

VOLUME-2
PART- I
Section-8
Supervisory Control and Data
Acquisition System

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8. Supervisory Control and Data Acquisition System

8.1 Intent of Specifications

The intent of these specifications is to define the scope of work under this section which covers the provision of labour, tools, plants, materials and performance of work necessary for the design, manufacture, quality assurance, quality control, shop assembly, shop testing, delivery at site, storage at site, erection, acceptance testing, commissioning, performance testing, handing over to Purchaser and guarantee for trouble free operation of Supervisory control and Data Acquisition system for Keyi Hydro Electric Project, Arunachal Pradesh as per the specifications hereunder, complete with all auxiliaries, accessories, spare parts and warranting a trouble free safe operation of the installation.

It is not the intention to specify the minute details/smallest items to deliver a functional system or to define the standard manufacturing practice but to outline the performance, constructional, operational and guaranteed requirements. It is the responsibility of the contractor to ensure these requirements.

8.2 Scope of Supply

8.2.1 Control Boards

The Computerized Control and Monitoring System shall contain at least the following Control Boards:

- Two (2) sets of Unit Control & Protection Panel (UCPP) complete with local operator's work station; single processor; RTUs, I/O modules for turbine, governor, generator, MIV & excitation system; hardwired interfacing with generator & transformer protection system; multi-function meter cabinets for generator & transformers and including all other necessary accessories
- One (1) set of CCB (Common Control Board) for Common and station Services Boards complete with local operator's work station; single processor; RTUs / I/O modules for balance of plant equipment, MV/LV switchgear, common station auxiliaries and upstream equipment like water level sensor, hardwired interfacing with protection system of balance of plant, Switchyard multi-function meter cabinets for balance of plant equipment & common station auxiliaries and including all other necessary accessories.
- RTU for Interfacing & monitoring equipment for integration of weir equipment with powerhouse SCADA system through CCB for common & station auxiliaries. Necessary remote terminal unit for the purpose shall be included with Optic fiber cable from weir site to powerhouse. This also includes 2 sets of reservoir level sensors with local display as well as communication to powerhouse control room.

8.2.2 Central control center

Central Control Centre shall comprise of the following equipment:

- Two (2) fixed Operator Workstations each with two sets of TFT monitors and all necessary accessories and software.
- One (1) Mobile Engineering station with all necessary accessories and software.

- Data Acquisition System (DAS) / Data logger system comprising of two (2) nos. of high-capacity Network Attached Storage systems (one main + one hot standby).

8.2.3 Process control networks & Plant house LAN

- Fiber optic Plant LAN including all necessary nodes, devices, accessories and interfaces
- Fiber optic Central control room LAN including all necessary nodes, devices, accessories and interfaces
- Ethernet switch interconnection between Plant LAN and Control room LAN and with other CPUs.
- 24 core ADSS/OFC type Fibre cable between Intake and Powerhouse.

8.2.4 Software

- Supply of all necessary software, with license for use, and source codes for the process software that are specific for this project.
- Necessary routers and firewalls to prevent unauthorized access of process control networks from LAN/WAN connections including Plant LAN.

8.2.5 Time synchronization

Universal time synchronization system complete with master clocks, at least Two (2) nos. of master/slave clocks, antenna and any other instrumentation / provisions required for time synchronization of all the equipment of the control system as well as protection system equipment, with Global Positioning System (GPS), so that each piece of equipment shall be synchronized individually.

8.2.6 Interfacing services and supply

Coordination, supply of associated interfaces including transducers and integration of all plant equipment and subsystems including all auxiliaries and station services with the supervisory control and data acquisition (SCADA) system for complete control, real-time communication and data acquisition; The time accuracy of offered system shall be equal to or better than 1 (one) microsecond.

8.2.7 Miscellaneous items

- Printers as per clause "Printers" of this section.
- Spare parts as per the clause "Spare Parts" of this section.
- Special tools and instruments as per the clause "Tools and Instruments" of this section.
- Any other items not mentioned specifically but necessary for the satisfactory completion of scope of work defined above, as per accepted standard(s) / best international practices

8.2.8 Services

- Transportation and delivery to site including all logistics and proper site storage and preservation as per manufacturer's recommendation.

