2 TELEMETRY/SCADA

2.1 GENERAL

2.1.1 Scope

1 This Part includes the hardware manufacture, system software, factory testing, installation, site testing and training of Owner's personnel in Telemetry/SCADA.

2 Related Sections and Parts

This Section
Part 1, ... General
Part 4, ... Panel Mounted and Miscellaneous Field Instruments
Part 5, ... Panels and Control Room Hardware

2.1.2 References

1 The following standards are referred to in this Part:

AG-181 Revision .....3.2 FOUNDATION Fieldbus System Engineering Guidelines

BS 1646 .....Symbolic representation for process measurement control functions and instrumentation.

EN 60073 .....Basic and safety principles for man-machine interface, marking and identification. Coding principles for indicators and actuators

EN 60255-22-5.....Surge protection

EN 61000-6 .....Electromagnetic Compatibility

EN 61131-3 .....Programming Languages for Programmable Controllers.

ISO/IEC 90003 .....Software engineering — Guidelines for the application of ISO 9001:2008 to computer software

ISO 9001 .....Quality management systems — Requirements

ISO/IEC 6592 .....Guidelines for the Documentation of computer based systems (ISO/IEC 26514 Systems and software engineering — Requirements for designers and developers of user documentation)

ISO/IEC 9075 .....Structured Query Language (SQL)FF-816 FOUNDATION Specification 31.25 kbits/s Physical Layer Profile.

IEC 60079-27 .....Fieldbus Intrinsically Safe Concept (FISCO) for hazardous areas

IEC 60488 .....Higher performance protocol for the standard digital interface for programmable instrumentation

IEC 60529 .....Classification of degrees of protection provided by enclosures (IP code)

IEC 60654 .....Operating conditions for Industrial Process Measurement and Control Equipment.

IEC 60751 .....Industrial Platinum Resistance Thermometer Sensors.

IEC 60839 .....Alarm and warning systems

IEC 61000-4-2, 3, 4 ..Electromagnetic Compatibility (EMC).

IEC 61131-1 .....PLC Design and Construction

IEC 61131-3……. Sequential Function Charts.

IEC 61158 Series .....Digital data communications for measurement and control Fieldbus for use in industrial control systems.

IEC 61158-2 .....Foundation Fieldbus Standard for Use in Industrial Control Systems - Physical Layer Specification and Service Definition.

IEC 61499-1, 2 .....Function Blocks for Industrial Process Measurement and Control Systems.

ISA 18.2/EEMUA 191.Alarm Management System

ISA 84/IEC 61511 .....Safety Instrumented System

ISA 95 for collaboration compatibility (workflow, procedures, operation management)

ISA 99/ IEC 62443 .....System Security guidelines

ISA S50.02 .....Fieldbus Standard for Use in Industrial Control Systems, Part 2: Physical Layer Specification and Service Definition.

ISO 3511 .....Process measurement control functions - instrumentation symbolic representation

ISO/IEC 26514 .....Systems and software engineering- Requirements for designers and developers of user documentation

Part 1: Temperature, humidity and barometric pressure

Part 3: Mechanical influences

Part 4: Corrosive and erosive influences

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2.1.3 Submittals

1 Submittals shall be in accordance with Part 1 of this Section and Section 01 Part 07 - Submittals.

2 Functional Design Specification (FDS). FDS shall be submitted to the Engineer and approved before manufacture and purchasing commences. The ICA Subcontractor shall include the following information as a minimum :

(a) design concept and criteria

(b) details of associated equipment

(c) functional design description including VDU mimics and report format.

(d) details of data archiving and trend configuration.

(e) quality plan

(f) outline of acceptance test procedures

(g) implementation program for manufacture, installation and commissioning with Particular reference to interface with existing equipment

(h) manufacturers literature for each item of equipment supplied

(i) name of the specialist Subcontractor

(j) The preliminary Function design specification and the control philosophy.

(k) The I/O list as per the P&ID and the required interfaced signals.

(l) PLC shall be replaced by PLC/DCS.

3 Drawings and Documentation. All drawings of telemetry and ICA equipment shall be on A3 or A4 size sheets with title blocks approved by the Engineer. The signature of the Contractors authorised representative shall appear on each drawing to indicate the drawing has been checked prior to submission.

4 Subcontractor's Drawings. The ICA Subcontractor shall submit four (4) reproducible copies plus two photocopies of general and detailed dimensioned arrangement drawings, schematics and wiring diagrams of all major items of equipment for the Engineer's approval. Manufacture of an item of equipment shall not commence until the associated drawings have been approved in writing by the Engineer. All modifications or revisions to drawings shall be clearly indicated and the revision reference changed. Drawings affecting work by other disciplines shall be provided to the Engineer within 6 weeks from the date of placing of the order for the works. Drawings for electrical equipment shall include:

(a) Contractor's general arrangement drawings for all items showing clearly the position of all cable glands and main components including, where appropriate, foundation plans showing the position of all required holes and cut-outs

(b) Manufacturers' schematic diagrams and connection diagrams for all items showing all internal wiring and terminal connections suitably referenced. Connection diagrams shall include existing and proposed outgoing cable connections

(c) general layout of equipment showing cable routing

(d) block diagram showing all equipment, cable runs and cable reference numbers

(e) cable schedules giving full details of use, destinations, size and number of conductors, grade and class

(f) layout of grounding facilities

(g) proposed arrangements for cables laid below and above ground showing identification references, voltage, depth of laying or cable rack size , route and length, crossings with other services, location of any joints and position of ducts with cross Sectional arrangements.

5 Where modifications to existing systems are involved, the Contractor shall modify existing drawings to show the modifications. If suitable existing drawings are not available the Contractor shall provide drawings showing the modifications.

6 As built Drawings. Comply with Part 1 of this Section.

7 Instruction Manuals. Comply with Part 1 of this Section and provide the following additional information:

(a) configuration of data base, reports, logs and screen displays

(b) data communication interface standards and protocols.

8 The submittal shall be subject to approval by the Engineer. The Contractor shall submit the final documentation based on the Engineer's comments. The Engineer's comments/approval shall be issued to the Contractor within 21 calendar days of the submittal.

2.1.4 Quality Assurance

1 All hardware and software proposed shall have been successfully proven in a similar water application for a period of at least three years, and be from established and reputable suppliers. A single hardware vendor for each functional component of the system shall be used exclusively on a given site. If this is not possible full compatibility shall be demonstrated.

2 Upgrades and improvements to the manufacturers standard system that are released before the expiration of the warranty period shall be supplied, installed and commissioned at no additional cost. These shall include all hardware and software necessary to implement the upgrade.

2.1.5 Delivery, Storage and Handling

1 The Contractor shall arrange for the delivery to Site, off-loading, temporary storage in a suitable environment.

2.1.6 Site Conditions

1 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 % (Non-condensing). 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.

2 EMI/RFI Noise Immunity. The equipment to be provided shall be adequately protected against interference from the use of the 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.

3 Generated Interference. The Contractor shall ensure that the computer, instrumentation and communications equipment conforms to EN 50081-1 for noise emissions.

4 The Approved contractor shall apply for application for concerned Licensed Telecom Service Providers for provision of communications and Qatar General Electricity & Water Corporation (QGEWC) for power supply services. Applications shall applied in time to ensure services are available for installation and commissioning of the telemetry equipment.

5 Coordination: The Contractor shall check with other trades to ensure equipment and material can be installed in space provided. Provide other trades with information necessary for them to execute their work. Details on Drawings that are specific regarding dimensions and locations are for information purposes. Coordinate with other trades to ensure work can be installed as indicated.

2.1.7 Commissioning

1 The Contractor, the Engineer and any appropriate personnel of the Owner shall be present when the equipment or installation is commissioned.

2 Commissioning shall include operating the equipment in a variety of modes and sequences to prove its satisfactory operation, prior to initialising the formal site inspection and testing.

2.2 DESIGN

2.2.1 Pre-Design Documentation

1 Prior to design of the system the following documentation shall be submitted:

(a) operational functional requirements including MIS functional description;
(b) process description, including interlocks and alarms;
(c) process flow diagrams (PFDs)
(d) process and instrumentation diagrams (P&IDs)
(e) SCADA I/Os data base (Instrument data base)
(f) Programmable Logic Controller (PLC) listing
(g) process control strategies
(h) process monitoring requirements (manual & automatic)

2.2.2 Hardware Design

1 DCS (Distributed control System) shall be mentioned as a control system along with SCADA & PLC as per the tender document and project specifications and requirements.

2 PLCs shall be installed at strategic locations throughout the plant areas to make optimal use of the LAN and to minimize hardwiring of I/O's. Man machine interfaces (MMIs) shall be strategically located and installed within each nominated process area. These installations shall form the nodes of a supervisory and distributed control and monitoring system.

