SUBSECTION 10: INSTRUMENTATION, AUTOMATION AND CONTROL SYSTEM

10.1 Introduction

10.1.1 Overview of Project

The present scheme is proposed to collect, treat and dispose into the Creek wastewater of domestic origin with a very small quantity of industrial wastewater in the city of Mira Bhayander. The system is configured as a de-centralized wastewater management system consisting of distinct drainage districts each having an independent wastewater treatment facility. Treated effluent is to be pumped into outfall sewers taking off in different directions. The outfall may have tappings for drawal of water for green zone development. The system is controlled by a pressure transmitter and control valves with a PID controller to open depending on the pressure carried by the ring main. The treatment plants and disposal system is Supervisory Control and Data Acquisition (SCADA) operated from a central control station.

10.1.2 Operating Philosophy

The Scheme is to be provided with facilities to permit automatic operation of the overall system.

Also it is proposed to make available backup of all data available at MCC SCADA system to PC Based Management Information System (MIS) & Back-up system at the Mira Bhayander Municipal Main Office. This is proposed to be done through UHF Communication Network. Also voice communication facilities shall be provided at each of the sites and among the sites. To achieve this, a reliable voice and data radio UHF radio communication system is proposed to use.

All data from these various sites shall be made available for monitoring and control operations over Waste water network linked via a communications link to the Master Control Centre (MCC). The MCC is proposed at the MBMC office where a PC based supervisory control and data acquisition (SCADA) system shall be provided.

10.1.3 Scope of Instrumentation & control, SCADA, MIS & Back-up and UHF Radio Voice and Data Communication Systems

(a) Design, factory test, supply, install and test at site the complete Instrumentation & control, SCADA, MIS & Back-up and UHF Radio Voice and Data Communication Systems including all necessary hardware, software and configuration services;

Schematic diagram of Instrumentation & control, SCADA, MIS & Back-up and UHF Radio Voice & Data Communication Systems to be provided

(b) Design, supply, factory test, install and test at site the instrumentation consisting of PLC based control panels, power supply systems, level, pressure and flow measuring systems at various locations in the system.

(c) Interfacing of SCADA, MIS & Back-up and UHF voice and data communication systems with Instrumentation and SCADA system.

(d) Design, factory test, supply, install and test at site the UHF radio voice and data communication network between MCC, pumping stations, wastewater treatment plants, flow control facilities, and Management and Information System (MIS

(e) Supply, laying and termination of instrumentation signal, control, communication and power supply cables, cable trenches, trays, conduits, lugs, glands, steel supports for trays etc. between the equipments supplied by the contractor.

(f) Design, supply & construction of a concrete underground chamber (s) around the pipe for enclosing the flow measuring systems at all sites.

(g) The motorised valves on the treated effluent disposal lines will be in the contractor's scope. In addition, the power supply cabling and supply feeder panel for these motorised valves, the control cabling for automation and monitoring of these motorised valves shall be carried out by the Contractor.

(h) Provide all necessary input to the 'end to end' tests which will form part of the pre-commissioning procedure for the control and monitoring system as a complete entity.

(i) Provide all facilities such as test rigs and test equipment and all consumables necessary for the satisfactory completion and operation & maintenance of the instrumentation & control, SCADA, MIS & Back-up and UHF radio voice and data communication systems.

(j) Carry out all other work necessary for the satisfactory commissioning of instrumentation & control, SCADA, MIS & Back-up and UHF radio voice and data communication systems including radio survey and liasoning for obtained necessary radio frequency license from Government of India.

(k) Provide class room based and on job training for those persons involved in management, operation, maintenance and development of the instrumentation & control, SCADA, MIS & Back-up and UHF radio voice and data communication systems

(l) Provide As Built and Operation and Maintenance documentation for all these mentioned system.

(m) Provide necessary spares for five years of Operations and Maintenance of Control and Communication Systems including their power supply systems.

(n) Install Telemetry towers at various locations

10.1.4 Structure of Control and Monitoring System

The control and monitoring facilities for Wastewater system are to be layered as follows:

(a) Supervisory control & monitoring of each pumping station, Wastewater Treatment Plant, ring mains and disposal system, from the central location (MCC) at MBMC office using the SCADA system.

(b) Supervisory control & monitoring of each pumping station, and treatment plant from the local SCADA system.

(c) Automatic control of each pumping station and wastewater treatment plants by programmable logic controllers (PLCs). This automatic control should continue to function satisfactorily even in the event of a complete failure of SCADA and communications system.

(d) MIS & Back-up system integrated through UHF communication system to MCC SCADA

(e) Hard wired systems - Such systems are to be used to effect safety critical interlocks, to provide a means of starting and stopping drives from the motor control centres.

10.1.5 Applicable standards:

The design, manufacture, performance and testing of all equipment, system software and services covered under this specifications shall comply with all currently applicable standards. If such standards do not exist for any equipment or system, the same shall comply with the applicable recommendations of the following professional institute:

- International Electrotechnical Commission (IEC)
- International standards Organisation (ISO)
- International Telecommunication Union (ITU-T)
- Institution of Electrical and Electronics Engineers (IEEE)
- Instrument Society of America (ISA)
- American National Standards Institute (ANSI)
- National Electricity Manufacturers Association (NEMA)
- British Standards Institute (BSI)
- European Telecommunication Standards Institute (ETSI)
- Electronics Industry Association (EIA)/Telecommunication Industry Association (TIA)
- Department of Telecommunication (DoT), India
- Wireless Planning and Co-ordination wing, Ministry of Communication, Govt. of India, Aviation Administration & Local Authorities

10.2 CONTROL, INSTRUMENTATION AND AUTOMATION

10.2.1 General

For uniformity of appearance all switchgear and control panels shall have a common appearance and colour.

