it shall be possible to display or acknowledge any alarm and/or the most recent alarm on any page.

The software shall provide multiple levels of alarm priority or category. The priority of an alarm shall be identifiable by the color and font settings of the alarm message on the screen. The color coding of prioritized alarm messages shall be configurable by engineers.

Sound indication for each alarm category shall be configurable. This must be possible at each station. It shall be possible to have the alarm sound either by internal or external speaker.

The software shall have a standard alarm display page that can be modified for the project. The standard alarm page shall have the facility for scrolling through multiple pages of alarms and for acknowledgment and disablement of individual alarms.

It shall be possible to display the following information for each alarm as it appears on an alarm display page:

- Alarm Tag Name
- Alarm Description
- Value of the Tag
- Trip limit
- Alarm Status - Disabled, Acknowledged, Unacknowledged
- Alarm Category
- Alarm Priority
- Time & Date
- Privilege
- Category
- Operator Comments
- Value of any Tag or result of any calculation.

It shall be possible to display each alarm category in a different font and color (including flashing colors) dependent on whether the alarm is Active Unacknowledged, Active Acknowledged, Acknowledged Cleared, Unacknowledged Cleared or Disabled. The alarm display shall support both proportional and fixed fonts with all alarm fields displayed in properly aligned columns. It shall be possible to disable alarms on individual basis, by page, by alarm category, or for all alarms.

When an alarm is disabled, the alarm shall be displayed on a separate disabled alarms page so every user of the system can easily determine which alarms have been disabled. At any station on the system it shall be possible to acknowledge alarms individually, by category or by page.

The SCADA software shall allow for operator comments to be attached to any alarm when it is acknowledged or at a later time. These operator comments shall either be displayed with the alarm or displayed by clicking on the alarm.

It shall be possible to automatically display any graphic display when an alarm occurs or to dynamically change the appearance of any graphical object based on whether an alarm is On, Off, Acknowledged, Communications Error, or Disabled.

The alarm display shall have a mechanism for operators to dynamically define filtering of alarms by alarm tag, alarm name, alarm description, date/time range, state including sub-states for analogue alarms, type, area, category and priority. Additionally, up to 8 custom filters can be defined for each alarm during development and runtime, for fast access by operators.

d. Alarm Sorting

It shall be possible to sort (ascending and descending) active alarm displays by one or more alarm fields without grouping restrictions. Alarm fields that can be used for sorting include:

Tag
Name
Category
Priority
Area
Privilege
State
OnTime
OffTime
AckTime.

e. Alarm Delay

It shall be possible to set a time period on individual alarms such that the alarm must be active for the time period before it is annunciated to the operator. The time stamp of the alarm must be the time when the alarm first became active, not at the completion of the time delay.

f. Alarm Logging

For each alarm category it shall be possible to define a different method of logging alarms. It shall be possible to define if alarms are to be logged when the alarm transitions to ON, to OFF or on Acknowledgement. The alarms shall be able to be logged to a designated printer, disk file or database with alarm text and time and date labels. Alarms shall be printed or filed in a user-configurable format. The SCADA software shall allow logging to any printer on the network.

The software shall be able to redirect printing to another printer while the system is on-line. Alarms that are logged to disk shall be available for viewing while the system is on-line or off-line without causing any interruption to data collection. The number of alarms logged to disk shall not be limited by the software. The alarm logging function shall be capable of logging an instantaneous burst of at least 2000 alarms received in a single scan.

g. Alarm Redundancy

The software shall automatically ensure that if the Primary Alarm Server fails, all alarm functions shall continue to operate normally and transparently to the clients. The software shall automatically generate a diagnostic alarm to indicate that the Primary or Standby has failed. Adding, deleting or modifying alarms shall not require any changes to the software that handles the redundancy. On restoration of a failed Server, the historical alarm history must synchronize between the Primary and Standby servers so that there are no miss-matches in historical alarm history. No programming or scripting shall be required to achieve this synchronization.

The alarm module shall be of modular design, with separate components for: Alarm Configuration; Alarm Server; Alarm Logging to a Database and Printer; Live "Active" Alarm Viewing with

Charting; and Historical Alarm Reporting. The Alarm module shall be connected to the security module of the SCADA software package. The Alarm module shall reset to a default configuration when users change to mitigate access problems for different users. The Alarm module shall supports Silverlight communication.

h. Alarm Server

The Alarm Server Module shall associate one or more (up to 10) OPC Tags/Expressions with each alarm as “supplemental” information to the alarm.

The Alarm Server Module shall enable storage of the alarm configuration data itself in an open database (e.g., Microsoft SQL Express, etc.) and trouble shooting.

Alarm Server – Digital Alarms

Alarm Server – Analog Limit Alarms

Alarm Server – Deviation Alarms

Alarm Server – Rate of Change Alarms

Alarm Server – Alarm Toggle Count

Alarm Server – Time in Alarm

i. Multimedia Alarm Notification

The software shall be an OPC-compliant, distributed, enterprise-wide alarm notification system that delivers real-time alarm information via e-mail, pager, fax, voice, text-to-speech, phone and software and Ethernet-hardware marquees. The multimedia alarming shall be integrated like any other module

j. Alarm Logger

The Alarm Logger Module shall support redundant logging configurations with node pair database synchronization as well as “Store and Forward” capability, which ensures data logging integrity even when the database server fails, or communications fail. It logs the alarms/events to a user-defined table name within the specified database

k. Alarm Live/Active Alarm Viewing Configuration

The Alarm Viewer component shall allow for Different Font Styles (font name, size, bold, italic, underline, color), which can be defined for the following 5 categories: Active alarms not yet acknowledged; Active alarms which are acknowledged; Alarms which have returned to their normal state, but which have not yet been acknowledged; Simple "System" Events; and Tracking Events for following operator actions. Within each of the above five categories, additional font styles can be defined for different priorities. For example, unacknowledged alarms are white text on red background, Arial size 12; in addition, any of those which are also over 500 in priority shall also be Bold, Underline, and overriding the size to 14).

l. Alarm Live/Active Alarm Viewing Runtime

The Alarm Viewer shall comply with the following requirements while it is in "runtime" mode showing live/active alarms: If more alarms exist than there are rows visible, then a scroll bar shall be provided such that operators can scroll through the listing. If the operator scrolls down to another part of the listing and a new alarm comes into the system, a visual indicator shall be given (so the operator knows the view has changed beyond what he's looking at). The SCADA

SOFTWARE shall provide messages for users for specific cases such as an attempt to acknowledge an alarm that has been previously acknowledged.

m. Historical Alarm Reporting

The Historical Alarm Report component shall be capable of being embedded within a graphic display file. Alarms gathered from the Alarm Log Database, as created by the Alarm Logger component. This is from either the local machine, a networked PC, or via a URL Web site. These historical alarms presented in one of four main report styles: Tabular view; Bar Chart view; Pie Chart view; and Report view.

n. Grid Visualization

The software shall provides a module for creating grid or “spreadsheet” type visualization of large amounts of data. The data shall be configurable update rate (or on request polling) but provide real-time data. Date source support for the module shall include SQL Server Databases, OLEDB, ODBC, SAP, OPC DA and OPC UA DA data.

o. Scheduling

Scheduling module shall allow the definition of an unlimited number of schedule definitions. Each schedule definition shall allows for “normal” or “default” conditions as well as support for “exceptions” on specified days, seasonal changes, holidays, and manual overrides. Each schedule shall allow for an unlimited number of scheduled actions is a specific 24-hour time frame, with a schedule SCADA Software of xx seconds. The software shall manage these events within its central interface for reuse with multiple schedules automatically.

p. Fault Detection and Diagnostics

The software shall provide a rule execution engine, which can monitor all available monitored data and alarms, and execute user defined logic to determine or predict equipment operational or efficiency faults. The software shall monitor equipment parameters in real-time, and read historical data and data derivations, via any or all open data connectivity methods specified herein. The Fault Detection and Diagnostic Module shall allow to integration of data from alarms, real-time data values, historical trends/data, manual cause/symptom entries, and external customer supplied networked databases.

q. Language Switching

The software shall provide a native function for language-aliasing supported by a language configurator for multilingual language switching with automatic range and value scaling, as well as engineering unit conversions, formatting, and font selection. Language aliasing shall apply to graphics displays, alarms, and historical trends. Configurations data must be stored in an open database, such as MS-Access or MS-SQL Server.

r. System Monitoring and Diagnostics

The software shall offer a “Monitor View” and a “Tracing View” (for diagnostics), which includes a centralized diagnostic area or form, and be offered to users with the minimum privileges. It shall also

support visualization of application version information; application Runtime status; and connections including OPC, Licensing and Runtime.

The software System Monitoring and Diagnostics component shall support monitoring of redundancy and provide warnings and statistics. It shall support notification when connected OPC servers become available and allow export of diagnostics to a usable format (e.g., .xml). The “Monitor View” shall support a System Tray icon which shall provide a “visual balloon” interface.

s. Operator Event Logging

The software shall support logging of all operator actions to disk, printer or screen.

The software shall be capable of logging the following information, User Name, Action, Time, Date, Value, and Comment in a user definable format.

t. Development

The SCADA software shall include an integrated development package utilizing menu driven, fill in the forms style configuration to develop the runtime system. Commonly used features shall be supplied inherently in the system without requiring any engineering effort. As a minimum this shall include:

- Default display layouts including:
 - Current date/time
 - Most recent 3 alarms
 - Navigation bar
 - Prompt and echo
 - Alarm status indicators
 - Security login/logout
 - Print
 - Help
 - Comprehensive symbol libraries for display objects
- Alarm displays including:
 - Active Alarms
 - Historical Summary Alarms
 - Disabled Alarms
 - System Diagnostic Alarms
- Fully functional Trend displays including:
 - Single Trend display
 - Multi-Trend display
 - Popup Trend display
 - Instant Trend display (for monitoring tags which are not configured for historical trending)
 - The ability to fully configure the trend display at runtime (see Trends)
 - The ability to add trend pens to displays at runtime
- Administration Tools including:
 - Tag Debug utility
 - Diagnostics statistics, including communications statistics
 - Error logs
 - Memory utilization
 - Disk utilization
 - SCADA License utilization

- SCADA version
- Date/Time controls
- Online configuration of the navigation bar
- The ability to assign trend groups at runtime
- The ability to assign alarm groups at runtime

The same configuration interface shall be used for SCADA stations and Web clients, with the ability to reuse configuration between all systems without any additional engineering, including automatic rescaling of runtime graphics when different clients use different screen resolutions. All development functions shall be available on any PC on the network. There shall be no copy protection on the development package and users shall be permitted to use the development package freely on an unlimited number of computers. The system shall provide the ability to run without a license for testing purposes. It would be acceptable if it is time limited.

Comprehensive on-line help shall be available for all development functions, the on-line help shall contain all information provided in the hard copy manuals. The on-line help shall have hot spots that explain meanings for all technical terms, in everyday language. The on-line help shall have the facility to search by word or logical expression, including all words in the entire help system.

A utility shall be included to back-up or restore an entire database including all graphic displays, configuration data, source code, runtime navigation menu configuration, runtime trend group configuration, runtime alarm group configuration and so on, via a simple point and click method. The backup/restore utility shall prompt the user prior to over-writing any existing files. The backup/restore facility shall employ automatic file compression/decompression and shall be capable of operating with removal media, local disk or any drive on the network. If the database requires more than one disk, the utility shall automatically prompt the user to insert the next disk of the set, and shall have in-built checking to ensure correct loading of disks.

Multiple projects shall be able to be developed on the same computer at the same time, and the development environment shall allow fast switching (< 10 seconds) between different projects. Multiple projects shall be able to be run as a single global system without migrating the configuration into a single project. This is to allow segregating the system into manageable sizes, to allow different teams to work on different areas, and to cater for staged commissioning.

9.11 Approved Vendor List/Manufacturer/Make List-Control & Automation

The naming of a manufacturer in this specification is not intended to eliminate competition or prohibit qualified manufacturers from offering equipment. Rather, the intent is to establish a standard of excellence for the material used, and to indicate a principle of operation desired.

S/N	Equipment/Instrument	Vendor /Make
1	PROGRAMMABLE LOGIC CONTROLLER/RTU	M/S SIEMENS---GERMANY M/S MITSUBISHI ELECTRIC ---JAPAN M/S YOKOGAWA ----JAPAN M/S SCHNEIDER ELECTRIC----FRANCE M/S Rockwell Automation---USA M/S ABB ---GERMANY M/S PHOENIX---GERMANY
2	DC POWER SUPPLY	APLAB, WAGO, PHOENIX CONTACT, MEAN WELL, WEIDMULLER, OMRON.
3	SERVERS AND WORKSTATIONS	M/S DELL, M/S HP, M/S IBM.
4	LED MONITORS FOR WORKSTATIONS	M/S SAMSUNG, M/S LG, M/S DELL
5	19" RACK-MOUNT PATCH-PANELS	3M, BELDEN, CISCO, D LINK
6	SCADA SOFTWARE	WONDERWARE-AVEVA (System Platform) GENESIS 64, WINCC 7X-, CX-SUPERVISOR ,FACTORYTALK,FAST TOOLS,SHOPWORX, ABILITY SYMPHONY PLUS SCADA
7	HISTORIAN SOFTWARE	WONDERWARE-AVEVA (System Platform), GENESIS 64, SIEMENS WINCC7X, CX-SUPERVISOR, FACTORYTALK, FAST/TOOLS, ABILITY SYMPHONY PLUS SCADA Visu +2
8	PRINTER	HP, CANON, FUJI XEROX, SAMSUNG, EPSON, RICOH
9	GPRS ROUTER/MODEM	MOXA, ROBUSTEL, HMS, MITSUBISHI, ICP DAS, NIMBUS
10	ENCLOSURES/PANELS	M/S RITTAL, M/S HOFFMAN, M/S ELDEN, M/S CEPL, Equivalent with Type test Certificate, with Pre formed PU gaskets
11	LED VIDEOWALL CONTROLLER-	&M/S NEC M/S SONY M/S DELTA M/s MITSUBISHI M/S BARCO

12	NETWORK SWITCH	M/S CISCO,M/S NETGEAR,M/S ICP DAS,M/S DIGISOL,M/S D-LINK
13	PRINTERS	M/S- CANON, M/S- FUJI, M/S- XEROX, M/S- EPSON, M/S-RICOH.M/S HP
14	CONTROL ROOM CONSOLES & FURNITURE	M/S EVANS,M/S QUEST, M/S WINSTED,M/S GODREJ
15	FIRE ALARM SYSTEM	M/S HONEYWELL M/S SEIMENS M/S BOSCH M/S HOCHIKI M/S ABB
16	FIREWALL	M/S CHECKPOINT M/S SOPHOS M/S CISCO FIREWALL
17	ANTIVIRUS	M/S CHECKPOINT M/S SENTINEL ONE M/S BIT DEFENDER

Note-1: In order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer's service, like items of equipment provided hereunder shall be the end products of one (1) manufacturer.

Note-2: All products shall be completely manufactured in the country of Origin as indicated. Assembled products shall not be accepted.

Note-3: In the event that the contractor wishes to propose alternate makes for the equipment mentioned above, he shall submit the following during detailed engineering:

- 1) Demonstrate that the proposed makes are “equivalent” to the approved makes or superior. The contractor shall ensure that alternate makes proposed, shall comply completely to the tender specifications, before the same is submitted for approval.
- 2) Submit ISO certificates for the OEM and CE certificates for the equipment.
- 3) Submit quality certificates that the equipment adheres to, as required under this contract.
- 4) Submit product brochures for the proposed equipment.
- 5) Manufacturer involved in manufacture of specified equipment for at least 10 years before bid date
- 6) End user performance certificates for minimum 5 successful individual installations of similar size, similar application as per this contract with the proposed equipment and model no, commissioned in last 5 years before bid date and satisfactorily operating for at least five years before bid date.
- 7) Manufacturer to provide full contact information for each reference as part of credential submission.

9.12 Cyber Security for the Centralized SCADA Center

Centralized Cyber Security Management System shall follow the cyber security policy of GJB, it shall felicitate purchaser for Firewall Management, Security Patching, Network Port Management, System Hardening, , Customized Source Code Review and Revision, Patch Management, Anti- Virus

Management, Anti-APT Management, Anti- Bot Management, Network Partitioning and Security Zones, , Digital Risk Monitoring and Log Management .It shall be contractor responsibility ensure data privacy owned by GJB. Hence contractor and agency shall sign a Non-disclosure Agreement (NDA) with GJB.

1. The contractor shall ensure that the System shall conform to ISO:270001 standard in context of cyber security.
2. Contractor scope shall include designing of cyber security architecture and operation plans as per principals of cyber security as stated in relevant Govt. of India guidelines. Contractor shall implement system while ensuring periodic updation of anti-malware software, virus definition and firewall security patches.
3. All IT equipment (Server, workstations, firewalls, routers etc.) shall be either Common criteria certified product or relevant test report from STQC (Standardization Testing and quality Certification) shall be submitted. The proposed system shall deal with any type of cyber security breach incident as per cyber crisis management plan (CCMP) and as per advice/guidelines of NCIIPC / Descom-Cert-in.. Implementation Agency (Contractor) shall implement NCIIPC (National Critical Information Infrastructure Protection Center) and CERT-in (Computer Emergency Response Team-India) advisories/guidelines in the system from time-to-time throughout the period spanning from the inception up to the end of operation and maintenance period.
4. Contractor shall conduct bi-annual cyber-security audit of the system without any additional financial implication on GJB and Contractor shall allow GJB's cyber security auditors/security consultant/GJB recommended third party security auditors to conduct audit of the system as and when required.
5. Contractor shall ensure role-based user access of the system and shall submit the details of users from Contractor who will access the system and clearly mention their roles and contractor shall implement two factor authentication of the users in addition to biometric based authentication.
6. Contractor shall submit monthly configuration review report of the system hardware and software to GJB. This solution shall provide multiple capabilities to support cyber security best practices. Functionality includes centralized patch management, anti-virus detection updates, centralized account management, logging and event management, whitelisting and automated backup
7. Contractor shall ensure that the hardware and software systems are periodically upgraded throughout operation and maintenance period to minimize system vulnerabilities, availability of latest security patches in the hardware and software while also ensuring compatibility/interoperability among different hardware and software of the systems.
8. Contractor shall submit detailed plan for periodic upgradation of the system and before any system upgradation GJB shall be notified well in advance.
9. Contractor shall implement a centralized system for cyber security related monitoring and network management for preventive, detective and corrective actions related to cyber-security.
10. Contractor shall prepare a detailed architecture of the system and data flow diagram of the system compliant with relevant CEA/NCIIPC guidelines
11. Every system and event log shall be retained for at least 06(six) months for review and log shall be periodically reviewed by contractor with log analysis tool. Moreover, logs of the system admin of the contractor shall be kept in a separate data repository which can only be accessed by GJB.
12. Contractor shall provide Server codes and documentation for each server.

13. The contractor shall implement in Group policy an active directory server where data has to be exchanged with secured LDAP only

9.12.1 Solution Hardening

Table A: Security Levels Categorization

Solution Hardening relates to reducing automation solution attack surface, including risk assessments, detection of threats and vulnerabilities, and management of USB ports. Contractor shall consider the following aspects for Solution Hardening

1. Security-segmented reference architecture and hardening measures designed to reduce exposure to security threats.
2. System hardening evaluations specific to the security environment and policies of each site locations are conducted.
3. Firewall and IDS placement and their rules are specified as part of the architecture. Switches can be locked down.
4. Unnecessary ports, services, and programs are removed or disabled from workstations, servers, and controllers, thus eliminating them as an avenue of attack.
5. Workstations employ session locking for protection while unoccupied.
6. Identification of missing security patches is automated.
7. Workstations and servers employ anti-virus software and capabilities for validating and installing the latest virus definition files.
8. Ensure that portable media used during integration and maintenance are authorized, virus-free, and not used for other purposes
9. All system constituents shall be hardened, i.e. all external access shall be controlled and set to deny/disable all by default. This shall involve closing/disabling network accessible ports/protocols and services, and implementation of proper authentication and encryption schemes of all external communication. Unnecessary ports and services shall be disabled.
10. Documentation shall be provided describing the required service so that system administrators can set up the firewall appropriately. Also, scripts shall be provided to help harden the operating system. Network devices shall also be configured to match the requirements of the SCADA system. All the unused ports on the Switches and Routers shall be disabled. Similarly, all USB ports in the computers shall be disabled
11. Network security and robustness testing should be conducted on products used in solutions to ensure reliability and integrity

9.12.2 Network Security

Network security Capabilities relate to supporting the segmentation and administration of networks.

1. System shall have Multilayer (at least network, application layer) firewall which shall protect the complete system network from unwanted users and shall have High Availability architecture with No Single Point of Failure.
2. Gateway Firewall should be capable of load balancing multiple links from different service providers.
3. LAN Firewall shall provide isolation/security services between the subsystems. All firewalls shall have 15Gbps of Threat Protection performance that include Firewall, Application Control, URL Filtering, IPS, Antivirus, Anti-Bot and Sandboxing for Zero-Day Protection with logging enabled (Zero-day shall be enabled in TP

- performance measuring) for better throughput. Underlying communication network of the whole SCADA system shall be a secured VPN (Secured Virtual Private Network) and Geo-fencing shall be implemented in all external firewalls.
4. There has be a binding of IP, Ports and MAC addresses for every Server, workstations etc. NIPS Network based shall be deployed with minimum hardware & they should not go blind in peak traffics. NIPS in Firewall shall be considerable on top of additional IPS appliance / solution.
 5. Shall have Gateway antivirus which will protect from inflow of virus from the Internet and other WAN locations at the gateway itself with content filtering without any lag in data transmission.
 6. Shall have strong authentication containing user name and passwords which shall be very difficult to compromise.
 7. Wireless access shall be prohibited on the control system network.
 8. Control systems should be designed and installed to reduce interactions between networks, specifically the supervisory/HMI network, the control network, and I/O networks. The I/O network, where control system I/O is located, is physically separated from all other networks.
 9. There has be to IP stack for both IPV4 and IPV6 for all IT equipment with IPV6 initially disabled.

9.12.3 Coding Practices (Not related to Cyber Security)

The proposal should include a section that describes the development practices and standards applied to Vendor-written control system software (including firmware) used to ensure a high level of defense against unauthorized access. Responses should also discuss assurances that source code is developed and supported within trustworthy countries and not circulating in unstable foreign areas. The Vendor shall disclose all the countries in which the source code has been distributed. All critical control system software should be developed by the supplier in a contained environment with development and maintenance staff having undergone the required background checks. Outsourcing of development to off- shore entities with unproven security track records will not be accepted. Contractor shall submit documentation to verify the same at the time of bidding & Functional design specifications for the main SCADA software and other softwares as required under this contract.

9.12.4 Intrusion Prevention System (Network Based) (Firewall feature)

After detecting any intrusion attempt the system shall perform the following functions:

- a) Capability for Detecting the intrusion attempt that may take place, intrusion in progress and the intrusion that has taken place
- b) Reconfigure the firewall provided in this package.
- c) Beep or play a .WAV file
- d) Send an SNMP Trap datagram to the management console. The NMS server envisaged under the specification shall be used as management console also.
- e) Send an event to the event log.
- f) Send E-mail to an administrator to notify of the attack.
- g) Save the attack information (Timestamp, intruder IP address, victim IP address/port, protocol information).
- h) Save a trace file of the raw packets for later analysis i.
- i) Launch a separate program to handle the event

- j) Forge a TCP FIN packet to force a connection to terminate.
- k) Detect multiple forms of illicit network activity: -Attempted
- l) Vulnerability Exploits -Worms -Trojans -Network Scans -Malformed Traffic -Login Activity
- m) The System shall support monitoring of multiple networks. The system shall also support the monitoring of additions or changes to addresses of devices on the network.
- n) The system shall have detection rules for monitoring faults, dangerous and malicious activity related to IP based protocols.