3 PLC nodes and MMI nodes shall be connected via the selected PLC/network communication system to form a Local Area Network (LAN) for the site.

4 Loss of the communication shall not impact on the internal control strategy. Control system network shall be full-redundant with no common cause failure aspect. Ring topology is highly recommended with route diversification.

5 All system shall be capable of redundant communication. The failure of either of these links shall not result in loss of system communication functionality and response. The failure shall cause an alarm to the operator and to remote monitoring systems where required.

6 Plant areas and functional groups shall not be split across PLC's unless reliability benefits are demonstrated. Any PLCs failure shall not interfere with more than a maximum of one plant area.

7 Investigation of the surrounding environment (physical and other hardware components) shall be conducted for all hardware components to optimize components' selection and location for the site.

8 All PLCs shall be programmable via the SCADA network.

9 For retrofit installations, PLCs used to replace conventional hard-wired process system control/starter controls shall be compatible to existing SCADA system and standards.

10 SOE Sequence of Event shall be provided with high accuracy of at least 1 ms accuracy (or as per specified by Engineer) with time stamping of the I/O module level.

11 Controllers shall be redundant if it will be used for control not monitoring only to ensure higher availability and reliability. In case of active CPU fails, kindly ensure that the route of data flow shall be re-routed properly to the standby with no impact on the control and monitoring features.

12 DCS/PLC modules shall be modular type with the following specifications: -

(a) 16 digital inputs in 8 grouped.
(b) 8 digital outputs
(c) 8 analogue inputs
(d) 8 analogue outputs
(e) 8 pulse inputs

13 proper shutdown system shall be provided in compliance with IEC 61511 ensuring the smooth trip sequence considering all Hazop studies.

2.2.3 Software Design

1 PLCs software shall support higher-level languages such as ladder logic or any other language (Function Block concept etc) and should comply with the intent of relevant British Standard and International Standards.

2 Machine coded program segment shall not be offered nor accepted as solutions for control implementation.

3 Higher-level programming shall be in structured English statements.

4 Communication protocols shall be able to communicate with PLC manufacturer's equipment currently in use and any new PLCs. As much as possible secure protocols shall be used especially for remote sites

5 Application software shall be selected from packages with ample support and market base, proven in the industrial field to which it is applied. They shall have adequate local resources for support and program development. Provision for automatic upgrade from the delivered versions and future versions of software for a period of up to five years after delivery, shall be included in the base contract.

6 Application software shall provide information in a clear and simple manner, at both summary and details levels. This information shall include plant operational status, and the ability to adjust and optimize readily start/stop or isolate the plant processes or individual items of equipment. The specific control actions required shall be as described in the functional requirements.

7 The system shall have provisions for an operator to intervene or select alternative predefined control strategies.

8 The software shall allow data exchange and have software to allow external application software developers to add-on to the functionality of the software.

9 The system shall be capable of providing additional parts for communication with the following:

(a) Existing SCADA systems

(b) Radio modem where specified in the contract documents

(c) Existing RTUs

(d) Future business management systems.

10 No degradation of the plant SCADA system response times shall occur because of overhead imposed on the SCADA operating system as a result of these interfaces.

11 All operating systems and applications shall be up to date with the latest versions to ensure the best performance and security features. All software and applications shall be life time license.

12 MIMICs shall follow the company's standard or applicable international standards as per the Engineer's requirements. It shall consider the number of displayed points per mimic, symbols and color in such convenient way to operation recommendations.

2.2.4 System Security

1 The Network and Physical Security shall be in accordance with the National ICS (Industrial Control Systems) Security Standard Qatar version 3.0 or latest and ISA 99 ICS Security Standard .

2 All access to the system shall be via password for operator access control functions and system configuration. A minimum of two-step multi-level security shall be used. An automatic timed log-out shall be provided.

3 Supplementary hardware-type security shall be provided where indicated in the contract documents.

4 An automatic timed log-out shall be provided. Timing configuration for the log-out shall be adjustable and determinable by the site's needs.

5 External access to the system shall be secured in such methods as dial-back and encryption.

6 All disk used in the system shall have scanned (including the data) labels and shall have virus protection maintenance schedules.

7 The SCADA software shall provide for 'Console Mode Assignment' features, giving the plant operational team the ability to limit the use of the MMIs to specific levels of control and monitoring as required.

8 Interfaces with external systems shall be on a read-only basis.

9 For remote sites proper VPN connectivity, firewall policies and deep packet inspection with rigorous IPS (Intrusion prevention systems) rules shall be provided. Two different redundant layers of firewall may be required for the main control center.

10 Network Management LAN shall be segregated from the production LAN.

2.2.5 Control Room Architecture

1 The Control Systems Architecture shall be based on three levels in accordance with the National ICS Security Standard, which is as follows.

(a) Operations and Management Level (Untrusted Zone)

(b) DMZs(Demilitarized Zone)

(c) Control Network (Trusted Zone)

2.2.6 Operator Interface

1 Number and location of MMIs and input devices such as touch screens or keyboards shall be determined depending on plant production needs. Full control and monitoring capability shall be available at each screen.

2 There shall be no single point of failure, i.e. the failure of one screen or its associated hardware will not compromise the integrity of other MMIs.

3 For services plants a minimum one printer shall be provided for alarms/operator's actions. The use of the printer shall be minimized and all alarms and operator records shall be electronically stored and shall be periodically (and as required) printed in reporting format. An additional printer shall be provided as required to satisfy report generation needs. At least one colour printer shall be provided for serviced sites.

4 MMIs shall provide a focus for such activities as alarm reports generation, events logging and the archiving of historical data. Where it can be justified operationally, remote MMI may also be installed in area equipment rooms for the control of adjacent systems and plant items.

5 Where the MMI is used in an office environment, it shall be capable of generating business reports using commonly used packages and shall have access to printer via LAN.

6 For plants with permanent staffing besides MMI, a programming console shall be provide for on-line system modifications and maintenance without disruptions to production activities.

7 For unattended (remote) plants provisions shall be made for the connection of a portable programming console and printing facility.

8 The system shall be designed so that data input shall be collected/entered only once and shall be accessible for various business reports. It shall also be capable of sharing this data with external computing systems as required, to provide the necessary plant information to other applications in an accurate and timely manner.

9 The Plant operator/Management shall be able to access the plant from remote sites through dial-up or secured Internet laptop MMI. Critical alarms shall be reported to the central control room as required for any emergency response during after hours.

10 A standard library of interface screens, graphics, symbols and colours shall be utilized to create uniformity between systems. This shall be in accordance with BS 1646, EN 60073 unless otherwise stated in the contract documents.

2.3 MASTER STATION HARDWARE

2.3.1 Computer

1 The SCADA computer shall be an Industrial type PC (personal computer) of server / workstation category running multitasking real time operating system suitable for process control operations. The Servers shall be RAID 5 or 10 not RAID 1. Multiple processor shall be provided for servers' specifications especially for virtualization environment. Servers and workstations shall be rack mounted type. . The PC shall be latest one available specification in the market ensuring the best performance of the control system in the market. Unless otherwise specified in the project specification ,PC shall be minimum Intel core i7 processors with 6GB RAM ,1 Terabyte Hard disk, DVD R/W ,Sound cards and speakers ,2 numbers. Integrated 3 COM 10/100/1000 Ethernet Network Cards with other serial, USB, parallel ports, Keyboard and mouse

2 The system shall support hardware and software interconnectivity to Programmable Logic Controllers (PLCs) over RS 232/RS485 serial link or Ethernet over fiber/copper media using appropriate protocols, or similar, subject to the approval of the Engineer.

The memory capacity supplied shall be sized to accommodate an increase in inputs, outputs or Programmable Logic Controller (PLC) of up to 50% of the original specified without replacement of the memory unit. Further memory expansion shall be possible. The Contractor shall state the maximum memory capacity that may be fitted.

3 Local HMI (Panel Mounted)

The local HMI (panel mounted) shall be an industrial type PC of server / workstation category running multitasking real time operating system suitable for process control operations as specified in clause -2.3.1 except RAID5 or 10 implementation, unless otherwise specified in the project specification.

2.3.2 Redundancy

1 The master station shall be supplied with dual redundant computer equipment and suitable software to ensure high system availability and to prevent loss of operational data.

2.3.3 Visual Display Unit (VDU)

1 Visual Display Units (VDU's) shall be 22 inch colour monitor screens unless otherwise stated, capable of displaying information in alphanumeric, bar histogram, graphical.. The VDU shall be HDLED color monitor with a 256-color palette as minimum and shall have the ability of displaying mixed alphanumeric/semi graphical information. VDU shall be capable of high resolution graphic displays non - interlaced, low radiation, flat screen with no discernible flicker. Display of characters shall be legible and stable on a shadow mask tube, having a resolution of not less than 1024 by 768 pixels and a refresh rate of not less than 70 Hz.The units shall include all the necessary picture controls to adjust the sharpness, contrast and position of the image. The VDU shall have non-volatile memory of 2MB minimum. The VDU shall be industrial type.