- Site installation and commissioning
- Field / touch-up painting including all painting materials
- Performance and field acceptance testing as per the relevant clause of this section and submission of report
- Training of Purchaser's personnel including operation and maintenance staff
- All the technical documentation including preparation and submission of O & M manuals

8.3 Specific Parameters and Layout Conditions

8.3.1 Control Philosophy

SCADA system comprising of Distributed Digital Control, Monitoring & Information system for the entire power plant & associated electro mechanical services covering the total functional requirements of control, sequence, interlocks & equipment protection, monitoring, feedbacks, system disturbance feedback etc. shall be incorporated.

The control system shall be configured in mainly three control levels as defined below.

- Level -1 Local Control Level (Level 0 and Level 1 of each unit shall be integrated at one place)
- Level -2 Central Control level

The highest level shall be central control level. The control at this levels is integrated control of entire plant through a number of functional groups for supervisory control and man-machine communication.

The middle level shall be the local automatic control level which comprises a number of functional sub-groups such as units, switchyard, station services etc.

The lowest level of control integrated with middle level, shall be the equipment manual control level which can directly control equipment such as governor, AVR etc. and mainly used for testing and adjustment.

All the components and subsystems in the hierarchical control levels of the control system shall be seamlessly integrated to achieve a highly reliable and scalable power plant control system.

The central control level shall include functions / groups for overall and centralized control of the station. Typical functions shall be control functions such as start / stop /loading / protection and other operational control of the machines, supervisory functions such as supervision & monitoring of the machine conditions, data storage function such as recording the operational status/faults & providing logs and operational information to assist the operators.

The local automatic control level shall be unit control & Protection panel (UCPP) / Common control boards (CCB) which shall be local distributed control centre for overall sequence of operation. Unit Control boards of each unit shall be equipped with process control computers to execute set programs. At start up or shut down, process control computer will execute a set of sequence programs. Based on process criteria, it shall generate commands for drive control or functional group for execution of program. It shall check for presence of all required criteria before it shall issues a particular command. The execution time will also be monitored and if execution time exceeds the stipulated time limit, a trip

or an alarm command shall be issued. It shall be possible to control the unit from unit control boards in fully automatic mode /step by step mode. Step by step control is mainly used for testing of the plant unit-wise after ensuring the satisfactory operational capability of unit auxiliaries.

The local manual control level shall be local control cubicle for individual control of equipment directly and is mainly used for testing of equipment. The data transmission between station control level and local control level shall be accomplished by means of LAN with high speed large capacity data bus of optical fiber cables.

A mimic bus diagram shall be provided on operator's console to depict the status and operational information of transmission lines, bus, generating units and station service circuits, weir gates etc. in real time and to operate equipment with functional switches. Reservoir water level & tail race level indicators and recorders shall be incorporated on this diagram. All required mimic shall be displayed on operator work station/local HMI.

No separate operator's console or MIMIC panel is required.

8.3.2 Station/ Central Control Centre

The control and monitoring system shall be built up of distributed and independent control modules in hierarchical control levels.

The overall control shall be accessible from the Central Control Room. The highest control level shall be the Operator's Workstation in the Central Control Room (CCR). From the Operator's Workstation, the operator shall have the possibility to perform in real-time, controls and adjustments for all the equipment of the scheme.

All the computers, peripherals, software, actuators, sensors, measuring instruments and other hardware shall be of latest state of the art at the time of supply. If the control system mentioned in the awarded contract becomes obsolete at the time of supply, the Contractor shall offer a latest model without any extra cost to Purchaser.

The control system should be built in such a way that in case of a fault in any single equipment others are not affected and system continues to function effectively.

The control system shall be designed on open standards based on IEC 60870-5 series and Object Linking and Embedding for process control (OPC) standards.

The control and monitoring system and the components shall be selected taking the following requirements into consideration:

- Reliability of components and subsystems,
- Scalability of the system for future extensions,
- Backward compatibility and Interoperability with other subsystems,
- Availability of spares,
- Ease of maintenance,
- Service availability and adaptability for future technology developments,

8.3.3 Unit Control Centre

At unit control level, each functional group of the plant shall have its dedicated control centre. Each generating unit shall have individual control boards designated as Unit Control Boards. The common station auxiliaries group shall have an integrated control of station auxiliaries, balance of plant and upstream equipment like weir gates and surge shaft through its Local Control Board for station auxiliaries. Likewise, for control & monitoring of switchyard equipment controls shall be grouped on respective Local Control boards for switchyard equipment.