9.12.5 Gateway Antivirus (Firewall feature)

This shall be used for Gateway scanning of viruses. Gateway antivirus shall have Centralized- user Administration which will communicate directly with centralized user directories such as LDAP. It shall have the all the essential/standard features of Latest version of Gateway antivirus, shall have features are as below:

- a) It shall have Policy-based URL filtering and Dynamic Document Review.
- b) It shall protect web traffic with high-performance, integrated virus scanning and web content filtering at the gateway
- c) It shall ensure protection by combining list-based prevention with heuristic content analysis for both virus protection and web content filtering
- d) It shall eliminate unwanted content and malicious code & Scan all incoming and outgoing
- e) HTTP and FTP traffic etc.
- f) The Security System shall use the best practices to prevent the System itself being a source of security compromise. The System shall be hardened, patched, tested, and designed with security as a primary.

9.12.6 Central Cyber Security Management System

The Centralized threat management system shall be capable of displaying real time & historical information of the connected Firewall, IDS, IPS systems and the threats encountered / logged / quarantined. Main Functionalities of this system will be as follows:

- a) Management of all the HA Next Generation Firewalls and Intrusion Detection Systems
- b) Gathering of cyber logs generated by IDS at various locations
- c) Taking automated actions/raising alarms, whenever any vulnerability/anomaly is detected
- d) Gathering patch updates include antivirus updates from patch management server
- e) Rolling out patch updates to all the systems connected to CSMS such as IDS, Firewall, etc.
- f) Automatically rolling out Zero-day updates at a particular time of the day to Firewalls and IDSs
- g) This system shall have advanced machine learning capabilities to recognize pattern, algorithms and pre-diagnostic features.

9.12.7 Web Browser Based View-Only Access

The Contractor shall provide access to SCADA displays such as graphical world map, remote station one-line and tabular displays using a web browser-based view-only user interface. The user interface shall support the use of multiple devices including desktops, laptops, tablets and smartphones. Multiple web browsers such as Microsoft Edge, Chrome, or Firefox shall be supported and shall not require any special plugins, browser cookies, or Java. Panning and zooming shall be supported on each of the listed devices including touch screen pinch to zoom support on tablets and smartphones. The web browser-based user interface shall not require

additional display creation tools but shall use the same standard display editing tools within the SCADA system.

9.12.8 Malware Detection and Protection

The Contractor shall disclose the existence and reasons for any known or identified backdoor codes. The Contractor shall meet the following conditions:

Provide a host-based malware detection scheme for the control system network. The Contractor shall verify adequate system performance for host-based malware detection, quarantine (instead of automatically deleting) suspected infected files and provide an updating scheme for the signatures. Prior to Factory Acceptance Testing (FAT), the Contractor shall also test major updates to malware detection applications and provide performance measurement data on the impact of using the malware detection applications in an active system. Measurements shall include, but are not limited to, network usage, CPU usage, memory usage and any other impact to normal communications processing.

The proposed solution architecture should be robust enough to protect the infrastructure from unknown threats arising in the future. The Centralized threat management system shall be capable of displaying real time & historical information of the connected Firewall systems and the threats encountered / logged / quarantined.

Following are the key requirements for next generation Firewalls:

- a) Solution should be Next-Generation Aware with Application & User Visibility.
- b) Solution should detect and prevent both known and unknown threats at the Network level.
- c) Should provide detailed Logging & advance reporting with forensic Analysis
- d) Should integrate & share threat intelligence with existing point solution.
- e) Central Management
- f) Incident Response service (in case of any threat/incident),

All equipment, system and services covered under this specification shall comply with all current applicable statutory regulations and safety codes where the equipment is proposed to be installed. The equipment and systems shall also conform to the latest version of applicable codes, standards and software versions on the date of offer made by the Contractor unless otherwise indicated. Nothing in this specification shall be construed to relieve the Contractor of this responsibility

Firewall Features

- 1) Firewall should provide application inspection for LDAP, SIP, H.323, SNMP, FTP, SMTP, HTTP, DNS, ICMP, DHCP, SNMP, etc.
- 2) Firewalls should seamlessly have integrated for reporting to any third-party systems or SOC solution at present or in future
- 3) The platform shall be supplied with minimum 8x 10/100/1000GE RJ45 inbuilt interfaces
Additional spare slot for accommodating future ports (min. 4) to be suitable considered
- 4) Offered products should be of latest hardware / software versions and not obsolete for minimum of 5 years along with support for spares updates and services
- 5) The firewall should support transparent (Layer 2) firewall or routed (Layer 3) firewall Operation

- 6) Firewall should support static NAT, Dynamic NAT and PAT
- 7) Firewall should support IPsec data encryption
- 8) It should support the IPsec VPN for both site-site and remote access VPN
- 9) Control SNMP access through the use of SNMP and MD5 authentication.
- 10) Firewall shall support unlimited policy option.
- 11) Firewall shall have support of at least 1000-time based policies
- 12) Solution shall support data integrity with AES-XCBC

Antivirus & Anti-bot

- 1) The solution should be able to block traffic between infected bot Host & Remote C&C Operator and should allow the traffic to legitimate destinations
- 2) The solution should inspect HTTP, HTTPS, DNS & SMTP traffic for the detection and prevention of the Bot related activities and Malware activities.
- 3) The proposed solution should have an option of configuring file type recognition along with following actions i.e. Scan, Block, pass on detecting the Known Malware. Should allow blocking of known malware file-types directly from firewall.
- 4) The known Malware scanning should not be restricted by the any specific limit on the size of the of the file(s) & should support achieve scanning to detect threat hidden in achieve
- 5) The proposed solution should be able to detect & prevent the malware by scanning different file types with configurable option to inspect, bypass or blocked various file- types as per organization need.
- 6) Reverse engineer malware in order to uncover their DGA (Domain Name Generation)
- 7) The solution should prevent the users to access the malware hosting websites and/or web resources.
- 8) The solution should have the intelligence to analyse & detect known threats as well as the unknown threats which are commonly known as zero-day threats by integrating with the threat protection solution .
- 9) The solution should detect C&C traffic according to dynamic IP/URL reputation.

Application awareness, Web-filtering & User visibility

- 1) Firewall should support Identity based controls for Granular user, group-based visibility and policy enforcement using Identity Awareness functionality.
- 2) Solution should support Upload / Download bandwidth control feature per User, Group or Application regardless of port, protocol etc.
- 3) The proposed solution shall delineate different parts of the application such as allowing Facebook chat but blocking its Facebook-post / file-upload capability etc.
- 4) Solution should be able to natively understand & should have ability to control ICS applications like Modbus, OPC (OLE for Process Control), TCP /IP.
- 5) In addition to afore mentioned protocols, solution shall be able to understand any other protocol such as CIP-Ethernet-IP, Profinet, IEC-60870-5-104, V-net, VL-net, V- net IP etc.

Licensing

- 1) Solution should have enterprise license without any restrictions.

Other Aspects of Security

SCADA Threats Visibility

- 1) Solution shall be capable to manage from a single console
- 2) Proposed solution shall be capable of understanding ICS protocols: Modbus, CIP, DNP3, BACnet, IEC-60870-5-104, IEC-60870-5-103, IEC-60870-5-101, Modbus RTU/TCP-IP, IEC 60870-6 (Secured ICCP), IEC 61850, MMS, OPC DA, OPC UA, Ethernet Protocols, and others
- 3) Proposed solution shall have Deep Packet Inspection capability
- 4) Proposed appliance shall support ACL (Access control list) based on IEC-104, ACL flow-based limiting.
- 5) Proposed Solution shall have intrusion prevention capabilities for SCADA protocols proposed next generation firewall shall support SCADA Apps/Commands and SCADA protocols.
- 6) Proposed firewall shall support Firewall rules (incoming/outgoing, management),
- 7) Proposed solution shall have the ability to log all traffic of above-mentioned protocols and investigate commands down to the parameter level

Application Security Monitoring

The standard operating system shall support the monitoring of security on host installed applications. The system shall support or allow the creation of monitoring for:

- 1) Application Software Error Conditions
- 2) Application Software Performance Issues
- 3) Application Configuration Changes
- 4) Application Logins, etc.

Security alarms

The system shall be capable of annunciation, to include audible and visual alarms and remote paging whenever a security event takes place and shall support the following:

- 1) Instant notification through email or SMS
- 2) Logical grouping of security events by time, location, and device, etc.
- 3) Interactive dashboard window for viewing and acknowledgement.

Analysis and reports

- 1) The system with the stored information shall be able to produce analyses and reports to meet security compliance requirements. The system shall be equipped with best practices ad-hoc reports widely used in the industry.
- 2) The contractor personnel shall be trained to be capable of creating new custom analysis and reports, and revising existing, without requiring external consultation.

Log Archiving and Management Solution

The security system shall archive, record, and store all security related events in raw form for at least five years. As a minimum, the event logger shall record all security related events from the perimeter security devices and the host IPS. Graphical trend displays of each event shall be

available along with specific information on the type of intrusion, the area affected and the source via IP address.

Signature updating requirements

The system shall be able to accept timely updates. The updates shall keep the threat signatures current, providing the latest detection and protection. The updates shall also incorporate the latest security enhancements into the Security Management System. These enhancements shall increase security and functionality, without requiring redesign or reengineering efforts.

Network encryption

All communication with system constituents shall be encrypted on application level, regardless of the security zone. The mechanisms such as using service session keys.

Malicious code and Anti-virus protection

Each of the Windows computers in the system shall be provided with Anti-virus/ software. This monitoring software shall be enabled at all times. The anti-virus application for end points (workstations/servers) shall be different from the gateway antivirus in the Firewalls.

Security Patch Management

Security Patch Management services shall be provided through which new security patches and the precautions about installing these patches shall be provided. The cyber security architecture shall permit the distribution of patches without the need for each of the system's computer to be connected to the Internet. The patches shall be updated from the Web server through Internet. These patches shall then be distributed to all other computers and security equipment. The latest patches for all parts of the system shall be deployed before the Factory Acceptance tests.

The patches for Operating system shall be tested on the DTS or Development system before deploying on the real-time system. Similarly, any patches for an application shall be tested on the DTS or development system.

The Contractor shall share all the vulnerabilities with GJB as and when they are discovered and shall provide the patches for them.

Antivirus and Patch Management

The Contractor shall also be responsible for providing & installing updates/patches for its own software product and Third-party software products. All other patches of third-party product like Operating System and Antivirus shall be tested by the Contractor prior to installing.

A secure patch management/deployment system is to be established which will be placed in DMZ. All the patches shall be downloaded through this single point of connection. Other products like IPS, Network IPS, Host based IPS, Firewalls shall also be provided with secure patch management.

The update of firewall signatures shall be preferably deployed on daily basis.

Updates will be provided offline. No external internet access to system will be given.

The Contractor shall provide a mechanism for patch management so that it is known that what patches have been applied, what all patches are pending but available, and what is the recent release of patches for the various products. Any patch shall be applied only with express permission of the GJB

END OF PART-9

PART 10

PARTICULAR ELECTRICAL PLANT REQUIREMENTS

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PART 10

PARTICULAR ELECTRICAL REQUIREMENTS

10.1 Introduction

The specific design and performance requirements for all electrical equipment are given in this part of the Specifications. The Requirement specified shall be fully met with by the Contractor. In case of any deviations, the Contractor shall bring out the same in "Schedule of Deviations from Particular Requirement" failing which shall be considered that the Contractor fully complies with these requirements.

10.2 Scope of works

The scope of works for CWMC-CENTRALIZED SCADA CONTROL CENTRE consists of Additions, modifications and replacements of the existing low voltage electrical items, Air conditioner installations to suite the proposed Water SCADA control.

The scope of works includes the Tie in of 3phase 415 V 50 Hz Power supply from the utility supply provider with any modification required at the Tie in point as suggested by the power supply provider.

The contractor shall liaison with the Utility supply provider and carry out the modifications or additions suggested by the Utility supply provider inclusive of all commercial aspects like connection charges.\

The scope includes design, manufacture, testing at works, supply and delivery at site, unloading and storing the equipment at site, installation, testing and commissioning of the major equipment's as described below, but not limited to same.

10.3 Primary Power Source

The primary power source shall be from the utility supply provider which will be backed up with UPS.

10.4 General Design Criteria

All electrical equipment shall be rated for 45°C design ambient temperature. The installation shall generally conform to Indian Standards / IEC.

(a) AC Control, Lighting and Space Heating

- Voltage: 240 V
- Phases: 1
- Frequency: 50 Hz
- Connection: 2 wire (Phase & Neutral)

(b) DC Control, Protection and Alarm

- Voltage: 110 V
- Phases: 1
- Connection: 2 wire (unearthed)

10.5 UPS Power Supply

UPS should be designed and constructed in accordance with IEC 62040. All the components should be mounted in an indoor, floor-mounted, metal enclosed panel with enclosure protection IP 42. UPS Cubicle must be dust and vermin-proof and designed for ambient of 50° C and relative humidity band as per site condition.

UPS System shall be with Parallel Redundant, three phase, 415 V, 50 Hz stand alone, online, microprocessor-based UPS System with SMF batteries for 120 minutes backup with accessories.

The UPS system shall consist of

- Incoming MCCB in Inverter lines & By-pass lines
- Input Isolation Transformer
- Harmonic Filter
- Rectifier / charger unit
- Lead Acid sealed maintenance free Batteries
- Inverter unit
- Servo-controlled Voltage Regulator in the Bypass line
- Automatic switching (Static Switch)
- Maintenance bypass switch
- Protective devices and other accessories
- Control and Display Unit for monitoring of parameters and control of UPS

The solid-state rectifier/charger shall convert incoming AC power to DC power. The rectifier/charger output shall be fed to a solid-state inverter.

The inverter shall convert the DC power into AC power which shall supply to the load. Upon failure of AC power or in case voltage drops below the operating range of battery charger, input power for inverter shall automatically be supplied from the battery with no interruption/disturbance in inverter output in excess of limits specified in this specification. At the same time, UPS shall energize an alarm circuit.

UPS shall have a storage battery with 120 minutes (for double battery bank) minimum backup capacity to meet the power requirements in the event of failure of the main supply. Battery Bank shall consist of 12 Volt battery blocks.

System Configuration

A parallel Redundant UPS system comprising of two sets of UPS streams each of a designed kVA rating and a common Bypass with servo-controlled Voltage Stabilizer (SCVS) shall be provided. Each UPS shall be supplied with Battery banks of a size suitable for UPS rating. Both the UPS shall run in Parallel and share the connected load.

The switchover from UPS to standby and vice versa shall be without any interruption. Bypass with SCVS shall come in line only when both the UPS are out of order and not in working condition.

Rectifier / Charger Unit

An input AC filter shall be incorporated into the rectifier or charger unit. The filter is not to be an add-on in front of the rectifier or charger.

This filter's purpose is to reduce the current harmonics feedback into the input AC line to not more than 5%. The filter is needed also to improve the input power factor so that it is 0.8 lag or better.

Power semiconductors in the rectifier/charger shall be used with fast-acting fuses so that the loss of anyone power semiconductor will not cause cascading failures.

All fuses shall be provided with a blown fuse indicator with an alarm indicator on the control panel. The filter shall be adequate to ensure that the DC output of the rectifier/ charger will meet the input requirements of the inverter.

Inverter Unit

The inverter unit shall be an IGBT based capable of accepting the output of the rectifier and charger or the unregulated voltage of the battery and provide regulated rated AC output within specified limits.

Means shall be provided to hold the inverter output frequency to +0.1% for both steady state and transient conditions.

Total frequency deviation, including short time fluctuations and drift, shall not exceed +0.1% from the rated frequency. The inverter output shall stay synchronized with the static bypass line provided the static bypass line remains within +3 Hz of the nominal frequency

If the line frequency goes outside these limits, the inverter is to break synchronization with the line and Run on its internal frequency. When the line frequency returns, within limits, the inverter output is to automatically re-synchronize with the line.

The rate of change of frequency is not to exceed 0.1 Hz per second. The unit shall be provided with an internal switch so that the synchronizing frequency range can be changed from +3 Hz to +1 Hz or to+0.5 Hz.

Static Transfer Switch

The Static Transfer Switch, using solid state devices, shall be provided to transfer the load between the UPS module and the static bypass line uninterrupted.

Automatic static load transfers shall be initiated when a system overload is greater than Specified here, a branch load circuit faults, or a fault within the UPS module occurs.

If the static transfer was caused by an overload or branch fault and this condition was rectified, then the static transfer switch is to automatically re-transfer the load to the UPS module.

The static transfer switch shall be sized to provide 125% rated load continuously. The switch shall also have an overload rating of 2000 % rated load for two cycles.

Maintenance Bypasses Switch

A manually operated maintenance bypass switch is to be incorporated into the UPS module cabinet that will connect the load to the input AC power source bypassing the rectifier/charger, inverter, and static transfer switch.

While the load is on the maintenance bypass line, it shall be possible to check out the operation of the rectifier/charger, inverter, and static transfer switch. It shall also be possible to check the battery.

Control and Display Unit

The control Panel is to depict a single-line diagram of the UPS. Indicating Lights shall be integrated with the single-line diagram to illustrate the status of the UPS power paths.

The functions whose status is to be displayed shall include, but are not limited to the following:

1. Input power available
2. Output power available
3. Normal operation
4. Bypass operation

In addition to the above, each UPS shall be supplied with LED/LCD control and Display Unit to monitor various parameters as explained in various sub-clauses of this section and others as deemed necessary.

The UPS shall be with Modbus communication facility to interface with Scada for remote monitoring and control.

10.6 Power points:

Small Power Outlets: -

Switched single phase three pin 5 A and 15A receptacles shall be provided throughout. In offices and control rooms they shall be modular decorative type and industrial type in all other areas for single and three phase sockets. All outlets for domestic pump, dewatering pump, submersible sump pump shall be provided with local starter panel or control cubicle. All metal clad sockets shall be provided with suitable metal clad plug.

Unless required to be provided in greater numbers to power specific Plant items the number of such outlets shall be as follows:

- 5 A type one outlet per 5 m or part thereof of perimeter in offices and laboratories
- 5 A type one outlet per 20 m or part thereof of perimeter in all other areas
- 15 A type one outlet per 20 m or part thereof of perimeter in offices and laboratories
- 15 A type one outlet per 20 m or part thereof of perimeter in all other areas.

10.7 System Earthing

An earthing system comprising earth electrodes and conductors shall be established for SCADA Centre

The earthing system shall be designed to give a combined earth resistance value of not greater than 1 ohm.

In order to be sure of obtaining suitable final values, soil resistivity shall be measured at the various sites during the detailed design phase of the work.

In outdoor substation areas the main earth electrode conductors shall be located, to ensure potential gradients occurring at the surface during fault conditions are kept within allowable limits.

Materials used for earth electrodes shall be designed to suit the ground conditions and shall either be plain mild steel or Galvanised steel.

Advance early fire detection system, Fire Alarm system., addressable fire alarm system for the entire centralized SCADA centre along with central control panel and integration with SCADA system for monitoring.

10.8 Air conditioning System

Air conditioning system for the entire control centre with all required accessories, hard ware, related work etc. Precision air conditioning system for server room areas shall be provided.

10.9 Battery

Sr. No.	Description	Unit	Technical Particulars
	Make		As per Preferred Makes/Manufacturers
	Type of battery		Ni-Cd
	Applicable Standards		As per Specification
	Number of battery banks required		(*)
	Ambient conditions		Min. Temp. 25° C
			Max. Temp. 45° C
	D.C. system voltage	V	110 ±10%
	Ampere hour capacity of battery at 27 Deg. C at 5-hour rate to give final cell voltage of 1.16 volts/cell	Ah	As per the Requirement
	Momentary load/duration	A	To be furnished by the Bidder
	Emergency load/duration	A	
	Continuous load/duration	A	
	Nominal voltage	V	1.2 V per cell
	Cell voltage - initial/final	V	1.42/1.14 V
	Number of cells per bankrequired to give rated voltage	Nos	(*)
	Number of spare cells per bank	Nos	(*)
	Mounting arrangement		Multi tier
	Charging method		Float cum boost charging

10.10 Battery Charger

Sr. No.	Description	Unit	Technical Particulars
	General		
(a)	Make		As per Preferred Makes/Manufacturers
(b)	Applicable Standards		As per Specification
(c)	Type		Float and Float cum Boost Charge

Sr. No.	Description		Unit	Technical Particulars
(d)	Number required		Nos	(*)
(e)	Rated Output voltage (DC)		V	110
(f)	Rated Output		kW	(*)
(g)	DC System Earthing			Unearthed
(h)	Voltage regulation from no load to rated load		%	± 1
(i)	Ambient Design Temperature		Deg C	45
(j)	AC ripple in DC output voltage at rated continuous load			Less than 1%
(k)	Type of rectifier			SCR, full wave fully controlled
(l)	Transformer			Copper double wound dry type with class-F insulation
(m)	Float/Trickle charging current of battery		mA	As per manufacturer
(n)	Boost Charging Current of Battery(Maximum)		A	As per manufacturer
(o)	Boost Charging Voltage of Battery (maximum)		V	As per manufacturer
(p)	Maximum Time for Boost charging of Battery		hr	As per manufacturer
	Battery Details			
(a)	Float/Trickle charging current of battery		mA	As per manufacturer
(b)	Boost Charging Current of Battery (Maximum)		A	As per manufacturer
(c)	Boost Charging Voltage of Battery (maximum)		V	As per manufacturer
(d)	Maximum Time for Boost charging of Battery		hr	As per manufacturer
(e)	Battery capacity & no. of cells		Ah	(*)
			Nos.	(*)
	AC System Data			
(a)	Supply	Voltage	V	415
		Phase		3
(b)	(i) Variation in supply Voltage		%	± 10
	(ii) Variation in supply frequency		%	± 5

Sr. No.	Description		Unit	Technical Particulars
(c)	Short Circuit level		kA	50
(d)	Type of earthing			Solidly Earthed
	Performance			
(a)	DC voltage setting adjustment for float charger			±10% of nominal voltage
(b)	Voltage stabilisation for constant voltage regulator			±1% of set D.C. voltage, with AC input variation and DC load variation from 0 to 100%
(c)	Maximum permissible variation in DC voltage (no load to full load)			± 1%
(d)	D.C. voltage setting adjustment for boost charging			70% to 100% of max. boost charging voltage
(e)	D.C. current adjustment for boost Charging			30% to 100% of max. boost charging current
(f)	Current stabilisation for constant current regulator for boost charger			± 2%
(g)	Minimum permissible power factor to rated continuous load			0.8
(h)	Permissible ripple content at rated continuous load			3% (maximum)
(i)	Relay for auto changeover from Float to boost mode to be provided (in case of float-cum-boost charger)			Yes
	Constructional Features			
(a)	Thickness of sheet steel Frame, Frame enclosures, doors, covers and partition		mm	Cold rolled 2.0
(b)	Degree of protection			IP 42
(c)	Colour finish shade			Interior: Glossy white Exterior: Light Grey Semi Glossy Shade 631 of IS 5
(d)	Earthing bus	Material		Copper
		Size	mm x mm	(*)
(e)	Earthing conductor	Material		GS
		Size	mm x mm	(*)
(f)	Cable entry			Bottom
(g)	Cable Sizes			