2 Thin client may be required for control room as subject to the Engineer's approval or tender document.

3 The keyboards shall be equipped with special preprogrammed keys for faster function/mimics recall.

4 Control room VDU's (Monitor) shall be 22inch and VDU's for local HMI at other locations (PLC panel), shall be 17 inch minimum size.

5 VDU's shall be fitted with a power management system to reduce consumption upon detection of a stand-by signal from the PC.

2.3.4 Keyboard

1 The master station keyboards shall be of an enhanced pattern personal computer (PC) keyboard, separate from the VDU, low profile and have non-reflecting surfaces and keys of low intensity to minimise unwanted reflections.

2.3.5 Logging / Alarm / Report Printers - Continuous Feed

1 printer shall comply with at least the following requirement:-

(a)	print speed	:	160 characters per second
(b)	print quality	:	letter print with optional draft mode
(c)	paper feed	:	adjustable width tractor feed mechanism
(d)	paper width	:	18 to 38 cm fan fold
(e)	print pitch	:	10 or 12 cpi
(f)	print width	:	132 characters at 10 cpi
(g)	character set	:	Full ASCII
(h)	noise level	:	< 50 dBA.

2.3.6 Colour Printers

1 printer shall comply with at least the following requirement:

(a)	print speed	:	text, 80 characters per second
(b)	print speed	:	colour graphics, 2 minutes per page full
(c)	colours	:	compatible with VDU graphics
(d)	paper feed	:	A3 and A4 with auto sheet feeder mechanism and minimum 50 sheets per tray
(e)	paper width	:	A4/A3
(f)	resolution	:	600 DPI
(g)	RAM	:	8 MB

2.3.7 Monochrome Printers (Laser)

1 printer shall comply with at least the following requirement:

(a)	print Speed	:	8 pages per minute
(b)	paper feed	:	A4 with auto sheet feeder mechanism and minimum 250 sheet paper tray.
(c)	Resolution	:	600 DPI
(d)	character set	:	full ASCII
(e)	RAM	:	4 MB

2.3.8 Audible Alarm

1 An audible alarm located on the control desk, shall be provided which is initiated by any fault condition arising and silenced on operator acceptance of all fault conditions. An alarm mute function shall be provided to silence the audible alarm without accepting any fault conditions. It shall be possible to enable/disable this audible alarm only at the highest system access level.

2 Use of the internal PC audible alarm will not be acceptable.

3 it shall comply with ISA 18.2/EEMUA 191 Alarm Management System.

2.3.9 Data Storage

1 Provide a historical data storage system with removable media for archive and backup.

2 The data storage system shall store alarms and events, with the time of occurrence for at least 6 months with monthly periodic off-backup and applicability of retrieving the off-backup upon request and selected analogue signals connected to the system. All alarms and events shall be archived in a first in first out buffer, for a period of 40 days.

3 A high speed back up device with removable media, such as streaming tape cartridge or optical disk, shall be provided for each server, suitable for backing up the whole system on a weekly basis.

4 Data selected for archive shall be written to removable media which shall be sized to support at least 180 days worth of archive data. The archive media also shall be sized to store logged analogue data, at a maximum sampling rate shall be minimum of 1 sec for 6 month of analog signals.

2.3.10 Uninterruptible Power Supply (UPS) System

1 The Contractor shall supply a UPS system with sufficient capacity to maintain power to the computer equipment, its peripherals and process critical instrumentation during a mains power failure for a minimum period of 8 hours with reliable fixed diesel generator or at least 24 hours or more as per the approval of the Engineer. Considering the rural area, the backup time may be increased as per the approval of the Engineer. Refer to Section 21, Part 18 Uninterruptible Power Supply Systems more detailed specification .

2 In the event of power failure, the master central system shall be supported by the UPS.

3 The central system equipment shall be programmed to degrade gracefully once UPS power is exhausted or execute a shutdown routine after a preset time from the original mains failure.

4 The UPS systems shall be monitored by the SCADA and a fault in the UPS system shall be accorded the highest priority alarm status.

5 The FDS shall detail modes of failure and process shutdowns and itemise signals to be supported by UPS.

6 Power distribution from the UPS in the control room area shall be via protected sockets, the design of which will be such as to prevent inadvertent connections of non-system hardware.

7 UPS for system control or control rooms shall be redundant.

2.4 MASTER STATION SOFTWARE FUNCTIONS

2.4.1 General

1 The Contractor shall be responsible for supplying complete software packages to enable the equipment to operate as stated in this specification. Provision must be made for the adding of further software tasks as and when required. All software functions shall be user friendly with instruction and messages to aid the operator. The Contractor shall make available all standard software functions even if not specifically detailed in the specification. The sever / operator works stations shall be OPC UA compliant for communicating to other client works station

2 The computers shall utilise a real time multi-tasking and networked operating system with a proven track record in real time control applications.

3 It is a requirement that the system be supported by on line configuration and editing of all VDU mimic displays and database and to create new displays and additional database.

4 The system shall be capable of supporting the allocation of equipment groups into zones and these zones may be allocated for the attention of Particular operator workstations (OWs).

5 Operational mimics and other graphics shall be presented in an industry standard graphical user interface (GUI) format. A minimum of two active windows should be displayable concurrently. Both text and graphics shall resize automatically to accommodate changes made to the size of a window. The system shall be designed to minimise the operators use of the keyboard. All major functions shall be accessible on-screen through use of the mouse or track ball.

6 When designated in the Project Specification additional operator workstations shall be provided for each process area. Functionality shall be identical to that of the master station OW's allowing full access to all system functions at the authorised access level. Operator system entry for each area will be password coded with different levels of entry depending on the level of authority of the operator. Development and systems level entry passwords will be provided for engineering workstations. Each action taken by any operator at any level of entry, or, at any operator terminal shall be log file recorded, and time and date stamped. Log in and out time and dates will be printed on the control room event logging printer.

7 VDU mimics will display dynamic colour details of flow rates and pressures, pump status, well levels, alarms, electrical power supplies and other general equipment status conditions. All requests and commands shall be via icons, whether menu linked or linked to equipment control actions. A permanent dynamic alarm banner shall be displayed at the bottom or top of each operator screen. Each control action will be routed through a series of confirmation routines.

8 The complete system database shall be available to each master-station OW offering preconfigured reports per process area. These reports shall be available for printing in graph or tabular format. Dynamic trend displays shall also be available for all analogue flow, level and pressure values. Custom, as well as preconfigured reports and trends shall be available to a higher level of entry. A colour A4 size screen dump printer shall be provided for graph and trend prints.

9 An operator help utility shall be provided offering help linked to the particular action being carried out by the operator at that time. At least one help screen per screen page shall be available. This facility shall be preconfigured with an option for updating by operators via a password entry. Typical information available shall consist of guides of actions to take under Particular equipment conditions, general process information and help in operating the telemetry system itself.

10 Provide a software watchdog timer function connected to one set of normally closed relay contacts which are held open whilst the watchdog is healthy.

2.4.2 Display Facilities

1 The displays shall be user configurable, with the user being able to construct any desired symbol for display. Any display shall appear (excluding historical recall) within 3 to 5 s of selection and the displayed data shall be updated from the database as information is recovered from the Programmable Logic Controllers (PLC's). Alarms shall typically appear within 3 to 5 s of occurrence and within 1 s of being received into the central system database.

2 The Contractor shall configure all display pages as fully as possible. However, facility must be incorporated to permit easy construction and modification of the display pages by using a standard library of shapes and symbols. The library shall be added to and modified by the user as required. The configuration shall be object orientated for ease of use. All layout details and dimensions, including colours, symbols, line diagrams, legend text and indications, shall be agreed with the Engineer.

3 The initial application software shall provide for the display pages listed below and any pages necessary for the system to function as a complete entity.

(a) mimic displays
(b) alphanumeric configuration pages for the complete I/O and PLC's
(c) graphic displays
(d) trend displays
(e) process alarms with tag, date time and cause
(f) event logs of past 72 h with date and time
(g) tabular display of data
(h) inset windows showing an analogue trends may be mixed with mimic displays. In such a display the main mimic and inset trend shall all be live with automatic display updates.
(i) network status and configuration.
(j) main power supplies status.
(k) system alarms with equipment identity, date and time.

4 Indexing of information and menus shall be presented in the form of active windows on the screen while the mimics etc. are still available for view.

5 No display or function shall effect the logging/monitoring of data. It shall be possible for the master station terminal and auxiliary terminals to perform different tasks within the displays simultaneously.