All UCPP and CCB panels shall be based on IP 54 class of protection for enclosure.

At the unit control level, each local control system shall have its own control mode selector switch. These switches shall have three positions viz. Remote /Local Auto/Local Manual. The local auto shall have selector switches for Local Automatic / Local Step by Step

The Unit Control & protection panel installed inside control room shall comprise of following sections.

- Electronic Governor Section (to be supplied along with turbine)
- Local Control, indication and monitoring Sections
- Transducers and relay section.
- Alarm and annunciation section
- Auto sequencer section
- Excitation panels
- Protection relays

The unit control system mainly comprises the control & monitoring of

- Turbine
- Main inlet valve
- Governing system
- Generator
- Excitation system
- Generator Transformers

8.3.4 Interoperability

The complete design of the computerized control and monitoring system shall be based on interoperability of equipment from different manufacturers and the Contractor shall be responsible for overall functional integration of the system. The control system shall be implemented on open standards based on Object oriented design.

It shall be the responsibility of the Contractor to verify and solve all interoperability issues of various components / equipment connected to the network. The Contractor shall perform a type conformance test to validate the implementation of the communication protocols.

8.3.5 Power supply for Local Control Boards

Power supply for control of all Local Control Boards shall be 110 V DC. Each LCB shall be fed from two independent power supplies for control function. One power supply shall be main and other standby. In case of failure of main supply, standby supply shall be switched on automatically.

Power supply converters / units /modules provided in the UCPP / LCBs shall be 100% redundant.

8.3.6 Emergency shutdown

An independent emergency shutdown sequence controller shall be provided for each unit to override the normal control, to disconnect the respective unit from the system and affect a safe, controlled and rapid shutdown.

Emergency shutdown equipment shall be implemented through hardwired logic. Emergency shutdown shall be initiated by the monitoring and protection devices as well as by manual release of the emergency shutdown buttons to be provided in the UCPP and Central Control Room. The timing of emergency shutdown and associated closure devices shall be adjusted according to the hydraulic requirements of the system.

In addition to the individual unit emergency shutdown systems, an emergency plant shut down system shall be provided in the control room to achieve safe shut-down of all units together

8.3.7 Metering

For monitoring the generation and transmission of power, a metering system using digital multi-function meters and recorders shall be provided for all lines and feeders of 132 kV Switchyard, Generators at 11 kV level, Station Auxiliary Transformers and DG Set. All measurements such as voltage, current, power, energy etc., used for monitoring, shall be provided as per tender drawings. All the energy meters used for measurements shall have minimum accuracy of 0.2S and shall be connected to the data acquisition system for automatic meter readings.

Each Transmission line shall be provided with one main and one backup energy meter for tariff metering. The trivector meters shall have accuracy class of 0.2S or better.

8.3.8 Time resolution of events

Local dating of events shall be accomplished through the programmable controllers with high resolutions of 10 millisecond.

8.4 Rating and Functional Characteristics

The basic configuration and general layout of the control system shall be as per drawing

8.4.1 Standards

Standard	Description
IEC 60255	Electrical relays
IEC 60297	Dimension of mechanical structure of 19 inch series
IEC 60326	Printed Boards
IEC 60446	Basic and safety principles for man-machine interface, marking and identification, identification of conductors by colours or numerals
IEC 60478	Stabilized power supplies, DC output
IEC 60625	Interface system for programmable measuring instruments
IEC 61000	Electromagnetic compatibility for industrial process - measurement and control equipment
IEC61131	Programmable controllers
IEC61158	Digital data communications for measurement and control - Field bus for use in industrial control systems
ISO/IEC 8802	Information technology
IEEE 1046	Application guide for distributed digital control and monitoring for power stations
IEC 60870-5	Tele-control equipment and systems
IEC 60793 Part 1	Optical fiber- Measurement and test procedures
IEC 60793 Part 2	Optical fiber- Product specifications

Unless specific requirements are otherwise specified, standards concerning supervisory control and data acquisition (SCADA) system shall comply with the provisions and requirements of the latest applicable International Standards. The list of applicable standards shall be at least as described below in this section.

Optical fibre Cables used shall comply with the provisions of latest ITU-T Specifications and IEC standards. The communications and networks of the control system shall be implemented on open network standards conforming to IEC 60870-5-104 series standards. Any design feature or detail not specified herein shall be in accordance with the above-mentioned standards, which shall supplement these specifications.