In order to reduce the holding of the spares to a minimum, the instruments and, electrical, control and instrumentation equipment and components of similar type and purpose, used throughout the Works shall be of the same manufacturer and type / series.

All ventilation grills provided to the control panel shall be provided with fly screens to prevent the entry of insects.

10.2.2 Abbreviations

The following abbreviations have been used in this document:

(a) AC - alternating current
(b) DC - direct current
(c) I & C - Instrumentation and Control
(d) A - amp
(e) mA - milliamp
(f) V - volt
(g) Hz - hertz (cycles per second)
(h) MCB - Miniature Circuit Breaker
(i) CP - control panel
(j) UPS - uninterruptible power supply
(k) PLC - programmable logic controller
(l) I / O - input / output
(m) OIU - Operator interface Unit
(n) LAN - local area network
(o) PC - personal computer
(p) SPD - surge protection device

10.2.3 INSTRUMENTATION SYSTEM DESIGN CRITERIA

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

(a) all instruments shall be suitable for continuous operation
(b) all transmitting instruments shall have a 4 - 20 mA linear output
(c) all digital outputs shall be volt free
(d) all instruments shall be designed for the ambient conditions of temperature and humidity
(e) all wetted parts of instruments sensors shall be non-corrosive and suitable for use with wastewater
(f) all instrumentation systems for use out of doors shall be protected to IP 65
(g) all analogue displays shall be of the digital type with no moving parts utilising back lit liquid crystal diode technology
(h) instrumentation shall utilise solid state electronic technology and avoid the use where practical of any moving parts
(i) instruments shall resume operation automatically on application of power following a power failure

10.2.4 INSTRUMENTATION & CONTROL SYSTEM POWER SUPPLY

415 V AC, 50 Hz feeders shall be made available for power supply to I & C equipment. UPS shall be provided as a back-up power supply for complete instrumentation & control, SCADA and UHF Voice and Data Communication System. The required DC voltages for these systems shall be derived from the UPS supply by providing necessary converters in redundant configuration.

10.2.5 INSTRUMENTATION EARTH

A copper bar shall be provided inside each control panel as earth-bus, and the same shall be connected to the earth-pit by isolated copper conductor. The earth pit for instrumentation system shall be separate. Electrical earth-pit shall not be used for earthing of instrumentation equipment.

All signal cable screens (analog and digital) shall be terminated onto the instrument earth bar. Signal cable screens shall be earthed at the control panel end only. Screens at the field end shall be tied back and insulated.

SPDs associated with the control and instrumentation system shall be earthed to the instrument earth.

10.2.6 INSTRUMENTATION CABLE

Each drum or coil of cable shall be accompanied by a certificate stating the manufacturer's name, cable size, number of cores, length, result and date of tests as required in the particular requirements.

Cables manufactured more than 12 months before delivery will not be accepted. All cables shall be delivered with cable ends effectively sealed. When a cable is cut from a drum both ends shall be immediately sealed to prevent ingress of moisture.

Cables shall not be transported to site in loose coils but a number of short lengths of cable may be transported on the same drum.

For data transmission, the cable to be provided shall be in accordance with the recommendations of the PLC, SCADA and UHF radio communication system manufacturer.

For power supply to instruments (230 V AC), 3 core x 1.5 mm^2 PVC insulated, armoured copper conductor shall be used.

All instrumentation cables shall be sized for continuous current carrying capacity at the ambient temperature.

All signal cables (Analog/Digital) shall be 660V, PVC insulated with stranded tinned copper conductors and laid up as twisted pairs with approximately one twist per 30mm approx. Each cable shall be overall screened and pair screened of aluminium-mylar tape including drain wire giving a coverage of 85%, steel wire armouring insulated from the screen and from any ducting and overall PVC sheath. The signal and power supply (24 V dc) shall have a conductor of 1.0 sq.mm.

Cables from temperature sensors viz., resistance thermometer be laid in triads and shall be overall screened. In case of multicore cables, the cables shall be individual triad screened and overall screened.

Initiating devices for plant protection and personal safety shall be connected by individual cables direct to tripping or safety device and shall not be routed via any intermediate junction box, marshalling box relay etc.,

The power supply cable to instruments shall be overall screened. All the cables shall confirm to IS 1554, and IEC 1810.

Cable Colours

All cable cores in multicore cables shall be colour coded or marked throughout their lengths and shall be connected such that the correct sequence of colours are preserved throughout the loop.

Cable Identification and Numbering

(a) At each end of each cable, in a uniform and visible position a label shall be fixed on the cable in accordance with the cable schedule. Labels shall be made of aluminum and shall be indelibly marked. The label shall be retained using proprietary nylon strips passing through two fixing holes at either end of the label. If the cable gland is not normally visible, then the label shall be fixed inside the panel by means of screws.

(b) All cables shall be allocated a unique number which shall be fixed to each end of the cable using a corrosion resistant label. Cables of different categories shall be tagged with the following subscripts and three digit number:

Control	C - ****
Instrumentation	I - ****
Telecommunication	T - ****

(* stands for a numeric character)

10.2.7 CABLE INSTALLATION

Junction Boxes

(a) In order to make the most economic use of cable ladder/tray and duct capacity, multicore cabling shall be utilised in order to connect instrumentation groups by using suitably located sub-distribution junction boxes. The junction boxes shall have weather protection suitable for the area in which they are to be installed and for the type of circuit. They shall be readily accessible for maintenance and clearly labelled. Junction boxes shall be constructed of die cast aluminium and provide degree of protection IP 65.