Sr. No.	Description	Unit	Technical Particulars
	(i) Battery	sq.mm	(*)
	(ii) DC output	sq.mm	(*)
	(iii) AC input	sq.mm	(*)

10.11 DC Distribution Board

Sr. No.	Description	Unit	Technical Particulars
	General		
(a)	Make		As per Preferred Makes/Manufacturers
(b)	Applicable standards		As per specification
(c)	Quantity	Nos	(*)
(d)	DC System voltage (Nominal)	V	110
(e)	DC System Earthing		Unearthed
(f)	Ambient Design Temperature	Deg. C	45° C
(g)	Busbar material, rating and size		Copper, Rating & Size (*)
	DC Bus Load		
(a)	Total continuous DC load	A	(*)
(b)	Short time loads (Additional to continuous loads)		
	(i) DC lights/Facia lamps	A	(*)
	(ii) Starting current and duration of Largest Connected DC Motor	A	(*)
		Secs	(*)
	Constructional Features		
(a)	Thickness of sheet steel Frame, Frame enclosures, doors, covers and partition	mm	CRCA 2.0 min.
(b)	Degree of protection		IP 54
(c)	Colour finish shade		Interior: Glossy white
			Exterior: Light Grey Semi Glossy Shade 631 of IS 5
(d)	Earthing bus	Material	Copper (run throughout the panel)
		Size	mm x mm (*)
(e)	Earthing conductor	Material	GS

		Size	mm x mm	(*)
(f)	Cable entry			Bottom
(g)	Cable Sizes			
	(i) DC Input from Battery		sq.mm	(*)
	(ii) DC output to Load		sq.mm	(*)

10.12 Cables

Sr. No.	Description	Unit	Technical Particulars
	11kV (UE) XLPE Insulated Power Cables		
(a)	Make		As per Preferred Makes/Manufacturers
(b)	Applicable Standards		As per specification
(c)	Cable size selection		As per requirement
(d)	Continuous current rating with cable laid in air/ ground under specified ambient temperature	A	(*)
(e)	Conductor material		Stranded, aluminium, EC grade/class-2
(f)	Conductor screening		Semiconducting compound by extrusion
(g)	Insulation		Extruded XLPE
(h)	Screening on Insulation		Semiconducting compound by extrusion (non-metallic), copper tape (metallic)
(i)	Identification of codes		By providing strip of Red, Yellow & Blue colours
(j)	Inner sheath		Extruded PVC, type ST-2
(k)	Filler material		PVC
(l)	Armouring		Galvanised steel flat strip
(m)	Outer sheath		Extruded PVC, type ST-2
(n)	Overall diameter of cable		To be furnished by the Bidder
(o)	Recommended minimum bending radius	mm	To be furnished by the bidder
(p)	Standard length of cable on each drum	mts	(*)
	1100V Grade XLPE Insulated Power Cables		
(a)	Make		As per Preferred Makes
(b)	Applicable Standards		As per specification requirement
(c)	Cable size selection		As per specification
(d)	Conductor material		Stranded, aluminium/copper, EC grade
(e)	Insulation		XLPE

Sr. No.	Description	Unit	Technical Particulars
(f)	Inner sheath		Extruded PVC, type ST-2
(g)	Armouring		Galvanised steel flat strip/round wire
(h)	Outer sheath		Extruded PVC, type ST-2
(i)	Overall diameter of cable		To be furnished by the Bidder
(j)	Recommended minimum bending radius	mm	To be furnished by the bidder
(k)	Standard length of cable on each drum	mts	(*)
	650/1100V Grade PVC Insulated Control Cables		
(a)	Make		As per Preferred Makes/Manufacturers
(b)	Applicable Standards		As per specification
(c)	Rated voltage	V	As per requirement
(d)	Cable size selection		As per specifications requirement
(e)	Conductor material		Stranded, copper, EC grade
(f)	Insulation		PVC
(g)	Inner sheath		Extruded PVC, type ST-1
(h)	Armouring		Galvanised steel round wire
(i)	Outer sheath		Extruded PVC, type ST-1
(j)	Standard length of cable on each drum	mts	(*)

End of Part 10

PART 11

INSPECTION, TESTING AND COMMISSIONING REQUIREMENTS

PART-11
INSPECTION, TESTING AND COMMISSIONING REQUIREMENTS

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PART 11

INSPECTION, TESTING AND COMMISSIONING REQUIREMENTS

11.1 Inspection and Testing During Manufacture

General

- (a) All inspection and testing shall be carried out in accordance with the Specification and in absence of Specification relevant Indian Standard or internationally approved equivalent standard. After award of Contract, Contractor shall furnish a QA plan for approval by Employer. QA plan shall include testing for incoming supply of raw materials and bought out items, stage inspections and tests on finished products at manufacturer's works where the equipment has been manufactured. QA plan shall clearly indicate tests which are intended to be witnessed by the Contractor alone and those by both contractor and Employer.
- (b) **Inspection and tests schedule shall be as follows;**
- 1) Manufacture tests
 - 2) Acceptance inspection / Quantity checking
 - 3) Install /site inspection
Site acceptance test
 - 4) Tests on Completion
 - 5) Operation Test (Tests After Completion)
 - 6) Complete performance tests of Plant after 5-year comprehensive Operation (Before plant handing over)
 - 7) Test furnished as per IS Code/manufacturer QAP
- (c) The Contractor shall carry out at the place of manufacture tests of the Plant /Equipment of any part of the Works as per approved QAP.
- (d) The Employer and duly authorised and designated representative(s) shall be entitled to attend the aforesaid inspection and/or tests.
- (e) The Employer and his duly authorised representative shall have access to the Contractor's premises at all times to inspect and examine the material and workmanship of all the equipment inclusive of electrical plant and equipment during its manufacture there. If part of the plant and equipment is being manufactured on other premises, the Contractor shall obtain permission for the Employer or his duly authorised representative, to inspect as if the plant and equipment was manufactured on the Contractor's own premises. Testing (including testing for chemical analysis and physical properties) shall be carried out by the Contractor and certificates submitted to the Engineer who will have the right to witness or inspect the above mentioned inspection /testing at any stage desired by him. Where inspection or testing is to be carried out at a subcontractor's works, a representative of the Contractor shall be present.
- (f) Contractor shall provide test procedure, pre-factory test results, and calculation sheet, photo in advance and provide all of test result with necessary document including its data and photo to

show Engineer that test is carried out in proper condition and the its test results. Construction material shall be tested by contractor at the approved laboratory

- (g) The procedure for the testing and inspection to be carried out during or following the manufacture of the materials to ensure the quality and workmanship of the materials and to further ensure that they conform to the Contract in whatever place they are specified shall be as described below.
- (i) The Contractor shall give the Employer at least 21 clear days' notice in writing of the date and the place at which any plant or equipment will be ready for inspection/testing as provided in the Contract. Prior to notice, contractor should submit pre factory test results. The Employer or his duly authorised representative shall thereupon at his discretion notify the Contractor of his intention either to release such part of the plant and equipment upon receipt of works tests certificates or of his intention to inspect. The employer shall then give notice in writing to the Contractor, and attend at the place so named the said plant and equipment which will be ready for inspection and/or testing. As and when any plant shall have passed the tests referred to in this section, the Engineer shall issue to the Contractor a notification to that effect after obtaining clearance from the consultants.
- (ii) The Contractor shall forward to the Employer 6 duly certified copies of the test certificates along with characteristics performance curves/tables if any for all equipment obtaining dispatch clearance from the consultants/Engineer.
- (iii) If the Engineer(s) fails to attend the inspection and/or test, or if it is agreed between the parties that the Engineer(s) shall not do so, then the Contractor may proceed with the inspection and/or test in the absence of the Engineer and provide the Employer with a certified report of the results thereof as per (ii) above.
- (iv) If any materials or any part of the works fails to pass any inspection / test, the Contractor shall rectify or replace such materials or part of the works and shall repeat the inspection and/or test upon giving a notice as per (i) above. Any fault or shortcoming found during any inspection or test shall be rectified to the satisfaction of the Engineer before proceeding with further inspection of that item. Any circuit previously tested, which may have been affected by the rectification work, shall be re-tested.
- (v) Where the plant and equipment is a composite unit of several individual pieces manufactured in different places, it shall be assembled and tested as one complete working unit, at the original manufacturer's works.
- (vi) Neither the execution of an inspection test of materials or any part of the works, nor the attendance by the Engineer(s) nor the issue of any test certificate pursuant to (iii) above shall relieve the Contractor from his responsibilities under the Contract.
- (vii) The test equipment, meters, instruments etc., used for testing shall be calibrated at recognised test laboratories at regular intervals and valid certificates shall be made available to the Engineers at the time of testing. The calibrating instrument used as standards shall be traceable to National/International standards. Calibration certificates or test instruments shall be produced

from a recognised/Laboratory for the Engineer's consent in advance of testing and if necessary instruments shall be recalibrated or substituted before the commencement of the test.

- (viii) Items of plant or control systems not covered by standards shall be tested in accordance with the details and program agreed between the Engineer and Contractor's Representative. If such materials or works are found to be defective or not conforming to the Contract requirements, due to the fault of the Contractor or his sub-contractors the Contractor shall defray all the expenses of such inspection and/or test and of satisfactory reconstruction.
- (ix) Tests shall also be carried out such that due consideration is given to the site conditions under which the equipment is required to function. The test certificates shall give all details of such tests.
- (x) The Contractor shall establish and submit a detailed procedure for the inspection of materials or any part of the works to the Employer for approval within the date indicated in the Programme Details. The detailed procedure shall indicate or specify, without limitation, the following:
- Applicable code, standard, and regulations.
 - Fabrication sequence flow chart indicating tests and inspection points.
 - Detailed tests and inspection method, indicating the measuring apparatus to be used, items to be measured, calculation formula, etc.
 - Acceptance criteria.
 - Test report forms and required code certificates and data records.
 - Method of sampling, if any sampling test to be conducted.
 - Contractor's or Employer's witness points.
- (xi) The Contractor shall not pack for shipment any part of the Plant until he has obtained from the Employer or his authorised representative his written approval to the release of such part for shipment after any tests required by the Contract have been completed to the Employer's satisfaction.
- (xii) The following Inspection and Testing procedures shall be carried out for the equipment as per approved QAP.

The detailed procedure shall indicate or specify, without limitation, the following:

- Raw Material
- Visual Inspection/Appearance.
- Chemical and Mechanical property tests
- Dimension Checking
- Dynamic balancing for all rotating parts
- Stage inspection
- Hydrostatic / Leak testing for all pressure parts, Pneumatic Leak Test wherever applicable
- Repair procedure
- Operation check
- Procedure Qualification Record (PQR); Welding Procedure Qualification (WPQ) and Welders Qualification Report (WQR)
- Material Test
- Assembly/Connection
- Documentation

-
- (h) The Contractor shall maintain proper identification of all materials used, along with reports for all internal / stage inspection work carried out, based on the specific job requirement and or based on the datasheets / drawings / specifications.
 - (i) The expenses incurred during inspection shall include, but not be limited to all travelling, boarding, lodging and out-of- pocket expenses.
 - (1) The Contractor shall be responsible for all expenses incurred by the Engineer or person/s nominated by the Engineer in attending inspection and tests of Plant carried out during manufacture within India and abroad. Normally two persons from Employer side and one person from Consultants side will witness the Inspection and testing along with the contractor's representative within India and abroad. No separate payment will be made against to the inspection & testing, and same shall be included in bidder's quoted price.
 - (2) Cost of inspection when material or any part of the facilities is not ready at the time specified by the Contractor for inspection or when re-inspection is necessitated by prior rejection shall also be borne by the Contractor.
 - (3) In all factory inspection the authorized contractor person should be available along Employer and third party. Authorized contractor person who is attending inspection shall be a qualified factory inspector based on the type of inspection.
 - (j) Witnessed testing will normally be waived on standard types of equipment such as small motors made by approved manufacturers, individual standardised instruments, small mass produced components used in the manufacture of Plant items, small bore pipe work and fittings, minor installation materials and low voltage cable. In order to remove doubt this shall not relieve the Contractor of his obligation under the Contract to ensure that all Plant is tested at the manufacturer's works prior to delivery to Site.
 - (k) As a guide to the Contractor the Employer reserves the right to witness testing of the following but not limited to the following Plant items:

a) Electrical:

- (1) Power Capacitor and Control Panel
- (2) Diesel Standby Generator with AMF Control Panel
- (3) Battery, Battery charger and DC Distribution Board
- (4) Bus Duct
- (5) Power & Control Cables
- (6) Lighting System
- (7) Earthing and Lightning Protection Systems
- (8) Local Control Panels (LCP)
- (9) Junction Boxes
- (10) Cable Carrier System
- (11) UPS systems

b) Instrumentation and Control:

- (1) All centralized SCADA equipment, SCADA servers, FIP servers
- (2) LED Videowall system

- (3) Fire alarm system
- (4) Centralized air-conditioning & precision air conditioning system
- (5) All instrumentation inclusive of real time water quality monitoring equipment
- (6) Realtime online Influent & effluent monitoring equipment
- (7) Level Measuring System
- (8) Instrumentation and Control Cables
- (9) Power cables
- (10) Instrument Control Panel/integration panel
- (11) Panels and enclosures
- (12) RTU/Programmable Logic Controller
- (13) SCADA
- (14) Uninterruptible Power Supply System
- (15) Wireless GPRS gateway
- (16) FAT & SAT for complete ICA system inclusive of all centralized SCADA system equipment's

(l) All destructively tested samples shall be replaced with brand new.

(m) The Employer reserves the right to be present during the testing and inspection of all Plant items.

11.1.1 Materials, Plant and Equipment

The Contractor shall place orders for the material and the equipment only after approval QAP by the Engineer. The Contractor shall submit the detailed technical and its drawings from the approved manufacturer and the procedure of submission, review and revision shall be as specified herein below.

The Contractor shall inform the Employer about the likely dates of manufacturing, testing, and dispatching of any material and equipment to be incorporated into the Permanent Works. The Contractor shall notify the Employer for inspection and testing, at least twenty-eight (28) days prior to packing and shipping and shall supply the manufacturer's test results and quality control certificates.

The testing and approval for dispatching shall not absolve the Contractor from his obligations for satisfactory performance of the plant.

Dispatch Clearance

All equipment shall be tested at their respective factory which will be witnessed by tri parties (Contractor, GJB & Consultant inspecting team) in line with approved QAP and Equipment Data sheet.

The test observation sheets, material tests certificates (chemical and mechanical test at laboratory) and joint inspection report shall be signed by the Contractor, GJB & Consultant officials after successfully completion of tests.

Contractor shall forward all original reports to GJB and copy to Consultant for verification and issuances of Dispatch Clearance Certificates (ii). No Dispatch Clearance Certificate will be issued at the factory itself by the inspecting agency.

11.1.2 Factory Acceptance Test (FAT) Document

Fifty six (56) days prior to commencement of inspection of each Plant item / equipment the Contractor shall supply a Factory Acceptance Test (FAT) Document for approval. This shall comprise four copies of the following:

- Unpriced copy of the Contractors order for the Plant item / equipment concerned;
- Details of the inspection and test procedures to be carried out.
- Pre-factory test results and its photos.

The FAT Plan shall provide comprehensive details of the tests to be carried out, the purpose of each test, the equipment to be used in carrying out the test and the methods to be adopted in carrying out the tests. The FAT shall provide space within the documentation for results of the tests to be added and for each test and for the FAT as a whole to be signed off by the Contractor and the Engineer.

On completion of the tests the Contractor shall provide four copies of all test certificates, curves etc. for the inspected Plant item. To remove doubt test certificates shall be provided for the Plant item as a whole plus certificates for the relevant component parts.

Inspection and Testing Programme

The Contractor shall submit to the Engineer not later than 56 days prior to the commencement of the first inspection and test during manufacture a programme detailing the inspection dates for all Plant. Those items of Plant that the Engineer has specifically identified for witness testing test shall be highlighted in the programme.

The Contractor shall keep the Engineer informed of any changes to the programme.

The Engineer shall not be requested to inspect an item of Plant until the Contractor has satisfied himself that the equipment meets all requirements of the Employer's Requirements.

The Contractor shall inform the Engineer in writing at least 21 days in advance regarding readiness for carrying out inspection of equipment/material etc. at manufacturer's works or at places of inspection. The programme for inspection shall be finalised by the Engineer after the receipt of the above case equipment/material etc. is found not to comply with the specification, dates for re-inspection shall be finalised and expenses incurred by the Employer for such visits shall also be recovered from the Contractor. Contractor's Representatives shall essentially be present during all inspections of Plant items. The following information shall be given in the inspection call letter mentioned above:

- (a) Name of manufacturer/supplier;
- (b) Address of place where inspection is to be carried out;
- (c) Proposed date/s and equipment to be inspected;
- (d) Name/s of contact personnel at manufacturer's/ supplier/s works with their telephone and fax numbers.
- (e) Name of Contractor's Representative who will be present during the inspection.
- (f) Confirmation that internal testing has been completed. Submission of internal testing report for review before visiting the plant

The Contractor shall provide all the necessary instruments, test facility, water / electric power, test piece, samples, engineers/ workers, all cost and others to carry out the tests after assembly. All instruments used for such tests shall be calibrated and certified by and approved by an independent testing authority not more than one month prior to the tests in which they are used. Calibration certificates with expire date and name of authorization agency for instruments used for such tests shall be produced for the approval of the Engineer and if necessary, instruments shall be recalibrated before the commencement of the tests.

No material shall be delivered to the Site without Dispatch clearance certificate having been carried out or waived in writing by the Engineer.

If during or after testing, any item of plant fails to achieve its intended duty or otherwise proves defective, it shall be modified or altered as necessary and retested and re-inspected as required by the Engineer.

11.2 Manufacturer's Works Acceptance Tests on Electrical Equipment

The following equipment / items shall be subjected to inspection, routine /acceptance tests as per latest edition of relevant Indian / International standards in the presence of Employer/ his Engineer.

- (1) Power Capacitor and Control Panel
- (2) Diesel Standby Generator with AMF Control Panel
- (3) Battery, Battery charger and DC Distribution Board
- (4) Bus Duct
- (5) Power & Control Cables
- (6) Lighting System
- (7) Earthing and Lightning Protection Systems
- (8) Local Control Panels (LCP)
- (9) Junction Boxes
- (10) Cable Carrier System
- (11) UPS systems

Copies of test Certificates for the type tests and Special tests not later than 5 years conducted as per relevant Indian / International Standards for all the equipment /items of above shall be furnished for the perusal of Employer / his Engineer. If type tests and special tests have not been conducted on any of these items, the same shall be carried out in the presence of owner/ Engineer at no extra cost.

11.3 Inspection & Testing requirements

A. Inspection and Testing Requirements for Electrical, Instrumentation, Control & Automation works

1. Inspection, Testing and Setting to Work — General

Each item of plant shall be subjected to the manufacturer's own tests which shall be certified. Each item of plant and its installation shall be subject to inspection and testing at the place of manufacture. The Contractor shall be responsible for the provision of all necessary test equipment. The Contractor shall demonstrate to the Engineer, the correct operation of any item of plant and the Engineer may witness any test. Tests which, in the opinion of the Engineer, were failed or not performed correctly shall be repeated.

Before any test is made, the Contractor shall submit to the Engineer a full list of test equipment to be used. Each item of test equipment shall have a standard of accuracy better than that stated by the manufacturer of the item to be tested. The Contractor shall provide evidence of the condition and performance of any item of test equipment, in the form of test certificates issued by an appropriate authority independent of the Contractor and manufacturer, or as otherwise directed by the Engineer. Test equipment shall be checked frequently during the period of the tests.

The Contractor's staff responsible for supervising and carrying out tests shall be fully conversant with the various items of equipment of other manufacturers and if necessary the Contractor shall arrange for his personnel to attend suitable training courses on his own expense. The contractor has to get approval from the client's representative for the training personnel to be employed by the contractor.

Any fault or shortcoming found during any inspection or test shall be rectified to the satisfaction of the Engineer before proceeding with further inspection or testing of that item. Any circuit previously tested, which may have been affected by the rectification work, shall be re-tested.

2. Preliminary Inspection and Testing at the Place of Manufacture

Centralized SCADA equipment, Field Instruments and Analytical Instruments

After the successful completion of the manufacturer's own inspection and testing of instruments to be supplied under the Contract, complete functional tests inclusive of calibration checks shall be carried out in the presence of the Engineer, engineer's representative, consultant and the Contractor at the manufacturer's factory where the instruments have been manufactured. Such tests shall include a demonstration that an increase or decrease of the measured value at several points over the full range of the instrument produces a corresponding increase or decrease in the instrument output signal. These tests shall include checks on the specified accuracy of the instrument at all points. Complete functional testing of all instruments (Field instrumentation inclusive of all Real time water quality multi parameter instrumentation Videowall display system, wireless communication equipment, etc, covering all instruments and related equipment (Junction box, local control panels, all cables, cable trays)

3. Instrument panels, enclosures and mounting boards

The manufacturer shall not present instrument panels, enclosures, junction boxes and mounting boards (assemblies) for inspection and testing until the manufacturer's own tests and inspection has been completed. A preliminary inspection and test of these assemblies shall then be witnessed by the Engineer, engineer's representative. The Contractor shall give not less than 15 days' notice in writing that he has completed his tests and inspection and is ready for the witnessed tests and inspection. Where this notice period is different in the Conditions of Contract this shall take precedent.

The witnessed inspection and testing shall include the following on a minimum:

- l. Complete functional testing of the instrument inclusive of calibration and sampling system (applicable for all Field instrumentation inclusive of all Real time water quality multi parameter instrumentation, Videowall display system, wireless communication equipment, etc, covering all instruments and related equipment (Junction box, local control panels, all cables, cable trays).
- m. A visual inspection of the panel assembly to show that the design, construction and finish are satisfactory and in accordance with the Specification.
- n. A check that equipment is securely mounted, accessible for removal or calibration without damage to or undue disturbance of other components, wiring or piping.

- o. That all engraving and labels are correctly positioned, fixed and designated in accordance with the Specification.
- p. Panel power-distribution circuits have the correct breaker/fuse rating coordination and designation.
- q. Power-isolation facilities meet the Specification
- r. The main incoming supply voltage, frequency and/or pneumatic supply pressure is within the required limits, these being checked at the beginning and end of the test and the results recorded on test certificates.
- s. The output of all power supply units again at the beginning and end of the testing with results being recorded.
- t. The power supply voltage or air pressure of all component instruments of the assembly(s), these voltages/pressures being recorded on the test certificate.
- u. The insulation resistance of all circuits except sensitive electronic equipment which is liable to damage by application of the test voltage, such circuits being disconnected before making the insulation resistance tests and these tests being carried out in accordance with IEE Wiring Regulations.
- v. That the clean earth bar is isolated from main frame of the panel. Internal lighting and anti-condensation heaters and associated thermostats, isolators, limit switches and wiring shall be checked for compliance with the Specification. Spare capacity within the panel(s) shall be checked to see that it complies with the Specification. This shall include future equipment space, spare terminals, space in wiring trunking and provision for additional cable entry.