2.4.3 Monitoring and Alarms

1 The operator shall be able to monitor all of the information at all workstations. He shall be able to view active equipment information on a series of VDU based graphical and tabular displays.

2 In the event of an equipment alarm, the following shall occur at the master station:

(a) alarm message displayed in the alarm message area of the screen
(b) the audible alarm shall sound
(c) the appropriate Section of the display page shall change colour and flash
(d) a full message shall be written on the alarm page

(e) the full alarm message shall be printed on the alarm printer

(f) the full alarm message shall be recorded, stored on disk and automatically archived.

3 The operator should be able to acknowledge the alarm by pressing an accept alarm key or icon. This action shall stop all associated alarm messages and displays flashing, however the display shall remain in the alarm state fixed colour to indicate an accepted alarm. When all outstanding alarms have been acknowledged the audible alarm shall be silenced.

4 Once the alarm has cleared, the messages and displays shall return to normal. The alarm message shall stay recorded on the event/alarm log and an alarm cleared message shall also be recorded.

5 If the alarm clears before being acknowledged the sequence of events shall continue as above except the message shall change to indicate a cleared alarm.

6 An audible alarm silence function shall be provided to enable an operator to silence the audible alarm without acknowledging all alarms. On occurrence of any subsequent alarm the audible alarm shall sound.

7 For multiple bit points (where two or more inputs are combined to function as one point) the assignment of status/alarm levels shall be on the combined signals.

8 Each signal within the configured system shall be capable of being assigned an alarm based on the following:

(a) four levels per analogue (Lo Lo, Hi Hi, Lo and Hi)

(b) rate of change

(c) deviation from setpoint or other control parameter

9 The time tagged resolution shall be as per the tender document or Engineer's requirements with proper SOE sampling rate and resolution of 1 second of general alarm.

10 A minimum of four alarm priorities shall be provided so that those requiring immediate attention may be separated from alarms of lower priority. An audible alarm shall sound for alarms requiring operator action. It shall be possible to acknowledge alarms from any operator station provided the operator is logged on to an approved access level. Signals shall be configured with fail safe conditions concept unless it is mentioned elsewhere

11 Typical alarm assignments are as follows:

(a) critical alarm - an alarm that requires immediate operator action

(b) non critical alarm - an alarm that requires operator action but not necessarily immediate action

(c) operator guide alarm - an alarm that provides information to the operator

(d) event - a low priority condition which is recorded.

12 The alarm software shall produce an alarm summary which will show all currently active alarms in priority and chronological order.

2.4.4 Equipment Control

1 The system shall support a high security equipment control facility and employ revertive checking of control outputs based on a select, checkback and execute philosophy of operation. Any command entered at any OW shall complete its action within 2 s.

2 Command execution performance time excludes the time for call set-up on PSTN and assumes no transmission errors or re-transmission of data occurs.

2.4.5 Data Archiving

1 Continuous process (analogue) data, digital event states, alarms and operator actions shall be archived to a removable media system. The archive media shall be sized to store logged analogue data, at a maximum sample rate of 15 min for a period of 15 months. Data recording shall be on dual media. The archive system shall generate an alarm when a file is 90 % full.

2 Analogues will be stored at a rate selected by the operator in the range 1 second to 1 hour. The operator shall have the facility to select the way in which an analogue is stored. The system will provide any combination of the following:

(a) instantaneous value

(b) average value

(c) maximum value

(d) minimum value

(e) not stored.

3 Maximum, minimum and average values shall be calculated over a period set by the operator in the range 15 min to 24 h, the default shall be 1 h.

4 The logging of new data and reception of alarms must be carried out at the same time as the operator is viewing archived data. Any alarms received must be displayed as an overlay on the visual display unit.

2.4.6 VDU Mimic Displays

1 The Contractor shall configure all the mimics to provide total detailed coverage of the monitoring and control of equipment as detailed in this specification. It is expected that display modifications will be required in the future and therefore the ability to change the displays without programming skills is essential.

2 Instrumentation shall be displayed using ISO or ISA standard symbols. For mimic configuration, it shall be possible to call up a library of standard symbols representing items (e.g. pumps, valves) and add new symbols to the library. Building mimics shall be simple and be achieved by using a mouse or tracker ball pointing device. The mimic displays shall consist of the following pages:

(a) a general diagram covering the whole of the system on a single screen with key data

(b) a general block diagram for each site or area of Site showing the equipment displayed on a series of single screens with key data

(c) mimic of the equipment and instrumentation connected to each PLC displayed on as many screens as necessary.

2.4.7 Tabular Representation of Data

1 It shall be possible to put any data into a tabular format, with the data entered in row or columns. The user shall be able to add headings to any of the rows or columns and store the table as a blank for later use.

2.4.8 Trend Displays

1 It shall be possible to plot dynamically updated real time data and archived data on a line graph to represent analogue or digital information. Each graph shall be capable of displaying 8 plots overlaid on a graph of different colours and line texture. Next to the graph, there shall be a key relating each colour to its function. The horizontal axis shall be time based and user selectable in minutes, hours, days, weeks, for example, together with a start time.

2 The vertical axis shall be scaled as a percentage of range and be displayed in the colour of the selected reading. To avoid cluttering, the vertical axis scale shall be changed by selecting the individual display. The vertical axis shall be automatically scaled for each selected point between limits entered by the user. Actual values in engineering units shall be displayed by positioning a cursor at the desired point of the trend graph.

3 The display of the data shall also be available in tabular form.

4 The trend shall represent the associated alarms/events relevant to it in the bottom of the trend.

2.4.9 Manual Data Entry

1 The system shall be provided with facility for entering data manually via the keyboard. This data will fall into two types.

(a) constants which will be changed infrequently. This data may have time and date associated with it

(b) maintenance related comments.

2.4.10 Manually Corrected Data

1 The system shall allow a person with authorised access to manually correct erroneous data via the keyboard.

2.4.11 Reports

1 There shall be a real time spreadsheet facility supplied and installed by the Contractor in the master station. The users shall be able to transfer data from either the archive system or live data to the spreadsheet. The user shall be able to produce daily, weekly, monthly and annual reports using any data and a mixture of formats (tables, graphs, summaries, spreadsheets, pdf). Typical reports would be:

(a) power consumption

(b) total flows

(c) failures of equipment

(d) maintenance schedules.

2 It shall be possible to configure and store blank templates for later use. Facilities for editing stored templates shall also be provided.

2.4.12 Point Record

1 Each input shall have a record covering every characteristic of the input. This data shall be automatically sent to the appropriate locations when the user has completed entering or modifying data into the record. The Contractor shall compile all input records as indicated in the input/output schedules, plus any other I/O to enable the complete and optimum monitoring and control of the equipment. The user shall be able to modify, amend or create new records. The Contractor shall ensure all possible characteristics are included in the record including the following:

(a) point identity

(b) point description

(c) point type

(d) point state

(e) point range

(f) point units

(g) status/alarm and priority levels

(h) alarm set points - high, low, out of range high/low

(i) log interval - time between logs

(j) log type - average, total, and others as required

(k) log in PLC - for communications failures.

2.4.13 Profiling

1 From an average, typical or manually entered plot, it shall be possible to set an exception profile whereby readings within an upper and lower level are acceptable. Profiles shall be set graphically via OW. The user may select for the system to alarm if the reading is outside the profile and highlight such exceptions as Part of a report and so reduce the need to examine all data to ensure acceptability. The number of exceptions shall be logged.

2.4.14 Data Manipulation

1 It shall be possible to perform simple mathematical functions on any data, including the following functions:

(a) addition

(b) subtraction

(c) multiplication

(d) division

(e) square root

2 It shall be possible to log, display or use in a control loop the resultant data.

2.4.15 Database Query Facilities

1 The system shall support the use of database relationships and wild card characters to provide database query facilities. It shall be possible for applications integration to easily configure queries and save them for future use. Support of Dynamic Data Exchange (DDE) or Structured Query Language (SQL), to permit data exchange between the SCADA Master Station and external applications, including spread sheets and databases.

2 Data shall be presented in tabular format and contain any combination of fields from the main system database.

3 It shall be possible to manipulate the data by specifying search and sort criteria to define data range limits.

4 Once a query table has been created it shall be possible to store the configuration and initiate successive look ups using a point and shoot technique.

2.4.16 Downloading PLC Configuration

1 It shall be possible to download configuration to the PLC's from the engineer's terminal.

2.4.17 Diagnostics

1 The system shall have on-line diagnostic facilities to report system faults as they occur. A set of off-line diagnostic routines shall be supplied for more extensive fault diagnosis.

2.4.18 Access Levels

1 The functions available on the system shall be fully flexible so as to allow users access levels to be customised by the system operator to suit individual user requirements.

2 Access to management and engineering levels shall be restricted by user selectable passwords or keyswitch. The security systems shall be based on a set of privileges which may be granted or denied to individual uses by the system operator.