(b) Separate cables shall be used for digital and analog signals.

(c) Wires and terminals for the digital and analog signals shall be segregated within junction boxes.

Cable Terminations

(a) Control and Instrumentation cables cores shall have either crimped lugs or sleeves to match clamp terminals. Each core shall be labeled at the termination with a numbered sleeve.

(b) A sufficient number of terminals shall be provided to terminate all cable cores. Additional 20% spare terminals shall be provided.

(c) Not more than one core of internal or external wiring shall be connected on any one terminal. Where duplication of terminal blocks is necessary, purpose-made solid links shall be incorporated in the design of the terminal blocks.

(d) Terminals which remain energised when the main equipment is isolated shall be suitably screened and labeled.

(e) Terminal blocks for different voltages or circuit type shall be segregated into groups and distinctively labeled.

(f) Each cable entry into a terminating box shall be made through a suitable gland, which shall have provision for securing the armour where applicable. Where single core glands are required these shall be of the non-magnetic type and the associated box bottom plate, where the core passes through, shall not have a continuous magnetic path.

(g) Where cable glands are exposed to the atmosphere these shall be protected by heat shrink plastic sleeve or purpose moulded sleeves covering the gland continuously from overall sheath to the gland neck.

(h) Cable joints in control and instrumentation cables shall not be permitted.

10.2.8 CONTROL PANELS

Construction

(a) Cubicles for I & C, SCADA, UHF communication systems equipment shall be prefabricated out of sheet steel of not less than 2 mm thick for all the sides and 3mm thick for mounting and gland plate. Adjacent frames, dividers and covers shall be securely bolted to ensure earth continuity throughout.
(b) The exterior corners and edges shall be rounded to give a smooth overall appearance with projections kept to a minimum.
(c) Lifting lugs shall be provided for installation purposes and shall be replaced with corrosion-resistant bolts after installation.

(d) Unless otherwise specified assemblies shall be prefabricated and floor standing with lockable hinged front doors and bolted removable rear panels where access to live equipment such as busbar and terminals is possible.
(e) Instrumentation shall not be positioned above 2000 mm or below 500 mm and devices for isolation and switching shall be accessible within the zone 500 mm to 1600 mm above floor level. Suitable warning labels and instructions for earthing and isolating shall be fitted where necessary.
(f) Unless otherwise specified cable entry shall be from the base and shall enter an accessible cabling compartment via suitable cable glands and gland plate. Access to cable terminations shall be via bolted panels either from the rear or front as specified.
(g) Cubicles for outdoor locations shall be fitted with lockable outside doors and housing so designed that all controls, instruments and such like are fully enclosed with the whole assembly weatherproof and vandal proof. The doors shall be fitted with stays arranged to prevent overstraining of the hinge fixings and allow fixing of the doors in the open position.
(h) The internal cubicles shall also be weatherproof to allow operation of the controls when the outside doors are open during inclement weather.

(i) Control panels and instrument enclosures, shall give a degree of protection as follows:
(ii) Indoor installations
- Non air-conditioned areas : IP 52
- Air-conditioned areas : IP 44

(iii) Outdoor installation : IP 65

Safety

(a) Instrument cubicles shall be designed and constructed to provide a maximum standard of safety for operating and maintenance personnel.
(b) Where a test facility exists for use with the enclosure door open all live contacts shall be shrouded to prevent accidental contact.

Short Circuit

The short circuit rating of the assemblies shall be suitable for the point of installation in the system. Where possible short circuit protective devices shall be co-ordinated to ensure that a fault in any outgoing branch does not operate the assembly incoming protection device.

Earthing

An instrumentation earth shall be provided in each control panel. This shall comprise a copper bar of cross section not less than 25 x 6 mm and length to suit the number of connections. It shall be mounted on at least two insulated supports and be provided with a single earth connection to the instrumentation earth. If due to the physical size of a control panel more than one instrument earth bar is required the additional bar shall be connected again with a single earth connection to the same point as before on the control panel instrument earth bar. In this fashion all instrument earths shall be connected radially from the same earth point.

Assemblies shall be provided with earthing facilities as follows :

For small single compartment assemblies an earth stud shall be provided. For large single compartment or multi-compartment assemblies a clearly marked continuous copper earth bar shall run the length of the assembly and shall be provided with terminals for connections to the metal cladding or armouring of all incoming and outgoing cables.

The short-term rating of the earth busbar and connections shall be not less than that of the associated equipment, or the maximum through-fault current of the power source. The temperature rise of the busbar and connections under fault conditions shall not cause damage to the connections of any equipment to which they may be connected.

No earth terminal bolts or studs shall be less than 8 mm diameter.

An earth bond of minimum size 6 mm^2 shall be made to all enclosure doors.

Labels

(a) The assembly as a whole and each compartment shall be clearly and unambiguously identified.
(b) The labels shall be engraved letters and numbers filled black on a white background.
(c) Warning labels shall be engraved and filled black on a yellow background.
(d) Labels shall be affixed with non-corrodible rivets or screws.
(e) Internal labels shall be used to identify all components and terminal strips. They shall be of plastic in construction and shall be affixed adjacent to the component .