All the mimic views, software, printouts, documentation symbols, reports, labels etc. shall be in English language only.

8.4.2 Description of functional areas

The instrumentation and control system shall be based on the decentralized intelligence system, which means that Controllers of the corresponding system operates the logic and control functions.

The control system shall be divided into discrete functional subsystems. Each sub-system shall be controlled from its Local Control Board if the "LOCAL" position is selected. The Local Control Board of each system includes redundant power supply distribution, interfacing terminals with the process, controllers and HMI.

The Local Control Boards associated with generating units (Unit Control Boards) shall, in addition to the above, equipped with automatic and manual synchronizers.

8.5 Performance Guarantee

The supervisory control and data acquisition (SCADA) system along with all auxiliaries and accessories shall be capable of performing intended duties under specified conditions. It is the responsibility of the Contractor to supply the equipment as per guaranteed technical particulars and shall also guarantee the reliability and performance.

The control system shall have fail safe features so that even in case of failure of all controllers, the outputs shall be latched on to a safe value that ensures minimum plant safety features. The Contractor shall identify and submit to the Purchaser a detailed list of these fail safe outputs along with their safe values during detailed engineering.

Real time, full duplex data transmission rate, of at least 100 mbps shall be provided.

The Overall control and monitoring (SCADA) system availability for top order events shall be at least be 99% and shall be guaranteed.

The control system shall be guaranteed against interoperability with all the powerhouse equipment and shall comply with IEC 60870-5 series.

8.6 Design and Construction

8.6.1 General

The designed control & monitoring system shall be common state of art at the time of supply. This specification requires that all local & remote control systems in the power house & the ancillary plant areas shall be suitable for manual and automatic start-up, running, normal & emergency shut-down of the generating units and the station auxiliary systems. The Controllers of latest microprocessor based design with high processing speeds and solid-state electronic elements shall accomplish the control.

The controls provided on the unit control& protection panel and operator's console in main control room shall be interlocked electrically so as to eliminate the possibility of simultaneous operation of any control from the various boards positioned at different locations."

8.6.1.1 Operator workstations

The operator consoles shall assist the operator for an easy operation and control of power station and shall allow to print out and to show on the displays, all relevant signals, events, alarms, status, status changes, abnormalities, history data and plant conditions on request or immediately in case of alarm.

In the control room two operator workstations with desks shall be provided. Each operator desk shall be equipped with two VDUs, sealed membrane covered keyboard and pointing device such as mouse / trackball, sealed membrane covered function keyboard, integrated telephone set, microphone, writing pad and workplace integrated. Each of the two monitors, attached to the workstations, shall be interfaced to be capable of displaying any of the selected plant control mimic views.

All the Operator workstations shall be implemented in such a way so that each workstation shall be capable of individually controlling the entire control system even in the case of failure of other workstation.

The configuration of each workstation shall be:

- Two VDUs each of at least 20", TFT flat screen and flicker-free,
- Dual Processor CPU with highest CPU clock speeds and Mother Board Front Side Bus speeds available at the time of supply,
- Minimum of 8 GB RDRAM,
- Two (2) DVD Write drives,
- Tape drive
- Two (2) or more - SATA Hard Disk Drives each of at least 1 TB capacity,
- USB hub and ports,
- Functional keyboard with all functions and provision of shortcuts for alarms,
- Pointing device such as mouse or trackball.

The workstations shall be high performance systems with SCSI drives and controllers and latest configuration available at the time of supply. They shall be loaded with latest 'Professional version' of Microsoft Office Suite.

8.6.1.2 Engineering station (Mobile Laptop)

One (1) Engineering Workstation Mobile laptop shall be provided. The Engineering Station shall be equipped with single 15", SXGA resolution, flat screen monitor and other hardware configuration same as that of Operator Workstations mentioned above. This station shall have the following features including software for:

- Reprogramming,
- Process simulation,
- Engineering calculation,
- Program testing,
- Documentation,
- Low level expert system tester,
- Training functions.

Software and programming tools provided shall be responsible for the definition and creation of all mimic views to be displayed. From this desk, it shall be possible to follow the control and operation and

to execute trouble shooting, reprogramming, parameter and set point changes and all necessary work to support and maintain the system. Each Engineering station shall be provided with latest 'Developer version' of Microsoft Office Suite.