2.4.19 Control Loop and Sequence Programming

1 The method of programming will depend upon the Manufacturers system requirements. However, the following standards shall be followed:

(a) all programs shall be written such that they lend themselves easily to alterations and additions

(b) good programming practice shall be followed using structured programming techniques. All programs shall be tidy in format and logical to follow, and shall be accompanied by flow diagrams. Programs should be extensively annotated with comments and be self-documenting

(c) the system shall be supplied with programs that use a high level language for the OW.

2.4.20 Program - Documentation

1 As Part of the requirements of this specification full documentation is required as below :

(a) software user manuals

(b) database point allocation table

(c) complete program listing, flow charts for all sequences and control routines

(d) application software source code

(e) end user license agreements for the programming software.

2 The enclosure protection rate shall be IP 65 or higher as per the Engineer' requirement and the site conditions.

2.4.21 REMOTE TERMINAL UNITS (RTU) FOR Telemetry APPLICATIONRTU Hardware

1 Each microprocessor based RTU will be the main device used to control loops in each RTU process area. Each RTU shall be able to receive analogue and digital inputs from the field, perform input signal processing and alarm checking, perform algorithms control, and output to valves and other actuators.

2 Each RTU controller shall be mounted in an IP65 enclosure and constructed to allow easy replacement and maintenance of cards.

3 The RTU shall be with latest technology available in the market .

4 The RTU shall capable of programming and configuration remotely

5 The RTU shall be suitably protected against exposure to the severe environmental conditions prevalent in sewerage systems.

6 The RTU shall be an intelligent device capable of handling data collection, logging, report by exception, current data retrieval and pump sequence control programs.

7 Each RTU shall be sized for controlling the specified input/outputs and future expansion.

8 The RTU shall be of single board construction and as a minimum shall include input/output circuits:

(a) 16 digital inputs

(b) 8 digital outputs

(c) 4 analogue inputs

It shall be possible to add one of the following input/output types on a single plug-in module.

(d) 16 digital inputs
(e) 8 digital outputs
(f) 4 analogue inputs
(g) 4 analogue outputs
(h) 4 pulse inputs

9 The program and data held within memory shall remain intact and error free if all external power is removed from the RTU for a minimum period of two weeks.

10 The Contractor shall supply batteries for each RTU with sufficient backup time shall be at least 8 hours with reliable fixed diesel generator or at least 24 hours or more as per the approval of the Engineer. Considering the rural area, the backup time may be increased as per the approval of the Engineer, or as designated in the Project Specification, after a power failure. The UPS system shall be integral to the RTU. The batteries shall be of a sealed maintenance free type.

11 All field connections shall be made in terminal strips located for easy access. These terminals shall be clearly marked and identified. Terminals carrying voltages in excess of 24 V shall be fully shrouded. All terminals shall be of the 'flip up' isolator type with test points.

12 A hand held programmer, shall be provided for local display of signals, programming and fault diagnosis.

13 In case of communication failure, RTU shall be capable of storing three days of data with sampling rate of 15 minutes to be retrieved to the server after communication re-establishment.

(a) connection to other devices will use Modbus ASCII or RTU protocol as standard
(b) details of other protocols available should be included within the tender

14 RTU's shall be configured such that a single RTU failure will not interrupt or degrade equipment monitoring and control functions. RTU failure shall be alerted to the operator at the highest alarm priority.

15 Surge protection shall meet the requirements of IEEE 472-1974

16 RTU shall be able to communicate SCADA systems over DNP3 protocol and flexibility to support multiple operating modes such as poll-response, polled report by exception, unsolicited responses, and peer to peer communication.

17 Signal isolation shall be provided for each signal individually in the marshalling panels such as galvanic isolation, opti-coupler, fuses, and barriers as per the conditions of signal, instrument and site.

2.4.22 RTU Software

1 The RTU shall be capable of processing locally input equipment information before transmitting it to the master station to reduce transmission overheads.

2 Total internal scan time interval for all inputs and outputs in an RTU shall not exceed 1 s.

3 There shall be two pairs of alarm settings for each analogue input, one an alarm warning of a possible fault, the other warning that the input is outside a valid range of readings.

4 The RTU shall operate on a report by exception basis.

5 The RTU's shall have sophisticated in built control facilities to permit control loop configuration using simple building blocks. These blocks shall sequence control, three term control and other control routine components as required by the Specification. The RTU shall be capable of routine signal processing including integration, summation, subtraction and totalisation of one or more inputs. Control loops shall incorporate deviation and rate of change alarms, bumpless transfer facility, set point and output high and low limits.

6 The RTU shall be capable of executing sequential control logic. Programming of sequential control shall be by means of vendor supplied high level function block language or ladder diagram format as Part of an integrated package.

7 The RTU shall capable of data recording with time and date stamping

8 The RTU shall capable of Sequence of Event recording

9 The RTU's shall have standalone capability, able to continue monitoring equipment and executing control loops if the communication link to the master station fails. In the event of such a failure the RTU shall log all alarms and required analogues until all the total memory is filled. When the communication link is restored the RTU will automatically upload the logged data to the data archiving system.

10 The RTU's shall have a watchdog function and full self-diagnostics capable of detecting and reporting faults to the master station and displayed locally.

11 The Contractor shall program the RTU's fully under this Contract. It shall be possible to modify the programs remotely by downloading from the engineers terminal.

12 It shall be possible to initiate a current data retrieval on demand, from the master station, leaving the original RTU data contents intact for routine up-loading.

2.4.23 Future Expansion

1 The system hardware, application software and database shall be sized to accommodate a total of 10 % increase in signal capacity overall and up to 25 % increase in an individual RTU.

Sufficient plug in modules shall be provided and wired to terminals ready to accept future signals of up to 10 % or a minimum of one module, for each RTU.

2.5 PROGRAMMABLE LOGIC CONTROLLER (PLC)

2.5.1 PLC Hardware

1 The PLC system shall comprise of a central processing unit, input/output modules, serial interface modules and programming units. The PLC shall be of modular construction with plug in I/O cards and facility to install expansion racks/modules when necessary. The system shall include 25% spare capacity in hardware and memory for future modifications.

2 PLC's shall be installed inside Local Control Panels or in separate cubicles, as specified in the Project Specification. PLC shall be suitable for ambient temperature of up to 50^{O}C and 95% relative humidity.

(a) PLC diagnostic indications shall include the following:

(i) Power ok

(ii) Low battery

(iii) Forced I/O

(iv) CPU fault

(v) I/O status indicators

(b) Central Processing Unit. The CPU shall perform the following function:

(i) Scan all inputs, execute relay ladder logic programs and generate outputs for the final control elements

(ii) Monitor status of system hardware and provide diagnostic information .

(iii) Central Processing Unit (CPU) shall 80 µs per 1 kb minimum process scan time. Random Access Memory (RAM) for real time program execution with lithium battery backup for data retention and EEPROM flash backup for permanent storage shall be provided. The PLC memory shall be as required for the programs and future requirements with a minimum of 1 MB flash / I MB SRAM, with a minimum of 204 K for IEC Logic or equivalent .

3 PLCs shall be supplied complete with a laptop programming and diagnostic device plus all necessary leads and programming software & manuals. When a local SCADA computer is installed and connected to the PLC locally, the PLC programming software is to be installed in the same computer and the necessary cables/adaptors required for programming are to be supplied.

4 PLCs shall have a minimum of 1 x RS 232 plus 1 x RS 232 /485 ports and 1 Ethernet port.

5 Compact Version and/or Fixed I/O type PLC shall be considered (physical I/O counts only) at the discretion of the engineer depending upon the application requirements. The compact version CPU's specification shall meet all other communication parameters.

6 PLC control equipment shall be housed in the common controls section of the MCC, in physically separated panel and shall be fed by non-door interlocked MCCB. A separate signal marshalling section shall be provided to accommodate all input and output signals to the Control and Telemetry section.

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

8 PLC power supply shall be 24Vdc, 240 V ac as specified. The equipment shall be maintained in operation during a period of mains failure drawing power from the battery or UPS system for a minimum back-up time of 8 hours. The battery/UPS system shall include diagnostic and automatic self-test routines with volt-free contacts to initiate an alarm in the event of malfunction.

9 Panel mounted display (local HMI) units shall be provided for man machine interface, as a permanently connected means of accessing set points, timer settings, control and monitoring locally, unless otherwise specified in the project specification.

10 The HMI shall be pre-programmed to provide a basic graphical display of the process. Real-time numeric display of process variables and alarm messages shall be available. All process control functions shall be accessible for the operator from the HMI. The application program shall be stored in "Non Volatile Memory". Local HMI size shall be as specified in the clause 2.3.3 Visual Display Unit (VDU)

11 A schematic block diagrams for an overview of the PLC system and general arrangement in the MCC section indicating the location and proposed placement shall be submitted for Engineer's review.