Internal Power Distribution

(a) The internal power distribution arrangement for each assembly shall comprise a MCB distribution board arrangement for each voltage present. Separate switches on this board shall be dedicated to individual circuits in order to facilitate isolation and to localise faults.
(b) A separate MCB shall typically be provided for each of the supplies to the following I&C equipment:

(i) 240 V AC

- power supplies
- PLC CPU and input modules
- PLC output modules
- transformers
- rectifiers
- each instrumentation loop
- panel lighting
- panel cooling
- anti-condensation heating
- internal socket outlets

(ii) 24 V DC

- PLC input / output circuits and modules
- PCL modules

(c) Auxiliary contacts shall be fitted to each MCB to indicate a trip.
(d) The power supply for the 240V AC distribution board shall have immunity from mains voltage disturbances, an isolation transformer shall be provided for this purpose.
(e) The 24 V DC power shall be derived from a stabilised 240 V AC UPS.

Arrangement of Internal Components

(a) Internal components shall be laid out in a logical manner in order to provide freedom of access to terminations and to allow removal of any component without interference to adjacent components.
(b) Particular attention shall be paid to the location of heat dissipating equipment such as power supplies etc in order that they do not have a detrimental effect on adjacent cabling or components.
(c) An over-temperature alarm signal shall be provided by the volt free contacts.

Terminal Arrangements

(a) Cables entering and leaving an assembly shall do so via suitably positioned terminals.
(b) Terminals shall be arranged in function groups as follows:

(i) supply outputs to field devices
(ii) signal inputs from field devices
(iii) control output to starter sections
(iv) signal inputs from starter sections
(v) signal inputs to telemetry
(vi) signal outputs from telemetry

(c) Within each group terminal shall be arranged in subgroups as follows:

(i) voltage energised with panel door open
(ii) de-energised with panel door open
(iii) digital signal
(iv) analog signal

Terminals for circuits at voltages greater than 24 V that are not de-energised when the assembly door is open shall be screened and labelled accordingly.

Lighting

Each cubicle of an assembly shall be provided with an internal switched Compact fluorescent luminaire. It shall be positioned to illuminate all internal areas of the assembly cubicle.

Components

Assembly components mounted on the external surfaces of assemblies shall not reduce the degree of protection from that specified.

Indicator Lights

(a) Lens colours shall comply with BS EN 60037 as follows:

(i)	running	-	green
(ii)	tripped/alarm	-	red
(iii)	open status of valve	-	green
(iv)	close status of valve	-	red
(v)	ready to start	-	blue
(vi)	warning (no imminent danger)	-	amber
(vii)	power on / any other application	-	white

(b) The indicating lamps on the control panel shall be a cluster of LEDs.

Push buttons

(a) Colour of push buttons shall generally comply with BS EN 600 37 or IEC 73 and in particular shall be as follows :

(i)	Stop, emergency stop	-	red
(ii)	start	-	green
(iii)	jogging/inching	-	black
(iv)	reset	-	blue
(v)	lamp test	-	blue
(vi)	override/alarm accept	-	yellow

Internal wiring

(a) Switchboard wiring shall be carried out in 650/1100 V PVC cable to IS 1554 Part 1 or BS 6231 and the conductors shall not be less than 1.0 mm^2 and shall be stranded.
(b) Wiring within the switchboard shall be marked with colour coded ferrules at each end for identification. The letters and numbers used shall correspond with the assembly wiring diagram.

(c) The wiring colour code shall be as follows:

(i)	Control	-	blue (DC), red (AC)
(ii)	Earth	-	green/yellow

(d) The wiring shall be neatly laced and cleated to the switchboard structure or contained within purpose designed plastic trunking and arranged so that access to equipment is not impeded. Cables installed in trunking shall have a space factor not exceeding 50%. Where wiring passes through metalwork the access hole shall be fitted with a suitable grommet.
(e) Wiring between cubicles or panel sections shall be terminated in terminal blocks at each end. Each terminal shall be identified by its cable number.
(f) Crimped terminations shall be applied to all cable ends to ensure sound termination to terminal blocks and all circuit components. The type of termination used shall be suitable for the application in each instance.
(g) Wiring between cubicles or panel sections shall be terminated in terminal blocks at each end.
(h) No tees or joints between termination points shall be permitted.

Miniature Circuit Breakers

(a) Miniature circuit breakers shall comply with IS 8828 or BS EN 608910. They shall be type 3 with a breaking capacity of at least 4.5 kA at 240/415 V unless the fault level at the point of installation dictates otherwise.
(b) Miniature circuit breakers for dc circuits shall provide a double break (one pole protected plus one switched).
(c) Auxiliary contacts shall be fitted to each MCB to indicate a trip

10.2.9 Not Used

10.2.10 UNINTERRUPTIBLE POWER SUPPLY SYSTEM :

Introduction :

An uninterruptible power supply (UPS) suitable for instrumentation & control, SCADA, MIS & Back-up and UHF radio voice & data communication systems at following locations will be needed:

i) MCC at Administration Building - MBMC
ii) All pumping Stations
iii) All Wastewater Treatment Plants
iv) Ring main and disposal flow control system

The UPS shall be sized to provide sufficient power to maintain instrumentation & control, SCADA, MIS & Back-up and UHF voice and data communications systems functioning

for 'Three Hours' at full load. I&C System, SCADA and communication system at each WWTS & PS

Features :

(a) The UPS shall be a proprietary item and shall be free standing. It shall incorporate a static bypass switch and maintenance bypass in order to permit the removal of the UPS from service without interrupting the power supply to the control system. An AC distribution board shall be provided for I&C and SCADA system at each pumping station, at MCC, MBR, TBR and MIS & Back-up sites.

(b) The UPS shall be floor mounted, self contained and metal clad and shall be suitable for supplying a non linear load.

(c) It shall be possible to open the enclosure front door when the unit is in use without exposing any live contact to touch.