4. Functional Testing at the OEM factory where the equipment has been manufactured
General requirements

Once the preliminary inspection and testing is complete to the satisfaction of the Engineer, functional testing shall commence in the presence of the employer and employer's representative for 100% quantity of all equipment. The purpose of the functional tests are to demonstrate that all instruments Field instrumentation inclusive of all Real time water quality multi parameter instrumentation, Videowall display system, wireless communication equipment, etc, covering all instruments and related equipment (Junction box, local control panels, all cables, cable trays), panels' enclosures and mounting boards (assemblies),sampling system conform to requirements of the Specification. Functional testing on a minimum shall include, calibration check as per established international standards, transmitter function check, error reporting, alarm functions, communication check with external third party devices, etc.

Not less than 30 days before the commencement of functional tests, the Contractor shall submit to the Engineer, for approval, two copies of comprehensive test procedural documents detailing each test to be carried out. The document shall include results forms on which the results of each test will be entered. The forms shall include spaces for numerical values, where necessary, and witness signatures. All applicable drawings and data shall be provided at the place of inspection by the Contractor.

The Contractor shall provide all test instruments and equipment necessary to test the assemblies in their entirety.

The following is a typical list of the equipment required:

- Switch boxes;
- Indicator light boxes;
- Analogue signal sources;
- Dummy loads;
- Meters;
- Simulators;
- Desk-top computers;
- Programmers for PLC or outstations;
- Insulation test equipment.

5. Quality Assurance/Quality Control (QA/QC/QAP)

QA/QC shall comply with the Contract, with particular requirements specific to the equipment or service being provided as outlined below for ICA system and in full compliance detailed in above specifications. The quality assurance/control procedures shall include, but not be limited to the following:

- Continuity and Wiring tests;
- Calibration check;
- complete functional testing of equipment along with sampling system(as applicable);
- Insulation and High Potential Testing;
- Packaging and Shipping;
- Welding;
- Cleaning and Painting.

The quality assurance/quality control documentation shall include, but not be limited to the following:

- Material Certifications;
- Shop Test Reports;

All other documentation required by applicable codes and standards.

B. Inspection and Testing Requirements for Control &Automation works

a) Factory Acceptance Test (FAT)

The Contractor shall conduct a full programme of tests of the Centralized SCADA system at the Contractor's testing facility in the presence of the Engineer to verify that all features of the system have been provided, are operating correctly and are in full compliance with the Specification. Unless otherwise specified or agreed by the Engineer, the entire Centralized SCADA system shall be assembled and tested together as an integrated system, including all master station equipment, all operators' consoles, all outstations and telemetry equipment all instrumentation panels and uninterruptible power supplies included in this Specification. The scheduled date for the factory acceptance test shall be as agreed by the Contractor and the Engineer at least four weeks before the test.

The Centralized SCADA system shall be conducted as one complete system FAT only. No separate FAT for PLC and separate FAT for SCADA system shall be conducted. Contractor to note the importance of this clause.

Not less than one month before the scheduled factory acceptance test, the Contractor shall submit to the Engineer for approval two copies of a comprehensive manual detailing each test to be conducted. The manual shall include a results form on which the results of each test will be entered, including spaces for numerical values where appropriate and witness signatures.

Not less than 21 days before the scheduled factory acceptance test, the Contractor shall submit the internal completed FAT test reports to the Engineer as per contract requirements, which has been witnessed and signed by the contractor representative and that, in the opinion of the Contractor, the system exhibits stable operation and is ready for the formal factory acceptance test by the employer and the employer's representative.

The factory acceptance test will be considered successfully completed only when the system has successfully passed all factory tests as detailed in the FAT procedure and Functional design specifications. The system shall not be delivered to Site until the successful completion of the factory acceptance test is certified by the Engineer. Delay in the delivery of the system due to failure of the factory acceptance test shall not constitute an unavoidable delay. If the system fails the factory acceptance test, the test shall be extended or rescheduled at the discretion of the Engineer.

All hardware to be used in the testing of the system shall have passed an agreed preliminary hardware performance test to ensure known hardware operability before software testing begins.

After successful completion of the factory acceptance test, no software changes shall be made to the system without written authorisation by the Engineer. Any changes to the system which effect the system software documentation, such as input scale modifications or changes to the control logic, shall be entered into the system documentation before delivery of the system to Site.

The entire cost of the complete FAT and any other required testing(interoperability, site visits etc..), including reasonable per diem expenses to cover meals, lodging, transport and similar expenses for all GJB & employers representative, consultant personnel attending the tests, shall be the responsibility of the Contractor/ system supplier and shall be included in the contract price.

b) Factory Acceptance Test Procedures

1) General

The scope of the tests shall include the proving of every aspect of hardware and software operation and functions as detailed below.

2) Hardware tests

- (a) Verify the correct inventory of hardware including cables and printed circuit boards;
- (b) Demonstrate that all spare-memory, disk-capacity and system-expansion requirements have been met;
- (c) Demonstrate all hardware and software diagnostics;
- (d) Verify all power supply voltages are within tolerance;

- (e) Verify proper earth connections and isolation of instrumentation earth for all equipment;
- (f) Demonstrate operation of test simulation and indication equipment and its Suitability for adequate functional testing of all system functions.

3) Software tests

- (a) Demonstrate the editing of all system parameters including set-points, timers and the like;
- (b) Demonstrate system configuration capabilities including the addition and deletion of input and output points, outstations, and all data base parameters;
- (c) Demonstrate the addition, deletion and modification of mimic displays and report formats;
- (d) Complete control philosophy with water demand and consumption forecasting for each zone, division, sub division, etc. shall be demonstrated
- (e) Historian data check

4) Functional tests

The functional tests shall verify proper operation of every specified system function as an integrated system. These tests shall be conducted in conjunction with functional tests of instrumentation and control panels as specified elsewhere. All failures or discrepancies found shall be documented in the test manual.

Following a failure of any functional test, should software or hardware modifications be required it shall be the decision of the Engineer whether the factory acceptance test is to continue, re-start or be aborted. If testing is allowed to continue, any changes which are required shall be described in a system modification document, signed by both Contractor and Engineer and be incorporated into the final factory acceptance test documentation. The failed test shall be re-conducted and the Engineer may require the retest of functions which may be affected by the modification.

The functional tests shall include, as a minimum, the following:

- (a) Demonstration that the system meets the requirements of the Specification for response time and speed of screen update
- (b) Verification of the accuracy of all analogue input points in the system. The procedure shall include applying the appropriate signal to each analogue input at a minimum of three points within the range of the input, checking for expected numerical results, and verifying appropriate update of related mimic displays. Proper sensing and action by the system to high and low out-of-range inputs shall also be verified
- (c) Verification of the proper logic sense, pulse accumulation and rate computation where appropriate, of all digital inputs and verifying appropriate update of related mimic displays;
- (e) Verification of all control and sequencing operations and proper operation of all digital and analogue outputs. The procedure shall include simulation of all related process variables for both normal and abnormal conditions, including instrument and component failure, and demonstration of fail-safe response of the system. System outputs shall be indicated with appropriate lamps and indicators;
- (f) Simulation of outstation communications errors and failures and demonstration of error detection and handling, failure detection and handling, and appropriate changes to control actions as designed and specified;
- (g) Verification of fault detection and diagnostics by inducing a sufficient variety of fault conditions in the system to ensure that detection processes and fail-safe operation are adequately tested;

- (h) Demonstration of proper operation of all mimic displays, help pages, reports, operator procedures and historical data accumulation;
- (j) Demonstration of proper operation of all outstations following a simulated master station central processor failure;
- (k) Demonstration of proper operation of all equipment during both a system wide or isolated power failure, and following power restoration. The procedure shall include the demonstration of battery backup of both master station and outstation for the full length of time specified, and proper operation of power fail, low voltage warning and all associated alarms.

5) Reliability test

After successful completion of the functional tests a 48-hour continuous run of the system shall be performed. The test shall be passed if no system function is lost or no hardware or software failure occurs. Hardware failure is defined for this test as the loss of a major component such as the computer, an outstation, a VDU or a peripheral device. Non-repetitive mechanical failures of loggers, push-buttons and the like are excluded.

During this test, the system shall be exercised with simulated inputs and conditions in a manner which approximates the on-site operational environment. Unstructured testing by the Engineer shall be included during this test. Upon any system failure during this period, it shall be the decision of the Engineer whether the reliability test is to continue or be aborted. If testing is allowed to continue any changes to the system which are required shall be described in a system-modification document, signed by both Contractor and Engineer and the document shall be incorporated into the final factory acceptance test documentation.

c) Factory acceptance test documentation

As a minimum, the following information shall be included in the factory Acceptance test manual for each test:

- Test identification number;
- Test name and description;
- List of all equipment to be tested including any special test equipment required;
- Description of the test procedure broken down into logical steps, complete control philosophy check;
- Description of the expected system response verifying the completion of each logical step;
- Space for recording the results of the test and the time and date of the test;
- Space for signatures of the Contractor and the Engineer.

In addition, the Contractor shall provide a method for recording and tracing all problems, discrepancies, queries and suggestions regarding the system and software, and for formalised control of any modifications to the system.

d) Pre-commissioning tests

- e) The Contractor shall perform pre-commissioning, or preliminary, testing of the SCADA system in accordance with that specified for instrumentation. The purpose of pre-commissioning tests is to confirm readiness of the system for commissioning.

The scope of pre-commissioning tests shall be generally as specified for factory acceptance tests but real field inputs and final control elements shall be used wherever practical to provide inputs to the system and to confirm proper outputs.

Where this is impractical, simulation signals shall be injected as near as possible to their ultimate sources so as to include in the tests as much of the cabling system as possible.

f) Site Acceptance Tests (SAT)

The Contractor shall submit all relevant draft operating manuals for the centralized SCADA system along with all its ancillary System and field instrumentation, automation, data communication equipment inclusive of FOC and wireless GPRS, etc to the Engineer for approval prior to commissioning tests. Any faults or failures of the system detected during the previous tests shall be noted and corrected to the satisfaction of the Engineer before commissioning is allowed to commence.

As part of commissioning the centralized SCADA system (complete ICA system inclusive Field instrumentation, Analytical instrumentation, LED videowall system for both water display system, wireless communication equipment, etc, covering all instruments and related equipment (Junction box, local control panels, etc.) shall be tested for availability for a continuous period of ninety days. The entire system shall be subjected to SAT only after the complete works have been completed and tested to perform as per contract requirements. During this period, the system will perform the normal functions according to the procedures described in the SAT documentation approved by the Engineer.

The system shall have passed the SAT if all major components have been free from fault or failure and exhibit full error-free functionality for 100 % of the total duration of the test. Major components include all master station equipment, outstations, communications facilities and instrument panel components, excluding push-buttons, switches and lamps and any equipment not supplied by the Contractor. If the system fails to meet the above criteria, the SAT period shall be reinitiated further for a period of thirty days, till such time the complete system exhibits full error-free functionality for 100 % of the total duration of the test.

During SAT, no modifications to the system shall be made by the Contractor without the written approval of the Engineer. Erroneous functioning which requires software modifications or re-configuration to correct, other than set-point or parameter changes, shall constitute a failure of the availability test. Any changes to the system which are required and approved shall be described in a system-modification document, signed by both Contractor and Engineer and the document shall be incorporated into the final test documentation. The test shall be restarted after corrections have been made.

11.4 Manufacturer's Works Acceptance Tests on Uninterruptible Power Supplies

The Contractor shall carry out further specified tests as follows in addition to any tests stated or implied by the foregoing sections of this clause.

The tests shall be carried out on the fully assembled unit utilising the batteries that are to be supplied with the unit.

The Contractor shall demonstrate the following:

- (1) Change-over from full load with mains present to full load on battery supply

- (2) Carry out a discharge test on the system at full load and for the specified duty bridging time period.
- (3) Carry out recharge test after operation for the specified duty bridging time at full load. The UPS shall supply the full load during the recharge cycle.

11.5 Inspection at Site

During erection of the Plant the Engineer will inspect the installation from time to time in the presence of the Contractor's Supervisor to establish conformity with the requirements of the Specification. Any deviations found shall be corrected as instructed by the Engineer.

11.6 Plant protection on Site

Factory finished plant shall be adequately protected both before and during installation against damage to finished surfaces, fitted components, and the ingress of dust. It may be necessary for structural finishing operations to be carried out in the vicinity of installed plant before it is taken over and the Contractor shall take this into consideration in complying with the requirement of this clause.

11.7 Erection staff

The Contractor shall provide at least two approved senior English speaking working erectors to supervise the erection of all Plant in the Contract and in each case to act as the Contractor's Representative of the general conditions of contract.

The Contractor shall also provide sufficient erectors skilled in electrical, mechanical and instrument engineering, with such skilled, semi-skilled and unskilled labor as are necessary to ensure completion of the various sections of the Contract in the time required. The Contractor shall not remove any supervisory staff or labor from the site without the prior approval of the Engineer.

The Engineer will give the Contractor at least one month's notice in writing of the date on which the erection staff will be required on site, and the Contractor shall confirm the date of arrival in writing to the Engineer. The Contractor shall make all the necessary arrangements to ensure that sufficient plant has been or is about to be delivered to site, so that there shall be no delay to the start of erection.

It shall be the responsibility of the contractor to obtain necessary License / Authorization n/Permit for work from the Licensing Boards of the Locality/State where the work is to be carried out. The persons deputed by the Contractor's firm should also hold valid permits issued or recognized by the Licensing Board of the Locality/State where the work is to be carried out.

11.8 Erection and Building-in

The installation work shall comply with the latest applicable Standards, Regulations, Electricity Rules and Safety Codes of the locality where the installation is to be carried out. Nothing in this specification shall be construed to relieve the Contractor of this responsibility.

It will be the Contractor's responsibility to obtain approval/clearance from local statutory authorities including Electrical Inspector, wherever applicable for conducting of any work or for installation carried out which comes under the purview of such authorities.

The Contractor shall carry out the complete erection of all plant, including the provision of all necessary skilled and unskilled labor, material, transportation, supplies, power and fuel, Contractor's Equipment and appurtenances necessary, for the complete and satisfactory erection of the Plant.

The Contractor shall have a separate cleaning gang to clean all equipment under erection and as well as the work area and the project site at regular intervals to the satisfaction of the employer. In case the cleaning is not up to the employer's satisfaction, he will have the right to carry out the cleaning operations and any expenditure incurred by the employer in this regard will be to the Contractor's account.

Erectors

The Contractor's employees shall include skilled erection staff in sufficient number, who shall arrive on the site on or before the respective dates set out in the approved work programmed and prior to delivery of any item of Plant to the Site. The Engineer will not entertain any claim by the Contractor in respect of delayed erection due to a delay in the delivery of any items of Plant to the site.

Contractor's Equipment, materials and appurtenances

The Contractor shall have available on the Site sufficient suitable equipment and machinery, as well as all other materials and appurtenances required by him, of ample capacity to ensure the proper erection of Plant and to handle any emergencies such as may normally be expected in work of this character.

The Contractor shall be responsible if any installation materials are lost or damaged during installation. All damages and thefts of equipment/component parts, after takeover by the Contractor, till the installation is taken over by Employer shall be made good by the Contractor to the satisfaction of Engineer.

Workmanship

Plant shall be erected in a neat and workmanlike manner on the foundation and at the locations and elevations shown on the approved drawings and other Engineering documents. Unless otherwise directed by the Engineer the Contractor shall adhere strictly to the aforesaid drawings and no departures there from will be permitted.

All plant shall be correctly aligned, leveled and adjusted for satisfactory operation and shall be installed so that the proper and satisfactory connection can be made readily between the various units and pipe work and equipment installed under the Contract.

Building-in

Erection of Plant shall be phased in such a manner so as not to obstruct the work being done by other contractors. Before commencing any erection work, the Contractor shall check the dimensions of structures where the various items of plant are to be installed, and shall bring any deviations from the required positions, lined or dimensions to the notice of the Engineer and shall take such measures as are necessary for their correction.

The Contractor shall take particular care for the correct positioning and alignment of all puddle pipes which are required through concrete structures prior to, and during the pouring of concrete.

The Contractor shall pin and plug in the holes prepared, all small clips, plugs, screws, nails, sleeves, inserts, etc., required for fixing electric wires and conduits, small pipe work and all other apparatus.

The Contractor shall align all equipment and holding down bolts and shall inform the Engineer before proceeding with grouting-in the item or item concerned. The Contractor shall ensure that all equipment is securely held and remain in correct alignment before, during and after grouting-in.

The Contractor shall properly bed in cement grout each item of plant or its supporting base resting on foundations, and shall grout-in where required holding down bolts placed in the holes prepared in the foundations. The materials and workmanship used in grouting shall be such as will result in a solid anchoring of foundation bolts and complete filling of the gaps between the Plant or its base and the foundations, without shrinkage or cracking.

During erection of the Plant the Employer will inspect the installation from time to time in the presence of the Contractor's Site representative to establish conformity with the requirements of the Specification. Any deviations and deficiencies found or evidence of unsatisfactory workmanship shall be corrected as instructed by the Employer.

All plant shall be installed in accordance with the recommendations or instructions of the manufacturer, for the particular application. Each mounting position shall be chosen to give correct operation of the equipment, ease of operation, access for maintenance and servicing and freedom from any condition which could have adverse effects.

In accordance with the specific installation instructions, as shown in Contractor's drawings or as directed by the Engineer's Representative the Contractor shall unload, erect, install, wire, test and place into commercial use of all electrical & Instrumentation equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square, and properly aligned and oriented.

The Contractor shall furnish all supervision, labour, tools, equipment, rigging materials and incidental materials such as bolts, wedges, anchors, concrete inserts etc. required to completely install, test and adjust the equipment.

Drawings, instructions and recommendations shall be correctly followed in handling, settling, testing and commissioning of all equipment and care shall be exercised in handling to avoid distortion to stationary structures, the marring of finish, or damaging of delicate instruments or other electrical parts.

The Contractor shall erect and commission the equipment as per the instructions of the Engineer's Representative and shall extend all co-operations to him.

In case of any doubt/misunderstanding as to correct interpretation of drawings or instructions, necessary clarification shall be obtained from the Engineer's Representative. The Contractor shall be held responsible for any damage to the equipment consequent to not following instructions correctly.

The Contractor shall move all equipment into the respective buildings through regular doors or floor openings provided specifically for the equipment. The Contractor shall make his own arrangement for lifting of equipment.

Where assemblies are supplied in more than one section, the Contractor shall make all necessary mechanical and electrical connections between sections including the connections between bus bars/wires. The Contractor shall also carry out the adjustments/alignments necessary for proper operation of the circuit breakers. All insulators and bushings shall be protected against damage during installation. Insulators or bushings chipped, cracked or damaged due to negligence or carelessness shall be replaced by the Contractor at his own expenses.

The Contractor shall take utmost care in handling instruments, relays and other delicate mechanisms. Wherever the instruments or relays are supplied separately, they shall be mounted only after the associated control panels have been erected and aligned. The blocking material/mechanism employed for the safe transit of the instruments and relays shall be removed after ensuring that the panels have been completely installed and no further movement of the same would be necessary. Any damage to relays and instruments shall be immediately reported to the Engineer's Representative.

Care shall be taken during handling of insulating oil to prevent ingress of moisture or foreign matter. In the testing, circulation, filtering, or otherwise handling of oil, rubber hose shall not be used. Circulation and filtering of oil, the heating of oil by regulated short-circuit current during drying runs and sampling and testing of oil shall be in accordance with the latest Code of Practice IS:10028.

Equipment furnished with finished coats of paint shall be touched up by the Contractor if their surface is spoiled or marred while handling.

Foundation work and grouting-in of fixing bolts or channels for control panels will be carried out by the Contractor.

Precautions

The approval by the Engineer of the Contractor's proposals for rigging and hoisting of any item of plant into its final position shall not relieve the Contractor from his responsibility for avoiding damage to completed structures, parts or members thereof or other installed equipment. He shall at his own cost make good, repair or replace any damaged or injured items whether structural, mechanical, electrical, architectural, or of any other description, promptly and effectively to the satisfaction of the Engineer.

No plant or other loads shall be moved across the floors of structures without first covering the floors with timber of sufficient size so that applied loads will be transferred to floor beams and girders of steel or concrete. If it is required to reduce bending stresses or deflection, the beam and girders shall be provided with temporary supports. Any movement of Plant and other loads over the floor structures shall be subject to the prior approval of the Engineer.

11.9 Civil Inspection (Water Leakage Test)

Field Control Inspection

Contractor shall be conduct periodic field control inspection to prevent any field accident. The Engineer shall joint field inspect or conduct unannounced inspections.

Inspection after Erection

After the erection of any item of Plant and its associated equipment has been completed, it shall be offered to the Engineer for inspection in its static state prior to commissioning the item.

Completion of erection and procedure prior to setting to work.

The completion of plant under erection shall be deemed to occur if all the units/systems of the Works are structurally and mechanically complete as noted below:

All piping, electrical/instrumentation and other equipment under the scope of the Contract have been erected, installed and grouted and are as per the specifications.

All systems have been washed/flushed/drained/boxed up where necessary.

All system testing including pressure, vacuum and nondestructive tests, no load tests and such other tests are completed with safety valves/relief valves set to operating conditions installed in position.

All panels, local control desks erected with power/control cable terminations with all continuity checks, insulation checks and other installation checks are carried out.

Prior to pre-commissioning checks, the Contractor shall erect the entire Plant and ensure readiness of works to the satisfaction of Employer, so that the Works are physically ready to undergo pre-commissioning checks. Pre-commissioning checks will include checks like no-load running of machinery, checks on instruments and electrical including calibration and loop checks, functional checks, inter-lock checks etc.

At the stage of completion of erection, the Contractor shall ensure that all the physical, aesthetic and workmanship aspects are totally complete and the Plant is fit and sound to undergo pre-commissioning checks.

The following documentation shall be completed before the Contractor notifies Completion of Erection to the Employer

- (a) All shop inspection records compiled and bound in 4 (four) copies.
- (b) All erection and commissioning procedures duly approved.
- (c) All instruction manuals in draft form - with each sheet bearing a stamp to indicate "DRAFT FOR REVIEW ONLY" submitted in 4 (four) copies.

Upon achieving completion of erection, the Contractor shall notify the Employer of such completion of section/units/systems and readiness for inspection for acceptance of completion of erection. The Employer/ Engineer shall proceed with inspection of such sections/units/systems within 10 days of such notice.

Consequent to inspection, the Employer will inform the Contractor a list of deficiencies for rectification and the Contractor shall complete the rectification work within a jointly agreed period prior to start of pre-commissioning tests. The erection period allowed by the Contractor shall include all activities of completion as noted above.

11.10 Site Acceptance Test Document

Fifty six (56) days prior to commencement of Tests on Completion the Contractor shall supply a Site Acceptance Test (SAT) Document for approval. This shall comprise four copies of the details of the inspection and test procedures to be carried out in testing the Works.

The SAT Plan shall provide comprehensive details of the tests to be carried out, the purpose of each test, the equipment to be used in carrying out the test and the methods to be adopted in carrying out the tests. The SAT shall provide space within the documentation for results of the tests to be added and for each test and for the SAT as a whole to be signed off by the Contractor and the Engineer.

The SAT shall categorise tests as follows:

a) Dry tests

Dry tests are those tests carried out without process fluid being present.

b) Wet tests which can be further sub-divided into

(1) Hydraulic tests

Hydraulic wet tests are those tests carried out with potable water in order to prove the hydraulic capability of the Works.

(2) Process tests /System tests

Process wet tests are those tests carried out with actual media as the feed stock to prove the process capability of the Works.