12 The Contractor shall ensure while submitting his proposal that the PLC systems selected provides high availability and high level of integrity. The PLC shall be with the latest technology available in the market .PLCs used for controller applications require a minimum built-in redundancy of Power supply ,CPU modules, Communication modules and communications with a hot-backup logic configuration.

13 Each main PLC shall be restricted to maximum of up to 8 I/O racks; otherwise this is to be justified by the PLC manufacturer and approved by Engineer

14 Electronic Circuitry or printed circuit board in all PLC modules shall be protected with conformal coating where PLC installation in harsh environments that may contain moisture and or chemical contaminants

2.5.2 Input Modules

1 Digital input modules shall be 16-point (maximum per Card), 24 VDC, signal source type, with individual screw terminal connections. Where space restrictions or high-density signal requirements are apparent 32-point 24VDC digital input modules may be permitted with the approval of the engineer.

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

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

4 All Input modules shall be segregated into groups, which relate to 24VDC supply commons. Where different supplies are apparent in input connections, these shall be segregated in accordance with supply common grouping.

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

6 The analogue current input module shall be capable of converting 4, 8 or 16 channels of inputs in the range of 4 to 20 mA.

7 Resolution of the converted analogue current input signal shall be minimum 12 bits binary

8 All analogue signals shall be updated each scan into a dedicated area of data registers.

9 The conversion speed for all analogue current input channels shall be within 2 - 10 milliseconds

10 All digital input modules shall be provided with LED for each point (channel) for testing and maintenance purposes.

11 All digital input modules shall be provided with a dual independent power supply.

2.5.3 Output Modules

1 Discrete AC output modules shall have separate and independent commons allowing each group to be used on different voltages.

2 Discrete AC output where used shall be provided with an RC snubber circuit to protect against transient electrical noise on the power line.

3 Discrete AC outputs shall be suitable for controlling a wide range of inductive and resistive loads by providing a high degree of inrush current (10x the rated current).

4 Discrete DC output modules shall be available with positive and negative logic characteristics in compliance with the IEC industry standard.

5 Discrete DC output modules shall be provided with a maximum of eight output points in two groups with a common power input terminal per group.

6 Discrete DC output modules shall be compatible with a wide range of load devices, e.g. motor starters, valves, and indicators etc.

7 The current rating of the relay output shall be capable of supplying the load according to the applications.

8 The analogue output module shall be capable of converting digital data to analogue outputs in the range of -10 to +10 volts/ 4-20 mA.

9 Resolution of the converted output signal shall be minimum 12 bits.

10 All analogue signals shall be updated each scan into a dedicated area of data registers.

11 The analogue outputs shall be configurable to default to 4 mA or hold-last-state in the event of a CPU failure.

12 Output signals to 'DUTY' equipment shall not be derived from the same output module as 'STANDBY' equipment performing the same function.

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

14 Means shall be provided to allow the disconnection of outputs causing unsafe movements or actions without removing power from the PLC Processor or inhibiting program execution.

15 All digital input modules shall be provided with LED for each point (channel) for testing and maintenance purposes.

16 All digital input modules shall be provided with a dual independent power supply.

2.5.4 PLC Software

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

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

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

(a) suitable comments;

(b) function description;

(c) symbolic addressing local data areas;

(d) symbolic addressing global data areas;

(e) descriptions of all constants;

(f) list of cross-references.

4 The PLC shall be suitable to employ minimum two programming devices for development of application programs, a small hand-held device with back-lit LCD readout and a Software programming package running on a PLC compatible laptop or desktop computer.

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

6 Both the PC compatible computer and the hand-held programmer shall be connectable to the PLC via built-in serial communication port. The PLC shall connect to the computer over the computer's RS 232C serial port for programming.

7 In addition to the serial communications, the PLC compatible computer shall be connectable to the PLC via Ethernet TCPIP supporting the SRTP application protocol.

8 The programming devices shall have access to the application program, the CPU and I/O system configurations, all registers, CPU and I/O status, system diagnostic relays, and I/O over-ride capabilities

2.6 DATA COMMUNICATIONS LINKS

2.6.1 Communication Standards

1 Transmission of data shall conform to a recognised Consultative Committee for International Telephone and Telegraphy (CCITT) standard. The data transfer system shall be self monitoring such that any equipment or line failure shall be displayed at both ends.

2 The protocol used shall safeguard against false data transmission, allow for error detection, recovery, failure detection and initiate switchover the redundant data highway. A diagnostic routine shall be included to monitor the highway performance. Data protocols and diagnostics shall be fully documented.

2.6.2 Control Room Data Highway

1 All master station operator workstations and control room hardware shall be linked by a totally redundant local area network to transfer data between the servers, work stations and serial line multiplexers. The system shall continuously monitor the performance of both links and output an alarm on detection of an abnormal condition. Fiber Optic cables shall be provided for control room Data Highway, unless otherwise specified in the project specification

2 The following features shall be provided as a minimum:

(a) all data highway networks are to monitored at all times

(b) communications diagnostics are to be continuous such that a failure is alarmed in the minimum time

(c) each network node shall have message checking capability

(d) there shall be no single point of failure

(e) the maximum distance between nodes shall be up to 600 meters, with a maximum highway distance of 3500 meters

(f) communication rates shall be at least 10 M baud.

2.6.3 Leased lines or PSTN

1 The system shall use the public switched telephone network (PSTN) or leased data circuits to transfer data between the master station and the RTU's located at remote sites. The modems used by the master station and the RTU's shall have auto dial, auto answer capability and be PTT approved.

2 All radio equipment shall comply with the appropriate local recommendations and shall have been approved for licensing by the radio frequency allocation authority. Additionally the equipment shall comply with the most recent edition of the appropriate national and international standards specifications.

2.6.4 Radio

1 Type approval numbers issued by the national frequency allocation committee in the country of manufacture shall be supplied, together with CCIR recommendations, national and international standards, specification and recommendations met by the equipment at this time of tender.

The radio system shall be of the following type :

frequency	:	UHF/VHF as allocated by Frequency Allocation Authority
modulation	:	FM
base mode	:	full duplex
outstation mode	:	two frequency simplex
channel spacing	:	12.5 kHz

2.6.5 Radio Path Profiles

1 The Owner shall provide path profiles and subsequent technical examinations prior to detailed design of the radio system.

2.6.6 Radio Transmitters/Receivers

1 Transmitter/receiver radio units shall be single units without standby facilities. These units shall have sufficient battery back up for the system to function for 8 h in the event of mains failure. Provision for this may be from the main RTU battery back up supply. The units may be either wall mounted or incorporated within the RTU enclosure.

2.6.7 Base Station Radio Transmitter/Receivers

1 Base station transmitter/receiver radio units shall be of a dual main/standby type with auto changeover of the duty units. The Contractor shall supply within the tender document and explanation of how this changeover shall be accomplished. An alarm signal shall be transmitted to the Master Station when a changeover occurs. The base station shall be provided with power supply equipment, including nickel cadmium battery and 240 V 50 Hz a.c. mains fed battery charger and have sufficient battery back up to allow for the system to operate for 4 h in the event of mains failure and capable of automatically recharging the battery to full capacity within 24 h while the radio equipment continues to operate at full duty.

2.6.8 Aerials and Aerial Structures

1 The Contractor shall supply and install all aerials and aerial support structures and shall provide drawings to show how each type of aerial is to be mounted.

2 The base stations shall have omnidirectional aerials plus any associated duplexers.

3 UHF outstations shall have a single 12 element, yagi aerial with a gain of 12 dB with respect to a half wave dipole on the corresponding base station. Any VHF outstations shall have 3 element yagi VHF aerials planned on the corresponding base station.

4 The Contractor shall supply and install all necessary low loss coaxial down leads for connection for the radio unit and lightning protection for the aerial system.

2.6.9 Fiber Optic Network for the Telemetry / SCADA Systems

1 The Contractor shall carry out a study whether it is necessary to lay a fiber optic communication media for use as main data highway link. The study shall include the security level required in the designed site communication where fiber optic cable considered being highly secured and highly accurate communication medium.

2 This particular specification is to be read in conjunction with QCS 2010 Section 21 Part 14 Structured Cabling Systems

3 Qualifications and Responsibility of Contractor

4 The Contractor shall furnish and install all fiber optic equipment and materials specified in this section and shown on the tender drawings. The fiber optic system shall be the unit responsibility of one system supplier. The supplier shall use qualified personnel, possessing the necessary equipment and having experience in similar installations

(a) Submittals:

Submit the following information:

(i) Catalogue data and installation instructions on the splice method, hardware, and splicing

(ii) equipment (if any).