The mobile engineering station shall have 1TB HDD.

8.6.1.3 Unit Control & Protection panel (UCPP)

Unit Control & protection panel with HMI shall be installed for each turbine-generator unit. The governor, excitation system and protection panels shall be integrated with Unit Control & protection panel. These boards shall communicate with the central control system through the Plant Control Network. The main and unit controllers shall be mounted on Unit Control & protection panel together with all the electrical and mechanical protections of the generating unit, its auxiliaries, generator step-up transformers and measurement of all parameters of the unit. All facilities, equipment and interfaces shall be provided for complete local auto / step by step control of the unit from Unit control board in "Local Auto mode".

Each Unit Control & protection panel shall comprise of the all the required control and monitoring devices and components required for operation of the unit including:

- controllers with redundant power supply distribution,
- Necessary I/O module racks,
- redundant field bus and sub-local network as per requirement
- All necessary I/O interfacing,
- One colour Human-machine interface terminal to perform local supervision and control of the unit and its auxiliaries,
- All condition monitoring of Unit such as stator and rotor temperatures, transformer monitoring etc.,
- Necessary energy meters for metering,
- Automatic and manual synchronizing devices and one synchroscope
- All necessary electrical protection equipment,
- Cooling water system,
- Governor oil pressure unit,
- Main inlet valve,
- Integration with unit protection devices and their monitoring as described in "Section Protection System",
- Covered push button and necessary controller for unit emergency shutdown, Emergency shutdown shall be implemented with hardwired logic
- Other systems not mentioned but are essential for working of the unit.
- Each Unit Control & protection panel shall perform at least the following functions:
 - Monitoring of draft tube gate indications,

- Control and monitoring of inlet valve,
- Local acquisition of the logic and analogue information from generator, excitation, turbine, governor, unit auxiliaries, unit protection and generator transformer, sensors and actuators,
- Local dating of events through the programmable controllers with high resolutions of 10 milli second,
- Management of the unit starting and stopping sequences in local automatic and remote automatic modes,
- Management of emergency shutdown of the unit,
- Control of the process actuators with necessary interlocking and protections,
- Alarm supervision,
- Monitoring of numerical protection system,
- Automatic and manual synchronization control,
- Management of the local operator terminal (HMI),
- Communication with measuring devices,
- Communication with all condition monitoring systems of the unit such as temperature-monitoring device, etc,
- Communication with the other controllers and Local Control Boards and computer system through the Plant Control Network.

In manual mode, the operator shall be responsible for the good progress of the operating sequence from the UCPP. Only basic interlocking shall be provided in order to prevent damages to the unit. When the "Local Automatic" mode is selected, all the control and monitoring is made through the HMI of the Unit Control & protection panel.

Sequence controllers shall be provided with all indications on the Central Processor Unit that are required for trouble shooting in case of failures such as:

- missing start conditions,
- missing conditions for the next control step in case of sequence fault,
- Actual step and sequence.

All status information from the logic controllers shall be also transmitted to the Central Control Room (CCR).

All necessary controls and devices shall be provided to allow step by step control and synchronization of the generators from their UCPPs while the basic safety interlocking and the protection remain operative.

8.6.1.4 Manual control of unit

Manual control of the units shall only be possible from local control cubicle, which shall be provided with all features, accessories, wiring, indications, and meters that are necessary for manual control of the unit locally.

8.6.1.5 Alarms

Each Unit Control Board shall be provided with an Alarm and Annunciation System with all equipment to achieve the required functions, such as alarm units, Annunciation panels, horns, transmission facilities.

8.6.1.6 Generator step up transformers

All Generator step up transformers shall be monitored, controlled and supervised with the electrical system delivered with "Generator Transformers" for temperature, cooling water system (if applicable) and firefighting system.

8.6.1.7 Synchronizing equipment

Individual synchronizing facilities shall be provided from control room to allow automatic synchronizing of the units from UCPP/Common Control Board.

The fully automatic synchronizing devices shall be of the electronic type, complete with all auxiliaries for automatic connection of the generators to the grid.

The circuit-breaker closing time, maximum admissible frequency and voltage difference, as well as the control time shall be adjustable.

Selector switches with positions "Off/Test/Step by step /Automatic" and all necessary instruments for manual synchronizing shall be provided at the Unit Control Boards.