The Contractor shall make his own arrangements for water supply, chemical, electric power, fuel, instrument and labour during hydraulic wet tests.

It shall be assumed that the co-operation of other contractors in the carrying out of Tests on Completion will not be unreasonably withheld.

11.11 Tests on Completion

General

Prior to the commencement of Tests on Completion the Contractor shall submit for approval the following:

- (1) Site Acceptance Test Documents
- (2) As-Built Drawings
- (3) Operation and Maintenance Manuals
- (4) Site test results / data sheet and photo

Tests on Completion shall not be commenced until the aforementioned documents are approved.

The initial charges of oil, grease, electrolyte, generator fuel / oil, chemical, etc. necessary for Tests on Completion shall be provided by the Contractor. If necessary, Contractor shall create design loading conditions for testing purposes by testing fewer than the total number of installed units of process tanks or equipment at a time. In such cases, multiple tests shall be conducted to ensure that all installed units are tested. The Contractor shall provide adequate notice (this notice period shall be determined by the normal lead time for locally purchased chemicals plus at least 28 days) of his chemical requirements prior to commencement of the Tests on Completion involving their use.

The cost of chemicals used for the Tests on Completion shall be met by the Contractor.

The inspection and tests procedure which will be carried out are provided under the general conditions of contract and shall also consist of the following:

a) Manual Commissioning Tests (Clause i)

Manual Commissioning Tests shall be such preliminary trials, tests and retests on individual items of Plant or complete systems as are required by the Engineer in order to demonstrate that the Plant as a whole is ready to undergo the Manual Operation Tests and that these will take place with a minimum of interruption.

The Manual Commissioning Tests shall demonstrate not only the items of Plant under normal operation, but also their response to abnormal and emergency conditions.

The Engineer will notify to the Contractor which items of Plant will be tested and the extent to which they will be tested in order to fulfil the requirements of the Specification.

Leakage tests at 1.5 maximum working pressure shall be carried out on all erected pipe work prior to the Manual Commissioning Tests.

b) Manual Operation Tests (Clause ii)

When the Manual Commissioning Tests have been completed so that the items of Plant have been demonstrated to the satisfaction of the Employer Representative, the Contractor shall commence the Manual Operation Tests.

These tests shall demonstrate the correct operation of the whole Plant whilst using the minimum quantity of automatic control and monitoring equipment. Such equipment shall be at least that required both for the maintenance of safety and for the normal mode of operation of the Plant.

The Plant will be required to demonstrate satisfactory operation at all design flow rates.

The tests shall be of seven consecutive days' duration; if the supply of water should fail or other matters interfere outside the Contractor's control, the tests may be of such number of broken days as the Engineer considers is the equivalent.

The exact date of commencement shall be subject to the approval of the Engineer and shall be dependent on the following conditions having been met

- (1) All relevant items of Plant in approved working order
- (2) All items of Plant correctly identified with labels

c) Automatic Commissioning Tests (Clause iii)

The Automatic Commissioning Tests shall be such preliminary trials, tests and retests on individual items of Plant or complete system as are required by the Engineer in order to demonstrate that the Plant as a whole is ready to undergo the Tests of Completion and that these will take place with a minimum of interruption.

At least one week before the commencement of these tests, the Engineer will notify the Contractor which items of Plant will be tested and the extent to which they will be tested in order to fulfil the requirements of the specification.

The Tests on Completion as provided under the general conditions of contract-clause 37 shall not be carried out until the completion of the above tests.

- (1) The Contractor shall carry out all tests on the Plant and shall supply four copies of all test results to the Engineer.
- (2) All tests shall be to the approval of the Engineer who may require them to be repeated, prolonged or modified as may be necessary to ensure that any or all items of Plant conform to the Contract.
- (3) The Engineer shall be permitted to inspect all Plant which is undergoing tests and may himself conduct tests.

Where it is necessary for the Engineer to make arrangements for the supply of water, chemicals, power, etc., for any testing, the Contractor shall not commence the tests until after these arrangements have been made on or after a date agreed by the Engineer and the Contractor shall make no claim for delay to such testing on this account except as provided for under Clauses 44 of the General Conditions of contract.

If any item of plant fails during or after testing to achieve its intended duty or otherwise proves defective, it shall be modified or altered as necessary and re-tested and re-inspected as required by the Engineer.

The Contractor shall have a minimum of Five commissioning engineers for electrical, instrumentation and two SCADA programmers for works on site during all tests in order to both demonstrate the Plant and to correct any faults which may occur.

11.12 Dry Test Requirements

As a minimum requirement the following dry tests shall be carried out as a general requirement:

- (1) A general inspection to check for correct assembly and quality of workmanship
- (2) A check on the presence of lubricant, cooling medium, electrolyte, etc.
- (3) A check on adequacy and security of Plant fixing arrangements.
- (4) A general check to ensure that all covers, access ladders, water proofing, guard railings etc. are in place.
- (5) A check on damp-proofing, rust-proofing and vermin-proofing and particularly the sealing of apertures between building structures, chambers etc. and the outside.

a) Civil and Building Works

As a minimum requirement the following dry tests shall be carried out on the civil engineering and building works:

- Check for the presence of foreign bodies in pipe work and structures.

b) Mechanical Works

As a minimum requirement the following dry tests shall be carried out on the mechanical systems:

- Carry out preliminary running checks as far is permitted by circumstances in order to ensure smooth operation of Plant.

e) Electrical & Instrumentation Works

As a minimum requirement the following dry tests shall be carried out on the electrical systems:

- (1) Check phasing and polarity.
- (2) Carry out point to point check on all cables.
- (3) Check on security of cable terminations.
- (4) Check on completeness and adequacy of earthing systems.
- (5) Check setting on protection relays, sizes of Circuit Breakers (MCB/MCCB/MPCB) and motor overload settings.
- (6) Carry out checks on cabling systems in accordance with the requirements of the relevant standards.
- (7) Check operation of main circuit breakers by secondary injection methods.
- (8) Check instrument loop integrity, functionality and calibration.
- (9) Check operation of standby generator installation and mains / generator changeover procedures; a one hour load test (using the normal load of the Works) shall be carried out on the generator when the load is available.
- (11) Check plant functionality.
- (12) Check functionality of the central MMI and its power supply.

11.13 Process Plant Item / Equipment

All process plant items / equipment shall be tested to ensure they meet the Employer's Requirements for quality of workmanship, construction and performance.

11.14 Safety Audit

After satisfactory completion of hydraulic wet tests and prior to introduction of process fluid to the plant a safety audit shall be carried out to ensure compliance with the necessary requirement for safety and for operation of Plant. The safety audit shall be documented. The safety audit document shall be approved by the Engineer prior to commencement of Plant commissioning.

11.15 Co-operation with other Contractors in the Execution of their Tests

The Contractor shall, where required, assist other contractors in carrying out their tests on completion and or tests after completion.

Where this assistance does not constitute part of the Contractors own work associated with Tests on Completion or Tests after Completion the Contractor shall be reimbursed at the rates approved by the Engineer.

11.16 Tests after Completion

Not Applicable

11.17 Performance Certificate

The conditions for issuance of a Performance Certificate as detailed in relevant Clause of the Conditions of Contract shall inter alia comprise:

- a) The completion of the twelve months operation of the Works to the satisfaction of the Engineer.
- b) The O & M Manuals have been updated following one year's operational experience and approved by the Engineer.
- c) All defects identified prior to Taking Over and defects identified during one year operation of the Works have been rectified.
- d) All Tests "After Completion" have been completed to the satisfaction of the Engineer.
- e) All training detailed in the Employer's Requirements has been completed.

End of Part 11

Part-12

TRAINING REQUIREMENTS

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PART 12

TRAINING AND ADVISORY REQUIREMENTS

12.1 Training Requirements

12.2 General

The Contractor shall provide comprehensive training for the different categories of the Employer's operation and maintenance staff. Training shall fall into two main types which are 'off the job' and 'on the job'. Off the job training shall take place in the class room, on the job training shall be carried out on the running plant." Off the job" and " On the job" training shall be imparted for the following systems but not limited to (inclusive of running centralized SCADA system, its ancillaries system, field instrumentation, all equipment provided at Centralized SCADA Center, SCADA software modules for Water consumption & demand forecast, reporting, alarm monitoring, trends analysis for the complete water network, data communication monitoring, etc

12.3 Prices for Training and Advisory

The Contractor, at the time of bidding, will be responsible to ensure the completeness and adequacy of his Bid Price to fulfil the entire responsibilities as described below. His bid price, as quoted on a yearly basis in the Schedule of Prices, shall include all costs towards the training requirement.

12.4 Employer's Plant Operator

During 5 years of comprehensive Operation and Maintenance period, Employer may/might appoint Plant Operator/engineer's (General shifts) in addition to contractor's operational staff at the centralized SCADA center to monitor the complete network. This Employer's Operator, engineers shall be trained by the Contractor to operate the centralized SCADA system and to comprehend the various reports, trends and data generated by the SCADA system; Further Contractor shall make Employer's Operator involved in all day-to-day Operation and Maintenance activities, such that Employer's Operator should be competent to take over Operation and Maintenance during handing over period and updating the online document & material management system

Employer's Operator shall report to concerned Engineer from Employer and wages towards Employer's Operator shall be directly paid to Employer's Operator by the Employer.

Contractor shall make note that Employer's Operator is not authorised to certify any of the Contractor's monthly O&M bills, however Employer's Operator responsibilities shall be similar to the responsibilities of Plant In charge and/or Plant Manager.

12.5 Off The Job Training

The Contractor shall prepare formal training documentation for distribution to the trainees. Visual aids shall be used wherever required to illustrate the points being made and to make the training programme as interesting and enjoyable as possible for the participants.

The off the job training shall comprise the following:

1. Off the Job Training Program for all Trainees

To provide training:

- a) on the Centralized SCADA system configuration, various connected plants layouts, process principles involved in the operation of the Works for Water consumption & demand forecast, reporting, alarm monitoring, trends analysis for the complete water network, data communication monitoring
- b) SCADA system capabilities and its operation
- c) Safety Features inclusive of cyber security;
- d) Introduction to various software loaded in SCADA system with its salient features
- e) Various built in self diagnostic / Fault detection features
- f) Write up on various SCADA Screens/ Mimic Screens and MIS Report Generation
- g) Details of various types of Alarms features and list of alarms provided in the system and its corrective steps etc

2. On the Job (Hands On) Training Programme for Operators

To provide training:

- a) on the monitoring, operation, report generation etc of SCADA system including fault detections and rectifications in the event of any system components failure;
- b) on the day to day operation of the SCADA System and operational procedures;
- c) on a comprehensive list of 'what if' scenarios dealing with the actions to be taken in the event of potential data communication issues, alarms, plant failures, overflows, power failures etc.;
- d) on routine, preventive and break-down maintenance;
- e) safe methods of work general;
- f) on safety procedures to be followed in operating, maintaining and cleaning the Central SCADA Control & Monitoring center ;

3. Off the Job Training Programme for Electrical Maintenance Staff

To provide training:

- a) on the configuration, construction and operation of the electrical Plant;
 - b) on the electrical maintenance requirements of the Works;
 - c) on the switching and safety procedures to be followed;
 - d) safe methods of working;
 - e) on fault finding and repair procedures.
4. Off the Job Training Programme for Control and Automation Maintenance Staff
- a) on the configuration, construction and operation of the SCADA Systems ;
 - b) on fault finding and repair procedures;
 - c) safe methods of working;
 - d) special training on the use of the PC and associated programming software for fault finding on SCADA systems, Historian systems;
 - e) special training on the use and performance of the central SCADA hardware and software and other specialist hardware and software systems used in CP-09 Contract.;
 - f) special training on adding information/updation for the newly added plants to the online document & material management system
 - g) cyber security training ,intrusion detection,etc..

12.6 On The Job Training

The Contractor shall utilise the Operations and Maintenance Manuals as the primary training aid in carrying out the on the job training. Short comings, omissions and errors identified in the O & M Manuals during the training shall be rectified prior to final acceptance of the O & M Manuals.

1. On the Job Training Programme for all Trainees

To provide training:

- a) Centralized SCADA center familiarisation tour;
 - b) on the use of the central SCADA systems ;
 - c) health and safety;
 - d) identify areas where special safety precautions are necessary.
2. On the Job Process Training Programme for Operators

To provide training:

- a) under operational conditions on the operation of individual items of plant and sections of the Works including automatic operation and manual operation in the event of say automatic control failure;
 - b) illustrate by example the day to day operation of the Works and procedures;
 - c) illustrate by example the actions to be taken in the event of potential problems, alarms, plant failures overflows, power failures etc. (as identified in the 'what if' scenario off the job training);
 - d) illustrate by example the first line mechanical maintenance;
 - e) illustrate by example safety procedures to be followed in operation, maintenance and cleaning of the Works.
3. On the Job Training Programme for Electrical Maintenance Staff

To provide training:

- a) carry out detail tour of the electrical plant;
 - b) illustrate by example the operation of the electrical Plant;
 - c) illustrate by example the electrical isolation and maintenance procedures;
 - d) illustrate by example fault finding and repair procedures;
 - e) illustrate by example switching and safety procedures to be followed;
 - f) illustrate by example safe systems of work.
4. On the Job Training Programme for Control and Instrumentation Maintenance Staff

To provide training:

- a) illustrate by example the operation of the Works;
- b) illustrate by example the control and instrumentation maintenance requirements of the Works;
- c) illustrate by example fault finding and repair procedures
- d) illustrate by example fault finding on SCADA based control systems, the central SCADA hardware and software and other specialist hardware and software systems in CP-09Contract Package.
- e) illustrate by example safe systems of work.

12.7 Training Programme

Off the job training shall be carried out prior to Taking Over of the Works or any section of the Works.

With the permission of the Engineer and the Employer representative on the job training shall be carried out prior to Taking Over. On the job training shall be completed as a condition for acceptance of the Works following completion of the Tests After Completion.

The Contractor shall provide a training plan for each category of staff. The training plan shall detail the content and duration of each course. The training plan shall be submitted for the approval of the Engineer at least 120 days prior to the commencement of the training program. The duration of training offered for each category of staff shall not be less than that detailed in the following table.

Category of Staff	Off the Job (minimum days duration for each course)	On the Job (minimum weeks duration for each course)
All staff	1	1
Operator	7	12
Electrical technician/electrician	7	4
Control/automation technician	30	12
Management Engineers	7	4

The training day shall be assumed to be not less than 6 hours split into two sessions. The off the job training rooms shall be provided by the Employer at the Site in the centralized SCADA center. The Contractor shall provide facilities for training which shall include inter alia tables and chairs, projectors, audio video visual aids, white/black boards, training aids etc.

Where trainees of a given category can all be released from their Works operational duties simultaneously they may be trained together. Where this is not possible the Contractor shall repeat the complete course for those who could not attend.

12.8 Training Personnel

The Contractor shall provide suitably qualified trainers to carry out the off the job and on the job training. SCADA, Historian training shall be imparted by SCADA designers and programmers. All ancillary system, cyber security systems, DG set, UPS system, Field Instrumentation system, Online water quality Multi parameter system, shall be imparted by the agency engineers who have designed and installed the system

The trainers shall be experienced in , operation and maintenance in their relevant discipline and in the training of skilled and unskilled staff.

The Contractor shall submit the curriculum vitae of the nominee's to the Engineer for approval 120 days. The training expert shall be fluent in both English and Hindi or the Contractor shall provide the services of an interpreter during the training periods.

12.9 Advisory Requirements

General

The Contractor shall provide personnel to advise in the operation of the Works for a period of 1 year after issue of the Commissioning Certificate for Works or any Section of the Works. The personnel provided shall have proven experience in their intended roles. Those persons provided shall comprise:

- | | |
|--|--|
| Advisor to the Centralized SCADA center manager- | : Duration 12 months. |
| Advisor maintenance | : Duration 0.5 months and thereafter intermittently over a period of 12months. |
| Advisor electrical/control maintenance | : Duration 6 months and thereafter intermittently over a period of 12months. |

The electrical/control, mechanical and SCADA specialist/advisor visits shall be split; the first visit to establish the procedures and implement, the second visit to monitor and refine the procedures.

The Contractor's personnel will be assisted by staff trained by the Contractor and provided in sufficient numbers to the Employer.

The role of the Contractor's advisory personnel shall be to:

- To advise on day to day management of the Centralized SCADA center and its ancillary systems
- To advise on the development procedures for the ordering and reordering of consumables.
- To propose and develop systems to monitor the consumption of consumables and power and to advise actions to reduce their usage to a minimum.
- To establish analytical procedures within the SCADA software and carry out periodic checks to ensure that they are adhered to.
- To establish routines for the analysis of water quality multi-parameter monitoring, and other parameters and to establish procedures for corrective action in the event of parameter quality falling below that required.
- To establish systems for the recording of the above parameters appropriate to a plant of this type
- Ensure procedures for operation and planned maintenance of the Works as detailed in the O & M Manuals are carried out and advise on improvements to the Manuals based on operational experience
- Advise on the optimisation of water distribution and consumption settings, dosage rates, operating regimes etc, taking into account the increase/decrease in flows .
- Provide continuing informal on the job training to the Employers staff (this is in addition to formal training requirements detailed in bid document).

- Update the O & M Manuals in line with experience gained during the year’s operation.

12.10 Advisory Personnel

The Contractor shall provide suitable personnel to provide advisory services. The advisors shall be experienced in Centralized SCADA Center management, SCADA software functionality for control centers, operation and maintenance in their relevant discipline.

The Contractor shall submit the curriculum vitae of the advisory nominees to the Engineer 90 days prior for the approval. Prior to mobilisation, the advisors shall be fluent in both Hindi and English or the Contractor shall provide the services of an interpreter/s during the advisory period as necessary.

12.11 Capacity Building

This Operation & Maintenance manual shall be provided by the Contractor to establish guidelines for operator and GJB engineers to understand the Centralized SCADA center and its connected systems, stations to operate these efficiently and successfully.

The guidelines will be provided to the training personnel on how to operate the center .The system operation and unit operation of individual components may need to be adjusted and modified depending on characteristics and flows and the required data shall be collected during the training program as well as during the operation and maintenance period.

The Contractor shall train the Employer personnel about center operation knowledge, abilities and skill as follows:

Table 14. 1: Training Requirement for Capacity Building

Area of Capacity Building	Training Requirements
Knowledge	<ul style="list-style-type: none"> - System flow and unit operation, maintenance, other SCADA equipment and machinery. - Basic SCADA Functionality. - Water quality monitoring - Water demand, consumption mathematical modelling, reports and trends - Basic maintenance period and work sheet. - Basic techniques to make standardized tests. - Avoiding any chance of accident, and - Safety and Health.
Abilities	<ul style="list-style-type: none"> - Make adjustments to modelling modules according to water flow and consumption characteristics and flows, diurnal fluctuation in flow and control thereof. - calibration techniques. - Perform standardized tests for all equipment.

Area of Capacity Building	Training Requirements
	<ul style="list-style-type: none">- Make repairs and/or adjustments to equipment and to keep records and prepare reports including graphical representation of data.- Make repairs and/or adjustments to each equipment and to keep records and prepare reports.- Handling safety valves and associated pipelines.- Usage of safety Equipment in case of Emergency.

End of Part-12

PART 13
Comprehensive Operation and Maintenance Requirements

PART 13
Comprehensive Operation and Maintenance

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PART 13

Comprehensive Operation and Maintenance

13.1 General

This section applies to carry out comprehensive operation and maintenance of the facility and its ancillary systems, including all software, hardware, field instrumentation system, data communication systems, cyber security systems, etc ,all equipment and facilities installed under this contract, inclusive of the centralized SCADA center overall ,in meeting its objective. The section pertains to the specifications of system and equipment including materials used for comprehensive

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operation and maintenance, the workmanship, period for routine maintenance, maintenance of records, and responsibilities during comprehensive operation and maintenance period. The Contractor shall be responsible for providing continuous improvement in the system operation, for period of five (5) years, and to prevent any further sudden failure or breakdown through preventive maintenance works on system operation and its operation works. It is essential that Employer and contractor need to have sufficient information on operational issues under normal and emergency condition.

13.2 Comprehensive Operational and Maintenance

The contractor shall note that comprehensive operation and maintenance shall be termed as complete operation and maintenance of the supplied and installed equipment to have all software, hardware, field instrumentation, IT hardware, IT software, servers, data communication equipment and network in full working condition at all times without downtime and inclusive of preventive maintenance of the complete system (Centralized SCADA system, its ancillary systems, Field instrumentation, control and automation equipment), supply and maintaining of required of spares, replacement of faulty equipment, damaged equipment (inclusive of all IT hardware, instrumentation, control & automation equipment, data communication network and equipment, trouble shooting of any issues which may effect the functioning of the centralized SCADA center as per the requirements of the contract).

13.3 Comprehensive Operation & Maintenance Scope of Work

The contractor throughout the five years of comprehensive operation and maintenance shall be fully responsible for the following on a minimum but not limited to:

- 1) Man Power for running the control center inclusive of security staff, all required manpower (Centralized SCADA manager, SCADA programmers, SCADA operators, support staff, field engineers, technicians, etc as required on a minimum) for carrying out comprehensive & predictive O&M, all required manpower for carrying out repair works/replacement works. The manpower shall be trained and equipped to program the SCADA systems for integration of new and all other facilities that shall be made available for integration with the centralized SCADA center along with SCADA screen mimics, reports, etc as required by GJB. Note: The entire operation and maintenance staff, personnel, operators, programmers and manpower shall be from the contractor agency itself. No outsourcing of the operation & maintenance activity to any third party shall be allowed. Prior to the start of the operation and maintenance, the contractor shall submit detailed resumes of all personnel who would be in-charge of operation and maintenance for review and approval. Contractor shall take note of this clause and ensure complete compliance.
- 2) The contractor shall be entirely responsible for all travel, lodging & boarding cost for their personnel who would be required to travel to all of the project sites under this project to rectify, replace, and maintain all of the equipment installed under this project by the contractor.
- 3) The contractor shall be entirely responsible for the complete functioning of the centralized SCADA system at the centralized SCADA center.
- 4) The contractor shall be fully responsible for maintaining of vehicles required for his staff during the entire O&M period.