(iii) Catalogue data on the fiber optic cable, pull boxes, connectors, cable lubricant, duct

(iv) sealant, closures, pull rope, enclosures, identification tape, and mounting hardware.

(v) Catalogue data on the testing equipment including a written test procedure outlining the

(vi) steps and methods that will be used to test the cable during and after installation.

(vii) Include a sample copy of the test form that will be used in the test procedure.

(viii) Cable installation procedures for the applicable method of installation, outlining the

(ix) construction methods that will be used. Identify steps that will be taken to ensure

(x) that the cable is not damaged during the installation.

(xi) Complete factory test results for cable reel stating the signal loss for fiber in the cable

(xii) prior to and after extrusion of duct around cable if applicable.

(xiii) Record drawings indicating the locations of all splices (if any) and manholes.

(xiv) Certified test results for each cable after installation stating the signal loss of each fiber in the cable between splices, across all splices, and from end to end after splicing is complete.

(b) Qualifications and Responsibility of Contractor

(i) The Contractor shall furnish and install all fiber optic equipment and materials specified in this section and shown on the tender drawings. The fiber optic system shall be the unit responsibility of one system supplier. The supplier shall use qualified personnel, possessing the necessary equipment and having experience in similar installations.

(c) Material

(i) The Single mode optical fiber cables which are optimized for use in both wave lengths 1310 nm and 1550 nm.

(ii) The multimode optical fiber cables which are optimized for use in both wave lengths 850 nm and 1310 nm.

(iii) The optical fiber cables shall meet the requirements stated in ITU-T Rec. by international telecommunication Union, EN 50173-3 standard.

(iv) The cable shall be new, unused and of current design and manufacture. Suitable optical fiber cables shall be selected based on the distance travel, bandwidth, indoor and outdoor application and shall be approved by the Engineer.

(v) The single mode fiber shall be used for fiber optic network more than 300 m distance data transmission, unless otherwise justified by the manufacturer.

(vi) The material of the fiber shall be silica glass fiber.

(vii) The fiber optical cable shall maintain full optical performance over the Environmental temperature range where installed.

(d) Fiber characteristics

(i) The Fiber utilized in the cable must meet ITU-T: G651.1, G652 and have maximum attenuation at 850 nm of 3.75 dB/km at 1310 nm of 0.4 dB/km, at 1550 nm of 0.3 dB/km or less. If used for outdoor, then the fiber cable must be loose-tube non-dielectric type.

(e) Installation

(i) Refer to the QCS Section 21 Part 14, clause 14.2.3

(ii) The fiber cable is to be run in one continuous length (as applicable) except where the run of cable exceeds normal manufacturing lengths

2.7 INPUTS/OUTPUTS

2.7.1 General

1 All process I/O and equipment interface boards shall comply with the following:

(a) Equipment wiring terminations shall accommodate up to 0.9 mm diameter conductors. Terminals shall be of the test disconnect type to permit ease of signal isolation and loop monitoring for commissioning and maintenance purposes.

2 Hot (powered) removal of I/O boards shall be possible without special tools.

3 Provision to power two wire loop powered transmitters, where required.

4 Digital inputs shall meet the following requirements:

(a) all digital inputs shall be optically isolated.

(b) all alarm and state indications shall be from dry contacts or 24 V DC wet contacts. An isolated +24 V DC. supply shall be provided to source the opto-isolated inputs when connected to dry contacts, adequate filter circuits and software debounce techniques will be necessary.

(c) Contact operation shall be as follows :

(i) Alarms: in the healthy condition the contacts shall be closed with the relay coil energised: in the alarm condition the contacts shall be opened with the relay de-energised.

(ii) States: contacts shall be open with relay coil de-energised in the off (logic ‘0’) condition, and closed in the on (logic ‘1’) condition.

(iii) Two bit Digital: One contact shall close when the equipment is in one state and a second contact shall close when the equipment is in the opposite state.

2.7.2 Analogue Inputs

1 Independently configured channels in the range 4 - 20 mA, 1-5 V DC., 0-1 V DC., 0-5 V DC., 0-10 V DC. or +/-10 V DC. All analogues shall be screened and segregated from other cables. The signal ground shall be separate from the system ground. Input impedance shall be greater than 1 M Ω for voltage inputs. ADC conversion at ten times per second shall be 16 bit, system accuracy ± 0.2% of span.

2.7.3 Digital Outputs

1 All digital outputs shall be optically isolated.

2 All control circuits shall operate from a 24 V DC. supply. The contact will be normally open and energised to close when an action is initiated. Outputs shall be either open-collector or volt-free contacts as follows:

(a) Open collector : 100 mA at 35 V DC.

(b) Contact : 1 A at 24 V DC. or 120 VA (resistive) 0.5 A at 24 V DC. or 120 VA (inductive).

2.7.4 Analogue Outputs

1 In general all analogue outputs shall be 4-20 mA or 1-5 V DC., selectable, and drive a maximum loop impedance of 1000 Ω for current outputs and 2000 Ω for voltage outputs. The signal ground shall be separate from the system ground. DAC conversion shall be ~~14~~16-bit, system accuracy ± 0.2% of span.

2.7.5 RTD Input

1 Capable of receiving 10 Ω copper or 100 Ω platinum resistance temperature devices directly without external transmitter. Conditioned signal must be capable of being directly accessed by the on board RTU controller without external intervention.

2.7.6 Thermocouple Input

1 Capable of receiving type E, J, K, input directly without an external transmitter. Linearization shall be performed at the PLC without external intervention.

2.7.7 Pulse Input

1 Capable of receiving a zero based pulse or rectangular wave or sinusoidal wave form with amplitude of 4-6 or 21.6-27 V and rate of 0 to 5000 pulses per second for totalizing. Where frequency counting is required a rate of 0 to 1000 pulses per second should be provided

2.8 POWER SUPPLY REQUIREMENTS

1 All power supplies provided by the Contractor shall conform to the following:

(a) be comprised of standard available units

(b) be fitted with adequate input/output fuse protection

(c) power supplies to be fitted, if applicable, with short circuit protection and current limiting facilities

(d) all power supplies to be selected such that they are de-rated to allow for future expansion to improve the reliability, and help increase the MTBF of the units. With all the expansion described in this specification, the loading on the power supplies shall not exceed 75 % of their total capacity

(e) modular with one for N redundancy

(f) modular failure indicated at the PLC and Master Station

(g) failed module shall be removed without disconnecting system power or affecting control.

2.9 MIMIC DIAGRAM

2.9.1 General

1 Where required in the Project Specification a modular mimic diagram shall be provided. The Mimic will be configured to display the status of all principal items of equipment in the area covered.

2 No Part of the mimic panel display area shall be below 760 mm or above 2100 mm from the floor.

3 All layout details and dimensions, including main construction, colours, symbols, line diagrams, legend text and indications, shall be agreed with the Engineer.

4 The mimic diagram driver shall be housed in either the mimic diagram enclosure or a separate enclosure. In either case the driver shall consist of modules mounted in standard 19 inch card frames. The mimic driver shall consist of a client device directly connected to the data centre LAN.

5 Colour coding shall be in as provided below and where not stipulated in accordance with EN 60073:2000:

Status of Operation	**Colour Code**
Equipment running and normal	Green
Equipment stopped and normal	White/Grey
Equipment tripped	Yellow
Equipment selected “on Auto”	Blue
Equipment or process unsafe / danger in operation	Red
Panel Energized /isolator or ACB ON	White
Process Flow ON (e.g. Valves open)	Green
Process flow Stopped OFF (e.g. Valves closed)	White

2.9.2 Mosaic Tile

1 The face of the mimic diagram shall comprise a mosaic of precision formed tiles, which shall clip into a supporting grid to form a robust construction of flush and neat appearance. The tile faces shall have a durable, scratch-resistant non-reflective finish. The background colour of the mimic diagram tiles shall be to the approval of the Engineer. The face dimensions of tiles shall be subject to approval by the Engineer.

2 The face of the tile mosaic shall be engraved and/or printed or painted to provide a diagram. The printing or painting shall be durable throughout the lifetime of the equipment.

3 The mimic diagram face and supports shall be rigidly held in a robust floor mounting frame. The surround to the mosaic tile area and the ends of the frame shall be enclosed in decorative panelling to provide a high quality aesthetic finish. The complete construction shall be formed into an enclosed panel, with an access to enable the ready replacement of defective components and the rearrangement of tiles. Tiles and components shall be replaceable without disturbance to the surrounding areas of the mimic face.

4 Wiring troughs or clips shall be provided at the rear of the mimic diagram to enable wiring to electrically driven components to be neatly dressed and supported. Flexible wiring of adequate length shall be used to enable electrically driven components to be relocated on the mimic diagram without the necessity for rewiring.