(d) The UPS shall be an on-line type incorporating a six pulse rectifier and pulse width modulation inverter technology with microprocessor control. It shall incorporate a static bypass switch which shall operate in the event of UPS failure, overload or manual initiation in order to transfer the output supply to mains without disturbance to the output supply. Transfer time shall be less than 5 ms.

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

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

(g) The output of the inverter shall be a sine wave having less than 2% THD for linear loads and less than 4% for 50% non linear load. It shall be suitable for load power factors 0.8 lag to unity load.

(h) The unit shall have a dynamic response such that a 100% step load causes an output voltage transient of less than ± 4% with a recovery time of less than 4 ms.

(i) For three phase output units the output voltage shall not vary by more than ± 1% for an unbalance of 10%.

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

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

(l) Indicators & Protections shall be provided for the following

i) Mains ON
ii) Inverter ON
iii) Battery On charge
iv) Load On Inverter
v) Load on auxiliary supply
vi) Mains Overload/Underload Voltage
vii) Battery Low
viii) DC Overload/Underload Voltage
ix) Inverter Overload/Underload voltage
x) Inverter overload
xi) Overheat

A LCD meter shall be provided for metering of the following:

i) Input voltage, current
ii) Output voltage
iii) Output load current
iv) DC voltage
v) Frequency
vi) Battery %

(m) The UPS shall provide volt free contact outputs for the following purpose.

- Warning, (viz., low battery charge)
- UPS fault
- Static bypass in use

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

(o) The batteries shall be housed, within a separate matching battery cubicle suitable for location adjacent to the UPS.

(p) The batteries shall be of the rechargeable, sealed, maintenance free lead acid type. Terminals shall be shrouded to prevent accidental contact.

(q) Warning notices shall be provided for wall mounting to warn of the presence of charge gases.

(r) The battery supply to the UPS shall be via a fused load break switch disconnector circuit breaker.

(s) The battery recharge time to 90% of full charge shall be approximately ten times the discharge time at full load.

AC Distribution Board (ACDB) :

Required ACDB (s) shall be provided by the contractor WWTS & PS-I, II, III, MCC, MBR, TBR and MIS & Back-up sites as a part of UPS system.

(a)	General		
	Voltage	:	1 Phase, 2 wire, 240V, 50 Hz
	Short circuit level for 240 V AC	:	5KA (r.m.s)
	Reference temperature	:	Ambient
(b)	Main distribution board	:	
	Bus bar	:	Copper
	Bus bar current rating	:	25A
	Incoming lines	:	1 No., 30A MCB, SPN
	Outgoing lines	:	10 Nos., 10A MCB, SPN
(c)	Enclosure	:	
	Type	:	Pre-fabricated, Modular in construction
	Paint	:	Powder coated
	Sheet material	:	2mm
	Degree of protection	:	IP 52
	Earthing terminals	:	25 x 3mm GS FLAT

10.2.11 DC POWER SUPPLIES

(a) The required DC power supply for Instrumentation & Control and UHF voice and data radio communication system shall be derived from 230 V AC UPS at each of the sites. DC Power supply system shall produce required DC output voltage at full load current. The DC power supplies shall be provided in redundant configuration and in case of failure of main DC power supply the standby/redundant DC power supply shall automatically take over and an alarm shall be generated "Main DC power supply unit failed" on respective MMI/OIU as well as at MCC.

(b) DC power supply systems shall provide necessary isolation using required hardware, for UHF voice and data communication system power supply.

(c) Voltage regulation shall be 0.02% for ±10% mains voltage variation

(d) Load regulations shall be 0.3% from zero to full load conditions

(e) Ripple at full load shall be <1 mV rms

(f) The power supply shall incorporate an overvoltage protection circuit, the components of which shall be independent of the voltage regulating circuit.

(g) The protection circuit shall operate within 50 ms of an overvoltage occurring, and shall cause rupturing of the mains input or output fuses.

(h) Automatic reset of the overvoltage protection circuit is not permitted.

(i) For a 24 V power supply, the overvoltage tripping setting shall be 28 V.

(j) DC Distribution Board (DCDB) : Required DCDB (s) shall be provided by the contractor at WWTS & PS-I, II, III, MCC, MBR, TBR and MIS & Back-up sites.

10.2.12 PROCESS INSTRUMENTATION

(a) Instrumentation system shall be designed, manufactured, installed and tested to ensure the high standards of operational reliability. All electronic components shall be adequately rated and circuits shall be designed so that change of component characteristics shall not affect plant operation.

(b) All instrumentation equipment shall be new, of proven design, reputed make, and shall be suitable for continuous operation. Unless otherwise specified, all instruments shall be tropicalised. The outdoor equipments shall be designed to withstand tropical rain. Wherever necessary space heaters, dust and waterproof cabinets shall be provided. Instruments offered shall be complete with all the necessary mounting accessories.

(c) Electronic instruments shall utilise solid state electronic components, integrated circuits, microprocessors, etc., and shall be of proven design.

(d) No custom made hybrid type integrated circuits shall be used.

(e) Unless otherwise stated, overall accuracy of all measurement systems shall be ±1% of measured value, and repeatability shall be ±0.5%.

(f) Unless otherwise specified, the normal working range of all indicating instruments shall be between 30% and 80% of the full scale range.

(g) On resumption of the supply following a power failure the instruments and associated equipment shall start working automatically.

(h) The instruments shall be designed to permit maximum interchangeability of parts and ease of access during inspection and maintenance.

(i) The field instruments i.e., the instruments mounted outside the control panel shall be mounted at a convenient height of approximately 1.2 metres above grade platform.

(j) Unless otherwise stated, field mounted electrical and electronic instruments shall be weatherproof to IP-65.