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- 5) The contractor shall be responsible for all data Communication cost between various remote sites and their integration with centralized SCADA (inclusive of both wired & wireless data communication costs), inclusive of leased line and related costs ,high speed broadband internet charges, Telephone/smartphone(Android /IOS) recurring monthly & yearly costs, all other communication costs plus any incidental cost as required for carrying out comprehensive O&M under this contract.
- 6) The contractor shall be responsible for all software licensing, regular software patch upgrade for all software as and when made available by OEM with time stamping, applicable for all machines installed in the control center, servers, server components, display wall video controllers software, cyber security audit, as required by GJB to include the integration of future plants data in the system, etc. plus all other software's licensing and related incidental cost as required under the specifications for carrying out comprehensive O&M
- 7) The contractor shall be responsible for all required consumables for all online real-time water quality multi parameter monitoring instruments(both at ground level reservoirs and at water distribution network) inclusive of calibration of equipment, required chemicals, reagents, printer cartridges, data loggers, battery replacement, replacement of faulty sensors, probes, instruments ,required spares, wireless communication modules, UPS system, maintenance of the panel, enclosures and fencing in excellent condition, and all other consumables costs plus any other incidental cost as required for carrying out comprehensive O&M and ensure equipment availability and data communication at all times.
- 8) The contractor shall maintain insurance for all equipment against damage due to vandalism, flooding, earthquake, theft, any other force majeure conditions throughout the O&M period.
- 9) The contractor shall be responsible for complete Operation & maintenance of the SCADA software modules inclusive of mathematical water demand & consumption modules, data modelling to predict the water consumption, demand ,reports, trends, MIS reports, etc., SCADA system, Historian software & hardware systems, Cyber security for the control center & installed, connected components to prevent any cyber/hacking attacks, intrusion protection & antivirus protection for all components, cyber security audit, Software programming & integration of newly added plants/locations with all field data to be integrated to the SCADA system as applicable with SCADA mimics, interoperability test procedures, communication checks with all remote sites at regular intervals, communication checks with all networked components in the control center, Integration with all servers and machines installed at control center.
- 10) Contractor shall be responsible for complete comprehensive Operation & maintenance of all equipment (hardware, software, instrumentation, all control center equipment & associated systems) installed under this contract with preventive and predictive maintenance, replacement & repair of (instruments, all hardware equipment, data communication equipment ,supply of required spares parts ,electrical equipment, display video wall equipment and spares, RTU,PLC, instrumentation),replacement & repair of all equipment & facilities installed in centralized SCADA center, all other equipment costs(inclusive of supply, packing, forwarding, insurance, installation, testing, & commissioning, integration) plus any other incidental cost as required for carrying out comprehensive O&M and to have the functioning of the centralized SCADA center at all times without any downtime of the SCADA systems, Historian system, cyber security of the control center and connected components, android & IOS application updated and field instrumentation, data

communication network and equipment, and all other equipment and software under this contract.

- 11) Contractor shall be responsible for complete comprehensive Operation & maintenance of all electrical equipment installed at the control center, inclusive of DG set, UPS system with batteries, security of all installed systems, equipment, instrumentation, field instrumentation etc and all other items and incidental cost as required for carrying out comprehensive O&M of the entire system.
- 12) The contractor shall be responsible for regular SCADA programming, updation of report formats as required, trends formats as required.
- 13) The contractor shall be responsible for the regular maintenance and replacement (as required) of all control center luminary fittings, EPBAX system, biometric access systems, air-conditioning and precision air conditioning systems, fire alarm, UPS systems, DG set, etc and all other equipment installed in the control center to have all of the equipment fully functional at all times..
- 14) During the fifth year of comprehensive operation and maintenance, the contractor shall update the following system with latest version of the equipment , IT hardware, software on a minimum but not limited to:
 1. Front end integration server
 2. SCADA Servers along with latest version of server operating software system
 3. Historian servers along with latest version of server operating software system
 4. Rack monitoring system along with latest version of operating software system
 5. Desktop work stations, Engineering & operator work stations along with dual monitors with latest version of windows operating system, MS office ,all other software installed ,etc
 6. Multifunction printers
 7. SCADA software to the latest version of the software
 8. Broadband routers and network switches
 9. Antivirus software for all systems

13.4 General Tasks of Operation and Maintenance Works

Tasks of maintenance and operation works shall include but not necessarily be limited to the following:

- Operate & maintain the centralized SCADA center along with all its installed system, integrated systems inclusive of all remote locations and equipment, data communication network inclusive of wireless GPRS communication network.
- Select the facility or equipment to meet actual performance in case of for example: water quality multi parameter equipment's
- Set the system/equipment to adjust timer or operation period where necessary.
- Makes minor repairs and adjustments to machinery, equipment, pipes and other materials pertinent to the operation of the system.
- Work on troubleshooting.

- Maintain maintenance and operational records.
- Cleaning of machinery, instrument chambers, buildings, loading and unloading of materials and storage of chemicals ,reagents properly.
- Carry out complete maintenance of the plant, including, but not limited to, painting, general custodial work, maintenance of equipment, CCTV, check for leakages at the control center, potential damage from trees , etc.
- Inspection of all necessary equipment, sampling equipment and pipelines.
- Maintain hygienic standards in acceptable condition.

13.5 Operation And Maintenance Manual

The operation and maintenance manual shall include but not necessarily be limited to the following:

Information to be covered in the Operation and Maintenance Manual

Information	Details to be included
1) Background of project.	- Complete project background shall be included in manual.
2) Plan and design condition.	- As per approved designs.
3) System operation indices and unit operation indices.	- As per approved designs.
4) Water quality parameters,	- Site Actual. - Standard Requirement.
5) Outline of system operation	- Summary. - Flow diagrams, plan view, - Operation flow diagram. - Table of facilities. - (Tag number, Type, Number).
6) Outline of component and its aim.	- Normal operation. - Emergency operation. - Selection of facility. - Selection of Auto/Manual mode. - Notice of danger/peril/hazard.
7) Verification items of system operation mode	- Before start of system operation. - Start of system operation. - During regular operation. - Set value of sensors and safety pressure on safety devices. - Position of plant/equipment on the selected mode. - Remove potential danger/peril/hazard.
8) Detail of facility/equipment component	- Summary. - Specification.

Information	Details to be included
	<ul style="list-style-type: none"> - Outside dimension. - Weight, quality of material. - Outside drawing. - Graph, charts, performance curve, table. - Photo after installation. - Notice of danger/peril/hazard.
9) Verification items of component operation	<ul style="list-style-type: none"> - Preparation before the operation. - Starting operation flow. - Normal operation. - Set value of level sensors and safety valves. - Emergency maintenance. - Notice of danger, peril, hazard.
10) Outline of component and its aim	<ul style="list-style-type: none"> - Verify incoming power Hz, kWh. - Ordinary line or Emergency line operation. - Detail and full operation procedure. - Select standby generator. - Emergency operation. - Selection of facility. - Notice of danger/peril/hazard.
11) Verification items of system operation mode	<ul style="list-style-type: none"> - Before start of system operation. - Start of system operation. - Set value of level sensors and protection. - Select Auto/Manual mode on central control panel. - Remove potential danger/peril/hazard.
12) Detail of facility component	<ul style="list-style-type: none"> - Summary. - Specification. - Single line diagram. - Panel dimension. - Weight, quality of material. - Outside drawing. - Graph, charts, performance curve, table. - Photo after installation. - Notice of danger/peril/hazard.
13) Facility verification items	<ul style="list-style-type: none"> - Preparation before the operation. - Select Normal operation or Emergency operation. - Select equipment operation mode/switch by Auto /manual. - Before start of system operation.

Information	Details to be included
	<ul style="list-style-type: none"> - Start of system operation. - Set value of level sensors and protection. - Remove potential danger/peril/hazard. - Notice of danger/peril/hazard.
14) Standard.	<ul style="list-style-type: none"> - Water quality at inlet and outlet. - Emission control.
15) Frequency of sampling, analysis and evaluation.	<ul style="list-style-type: none"> - Inflow and outflow Quality /flow rate. - Regulated pollutants. - Operation index.
16) Maintenance schedule	<ul style="list-style-type: none"> - Routine work. - Regular work. - Manufacturer recommendation.
17) Calculation sheets	All sizing documentation
18) Troubleshooting guide (Phenomenon/action/comments).	- All equipment
19) Operation / test data.	<ul style="list-style-type: none"> - Operation index. - Electrical site inspection data. - Water quality and quantity - Regulated pollutants. - power /chemical consumption. - Operation cost during training period. - Consumables, spare parts and its list. - Photos of inspection (evidence).
20) List.	<ul style="list-style-type: none"> - Equipment control. - Operation record formats. - Maintenance record formats. - Material control. - Inventory. - Spare parts. - Safety and Health.
21) All equipment	- O&M manuals for all equipment including all software supplied and implemented.

13.6 O&M Manual Updating Every Six Months and Submit to GJB For Review and Approval

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The contractor shall ensure the following in the updating of the O&M manual on a regular basis (every six months):

1. Up-dating any changes in the procedures set out in the O&M manual, as deemed necessary based on any limitations observed during the maintenance period, including incorporating additional procedures for maintenance of other repairs/break downs not incorporated in the maintenance manual but faced during O&M period.
2. The O&M manual must be updated if any differences are observed during O&M period.
3. Records of trouble shooting points and details of events causing trouble (breakdowns) during maintenance of the system must be maintained and used for updating the contents of the manual.
4. Records of trouble shooting points and details of events causing trouble (breakdowns) during maintenance electrical equipment must be maintained and used for updating the contents of manual.
5. Records of Inventory used must be maintained and the relevant portion of O&M manual must be updated to list out the inventory requirements for maintaining the system for seven years
6. The provisions in the manual must incorporate every aspect of good industrial practices even if not elaborated here or in other parts of the bid document. The provisions in the approved operation and maintenance document shall be valid and binding for both the parties during operation and maintenance along with the additions and deletions made.
7. The manual so prepared must be updated after the end of six months of operation and maintenance, giving effect to the experience gained and the observations made by the board during the maintenance period.
8. At the time of handing over after completion of O&M period, all the System and equipment, including spares, must be in good working order to the satisfaction of the Employer.

13.7 O&M Manual Handing over Requirements:

Before handing over of the system to the Employer at the end of comprehensive five (5) years of O&M, the contractor shall submit the following documents:

- a) Four sets of Operation and Maintenance manuals (both hard copies and soft copies), together with vendor's manuals, fully updated to take account of the experience gained during the contract.
- b) Report summarizing the history of the operation and maintenance of the Centralized SCADA system during the contract, together with details of the optimized methodology for operating and maintaining the system as developed by the contractor during the contract.
- c) The inventory of spares and tools etc. held in stock showing that he has replenished the spares and tools consumed during the contract.
- d) The proposals, outline of the training modules and programmes, for the training of the Employer's staff.

The contractor shall correct these documents to incorporate any comments from the Engineer and any additional information as required by the Engineer. The final submission of these document shall not be later than sixty (60) days prior to due date of handing over the system to the Employer. Ninety (90) days prior to completion of O&M works, the Engineer and the contractor shall make a joint inspection of all equipment and structures etc to assess the condition of these items and agree a list of remedial works and replacements. The contractor shall carry out all remedial works and provide,

install and set to work such replacements at his expense to the satisfaction of the Employer as per agreed time schedule within the O&M period.

13.8 Duties and Responsibilities

The Contractor shall operate and maintain the centralized SCADA system and all its ancillary system, integrated systems on a regular and systematic basis, in compliance with designed /calculated operational index.

- The contractor shall manage system operations so as to restrict power consumption within the specified functional guarantees.
- The contractor shall ensure satisfactory operation and maintenance of the whole works so that the system operation provides reliable, consistent performance and is economical at all times.

13.9 Definition of Maintenance

Maintenance covers all the techniques and systems which, by means of regular monitoring of equipment and scheduled maintenance procedures, prevent failures and, in the event of problems, enable repairs and replacement to be carried out with the minimum downtime of the system. Maintenance is therefore a combination of technical, administrative, and management activities. Maintenance consists of preventive and corrective procedures including replacement procedures.

13.10 Preventive Maintenance

Preventive maintenance consist of all the regular work carried out in order to sustain the conditions necessary or smooth operation of the system and to keep the performance of the equipment as close as possible to its original performance level. Its purpose is to reduce the probabilities of failure of deterioration of equipment of the system. In simple terms, preventive maintenance involves the elementary operations such as lubrication, mechanical servicing, electrical and electronic servicing.

13.11 Corrective or Remedial Maintenance

Corrective or remedial maintenance consists of all work needed to re-establish the conditions necessary for an apparatus or set of equipment to operate properly subsequent to failure or deterioration of the results produced by the equipment. It includes the following operations,

- Dismantling of equipment,
- Replacement of parts, replacement of entire equipment

The work may be scheduled for the short or medium term in accordance with the checks carried out as part of the preventive maintenance procedure, the number of hours an apparatus has been operating, or an alarm factor (abnormal noise, repeated cut-out, weakening of the insulation, etc), or may be dictated by an unexpected breakdown.

13.12 Concurrent Maintenance

Concurrent maintenance is defined as testing, troubleshooting, repair or replacement of a component or subsystem while redundant component(s) or subsystem(s) are serving the load. The ability to perform concurrent maintenance is critical to attaining the specified reliability/availability criteria for facilities and must be designed into the SCADA system. Where SCADA components are associated

with equipment that has redundancy and therefore are not themselves redundant, their maintenance should be scheduled to occur during maintenance of the associated equipment. SCADA components and controllers that are redundant must be capable of being taken out of service, repaired or replaced and tested without interfering with the operation of the redundant component.

13.13 Reliability Centered Maintenance

Reliability-Centered Maintenance (RCM) is an approach for developing an effective and efficient maintenance program based on the reliability characteristics of the constituent parts and subsystems, economics, and safety. RCM provides a logical, structured framework for determining the optimum mix of applicable and effective maintenance activities needed to sustain the operational reliability of systems and equipment while ensuring their safe and economical operation and support.

A significant byproduct of the application of SCADA systems to the control of facilities is the large amount of operational data made available through the trending and data storage features of the SCADA. This operational data shall be used for automated performance monitoring of mechanical and electrical systems that can support a RCM approach.

13.14 Maintenance Work

The work consists of inspection work and maintenance work as mentioned below:

- Inspection work, that includes physical appearance, inspection and measurement with testing equipment to verify and survey that the system performance whether operation is normal or not.
- The inspection work shall be daily executed by each technical specialist as a routine and/or regular inspection and shall be recorded every each time. The evaluation on the collected data shall be immediately reviewed by the chief operational engineer to instruct the operator for operation on the same day and/or make a plan of detail inspection and/or make repair schedule to make sure continuous system operation without any problem.
- Maintenance work, for which main task-work shall include activities, such as lubrication, overhaul, replacement of parts/whole equipment, repair, adjustment, detail examination and test, cleaning, to maintain the system in a good condition, performance consistent and low cost operation based on a regular and preventive maintenance schedule including attending sudden Equipment breakdown and to achieve high operational efficiency.

I. Operation work

This work consists of operation work and monitoring work:

- Operation work is executing the centralized SCADA system operation based on the scheduled process and procedure to meet designed criteria including set-up monitoring work is to confirm the operation data, and readout its measurement value and check up the working performance of system appropriately, as well as keep the records of the out-put.

13.15 Specifications

The specification of materials used for repairs shall be the same as have been used in the original work. Specifications for any materials which were not used during installation shall be approved by the Engineer prior to commencement of the operation and maintenance period and must be incorporated in the O&M manual. Without being limited by this clause, during comprehensive

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O&M period the Contractor shall use appropriate material for repairs even if material required for such repairs has not been approved earlier, and no delay in making such repairs shall be subjected to such limitation. However, subsequent to use of such material the Contractor shall submit proposals for the approval of specifications of such material. The approved material will subsequently form a part of the O&M manual. The comprehensive information as detailed in Table A shall be submitted to the Engineer.

Table A: List of Execution Schedule

Items	Description
Maintenance of system/ facilities	Type of equipment, Method/ Frequency of maintenance.
Operation of system/facilities	List of system/equipment, Items to be monitoring/operation, Method of system control and its note, How to input data into computer, operation of backup, Period of Power failure and generator operation, wireless communication method.
Monitoring of signal strength	Scope of monitoring, Method of sampling and analysis, Software used, list of authorized personnel.
Renewal	Replace of equipment & Facilities.
Subcontracting	Method of contract out, Scope of works, limit of responsibility.
Evaluation & Report	Method of data analysis, Evaluation of collected data, Improvement program, Reporting.
Organization and administration	Executive organization chart, Segregation of duties, List of staff member, Experience, Health certificate of staff member, type of insurance, Criminal record, Personnel name of taking record and make soft data, method of data control, Operation and maintenance cost.

13.16 Activities during O & M Period

General

Within the framework of the Contractor’s responsibilities given above, the Contractor shall carry out the following activities on a minimum. However, these shall not limit the requirement for other activities which otherwise are required as per term and conditions of Contract or to fulfill the Contractor’s responsibilities or are essential as per good industrial practices. The Contractor shall be responsible for, but not limited to, the following:

1. Providing the required staff, but not less than the minimum specified numbers/ level, during operation and maintenance period and additional staff as per requirement during O&M period
2. Providing all required spares, tools, tackles & Equipment and consumables required for functioning of system and equipment.
3. Entering into AMC contracts with system / equipment suppliers of, GPRS wireless communication provider, and all proprietary equipment and others as necessary. The AMC contract shall include preventive maintenance and emergency corrective

maintenance programmers, so that breakdowns can be kept to absolute minimum in frequency and duration.

4. Establish work control procedures including preventive and corrective maintenance so that the entire system shall work properly at all times.
5. Maintenance of the lighting fixtures and the lighting system of all areas and replacement of all non-functional lighting fixtures within 24 hours.
6. Maintenance of the UPS system at centralized SCADA center, remote stations, DG set.
7. Maintaining;
 - a) Repair history of DG set, Main distribution boards, Lighting switch bards, UPS, Air conditioners, SCADA components, LED Videowall display systems, ,GPRS wireless communication equipments, Ethernet/OPC based LAN devices, CCTV system, Bio metric accessing system, Fire alarm system, etc,;
 - b) Logbooks;
 - c) Daily log of operations of all the important equipment with time tag;
 - d) Daily list of alarms with time tag;
 - e) Logbook format and the data to be included in the logbook shall be decided during commissioning in consultation with GJB;
 - f) Last periodic maintenance done for all equipment of the system;

In addition to maintenance of above logbooks, the Contractor is required to maintain one inspection book, which shall record the errors in data transmission between the Centralized SCADA Control Center and remote stations by means of verifying the data stored at the local SCADA in association with the Contractor concerned. The book shall keep the tag number given uniquely to any process value and process alarm missed to be transmitted, the event time, the cause of the error and the countermeasure for the error.

The Contractor is required, further, to prove that there is no error on the Contractor's equipment in disputes with other Contractors when data are missed to transmit. The Contractor has to provide tools, software, hardware and manpower required for the investigation works on data missing between the Centralized Control center and the local remote systems at no extra cost to the Employer.

8. Providing required spares, special tools and test equipment and maintaining adequate inventory of required accessories or equipment itself for repair of system so that the system may work efficiently as per the guarantees given or minimum required efficiencies asked for in the Contract, without any additional costs to GJB. The Contractor may use spares and tools and tackles supplied with the Contract as required by him.
9. An adequate on-site stock of spare parts is essential to obtaining high availability of ICA systems. All spare parts used for the equipment in the maintenance of the system must be from the manufacturer of the equipment or, if the equipment itself has been made with parts from other manufacturers, the parts must be of the same make as used in the equipment supplied and installed.
10. All spare parts shall be packed for long storage under the climatic conditions prevailing at the Site. Each spare part shall be labeled on the outside of its packing with its description, number and purpose and, if more than one spare is packed in a single case, a general description of the case contents shall be shown on the outside and a packing list enclosed.

11. Minimum recommended stocking levels include the following. These quantities may need to be increased for components which are used in large numbers in the facility:
Manufacturer's recommended spare parts list.
One each of all line replaceable boards or modules.
10% each power and control fuses used in the system.
Tools required to terminate coaxial
Laptop computer loaded with software required to access controllers. Licenses for all software installed on the system.
Spare cables for connecting computer to controllers (Eg: Modbus cable, etc.)
3 PLC /RTU CPU, 3Power supply module , 3 GPRS Communication module, 3 protocol converter.2 managed Ethernet switch.
10% of each rating of fuses Installed per panel
 12. At the end of the Contract the Contractor shall hand over the full spares, equipment, tools as supplied with the Contract by replacing the used items with fresh supplies of the same specifications.
 13. Providing manpower for the required repairs of all facilities along with the materials.
 14. Maintaining stores for the system spares. The maintenance of stores will include but shall not be limited to:
 - Loading / unloading of materials received and issued for works;
 - Proper arrangement of material in stores to ensure its safety and easy availability;
 - Maintaining store areas in a neat and tidy condition;
 - Keeping records and accounting for the incoming materials,
 - Keeping records and accounting for the consumed materials.
- Note: The Contractor shall be solely responsible for the safety and security of the goods in the store and will be responsible for any loss or damages in stores for any reason. The contractor shall have insurance cover against the value of the goods to be stored without any additional costs to GJB.
15. Updating and periodic submissions of the operation and maintenance manual as defined in specifications for O&M works. The Contractor shall take up all periodic maintenance works provided in the approved O&M manual.
 16. Submission of monthly report.
 - Co-ordination with other contractors and/ or agencies for integration/data availability to software system.
 - The Engineer shall be entitled to audit any aspect of the system and the contractor shall ensure remedial action as directed.
 - Safety reporting: Brief reports of all accidents and hazardous incidents including descriptions of causes, extent of injuries, action taken, and precautions instituted to prevent repetition of such events.
 17. Insurance: The Contractor shall, without limiting his or the Employer's obligations and responsibilities, insure;
 - The work together with material and system for incorporation therein, to the full

replacement cost (term “cost” in this context shall include profit).

- The Contractor’s equipment and other things brought onto site by the Contractor, for a sum sufficient to provide for their replacement at the site.
- The insurance shall be in the joint names of the Contractor and the Employer at the Contractor’s cost and shall cover the Employer and the Contractor against all losses or damages from whatsoever cause arising from the start of the O&M until the date of completion of O&M in respect of the facility or any section or part thereof as the case may be.
- Any amount not insured or not recovered from the insurer shall be borne by the Contractor.
- Insurance shall cover for civil works

18. The typical main inspection item and some sign of deterioration of system in Table B, which may be observed during routine inspection or monitoring, works. The maintenance works shall be systemized to improve or need to gather and analyze information to solve the problem.

Table B: Typical Indication of Sign of System Deterioration

Parameters	Concrete and structure	Electronic equipment
Deterioration of material quality	<ul style="list-style-type: none"> • appear crack on concrete structure • water leakage • scouring • wear/abrasion • corrosion (steel, rebar) • irregular subsidence • change of shape • reducing service life • settlement of floating substance • deterioration/peel-off of internal coating • spoil the facility • algae growing on the wall 	<ul style="list-style-type: none"> • insulation deterioration • corrosion/rust • wear/abrasion • zero-point disparity • increasing in measurement error • difficult to adjust accuracy • failure of total accuracy • performance defect • system malfunction, • mechanical down • burn up relays. • reducing service life • error codes • system hang-up • inappropriate installation of measuring devices • malfunction of measuring devices • system malfunction • Shut-down system or stop equipment. • On-off Emergency alert • defect of operation mode • failure of indication & accuracy

Decline in system/system performance	<ul style="list-style-type: none"> • decline in retention time • increasing dangerous unit operation • difficult to repair • declining facility efficiency • increasing operation cost 	<ul style="list-style-type: none"> • shaky system • increasing frequency of out of order • longer repair time • declining operational performance • missing/lack of operational/ maintenance data & record
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Table: Typical items in Electrical Facility

Daily		Periodic	
Equipment/Items	Description	Frequency	Description
AMF or ATS Cubicle	<ol style="list-style-type: none"> 1. Verification of mains voltage, current. 2. Verification of working of Energy meter. 3. Verification of Operation of MCB's . 4.Verification of Position of Change over MCB. 5. Verification of ON position of Earth Leakage Circuit Breaker & Incomer MCB. 	Every 6 Months	<ol style="list-style-type: none"> 1,Verification of Conditions of all MCB's, working of Energy meter &Earth Leakage Circuit breaker . 2. Verification of earthing, wiring & connection.
Distribution Board	<ol style="list-style-type: none"> 1. Check for loose connections, local heating etc. 2. Verification of operation of all MCB's. 	Every 6 Months	<ol style="list-style-type: none"> 1. Verification of conditions of all MCB's. 2. Verification of earthing, wiring and connections.
UPS	<ol style="list-style-type: none"> 1.Verification of Input voltage ,current and Frequency 2.Verification of output voltage, current and Frequency 3.Verification of Indications & Protections 4.Verification of operation of Switches , breakers. 5.Verification of battery voltage & charging. 6.Verification of Cables and Interconnections. 	Every 6 Months	<ol style="list-style-type: none"> 1. Verification of Conditions of meters, switches, breakers, protections & Indications. 2. Verification of working of converter, Inverter, by pass switch. 3. Verification of condition of battery and charging. 4. Verification of earthing , wiring & Connections.
Lighting Fixtures	<ol style="list-style-type: none"> 1.Verification of working of lamps & ballasts. 	Every 6 Months	<ol style="list-style-type: none"> 1. Verification of illumination level 2. Verification of condition of lamps & ballasts. 3. Cleaning of Lighting

Daily		Periodic	
Equipment/Items	Description	Frequency	Description
			fixtures. 4. Verification of wiring .
Switch board	1.Verification of operation of switches , sockets & fan regulators .	Every 6 Months	1. Verification of condition of switches , sockets & fan regulators . 2. Verification of wiring .
Ceiling Fan	1.Verification of working of ceiling fan . 2. Check for unusual sound / noise .	Every 6 Months	1. Verification of condition of ceiling fan . 2. .Verification of condition of bearing , abnormal sound /noise .
Power sockets	1. Verification of operation of MCB & Socket .	Every 6 Months	1. Verification of condition of MCB , Socket & Wiring .
General	1. Inspection of General appearance of various Electrical equipment /items . 2. Verification of Cable System for Short circuit , smell , damage etc.	Every 6 Months	1. Verification of condition of cables , wires& connections. 2. Verification of Insulation resistance of individual equipment , cables and total system.