The automatic synchronizing shall also be possible when the generating units are controlled locally from their respective Unit Control Boards and plant control network is non-functional.

8.6.2 CCB for Common and Station Auxiliaries & Switchyard

Common and station auxiliaries shall be supervised, interlocked and controlled from its local control board along with its local operator's station located in powerhouse machine hall. Necessary control and alarm functions along with data acquisition of parameters shall be provided. The protection cubicles described in Protection / individual equipment sections shall be integrated into Station auxiliaries CCB. The station auxiliary CCB shall cover the control, monitoring & protection of the following equipment

- LP compressed air system for oil pressure units, if provided
- Cooling water system,
- Electrical power supply distribution including DG sets, SAT of powerhouse,
- 110 V DC supply,
- Complete 11 kV system,
- 415 V switchgear
- Drainage/Dewatering system
- Firefighting system
- Protection for all the above systems

- water level measurement system
- 132kV Switchyard system

8.6.3 Software

All software along with necessary licenses, required for performing intended duties in an efficient manner, shall be provided in addition to the software explicitly specified for individual equipment. The source codes of project specific application software shall be the property of the Purchaser. The software shall be modular in structure, facilitating changes and extensions of the system. Complete literature including program listings in source language for application and customized application software shall be provided. All documentation and computer print-outs shall be in English only. All software shall comply with open system standards, shall make optimal use of CPU, main memory, and disk space, and shall not cause any problem for the operating systems.

8.6.3.1 Operating system

The operating system shall be latest Windows based network operating system available at the time of supply with a standardized, user friendly look and feel. All Servers shall be based on latest Enterprise edition of windows based Server operating system available at the time of supply.

8.6.3.2 Application software

The purpose of the Application Software is to allow a complete control and monitoring of the plant. The Application Software shall be structured in various levels. The lowest level shall assure system performance and contain basic functions / Application programming interfaces (API), which shall not be accessible by the application and maintenance Engineer for modifications. In order to ensure robust quality and reliable software functions, the main part of the application software shall consist of standard modules built as functional block elements based on Object Oriented Programming Standard programming language. The functional blocks shall be documented, thoroughly tested and formed into a library. The software shall be implemented in the computer systems of the control room. All operating parameters shall be modifiable by the operator and necessary interfaces /mimic views/ forms shall be provided for assigning set points with respect to voltage, load settings etc, assigning unit priorities, and giving direct orders/commands to the system.

All necessary provisions such as firewalls and other security measures shall be strictly implemented so as to insulate the Control system, networks, plant data bases etc. from unwanted intrusions.

8.6.4 Process Control Networks

8.6.4.1 Central control room network

A separate control room network shall be used in the control room to link the Operator's Workstations, Engineering Stations and other peripherals. Central control Room network shall be redundant Optical Fibre cables, based on Ethernet Standards at 100 mbps data transfer rate. The separate Control Room Network shall ensure to relieve the Plant Control Network from print jobs and dedicate the later only for transferring process data.

The Control Room Network shall be extendable to connect Plant LAN installed in the power plant as well as to connect to other networks such as Fire Alarm systems. The plant computers and servers shall be connected to this network, through routers and firewalls which shall be provided with the Central Control Room Network to restrict unauthorized access to the control room network and other process networks.

The fibre optic terminations for the central control room Network (LAN) shall be housed together in a closed unit along with the necessary switches.

8.6.4.2 Plant Control Network

The data transmission between the Local Control Boards and the workstations shall be implemented through a redundant fibre optic Plant Control Network in ring formation. The network shall be based on ETHERNET standard and use of TCP/IP protocol. 100 mbps data transfer rate shall be used to guarantee fast and reliable data transmission.

8.6.4.3 Field Communication Network

A redundant field communication network of high data transfer rate shall be configured for connecting Local control cubicles and other I/O to the Common Control Boards or Unit Control & protection panel. The network shall be based on Open Field Bus Standard / Ethernet international standard / TCP/IP and IEC standards. The media for data transmission shall be optical fibre cable.

8.6.4.4 Bus system

The data transmission shall be through optical fibre cables.

The bus systems shall be self-monitoring type. The main characteristics of the bus system shall be as follows:

High reliability of communication shall be realized by Ring type system.

Real time, full duplex data transmission rate, of at least 100 mbps shall be provided.