(k) The instruments shall be designed to work at the ambient conditions of temperature, humidity, and chlorine contamination that may prevail but in any case not less stringent than those conditions detailed in the Project Requirements. Instruments shall be resistant to corrosion in the atmosphere in which they are expected to operate.

(l) Lockable enclosures in addition to the instrument casing shall be provided for all the field mounted instruments.

(m) All field instruments, and cabinets/panel mounted instruments shall have tag plates/name plates permanently attached to them. Details of proposed inscriptions shall be submitted to the Employers Representative for approval before any labels are manufactured.

(n) All coated parts of sensors shall be made out of non-corrosive material capable of working with chlorine content of 5 ppm.

(o) For all instruments installed in the field, surge protection devices (SPD s) shall be provided at both ends of the connecting cable for protection against static discharges / lightning and electromagnetic interference.

10.2.12.1 FLOW MEASURING SYSTEMS

(a) Flow measuring systems shall consist of flow sensor / transducers, flow computer and flow transmitter and any other item required to complete the system.

(b) Flow transducers shall be rugged in construction and shall be suitable for continuous operation. Flow transducers shall have waterproof construction and shall be suitable for installation in underground / above ground pipelines. Sensors designed for insertion or removal into a pipeline shall have facilities to permit this action when the pipelines are pressurised.

(c) To avoid the effects of disturbances in the velocity profile, a straight and uninterrupted run, upstream as well as downstream from the location of the flow sensor shall be provided.

(d) The flow transmitter shall be suitable for field or panel mounting and shall accept an input from the flow sensor. It shall process the input signal and provide 4-20 mA DC output proportional to flow rate. The flow range shall be adjustable. The flowmeter shall be suitable for measuring flow at velocities from 0.6 to 2 m/sec.

(e) The overall accuracy of flow measuring systems shall be at least ±1% of the full scale.

(f) Ultrasonic flowmeters shall be provided on discharge header of each pumping station. Flowmeter shall be of a multi-path, multi-beam type.

(g) The flow computer shall be microprocessor based and shall have diagnosis facilities.

10.2.12.2 LEVEL MEASURING SYSTEM

Level measurements shall be provided for raw and treated wastewater sumps.

Ultrasonic level measuring devices shall comprise a transducer and control unit.

The transducer shall be suitable for flange or bracket mounting as required and shall be environmentally protected to IP 65. It shall have ambient temperature compensation, adjustable datum setting facilities.

It shall be programmable with an integral programming keyboard and provide a digital display of the measured variable. It shall be provided with diagnosis facilities and shall provide an isolated 4 to 20 mA DC output signal proportional to the range of measurement.

The design and application of ultrasonic level meters shall take into account the vessel or channel construction, the material, size, shape, environment, process fluid or material, the presence of foam, granules, size etc.

The installation shall avoid any degradation of performance from spurious reflections, absorption, sound velocity variations, sensor detection area, temperature fluctuations, specific gravity changes and condensation. For applications where spurious reflections are unavoidable the control unit shall be provided with facilities for spurious reflection rejection.

If turbulence exists, shielding, stilling tubes or other measures shall be provided to avoid effects on the measurement.

The accuracy of level measuring system shall be ±0.5% of full scale.

Capacitance type level measuring system :

The capacitance type level measuring system shall consist of a sensing probe, a transmitter and a digital indicator.

The level measuring electrodes shall be installed on a stand pipe connected to surge vessels. The probe assembly shall be connected to level transmitter which shall generate a DC analog signal for connecting it to the digital level indicator on the panel. The accuracy of the capacitance type level measuring system shall be ±1% of full scale.

Conductivity Level Switches

The electrodes used for conductivity level switches shall be stainless steel with insulated electrodes such that only the tip of each electrode is exposed to the liquid at the operating level.

Relay or control units operating with level electrodes shall have adjustable sensitivity. Electrodes for use in fluids of low or variable conductivity shall be fitted with

conductivity discs. Separate potential free contacts shall be provided in the control unit for each level of detection.

Float Type Level Switches

Float type level switches shall be provided for detection of very high and very low levels in the sumps. The level switches shall have top mounting arrangement with IP-68 weather protection class. The level switch shall have 2 NO + 2 NC contacts rated for 24 V dc, 2A.

10.2.12.3 PRESSURE MEASUREMENT

Pressure measuring systems shall consist of a combined pressure transducer, transmitter digital indicator and connecting pipe work and valves. Pressure measuring system shall be rugged in construction. They shall be designed for operation over 130% of full range. And be capable of withstanding surge pressures likely to occur in the monitored system. Pressure transmitters shall be suitable for field mounting. The pressure transmitter shall have two wire system and shall provide a 4-20 mA DC output proportional to pressure.

Pressure transmitters shall be provided on common discharge header of each pumping station and on the manifold of surge vessels. Each pressure transmitter shall be capable of operating in the range of pumping station discharge pressure, and be of the diaphragm type. It shall be provided complete with non-ferrous pipework, isolation, calibration valves and a surge damper device. Local and remote display units shall be provided.

Pressure Gauges

(a) Pressure gauges shall comply with IS 3624 / BS 1780. The pressure gauges shall be mounted on a separate gauge board wall mounted / pedestal supported near the pump where the gauge is subjected to pressure pulsations and / or vibrations. The internal and wetted parts of pressure gauge shall be of stainless steel(SS 316).

(b) The minimum diameter for round pressure gauges shall be 150 mm unless specified otherwise or where the gauge forms part of a standard item of equipment.