13.17 Contractor Care of System

The Contractor shall be completely responsible for the centralized SCADA system and all other systems constructed/renovated under this contract and other allied systems during the contract period till it is handed over to the Employer at the end of 5 years of comprehensive O&M.

If any loss or damage occurs to the system, during the period for the contractor is responsible, the contractor shall rectify such loss or damage, at his cost, so that the system conforms to its condition when the contractor took possession of the system at the commencement of the contract.

13.18 General Practices To Be Followed

1. Electricity
 - All the electrical equipments shall be handled and operated by a trained and authorized person only. All the equipment shall be checked for its proper earthing and loose connections prior to start the equipment. Naked wire, loose connections and faulty connections shall be repaired immediately prior to start for operation.
 - Electrical sockets and switch shall not be touched by bare or wet hands. If there is any live wire found naked or on wet ground, main switch shall be turned off first then the wire shall be repaired or moved.
 - For any electrical works proper insulated tools shall be used. Do not try to use tools made for other purpose; it may be hazardous.
2. Fall protection

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3. Only authorized person shall work at high place, people working at high level shall be very careful and protect himself from fall and injuries. Protective gears such as gloves, safety belts shall be worn and safety belts shall be tied to proper location prior to start the work. If any body feels dizzy and drowsy he should not work at high place and should come down immediately.
4. Wherever possible a ladder shall be used. Ladder shall be in stable condition and proper slope of ladder is 4 vertical and 1 horizontal and it shall be properly secured at base.
5. All the opening shall be secured properly by barrier of hand rail to avoid unauthorized person getting in. Wherever covers are provided for opening those covers shall keep closed all the time, except for maintenance time.
6. Health check up
 - o Any person not feeling well shall report to their superior and shall go through proper health checkups.
 - o All workers should go through medical checkup every year, and the result of check up shall be reported to the Engineer.
7. General personnel's cleaning
8. All personnel shall maintain a high level of personal hygiene. This includes clean work clothes, skin, fingernails, and hair.
9. Uniform – The personnel engaged shall be provided with distinct uniform so that the centralized SCADA center personnel are easily distinguishable from other personnel. The uniform design shall be submitted to GJB for review and approval.
10. All personnel engaged at site work shall wear helmet, safety shoes, and regular uniform

13.19 Mobilization of staff/Personnel, Qualification & Experience Required

The contractor shall be completely responsible for providing experienced personnel who shall be responsible for operating and maintaining the centralized SCADA center and its ancillary systems and equipment inclusive of the remote stations, locations in the water distribution network, GLR's, etc,

1. Requirements

Operation and maintenance staff shall have best experience, their health condition and education in addition to possessing best knowledge, abilities and skills.
2. Knowledge and abilities
 - a) Working Knowledge of SCADA system such as SCADA software and its functionality, Historian software and its functionality, Front end integration servers, rack monitoring system, Engineering & Operator Stations, Historian Servers, Reporting Servers, Engineering server, cyber security, videowall display system, etc,;
 - b) Knowledge of Ethernet based Local Area Network, over which communication/data transmission can be achieved within the SCADA components;
 - c) Knowledge of CCTV system and Bio-metric accessing system;
 - d) Knowledge of the method, materials, and equipment of SCADA system operation;
 - e) Knowledge of SCADA unit operation, maintenance, and servicing of SCADA and other system equipment and machinery;
 - f) Knowledge of LAN related devices operation and maintenance;
 - g) Knowledge of CCTV system and Bio-metric system operation and maintenance;
 - h) Knowledge of basic testing techniques to make standardized tests.
 - i) Abilities to make repairs and/or adjustments to SCADA equipment and to keep records and prepare reports;

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- j) Abilities to work efficiently with others.
3. Complete functional knowledge of field instrumentation, online real time water quality multi-parameter instrument
 4. For all operation and maintenance works, the Contractor shall provide skilled staff, which has adequate qualifications and sufficient experience of similar works. The contractor shall note that all personnel who shall be mobilized at the Centralized SCADA control center and associated sites shall be approved by GJB. The contractor shall submit the resumes with detailed work experience as required for operation and maintaining the centralized SCADA center to GJB for review and approval, at least 60 days before initiating the commissioning tests, so that the approved personnel are exposed to the plant testing and commissioning and subsequently are involved of the O&M
 5. The contractor shall provide the following personnel for the daily comprehensive operation and maintenance of the centralized SCADA center and its ancillary system. The contractor shall note that the personnel indicated below are the minimum personnel that shall be mobilized on a daily basis for regular operation and maintenance. If any other personnel are required to ensure the smooth functioning of the centralized SCADA center, the contractor shall provide the same at no extra cost to GJB.

Table: List of Personnel to be Mobilized, Qualification & Experience

Sr. No	Designation	Qualification	Experience	WorkShift	Required Nos.
Technical Personnel					
1.	Control Center Manager	Graduate Engineer (Instrumentation/Electronics)	10 Years	Full Time	1
2	SCADA Operators-	Graduate Engineer (Instrumentation/Electronics)	3 years	Per shift	1
3	Field Technician Refer Note below	Diploma/ITI (Electrical, Instrumentation, Telecommunication)	5 years	Per shift	2
Administrative & Support Staff at Centralized SCADA center					
8	Security Personnel Refer Note below	10 th pass (Working knowledge of Assamese & English language skills)		Per shift	1
9	Cleaners/Janitor Refer Note below	Working knowledge of Assamese & English language skills		Per shift	1
	Total No Man power per shift				06

Note:

1. The contractor shall operate and maintain the Centralized SCADA center and all its ancillary system in two work shifts of 12 hours each.
2. The above requirement is on a minimum to be provided by the contractor throughout the O&M period. The Contractor will arrange extra man power, as and when required and advised by GJB, so as to smoothly run the operation and maintenance including preventive maintenance, repairs etc. and general cleanliness of the installations.
3. The above staff strength is exclusive of leave reserve required for different category of staff. The Contractor shall ensure availability of the personnel given in the above table for all seven days in a week.
4. The personnel shall be sourced locally and reserved for local candidates (from State of Assam and shall be fully conversant with assamese language).
5. The Contractor shall make appropriate arrangements for maintenance of items like buildings, patrolling and maintenance of civil structures, vehicle operations and other activities defined to fulfil its obligations under O&M Contract.
6. In the event of absent of above indicated minimum number of staff during the O&M, the deduction of payment shall be done on per day basis for the number of days absent. A day salary will be calculated from the man month rate quoted by the bidder, considering the 30 calendar days in a month.

13.20 Job Description

1. Control Center Manager

The control center Manager will be in charge of all aspects linked to the performance of the comprehensive operations & maintenance contract. He will have authority to carry out or have carried out all tasks involved in the smooth operation of the installations he manages.

The Control Center manager shall:

- organize work
- assume full responsibility for ensuring compliance with safety regulations
- implement the resources required for compliance.
- Maintain the SCADA system, etc,
- Ensure data availability from the local remote stations to related servers at the centralized SCADA center,etc,.

13.21 Spare Parts

All spare parts used for the equipment in the maintenance of the system must be from the manufacturer of the equipment or, if the equipment itself has been made with parts from other manufacturers, the parts must be of the same make as used in the equipment supplied and installed.

All spare parts shall be packed for long storage under the climatic conditions prevailing at the Site. Each spare part shall be labeled on the outside of its packing with its description, number and purpose and, if more than one spare is packed in a single case, a general description of the case contents shall be shown on the outside and a packing list enclosed.

13.22 Facilities to Contractor

The Contractor will be permitted to use the premises developed under the Contract for use by his staff during operation and maintenance to the extent agreed and approved by the Engineer.

13.23 Payments

The Contractor, at the time of bidding, will be responsible to ensure the completeness and adequacy of his Bid Price to fulfill the entire responsibilities as described above. His bid price, as quoted on a yearly basis in the Schedule of Prices, shall include all costs for carrying out all O&M responsibilities, except for the following items for which the Employer will bear the cost:

- (i) The cost of electrical energy consumed, which will be paid directly to utility by the Employer.

13.24 Down Time

The centralized SCADA center and all its ancillary systems, remote locations connected shall never be operated at less than its design capacity due to maintenance and repair reasons. The period of such exceptional operation shall not exceed two consecutive days and shall not be more than three days a month.

The maximum downtime of the whole center or individual equipment, integration & data communication from remote sites, shall not exceed the time period as given in the succeeding clauses. The periods for repairs and maintenance have to be communicated to the Engineer at least one month in advance. For machinery and equipment which requires maintenance to be carried out by manufacturer/ manufacturer's authorized representative, the down time shall not exceed seven (7) days, (the Equipment spares shall be maintained which shall be used to restore the equipment back to its original state) to . Employer reserves the right to impose Liquidated damages, should there be any default by Contractor on this account. The Liquidated damages amount will be deducted in the next O & M bill if adequate reasons are not furnished by the Contractor for delay.

13.25 Penalties for Failure to Achieve the Functional Guarantees

In case of failure to achieve the functional guarantees, liquidated damages shall be imposed for such failure to meet the performance criteria, as described in the following clauses. The Employer will be entitled to recover any such damages from the monthly progress payments to be made to the Contractor in the month in which the failure occurred, or at any time thereafter from the subsequent monthly progress payments.

Applicable rate for Liquidated damages are as below:

For performance in the works execution period to be as follows:

Sr. No	Description	Performance Requirement	Liquidated damages Amount (INR)
			Rs. 10,000 per day
			Rs. 5,000 per day

Applicable rate for Liquidated damages shall be as given here below for performance in the execution & O&M period to be as follows

Sr. No	Description	Performance Requirement	Liquidated damages Amount (INR)
1	Water SCADA- CWMC	SCADA software, server's, hardware availability & uptime, mathematical modelling for water demand & forecasting Failure/downtime of more than 6 hours per day	5,000 INR per day
2.1		All software licensing, regular software patch upgrade- Failure to upgrade within two days on upgrade available	2,000 INR per day
2.2		Backed-up data retrieval to avoid any outages.--- Failure to update/retrieve data within Two hours	2,000 INR per day
2.3		Historian software with data from existing and new system- Failure/ downtime of more than 4 hours per day	2,000 INR per day
2.4		Leased line communication & data availability- Failure/ downtime of more than 4 hours per day	2,000 INR per day
2.6		Redundant wireless communication equipment & data communication- Failure/ downtime of more than 8 hours per day	2,000 INR per day
2.5		Android application for accessing data with latest data- Failure/ downtime of more than 2 hours per day	10,000 INR per day
2.6		Broadband High speed Internet connectivity availability- Failure/ downtime of more than 4 hours per day	10,000 INR per day
2.9		Integration with all remote	10,000 INR per day

		stations & data availability, data analysis - Failure/ downtime of more than 6 hours per day	
2.10		Complete cyber security for the centralized SCADA servers, hardware & software firewall, Zero downtime of systems and data analysis due to cyber/hacking attacks - For every incident which affects the operation of the systems, connected systems and till the same is rectified and brought back in service	15,000 INR per day
2.11		Antivirus protection for all systems against any virus attacks and Zero downtime of systems and data analysis due to virus attacks- For every incident which affects the operation of the systems, connected systems and till the same is rectified and brought back in service	15,000 INR per day
3	Video wall	Availability & uptime- Failure/Downtime of more than 6 hours per day	2,000 INR per day
4	Instrumentation, Automation-Reservoirs and water distribution network	Field Instrumentation availability (as applicable as provided under this contract), uptime, Calibrated data, equipment spares - Failure/ downtime of more than 6 hours per day	2,000 INR per day
5		wireless communication equipment & data communication- Failure/ downtime of more than 6 hours per day	2,000 INR per day
5.1		Integration with Centralized SCADA & data availability - Failure/ downtime of more than 4 hours per day	2,000 INR per day
5.2		Availability & uptime of Control & automation	2,000 INR per day

		equipment Failure/ downtime of more than 6 hours per day	
5.3		wireless communication equipment & data communication- Failure/ downtime of more than 6 hours per day	2,000 INR per day
5.4		Integration with Centralized SCADA & data availability - Failure/ downtime of more than 6 hours per day	2,000 INR per day

13.26 Technical Support

The Contractor should specify functional areas of the operating system and/or equipment where a Technical representative will be provided the manufacturer for training, test, checkout, validation, or pre-operational exercises.

Ongoing O&M of SCADA system software may require technical support from the system vendor or from agency technical personnel not located at the facility. Commercial SCADA software typically has provisions for remote modem access that permit this type of support from the vendor’s location or an agency central engineering group. Such remote access provisions represent a vulnerability to “hacking” and must be used with great caution. They should be monitored when in use and physically disconnected when not in use. This shall be done with prior written approval from GJB.

Password protection policies for all SCADA systems, including PLC’s, RTU , shall be in compliance with Established policies and to be agreed with the Engineer.

These policies require that the default password that came from the control supplier be changed when Placed into operation at the facility.

13.27 Power Consumption In Centralized SCADA center:

The guaranteed energy power consumption shall be calculated every month on the basis of the Technical schedules submitted by the Contractor along with the offer and the actual duty conditions for the month (calculation can be done on hourly basis). It will be compared with the actual energy power consumption and if the actual energy power consumption is higher than the guaranteed consumption, after taking into account , liquidated damages shall be recovered from the Contractor at the rate of two times of the charges for the extra energy power consumed.

Application of liquidated damages for excess power consumption will not be subject to any upper limit.

13.28 Defect Liability

A defect liability period of one year (365 days) shall commence upon issue of the Contract Completion Certificate or Taking over Certificate (as applicable as per contract), by the Engineer.

During defect liability period, the contractor shall be responsible for the followings:

- a. Provide to GJB the advisory services and follow-up training required.
- b. Complete any outstanding work notified to contractor in Contract Completion Certificate or Taking over Certificate (as applicable as per contract), issued by the Engineer under this clause.
- c. If during Defect Liability period, any defect should be found in the system, the contractor shall promptly, in consultation and agreement with the Employer remedy the defects, and at its cost, repair, replace or otherwise make good as the contractor shall determine at its discretion, such defect as well as any damage to the facilities caused by such defect.

13.29 Extension Of Defect Liability Period

The defect liability period shall be extended by the period during which any part of the works could not be used by reasons of a defect or damage, for which contractor was liable.

13.30 Failure To Remedy Defects

If the contractor fails to remedy any defect or damage within a reasonable time, a date may be fixed by the Engineer, on or by which the defect or damage is to be remedied.

If the contractor fails to remedy the defect or damage by such date, the Employer may carry out such works himself at the contractor's risk and cost. Such cost, determined by the Engineer, shall be final and binding.

13.31 Defect Liability Certificate

Within 28 days of the expiry of the defect liability period, Engineer shall issue a Defect Liability Certificate stating the date by which the contractor completed all his obligations under defect liability period of the seven years of comprehensive operation and maintenance, including remedying all the defects, to his satisfaction.

The decision of the Employer on all the sub clauses of this clause shall be final and binding on the contractor.

13.32 Sub Contracting of works during Operation & Maintenance period

The contractor shall not subcontract or assign any part of the comprehensive O & M contract except as described in this clause.

The contractor may enter into Annual Maintenance Contracts (AMC) with the vendors of certain specialist equipment such as :

1. IT hardware systems,
2. Leased line & broadband services
3. Videowall systems
4. Real time Multi-parameter water quality instrumentation system

The contractor shall notify his intention to do so and submit the copies of the AMC agreements of all the said equipment to the Engineer for his approval.

13.33 Frequency Of Testing

Activity	Frequency
Pneumatic Systems/Components/Instruments	
Check Regulators and Filters	Monthly
Inspect Tubing and Piping	Monthly
Calibrate Level measuring equipment Transmitters	6 months
Electronic Systems	
Lamp Test/Verify Indicators	Monthly
Inspect Enclosures for Dirt, Water, Heat	Monthly
Run PLC/RTU Diagnostics	3 Months
Calibrate Sensors and Transmitters	6 months
Calibrate Meters	Yearly
PLC/RTU Communication Modules	Monthly
PLC /RTU Batteries	Yearly
Test Automatic control Sequences	Monthly
Verify Alarms	Weekly
Software Maintenance and Patching	3months
Anti-virus Definition Updates	Monthly
Inspect Wire, Cable and Connections	Monthly
Inter site Communication Network	Weekly
Communication Interface, Interface Panel	Monthly
Dead Bus Relays	3 Months
UPS setting with SCADA	Weekly
PLC Redundant Power back up	Monthly
SCADA Redundancy	Monthly
Network Redundancy	Weekly
PLC Hot-Standby	Monthly
CCTV system	Weekly
Historian Package (Storage & archiving Capacity)	Monthly
General Data Archiving	Monthly
Run SCADA System Component Diagnostics	Weekly
Cyber security audit	Monthly
GPRS Communication Modules	Daily
Batteries	6 Months
Test Automatic report generation Sequences	Monthly
Verify Alarms	Weekly
Software Maintenance and Patching	3months
Anti-virus Definition Updates	Daily
Inspect Wire, Cable and Connections	Monthly
Inter site (within SCADA Center components) Communication Network	Weekly
Between control center and remote sites Communication Network	Weekly

LAN Devices	Monthly
UPS setting	Weekly
server Redundancy	Weekly
Data Archiving	Monthly

- Many components of SCADA systems, such as dead-bus relays, are not required to function under normal system operating modes. For this reason the system should be tested periodically under actual or simulated contingency conditions. These tests should approach as closely as possible the actual off- normal conditions in which the system must operate. For example, SCADA for Dual Redundant system should be tested by interrupting the utility source as far upstream of the normal service as possible.

- Periodic system testing procedures can be duplicated or be derived from the functional performance testing procedures (FAT, SAT testing procedures).

- The SCADA software maintenance should include timely updates of any new versions from the supplier and testing to verify proper installation on the SCADA computer. In addition, software antivirus updates should be maintained. This should be performed any time after the computer is connected to the Internet or the antivirus patch should be downloaded as and when the updates are available. Normal operation requires that the SCADA computer not be connected to the Internet.

- Faulty Instruments, sensors, transmitters, communication modules, computer hardware should be replaced with new components. Repair of the failure items would not be accepted. Instruments, modules would have to replace with a new instruments and components.

END OF PART 13

PART- 14

Handing Over Requirements

PART- 14

Handing Over Requirements

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PART- 11

Handing Over Requirements

14.1 General

This section applies to procedure(s) on handover the works related to centralized SCADA Control center and all its ancillary systems inclusive of all software, hardware, field instrumentation, data communication network, etc. to the employer at the end of five (5) years period of comprehensive operation and maintenance by the Contractor. The procedure for Handover shall be verified through the final examination by the Engineer. A completion approval Certificate shall be issued after the successful final examination and submission of the completion documents before the contract deadline.

14.2 Duties and Responsibilities

1. All the Responsibility lies with Contractor:
All cost for the examination/test/ training, and preparation of any document of the activities shall be the Contractor's responsibility.
2. Official certificate:
All test certificates shall be issued by authorized organization with qualified personnel with his signature.
3. Receiving inspection
All of electronic equipment and construction material arrived in site shall be inspected by the Engineer to verify whether damaged or not. Rejected items shall be replaced by the Contractor at his own cost.
The typical examination shall consist of as follows:
 - Appearance test /Visual examination
 - Check attached invoice
4. Conduct first training:
The Contractor shall provide the first training program to GJB staff members for 1 month before acceptance inspection.
The typical training program is as follows:
 - Study of Operation and maintenance manual
 - SCADA systems
 - Historian systems
 - Operation skill /technology including normal and emergency operation
 - Maintenance, repair skill/ technology
 - Recordkeeping and maintenance of records
 - Data communication system
 - Wireless GPRS communication systems
 - Safety & Health
 - Others requested by the Engineer
5. Conduct joint completion inspection:
A joint inspection shall be carried out by the employer along with the contractor for the complete system supplied under the contract. To verify the plant condition and its performance before five (5) year operation, joint inspection will be carried out using up-dated Operation and, maintenance manual

The typical inspection items show in Table 11.1.

6. Submission of the report of completion documents:

The contractor shall submit the completion document after completing the final examination before the deadline on the contract time.

The typical report consists of relevant documents, for request for issue the Completion certificate of 5 years of comprehensive O&M period, which shows in Table 11.2.

These data shall be provided in soft and hard copies in proper professional format.