Interfaces shall be according to relevant IEC standards.

8.6.4.5 Optical fibre

Design of optical fibres shall be in accordance with recommendations and practices of relevant IEC standards and ITU-T series standards.

Optical source safety shut off shall be provided to prevent exposure to laser light during maintenance. Equipment shall have sufficient test points to facilitate complete monitoring of the equipment performance without service interruption. Fibres shall be designed to limit degradation after thirty years of intermittent exposure to stagnant water, ambient temperature and 100% relative humidity conditions.

The availability of 100 mbps data channel between two remote stations shall be greater than 99.99% and this availability shall consider a maximum mean-time-to-repair (MTTR) of 2 hours.

The barrage site shall be linked to the Power Station through overhead fibre optic cables run on 11 kV line poles. The link shall provide facilities for voice and data channels required for control and monitoring system, Security & Surveillance system and Public Address System etc. Each optical fibre cable shall consist of at least 24 cores and shall be of single mode type.

8.6.4.6 Communication interfacing

The Contractor shall provide necessary provision through router/ gateway with firewall functionality, interfaces and accessories suitable for communication between powerhouse control room and remote control centre through Purchaser's CUG (Closed User Group) network if required in future.

8.6.5 Audio visual alarm system

Each Local Control Board shall have its independent facilities for Alarm and Annunciation. The system shall be complete with Horns, alarm network / cabling etc. In addition to the above, all alarms shall be presented to the operators in the central control room through audio visual indications. Suitable provisions shall be provided at all Local Control Boards including Unit Control Boards such that the audible alarms shall be activated or deactivated and option shall be available for freely selecting the location for annunciation of audio alarms - either at operator workstations of Control Room or at respective Local Control Boards. Alarms may be acknowledged from only one operator station at a time.

There shall be an alarm manager function catering to all the alarm services in the Central Control Room.

Proper mechanism for sorting and filtering of alarms shall be provided.

Each alarm shall be time tagged.

There shall be classification of alarms to four levels of priority each priority being associated with a distinguished colour code.

Each raised alarm shall be provided with a suggestive course of action associated with its alarm display window to aid the operator in quick assessment of the fault.

There shall be proper filtering of the alarms thus eliminating non-significant alarms in a systematic manner.

Alarms are to be classified at least by the following views:

- alarms by degree of priority,
- alarms by mimic view,
- alarms by functional subset.

During remote operation from the Central Control Room, the audible sound shall be silenced by automatic acknowledgement after 1 min.

8.6.6 Peripherals

The peripherals shall be divided in, but not be limited to:

Control Room-

Two (2) portable laser printer attached with engineering workstations.

The selection of peripherals shall take into consideration aesthetics with noise level not to exceed than 60 dB. All the printers shall be of heavy-duty, high speed laser type. Print speed for monochrome printers shall be at least 15 pages per minute and that of colour printers shall be at least 6 pages per minute. All peripherals shall be provided with necessary desks, paper baskets and noise absorption.

Alarm Printer shall be on a high speed colour printer. On the alarm printers, all incoming alarms shall be printed with all necessary details. The Alarm and event printers shall be dedicated for Alarm / Event printing and configured such that the healthy printer shall take over the duty of the failed one. The alarm system shall be based on the first-out principle. The printout in-groups shall be arranged. The noise level of all the printers shall be low as per relevant international standards. The event printers shall print all events, trends, curves and process data. Alarms/events shall be printed immediately after occurrence with a resolution time of 10 milli-seconds; data prints shall be released periodically or on request. The event prints shall show all details including time, date in clear text, with value and plant identification number code.

8.6.7 Cabinet Construction

The control cabinets shall be free-standing, floor mounted, made of cold rolled steel, minimum 14 gauges, NEMA 12 gasketed. Panel seams shall be continuously welded. Panel edges shall be smooth and without sharp edges. Body stiffeners shall be added for termination enclosures if the overall width is more than 36 inches.

Overall panel construction and workmanship shall be such as to present a finished and first quality panel.

Front and rear opening hinged doors shall be provided for interior access.

The panel shall be painted inside and outside without visual defects. Panel interior shall be white. External panel colour shall be selected by the Purchaser.

Four 10A, 240 V AC receptacles shall be provided in the inside of each physical cabinet section. The receptacles shall be ground fault interrupter (GFI) receptacles or supplied by a GFI breaker.