(c) The accuracy of pressure gauges shall be ± 1% over the operating range. Where compensation of more than 2% of instrument span is needed for the difference in level between the instrument and tapping point, the reading shall be suitably adjusted and the amount of compensation shall be marked on the dial.

(d) The zero and span of pressure gauge shall not change by more than ±0.1% of the span per ^{o}C changes in ambient temperature.

(e) The pressure gauge shall be supplied complete with a isolation valve and surge damper device and shall be fixed on a separate stand.

(f) Pressure gauges shall be provided on suction and discharge of each pump.

10.2.12.5 SURGE PROTECTION DEVICES

Surge protection devices (SPDs) shall be suitable for withstanding the surge arising out of high energy static discharge / lighting strikes and protects the instrument to which it is connected against damage. SPDs shall provide protection through the use of quick acting semiconductors like Tranzorb, zener diodes, varistors and an automatic disconnect and reset circuit. SPDs shall be passive and shall require no power for operation. During the occurrence of a surge it shall clamp on the allowable voltage and pass the excess voltage to the ground. The SPD shall be self resetting to minimise the down time of the measurement loop.

SPDs shall be provided to protect devices transmitting and receiving 4 to 20 mA dc analog signals and power supply loop of field devices located outdoors. The surge rating of the SPDs shall be minimum 10 kA.

10.2.12.6 CABINETS FOR FIELD INSTRUMENTS

A Cabinet shall be provided for enclosing instruments and associated accessories which are mounted outside the control panel such as transmitter, LPU, terminal blocks etc. at all measurement locations.

It shall be fabricated from cold rolled steel with powder coating sheet of standard gauge and shall be suitable for wall mounting or pedestal mounting as required.

The cabinet shall be properly painted from inside by white paint and from outside by paint shade RAL 7032.

The cabinet shall conform to IP-65 protection and shall have built in locking facility. The cabinet shall be earthed properly. A steel plate/pipe, as per the requirement, shall be provided in the cabinet for mounting the instrument and accessories.

10.2.12.7 TEMPERATURE MONITORING FOR PUMP MOTOR

Temperature scanner shall be provided to detect high and very high winding and bearing temperature. The high temperature signal shall be used for annunciation of alarm and very high temperature signal shall be used to for generating tripping signals. The input signals to temperature scanner shall be derived from industrial type Pt-100 resistance temperature detectors provided in the windings and bearings.

Temperature Scanner

(	Service	: Motor winding & bearings and pump bearings tem measurements
(	Quantity	: 36 Nos.(1 no. for each pump motor set)
(i	Range	: 0 to 200^{o} C
(i	Type	: Microprocessor based
('	Location	: On instrument control panel in control room
(v	Accuracy	: $\pm$ 0.1 % of range
(v	Power supply	: 24 Vdc
(v	No. of input channels	: 12 nos.
(i	Display	: 4 digit LED/LCD for data and 2 digit for channel nc
(	Resolution	: 0.1 deg.C
(>	Scanning rate	: Selectable
(>	Communication port for interfac PLC system	: required
(x	Set point	: 2 set points (high and very high) for group of c Minimum 3 groups of channels shall be provided. S relay for each set point..
(x	Type of contacts	: 2 change over contacts for each set point, 110 V d
(x	Input Signal	: From 6 nos.RTDs for each motor windings, 2 no for motor drive and non drive end bearings and 2 pump drive and non drive end bearings.
(x	Pragramming	: Through keyboard mounted on the front facia
(x'	Password facility	: Required
(x\	Weather protection class	: IP 54 of IS 13947 part 1

Note:

1. The vendor shall submit the test certificates for accuracy, repeatability and electrical test to consultant / purchaser for review and record.

10.2.12.8 SOUND LEVEL METER

Portable sound level meters shall be provided for each pumping station. The sound level meter shall comply with BS5969, BS6998, ANSI S 1.4 and S1.43 (Type 2)

Type	Portable sound level meter
Range	0-150 dB
Quantity	1 no.
Display	Back lit LCD to Display

	• Signal level with a quasi analog bar • Measuring range • Menus for displaying and editing setting • Stored measurement results • Selected parameters with levels
Microphone	Prepolorized free field ½" microphone
Power supply	Chargeable battery operated
Memory for previous records	Required
Internal Real time clock for measurements with date and time	Required
Data storage and processing	The instrument shall be capable of storing re measurement results
Accessories	Microphone, Shoulder bag, Protective cover, b battery charger

10.2.12.9 VIBRATION MEASURING SYSTEM

Vibration measuring system shall be provided for measurement of pump and motor vibrations.

Type	Portable vibration meter
Range	0-100 mm/sec, selectable for 0-1mm/sec and 0-10 mm/sec
Frequency range	10Hz to 10 KHz
Quantity	1 no.
Display	LED/LCD type displaying instantanous, true p with m/s and mm/s^2 scales
Sensor (Accelerometer)	Piezo electric type
Mounting Magnet	Required
PTFE Self adhesive tape	Required
Power supply	Chargeable battery operated
Memory for previous data stor processing	The instrument shall be capable of storing re measurement results
Accessories	Shoulder bag, Protective cover, batteries, charger

10.2.12.10 DIGITAL PANEL METERS

a)	Type	:	Microprocessor based
b)	Display	:	Digital, seven segment back-lit LCD /LED
c)	Digit Height	:	14 mm or higher
d)	No. of Digits	:	3 ½ Digits.
e)	Input	:	4-20 mA DC (Isolated) from level and pre transmitters
f)	Zero & Span Adjustment	:	Required
g)	Engineering Units for display	:	
	i. Level Indicators		meters
	ii. Pressure indicators		Kg/cm^2
	iii. Residual Chlorine		PPM
h)	Accuracy	:	±0.1 % of span
i)	Enclosure Material	:	Non corrosive
j)	Enclosure Protection Class	:	IP-54 of IS-13947 (Part-I)
k)	Retransmission output	:	Isolated 4-20 mA
k)	Power supply to Transmitters	:	24 Vdc Required
l)	Alarm outputs	:	2 NO+NC for high and low alarms (adjust

9.2.12.11 ELECTRIC ACTUATORS

(a) Each actuator shall be adequately sized to suit the application and be continuously rated to suit the modulating control required. The gearbox shall be oil or grease filled, and capable of installation in any position. All operating spindles, gears and head stocks shall be provided with adequate points for lubrication.