Table 11.1: Typical Items to be examined at the End of 7 Years of Comprehensive O & M Period

Items	Description
1. Appearance test /Visual examination (Damage/crack, peel off painting, missing/lost, leakage of water/corrosion, condition of maintenance, others)	<ul style="list-style-type: none"> - All Civil structures, building including interior/exterior of centralized SCADA center, flowmeter chambers, etc - All Electrical equipment/accessories, others - Central SCADA Control & Monitoring center.
2. Performance examination (central SCADA server's operation and all ancillaries systems, connected systems)	<ul style="list-style-type: none"> - Check specification of all facilities, others - Check specification of all electronic equipment including wireless GPRS communication equipment, , leased line, cyber security, central SCADA server others - Check specification of all Electrical equipment, others - Check specification of all Field instrumentation equipment, water quality multi parameter equipment,
3. Verification of rectified works (, leakage, crack, damage, soil settlement, corrosion, others)	<ul style="list-style-type: none"> - Check a list of all defect items, history, tendency, repeating, others - Check a list of all miss operation and maintenance items, others - Check all factors of defect / miss operation , others - Verification of action on the take measures, others - Verification of all rectified works with the reports and photo, others - Check emergency works and its factor, action plan, others - Check actual condition after rectified works, others
4. Operation skill (staff member, others)	<ul style="list-style-type: none"> - Review of daily report and summery reports on O/M activities - Check time and motion of staff member ,others - Interview operator regarding troubleshooting, others
5. Spare parts and others	<ul style="list-style-type: none"> - Check inventory list - Check the quantity of inventory, others - Check maintenance tools and equipment, others

Table 11.2: Typical Completion Documents to be handed over at the End of Comprehensive O & M

Contents	Description
1. Outline	Outline - Summary of project, scope of work, location of project, main component with specification, others
2. Completion Photographs (At acceptance complete inspection, completion inspection and final inspection)	Photographs with short description - Civil (structural, buildings, others) - - central SCADA Control & Monitoring centre (equipment, facility, all connected systems, data communication network with equipment, others)
3. inspection summary (At acceptance complete inspection, completion inspection and final inspection)	Appearance test /Visual/ performance examination - Table of Summary of test activity based on daily and monthly - List/ of type of test, date, inspector, evaluation, comments - Civil (name of structure, drawing No., drawings, design dimension, previous dimension, actual dimension photograph with short description others) - Central SCADA Monitoring center(name of facility/location and equipment, Tag.No, Q'Ty, others) - Electrical (name of facility and equipment, Tag.No, Q'T., others) - all other connected system to the centralized SCADA system
4. Main inspection data At during construction	Summary of data with graphic /chart - Civil (plate load bearing test, compressive strength test, water retaining test, compaction field test, road construction works in, others) - Electrical (earthing resistance test, others) Central SCADA systems Equipment's etc.
5. Inspection record (At acceptance complete inspection, completion inspection and final inspection)	Appearance test /Visual/ performance examination Performance examination Verification of rectified works - Civil - Central SCADA Control systems - Electrical
6. Training and commissioning record	- Summary (Schedule of training and commissioning, attendance rate, impression on training program) -Training attendance list (participants, trainings date, others) -Commissioning daily record -Photographs with short description
7. Operation/maintenance manual	All disciplines & equipment
8. Spare parts list	- Electrical & Instrumentation (name of parts, Tag. No., Q'Ty., location of stock others)

	<ul style="list-style-type: none"> - Central SCADA Control systems (name of parts, Tag. No., Q'Ty., location of stock others) --Others (name of parts, Tag. No., Q'Ty., location of stock others)
9.Key list with boxes	-Name of key, location, Tag. No., Q'Ty.
10. Manufacture produced catalogue (GPRS equipment, Electrical, others)	<ul style="list-style-type: none"> - Civil (all related material, others) - Electrical(all related equipment: electric wire, electric conduit, , others) - Central SCADA system, FOC equipment, Wireless GPRS communication equipment - Others
11. Instruction manual	See above All equipment
12. Factory inspection record or quality assurance	- central SCADA system equipments, electrical equipment, Others
13. Photograph (during Construction, at joint completion inspection, at defect liability) (Civil, Central SCADA systems, Electrical)	<p>History of construction Replacement of defect liability</p> <p>Civil: construction site before starting construction, earthwork arrangement of bar, rust, cleaning before placing, formwork, concrete mixing work, placing, violator, curing, remove of formwork, backfill, compaction, all field inspection and lab test, others</p> <p>Central SCADA Control & Monitoring system and Electrical: inspection at factory, receiving inspection, completion inspection, all field inspection and lab test, others</p>
14. Report	<ul style="list-style-type: none"> - Monthly and annual report - Others

Specifications

The specification of materials used for repairs shall be the same as have been used in the original work. Specifications for any materials which were not used during construction shall be approved by the Engineer prior to Handing over. Without being limited by this clause, the Contractor shall use appropriate material for repairs even if material required for such repairs has not been approved earlier, and no delay in making such repairs shall be subjected to such limitation. However, subsequent to use of such material the Contractor shall submit proposals for the approval of specifications of such material.

14.3 Check List to be done during handover after O&M Period

1. ELECTRICAL SYSTEM

The Contractor shall hand over the following at the end of Operation and Maintenance Period

- (i) Revised as built drawings based on all modifications during O&M Period. The Electrical drawings shall include the following:-

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- etc.
- (a) Single Line Diagrams with make , type ,rating etc of various equipment , components
 - (b) Equipment Layout drawings .
 - (c) Cable Layout drawings & Cable Schedules.
 - (d) Earthing Layout Drawing .
 - (e) Details of protective relay settings including changes done during O& M Period.
 - (f) Details of Lube oil changes , filter changes etc for Generator Set during O&M Period.
 - (g) Equipment wise maintenance record during O&M Period (daily & periodical).
 - (h) Log book showing details of Electrical faults that have occurred in the Central SCADA Monitoring center and record of corrective actions taken during O&M period.
 - (i) Equipment wise technical data given by equipment supplier, Catalogues and Operation & Maintenance Manual
 - (j) List of mandatory spares that are to be maintained at stores and their actual availability in Central SCADA center , and if it is below the actual requirement ,the same has to be replenished.
 - (k) Details of Measurement of Earth resistance , Earth Pit wise and Overall Values during the O&M Period.
 - (l) Details of Illumination Levels during the O&M Period along with details of changes of lighting fixtures, if any, effected during the O&M period. Make good all circuits and buildings all electrical, mechanical and instrumentation equipment, substation equipment, lighting, DG Set and earthing system associated including replacement, if any (as required).

A. ELECTRICAL CHECKS TO BE DONE DURING HANDOVER AFTER O&M PERIOD

- (i) Contractor to provide a test schedule & format to be approved by engineer before commencing any test.
- (ii) Checking of all electrical equipment, items etc as per bill of materials. Visual checking and tracing out the circuit based on revised as built drawings.
- (iii) Visual and Operational checks of all Equipment , Protections & Indications have to be done.
- (iv) Earth Resistance of individual, Equipment and the system should be checked during Hand over.

2. CONTROL & AUTOMATION SYSTEM.

The Contractor shall hand over the following documents/drawings/manuals/programs at the end of Operation and Maintenance Period

- i. SCADA systems Guideline document detailing the seamless integration procedure for all third party system to be integrated with the centralized SCADA systems
- ii. Revised As built drawings approved by the employer's representative based on all modifications during O&M Period. All Drawings like System configuration, wireless GPRS communication module drawings, cyber security systems and antivirus systems, , and cable layouts should be maintained and should be handed over.
- iii. Handing over document/manuals shall include on a minimum 5 sets of softcopies and 5 sets of hard copies. The hard copies shall be spiral bounded clearly indicating the version/revision submitted. All the contents shall be indexed .The contents of handing over

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document/manual shall be clearly legible and shall include original manufacturer's literature on a minimum, and in-corporate any changes as per site conditions.

- iv. A complete manual shall be provided which shall include operating instructions and troubleshooting techniques of Central SCADA Control & Monitoring system and accessories installed illustrated with examples. This shall be provided along with the standard manufacturer's literature.
- v. Interoperability testing tool/software shall be provided along with relevant manuals and operating instruction with examples.
- vi. Latest Central SCADA system program back-up, with license, software database backup, reports and alarm back-up, Historical archived data containing reports and alarms and data and configuration set-up shall be provided.
- vii. All software's used under CP-09 contract shall be handed over along with their original licenses.
- viii. Complete list of database /addresses shall be provided clearly indicating the spare tags for future expansion of central SCADA Control center.
- ix. List of mandatory spares that are to be maintained at stores for complete Central SCADA Control center system package and their actual availability in plant, has to be provided.
- x. Any password's set to access the internal SCADA system program; integration format shall be provided and demonstrated.
- xi. All passwords shall be provided in a sealed envelope and addressed to the Chief Engineer.
- xii. Latest licensed version of windows operating system along with MS –Office or equivalent software which is prevailing at that point of time shall be installed on SCADA machines and other machines installed and integrated with the SCADA package. The same shall be demonstrated to the engineer
- xiii. Contractor shall conduct a training session for the client's staff, SCADA configuration and trouble shooting techniques, and trouble shooting techniques for wireless technology employed for communication.
- xiv. The training session shall be conducted for the duration indicated elsewhere in the specification documents.
- xv. A complete and updated list of all manufacturers/system integrators/contractors of ICA with contact numbers shall be provided. The same shall also be made available on site for ready reference.
- xvi. The latest versions of all drawings of ICA, which will include cable termination details, I/O mapping, database details etc shall be provided in PDF format and editable format and loaded in the operator machine available on site. The same shall be demonstrated to the engineer.

3. ICA CHECKS TO BE DONE DURING HANDOVER AFTER O&M PERIOD

- i. Contractor to provide a test schedule and format to be approved by the engineer before commencing any of the tests.
- ii. Functional Checking of all ICA equipment including wireless equipment being used for communication.

- iii. Loop checks will be conducted.
- iv. All instrument cabling shall be inspected for continuity. If found faulty, the same shall be replaced and demonstrated.
- v. All instrumentation cable conduits shall be checked for damage. If found faulty, they should be rectified or replaced and sealed to the satisfaction of the engineer
- vi. Visual operational checks of SCADA system and interface control panel.
- vii. Licensing feature of SCADA software and hardware, Dual-redundant server feature of SCADA shall be demonstrated. If found to be faulty/non-operational, shall be rectified and if required replaced to normal working condition and demonstrated to the client.
- viii. Functional check of data received/transmitted from remote stations shall be conducted in conjunction with SCADA.
- ix. Historical archiving of all data shall be demonstrated.
- x. Availability of memory for smooth operation of, SCADA shall be demonstrated. If found to be in-adequate, the same shall be rectified /archived and demonstrated.
- xi. If any instruments and automation equipment are found to be faulty during the above tests, the same shall be rectified or replaced as necessary.

14.4 Completion Certificate

A joint inspection shall be arranged by the contractor to assess the condition of civil structure, electrical and instrumentation equipment. Based on this inspection, a list of remedial, repair and replacement for the components shall be prepared by employer. The contractor shall carryout such remedial works at his own cost. Again joint inspection shall be arranged by the contractor for certification completeness of remedial work as well condition of all civil work to its original appearance.

The contractor shall submit the entire required document to employer for review and comments. The contractor shall resubmit the document incorporating the comment.

The employer shall issue a completion certificate to the contractor on his request within 30 days after the take back of the plant by the employer subject to the above documents and obligation are met by the contractor before 90 days prior to hand over of the plant.

END OF PART-14

TECHNICAL SCHEDULE I

CONSTRUCTION PROGRAMME

The Tenderer shall submit a realistic construction programme which he proposes to adopt for executing the Works. This shall be in sufficient detail so as to show the order and duration of key activities required to carry out the Works (including each stage of mobilization of labour & equipment's, setting up of site offices/ workshops/ consents and approvals, procurement, manufacture, pre-delivery inspection and testing, delivery to Site, construction, erection, testing and commissioning).

The Tenderer should pay particular attention to ensuring that the proposed programme is integrated with the Method Statement.

The construction programme shall be developed and presented on a commercially available project management software (such as Primavera, MS Project or equivalent), together with bar charts and CPM diagrams which clearly illustrate the critical path to achieve the desired results.

TECHNICAL SCHEDULE II
Centralized SCADA Equipment, Instrumentation & Control Equipment's

Note: The bidder shall provide complete information in the technical schedule for technical evaluation and qualification

Sr. No.	Description	Unit	Particulars
1	Front end Integration server (i) Model: (ii) Type: (iii) Make: (iv) Configuration: (v) Country of Origin: (vi) OS (vii)List of all licensed Software:		
2	SCADA server (i) Model: (ii) Type: (iii) Make: (iv) Configuration: (v) Country of Origin: (vi) OS (vii)List of all licensed Software:		
3	Historian Server (i) Model: (ii) Type: (iii) Make: (iv) Configuration: (v) Country of Origin: (vi) OS (vii)List of all licensed Software:		
4	Rack monitoring system (List out all components) (i) Model: (ii) Type: (iii) Make: (iv) Configuration: (v) Country of Origin: (vi) OS (vii)List of all licensed Software:		

<p>5</p>	<p>Engineering & Operator Workstations (List all components as required under specifications to have a complete system)</p> <p>(i) Model: (ii) Type: (iii) Make: (iv) Configuration: (v) Country of Origin: (vi) OS (vii)List of all licensed Software:</p>		
<p>6</p>	<p>LED Monitor</p> <p>(i) Model: (ii) Type: (iii) Make: (iv) Configuration: (v) Type of Installation: (vi) Country of Origin:</p>		
<p>7</p>	<p>LED Videowall</p> <p>(i) Model: (ii) Make: (iii) Configuration: (iv) Video Controller (v) Country of Origin: (vi) Receiver Details: (vii)Decoder Details (viii)Transmitter Details (ix)Encoder Details (x)Network Switch Details</p>		
<p>8</p>	<p>Multifunction Laser Printer,</p> <p>(i) Model: (ii) Type: (iii) Make: (iv) Configuration: (v)Country of Origin:</p>		

<p>9</p>	<p>SCADA Software</p> <p>(i) Software Name: (ii) Version: (iii) Tag Details: (iv) Mathematical Modelling/Business Analytics Intelligence details: (v) Country of Origin: (vi) source code is developed and supported within trustworthy countries (List out the countries):</p>		
<p>10</p>	<p>Historian Software:</p> <p>(i) Software Name: (ii) Version: (iii) Tag Details: (iv) Country of Origin: (v) source code is developed and supported within trustworthy countries (List out the countries):</p>		
<p>11</p>	<p>Ethernet Managed Switch</p> <p>(i) Make /Model: (ii) No of Ports: (iii) Country of Origin:</p>		
	<p>Centralized SCADA Equipment</p>		
<p>12</p>	<p>GPRS Wireless Module</p> <p>(i) Make (ii) Model: (iii) Redundancy Offered: (iv) Country of Origin:</p>		
<p>13</p>	<p>ROUTER</p> <p>(i) Make: (ii) Model: (iii) Type: (iv) Country of Origin:</p>		

14	<p>EPABX system</p> <p>(i) Model: (ii) Make: (iii) No of Points: (iv) Country of Origin:</p>		
15	<p>Hi speed broadband</p> <p>(i) Service Provider details: (ii) SLA agreement:</p>		
16	<p>Antivirus software</p> <p>(i) Version: (ii) Country of Origin: (iii) List the features supported as required under this contract: (iv) Make & Origin (Contractor shall name Make & Origin without fail).</p>		
17	<p>Cyber Security System</p> <p>(i) Make: (ii) Model No: (iii) Configuration: (iv) Country of Origin: (v) List out all features offered as per specifications:</p>		
18	<p>Air-conditioning Equipment & precision air conditioning(List out separately for both of the above)</p>		
	Make		
	Model		
	Type		
	Capacity	TR	
	Quantity	Nos.	
	Motor Rating	kW	
	Air-Ducting:		
Material			

	Size		
	Quantity		
	Whether all the required accessories are provided	Yes/No	
	Country of Origin:		
19	<p>Uninterruptable Power Supply system at Control Center</p> <p>(i) Make (ii) Model: (iii) Minimum Capacity: (iv) No. of batteries: (v) Redundancy: (vi) Country of Origin: (vii)Backup time:</p>		
20	<p>DG SET with AMF Panel</p> <p>(i) Make (ii) Model: (iii)Capacity: (iv)Rated Voltage: (v)Rated Frequency: (vi)Power Factor: (vii)Country of Origin:</p>		
21	<p>Leased Line</p> <p>(i)Service Provider: (ii)SLA agreement:</p>		
22	<p>Pressure Transmitter</p> <p>(i) Make (ii) Model: (iii) Country Origin: (vi)Product Brochure attached:</p>		
23	<p>Digital Display Unit/Transmitter</p> <p>(i)Make (ii)Model: (iii)Country Origin: (iv) Product Brochure attached:</p>		

24	<p>Standalone PLC /RTU</p> <p>(i) Make (ii) Model: (iii) IP Rating (iv) CE Certification: (v) I/O Modules: (vi) I/O Modules series same as PLC series: Panel IP Rating: Country Origin Year of Introduction: Expected year of Continuity and spare availability: (vii)Product brochure.</p>		
25	<p>Enclosure</p> <p>(i) Make (ii) Model No: (iii) IP Rating: (iv) Country of Origin: (v) Product Brochure attached:</p>		
26	<p>Power supply Cable</p> <p>(i) No of Cores: (ii) Type: (iii) Make: (iv) Part No: (v) Country of Origin:</p>		
27	<p>Ethernet Cables</p> <p>(i) No of Cores: (ii) Type: (iii) Make: (iv) Part No: (v) Country of Origin:</p>		
28	<p>Surge Protection Devices</p> <p>(i) Surge Rating: (ii) Make (iii) Model: (iv) Country of Origin:</p>		

Note:

1. List the features supported as required under this contract.
2. Make & Origin (Contractor shall name Make & Origin without fail).
3. Product brochure shall be attached for each equipment
4. Drawings where applicable shall be provided along with the schedule.

TECHNICAL SCHEDULE III
 (To be completed by the Tenderer as applicable)

ELECTRICAL WORKS

Uninterruptible Power Supply (Include separate individual schedules for Control room, GLR Locations and in Water Distribution Network)

Item	Unit	Description
Ups Details		
Manufacturer		
Type	Redundant	
Voltage	V	
Phase	3	
Frequency	Hz	
Rated output of UPS	kVA	
Back up time	minutes	
Mains input to static bypass switch (voltage and phases)	V/ phase	
UPS output (voltage and phases)	V/ phase	
Type of Inverter unit	IGBT	
Static transfer switch	Yes	
Maintenance Bypass switch	Yes	
Communication facility	MODBUS	
Control/Display unit	Yes.	
Battery Details		
Manufacturer		
Type reference		
Voltage	V	
Ampere hour capacity	Ah	
Battery type	SMF	
Is battery maintenance free	yes	
Is battery sealed or vented	sealed	

TECHNICAL SCHEDULE V**QUALITY ASSURANCE & QUALITY CONTROL PLAN**

The Bidder shall provide copies of the company's standard rules and regulations regarding quality assurance and quality control procedures for works in general and works of a similar nature.

The Bidder shall provide its proposed Quality Assurance and Quality Control Plan in detail so as to demonstrate the procedures and tests that will be used to ensure that the quality concerns and requirements as set forth in conditions of contract, Quality Assurance as given in Technical Specifications are satisfactorily met.

The proposed plan will describe but not limited to:

- the type, frequency and procedure of tests to be done on sites;
- type, frequency and procedure of tests to be done in manufacturing units at site, if applicable;
- type, frequency and procedure of tests to be done at manufacturers' locations outside the sites;
- all parameters to be measured in these tests; permissible limits of such parameters; details of laboratories to be established at sites; details of testing equipments & machines and their calibration schedules
- details of the Bidder's internal systems for assuring quality control at the manufacturers' works outside the sites;
- details of qualifications and experience of the Quality Control professionals to be deployed for the entire project; and
- the systems of Quality Audit to be instituted for systematic and professional management as well as adherence with the highest standards of quality of all construction works.
- All the tests of samples taken from the site are proposed to be done through recognized test houses of international standards and number of samples and frequency of sampling of materials brought to the site and the products manufactured at site shall be as per I.S. Specifications. All such samples shall be taken in the presence of Employer's authorized representatives or the Engineer.

The Bidder shall provide separate descriptions of its proposed QA/QC plan during the construction phase, and the subsequent operations and maintenance phase.

This will be an initial QA/QC plan which will address to basic requirements of Quality control and Quality assurance of the works.

TECHNICAL SCHEDULE VI
ENVIRONMENTAL MANAGEMENT PLAN

The Bidder shall provide his proposed Environmental Management Plan in detail so as to demonstrate the procedures that will be used to ensure that the environmental concerns and requirements as set forth in General Requirements are satisfactorily met.

The Environment Management Plan shall identify the potential environmental impacts from the various construction and operations and maintenance activities to be undertaken in the Contract and set out in detail the approach he will adopt in mitigating these environmental impacts to ensure that the residual impacts are minor and confined to a short period.

While preparing the proposed Environmental Management Plan the Bidder shall consider but not be limited to the following:

- The Bidder shall pay attention to the methods of materials delivery, storage, usage and disposal; equipment usage; and site activities to ensure they have minimal impact on the environment,
- The Bidder shall propose only environmentally safe products and practices in performing his works, and
- The Bidder shall comply with all of the statutes regarding environmental effects.

The Bidder shall provide separate descriptions of its proposals for minimizing any adverse environmental impacts/effects during the construction phase and the subsequent operations and maintenance phase.

This will be an initial Environmental Management Plan (EMP) which will address all moderate significant negative impacts of Plant construction activities.

TECHNICAL SCHEDULE VII
SAFETY PLAN

The Bidder shall provide his proposed Safety Plan in detail so as to demonstrate compliance with the requirements set forth in Technical Specifications.

The Safety Plan shall include a policy statement signed by the CEO or equivalent authority of the Organization declaring that Safety and loss prevention shall be given the highest practicable priority in all aspects of the Contract.

The Bidder shall describe his proposed Safety Plan which shall be developed to ensure zero fatal accidents and zero hazardous incidents/occurrences in all construction works, including descriptions of the company's standard policies and procedures regarding its site organization and procedures, methods and frequency of conducting safety audits at the Site(s), record keeping and reporting, providing safety training for its personnel, issue and mandatory use of safety equipment, and details of the qualifications and experience of the Bidder's proposed safety officers to be deployed at the Site(s).

The Bidder shall provide separate descriptions of its proposed Safety Plan during the construction phase, and the subsequent operations and maintenance phase.

This will be an initial Safety Plan which will address to the safety of the all persons entitled to be at site including the Employer's personnel.

TECHNICAL SCHEDULE VIII
FUNCTIONAL GUARANTEES OF THE PLANT AND EQUIPMENT

General

This document sets out the functional guarantees required to be provided by the Bidder for assessing the performance of the Centralized SCADA center, ancillaries, instrumentation, software and hardware and facilities, and which shall be used by the Employer to evaluate its satisfactory performance during the Tests after Completion.

The Bidder shall complete the following sections and provide values to be processed on a daily basis, based on the performance criteria set out in the Particular Specifications.

2. Functional Guarantees**During Works execution & Comprehensive O&M period :**

Sr. No	Description	Performance Requirement
1	CWMC-Centralized SCADA	SCADA software, server's, hardware availability & uptime, mathematical modelling for water demand & forecasting - ____%
		All software licensing, regular software patch upgrade- ____%
		Historian software with data from existing and new system- __%
		Leased line communication & data availability- ____%
		Redundant wireless communication equipment & data communication- ____%
		Android application for accessing water & sewerage data-- ____% & within ____ days to be achieved.
		Broadband High speed Internet connectivity availability- ____%
		Integration with all remote stations & data availability, data analysis - ____%
		Complete cyber security for the centralized SCADA servers, hardware & software firewall- ____%
		Antivirus protection for all systems against any virus attacks and Zero downtime of systems and

		data analysis due to virus attacks-____%
		Availability of required manpower during O&M period -____%
	Video wall	Availability & uptime-____%
	Power backup Equipment	Availability & uptime-____%
	Instrumentation, Automation-Reservoir Locations	Field Instrumentation availability, uptime, Calibrated data, equipment spares -____%
		wireless communication equipment & data communication-____%
		Integration with Centralized SCADA & data availability -____%
		Availability & uptime of Control & automation equipment, -____%
	On-line Real time Water quality Multi-parameters Instrumentation	Multi-Parameter instrument availability, uptime, Calibrated data, equipment spares-____%
		wireless communication equipment & data communication-____%
		Integration with Centralized SCADA & data availability -____%
		Road restoration to original condition within 3 days of equipment installation -____%
	Manpower	Availability of skilled staff as per bid requirements-____%
	Spares, Consumables	Availability of spares, consumables for all equipment-____%

Note: The functional guarantees performance in the works execution period & during comprehensive O&M period will be used for evaluation of bids.