Each panel section shall be provided with a florescent light sufficient to illuminate the panel interior for maintenance. Lights shall illuminate automatically when the corresponding door is opened and turn off when the door is closed.

Lighting and convenience outlets will be powered from Purchaser's separate 240 V AC lighting circuit.

Ventilation openings shall be provided with screens and filters. Top openings, including ventilation shall have covers to prevent ingress of debris to the panel. Panels shall be provided with sufficient ventilation and cooling to maintain the interior temperature at least 10°C below the maximum operating temperature of the internal devices at the powerhouse maximum ambient temperature.

A continuous copper/steel ground bus, not less than 50 mm. X 6 mm, shall be furnished for the plant control and protection switchboard cabinet. The copper ground bus shall be furnished with two bolted

connectors suitable for connecting ground bus to the station ground system through 75 x 10 mm GI steel flat.

Each piece of equipment mounted on the front, back, or inside of the cabinet shall be provided with a nameplate.

The control and protection equipment inside the switchboard cubicles shall be fed with two independent circuits of 110 V DC control power.

The switchboards shall be designed for bottom access for external cables and conduits.

8.7 Drawings, Documents and Design Calculations

8.7.1 Design memorandum

The Contractor shall prepare and submit to the Purchaser a "Design Memorandum" of the proposed equipment/system fulfilling the contract specification/requirement for approval prior to submission of drawings and documents. The memorandum shall include the design philosophy, methodology, system description, input parameters for design, standard and codes, design and selection criteria, equipment data, material specification, major technical features, basic arrangement/ layout etc.

8.7.2 Drawings and documents

The Contractor shall submit all the drawings and documents in accordance with requirements stipulated in "General Technical Specification (GTS)".

8.8 Delivery, Installation and Commissioning

The Contractor shall follow the requirements of Delivery, Installation and commissioning elaborated in clause 1.9 "Delivery, Installation and commissioning" of "General Technical Specification (GTS)."

8.9 Spare Parts

The Spare parts shall be as per below under supply scope.

Sl. No.	Description	Quantities
1	Time synchronising network cable with connectors	1 (one) sets
2	Power supply module/unit and card type model used	2 (two) sets of each type used
3	Network interface card of type/model used	1 (one) sets of each type used
4	plug in card type/model	2 (two) sets of each type used

5	Transducers	2 (two) nos. of each type.
6	Fault indicators	2 (two) sets of each type used
7	Control switches, change-over switches	2 (two) sets of each type used
8	Push-buttons	2 (two) sets of each type used
9	Plugged in type relays	2 (two) sets of each type used
10	Fibre optic interface modules	1 (one) sets of each type used

8.10 Special Tools

The Contractor shall propose the list of recommended special tools (other than those included under “Tools and Appliances” above) including their make and detailed specification as recommended by manufacturer(s) and to be accepted by the Purchaser.

8.11 Quality Assurance and Testing

The bidder shall submit the quality assurance plan along with bid for approval of the purchaser. The Contractor shall follow the quality assurance and testing requirements as per quality assurance plan approved by the purchaser.

8.12 Guaranteed and Technical Particulars

Guaranteed and Technical Particulars as called for in Vol. VI shall be furnished along with the bid. Bids lacking in this may be considered unresponsive. Particulars subject to guarantees shall be clearly marked.

8.13 Completeness of Equipment

All fittings and accessories of the Control and Monitoring System and associated auxiliary & ancillary equipment which may not have been specifically mentioned in these specifications, but are usually necessary for completion of the above equipment, shall be deemed to be covered by the specification; and shall be indicated and furnished by the supplier without any charges to the purchaser.

8.14 Deviation from Specifications

While the purchaser does not bind himself to accept any deviation, due consideration will be given to any special devices or equipment put forward by the supplier with a view to increase the efficiency of the equipment and minimize the maintenance cost of the equipment as a whole.

Should the supplier wish to depart from these specifications, he shall submit a complete and itemized list of such deviations, together with full particulars of the reasons for the deviations in a separate schedule with special reference to clause and paragraph nos. of this specification. Unless this is done and also the purchaser's concurrence in respect of such deviations is obtained in writing, the equipment offered shall be deemed to comply in every respect with these specifications.

8.15 Schedule of Installation

The bidder shall furnish a list of similar equipment supplied and duly erected by him as per proforma enclosed with the bid.