5 All illuminated indications shall use high radiance, light emitting diodes (LED's). Either single peep-through or multiple-element/planar types shall be used, as appropriate. The illuminated area shall have even intensity across the whole face. All LED's shall have a wide viewing angle in excess of 60 ° without significant change in perceived luminosity.

6 A 20 % spare capacity shall be provided (equipped) within the mimic driver and the wiring to the mimic board to allow for future modifications. The spare capacity shall be evenly distributed.

7 All driver outputs shall be protected against overload and short-circuit.

8 Lamp test facilities shall be provided such that operators can initiate the test from their workstation positions. This facility shall ensure that both the mimic LED's and the driver circuitry are exercised.

2.9.3 Projection

1 The mimic diagram shall be displayed using high resolution 1280 by 1024 panel rear projection technology onto multiple projectors and screens arranged in a matrix to produce an integrated display, or an equivalent quality as specified in the particular Specifications.

2 The screens shall offer a wide viewing angle, + 40 ° horizontal and + 12 ° vertical, and good contrast in full ambient light conditions. The projector and screen assembly shall occupy a floor space of less than 1.5 m, deep by the length of the mimic.

3 Dynamic configuration of the display shall be from X-windows style environment and provide intuitive on screen menu drive display. The ability to interface multiple sources, up to a maximum of 10 using an RS232/422 serial interface shall be provided.

4 A software package shall be provided to adjust brightness, contrast, time, colour, sharpness and geometry and convergence settings from one computer. Image adjustments shall be stored for each source such that the projector will automatically select the correct settings for the Particular source.

5 An auto convergence system shall be provided to automatically align the projected image on the screen, manual convergence shall also be possible.

6 A live video window facility shall be provided to display real time video images anywhere on the screen matrix. The video signal may originate directly from a site security video camera or via a live antenna signal.

7 A remote pointer facility shall be provided to allow the operator to use the local keyboard and mouse to move the cursor on the mimic display and interact with the applications. The system shall support up to three operators simultaneously with a security interlock system to avoid conflicts between users.

2.10 FACTORY INSPECTION AND TESTING

2.10.1 General

1 The Contractor shall advise the Engineer the date on which the equipment is available for factory inspection and tests 30 days in advance. Factory inspection shall be made only after the manufacturer has performed satisfactory internal test. Factory internal test report shall be provided to the engineer in advance before the inspection visit .No equipment shall be shipped to Site without written permission of the Engineer.

2 Before dispatch from a manufacturer's works each item of equipment, software and its components shall be tested in accordance with the relevant specification or code issued by the British Standards Institution or similar internationally recognised standards authority. In the absence of such a specification or code, these tests shall be performed in a manner subject to the approval of the Engineer, and may be witnessed and approved by the Engineer or his representative. The equipment will be inspected by the Engineer and his representative, to ascertain compliance with the functional design specification, satisfactory finish and workmanship, and relevant functional tests shall be carried out with simulated inputs/outputs as necessary.

3 The FAT shall be conducted using suitable and duly approved simulation equipment to ensure satisfactory operation of the PLC / SCADA

4 Subject to the Engineer agreement, the works system tests shall take place according to the program detailed by the Contractor.

5 Any surface coating applied prior to the initial inspection of equipment shall be considered sufficient reason for its rejection. Where any attempt to conceal defects is discovered the works may be rejected.

2.10.2 Test Plan

1 A test plan shall be produced for the Engineer's approval, by the Contractor, for the factory and site acceptance tests. The plan shall indicate a logical step by step schedule comprising step, action and reaction, e.g.:

Step 1 Action : Simulate high level
Reaction : Tank Symbol Change Colour

(a) Hardware Tests

(i) All hardware including spares shall be required to pass an agreed preliminary hardware performance test to ensure known hardware operability before software testing begins.

(b) Functional Testing

(i) Functional testing using the system software shall be comprehensive. Simulation of the inputs and responses from equipment operation shall be as realistic a reproduction as possible of Site conditions. Systems to which the PLC/SCADA is required to interface with but are outside the scope of this contract shall be emulated to demonstrate correct operation of the hardware and software.

(c) System Diagnostics

(i) The means of fault detection and diagnostics provided by the system software shall be validated. This will involve making provision for including a sufficient variety of faults and out-of-range conditions in the system to ensure the detection processes are adequately tested.

(d) The Engineer shall have the option not to attend these tests and to instruct the Contractor to carry them out on a Self-Certification basis.

(e) Three copies of all manufacturers' tests certificates, log sheets, performance curves, etc. relating to the tests at manufacturer's works shall be dispatched to Site for the Engineer's approval prior to system installation and commissioning.

2.11 INSTALLATION

2.11.1 Tools

1 The Contractor shall include for the supply of all spanners, key, special tools, gauges and all other electronic and calibration tools required for the efficient installation, commissioning and operation of the equipment.

2.11.2 Training for Owner's Personnel

1 Training shall be conducted by personnel employed by the ICA Subcontractor, familiar with the system supplied, experienced and trained in developing and implementing instructional courses.

2 The Contractor shall submit information on the training program for approval prior to shipment of the equipment. This submittal shall include a course outline, time required, course schedule, sample workbook and instructor qualification information for each level.

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

4 The training times shall be scheduled by Owner in advance so as not to disrupt Owner's ability to operate the equipment.

5 Specialised training shall be provided for a minimum of three of the Owner's personnel in the operation and maintenance of the system at the manufacturer's facility or in Qatar, as specified in the Project Specification. The training programme shall be divided into two segments and each shall consist of at least five, eight hour working days.

6 The maintenance training programme 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:

(a) system architecture and layout
(b) hardware components
(c) module switch settings (configuration switches)
(d) I/O modules
(e) power supplies
(f) data highway
(g) programmer connection
(h) PLC programming and diagnostic techniques
(i) battery replacement and recording
(j) PC and workstation familiarization and maintenance
(k) troubleshooting
(l) disassembly
(m) cleaning
(n) component replacement
(o) reassembling.

7 The operation training program shall include the following topics:

(a) power-up, bootstrapping and shutdown of all hardware devices
(b) interpretation of all standard displays
(c) appropriate actions for software and hardware error occurrences

(d) use of operator interface displays and keyboards

(e) use of printer including replenishment of supplies

(f) manual data entries

(g) creation and editing of graphic operator display screens

(h) loading of any required software into the system

(i) data base creation and editing.

8 System Management:

The training in this area shall cover the following:

(a) the daily supervision of the System: e.g., archiving data, system housekeeping, fault reporting, preventing repetitive alarms

(b) system administration e.g., planning and providing system expansion and reconfiguration of hardware, control of users and privileges, software and hardware fault analysis

(c) Engineering functions, configuration and application programming e.g., additions and changes to the system, points, displays, reports and logs, preparation and downloading of sequence control programs and schedules and software development.

2.11.3 Site Inspection and Testing

1 The Engineer shall have the option to attend the inspection and tests before setting the equipment to work. The Contractor shall notify the Engineer, in writing, 48 hours before commencing tests.

2 A Site Acceptance Test (SAT) shall be conducted as part of the ICA system validation and shall include all equipment and software within the Contractor's scope of supply. This test shall be conducted after the above equipment has been installed at the Site and the Contractor is satisfied of the correctness of the installation and of the operation of the equipment.

3 Particular Test Requirements

(a) communication test

(i) the Contractor shall firstly conduct a test to establish the correct functioning and ability to correctly transmit data to and from each port on the system communications network. In the event of any problem or deficiency being identified in any equipment supplied by others, this shall be reported fully in writing by the Contractor to the Engineer

(b) hardware test

(i) demonstrate correct operation of hardware using off-line diagnostics

(c) functionality test

(i) demonstrate the system performance and functionality meets the specification

(d) test details

(i) the SAT shall be carried out in accordance with a test specification produced by the Contractor, and approved by the Engineer

(ii) test equipment and test software shall be provided by the Contractor to load the system to the worst case scenario defined in the test specification

(iii) the Contractor shall prepare a test report following the SAT.

4 System Commissioning

(a) where required in the Project Specification the Contractor shall provide staff to work in conjunction with the Owner to ensure the satisfactory operation in service of all equipment in the system, and to assist the Owner to adjust configuration data and to develop/modify application programs e.g., sequence controls.

5 System Takeover

(a) The criteria for takeover of the system shall be:

(i) submission by the Contractor and approval of as-built drawings

(ii) submission by the Contractor of all documentation

(iii) submission of all software design and support documentation and the lodging of source codes in a place of secure safe-keeping and storage with a third Party

(iv) provision of information and examples of each type of report and each item of user-configurable functionality

(v) issue of all relevant test certificates

(vi) successful completion of the SAT

(vii) system commissioning and issue of Final System Test Certificate by the Contractor.

6 Following satisfactory completion of the above, the 'Engineer' will issue the necessary system takeover certificate.

END OF PART