(b) The valve actuator shall be capable of producing not less than 1½ times the required valve torque and shall be suitable for at least 15 minutes continuous operation.

(c) The actuator starters shall be integrally housed with the actuator in robustly constructed and totally enclosed weatherproof housing. The motor starter shall be capable of starting the motor under the most severe conditions.

(d) The starter housing shall be fitted with contacts and terminals for power supply, remote control and remote positional indication, and shall also be fitted with internal heaters so as to provide protection against damage due to condensation. Heaters shall be suitable for single phase operation. The heaters shall be switched "ON" when the starters are "OFF" and shall be switched "OFF" when the starters are "ON".

(e) Each actuator shall be equipped as follows :

i) AC electric motor
ii) Reduction gear unit (with thrust bearing if required)
iii) Torque switch mechanism
iv) Limit switch mechanism
v) Hand wheel, for manual operation
vi) Valve position indicator
vii) Hand-Auto lever with suitable locking arrangement
viii) Valve position transmitter
ix) Reversing contactor starter complete with overload relays of suitable range and adequately rated control fuses
x) Actuator with integral starter shall have selection between local/remote operation
xi) Local control switch/ push buttons
xii) 415 V/240 V AC control transformer
xiii) A white lamp for supervision of main supply to be provided locally
xiv) A potential free contact shall be provided to annunciate the following on MMI/ OIU in the control room.

- over-load trip
- main supply/control supply failure
- Actuator in local mode
- Torque switch operated

(f) The following shall be included as standard feature for valve actuators

i) The control voltage for the actuator shall be 24 VDC.
ii) The motor shall be specially designed for valve operation, combining low inertia with a high torque and with linear characteristics.
iii) Each electric-motor operator shall be provided with a hand-wheel with handle for manual operation. The hand-wheel shall be automatically declutched when the electric motor is operating, but shall be capable of being engaged at other times by

positioning the clutch lever. The electric operation shall override the manual operation.

iv) A padlock arrangement shall be provided on the actuators for locking the actuator in remote position.

v) All motor operators shall be provided with visible local valve position indicators mounted on the operator assembly itself.

vi) The torque switch shall function to stop the motor on closing or opening of the valve, or upon actuation by the torque when the valve disc is restricted in its attempt to open or close. A minimum of two (2) torque switches, one for closing direction and one for opening direction shall be provided.

vii) The non-adjustable limit switches shall stop the motor and give indication when the disc has attained the fully open or close position.

viii) All wiring connections from the various switches shall be brought out on to separate terminal box mounted on the valve, having liberal space for wiring and making connections.

ix) The terminal box shall be suitable for outdoor use and shall be weatherproof and dust tight.

(g) Reversing Contactor starters for valve Actuators

i) The reversing starters shall comprise forward and reverse contactors, electrically interlocked with each other.

ii) The terminal overload relays provided with the reversing starters shall be three element, positive acting, ambient temperature compensated, time lagged thermal overload relay with adjustable settings. The setting range shall be properly selected in accordance with the rating of the motor.

iii) Thermal overload relays shall be hardest type.

iv) 'STOP' push button of the starter and hand reset device shall be separate from each other.

v) Overload relay reset push button shall be brought out to the front and made easily accessible.

vi) Overload relay shall be provided with at least one 'NO' and one 'NC' or one change-over contact.

vii) The minimum continuous current rating of the contractors shall be 16 Amps for all actuator valve motors up to 6 kW.

(h) Motorised actuators shall be provided for the valves at each Seweage pumping stations for the following.

i) 1 nos. on the discharge line of each pump

10.2.12.12 PROGRAMMABLE LOGIC CONTROLLERS

Design and Construction Requirements

(a) PLC shall be provided as a standalone controller to perform combinational and sequential logic functions, status monitoring, control and reporting functions with counter and timer facilities.

(b) PLC shall comprise necessary processors, input/output (I/O) modules, communication interface modules, power supply module (s), memory and Operator interface Unit(OIU) required to perform the desired functions.

(c) PLC shall have the following attributes as a stand alone controller :

(i) carry out sequential & combinational logic implementation for monitoring & control operations of plant
(ii) carry out computation and interfacing for data acquisition, data storage and retrieval
(iii) it shall accept downloaded program from a programmer
(iv) it shall have different functional modules to perform the desired functions
(v) it shall scan the inputs in time cycles and update the status of its outputs

(d) The PLC system shall be expandable and shall be modular in construction, so as to capable of future expansion without hardware modifications.

(e) PLCs shall be microprocessor based. PLCs shall use standard known protocols and structures for communication outside the system.

(f) In case of system failure or power supply failure the outputs shall attain a predetermined fail safe condition (this shall normally be 'off').

(g) The PLC used shall have a proven record in the type of application concerned and in the prevailing environmental conditions.

(h) For pumping stations, PLC (CPU, memory unit, power supply unit etc.) shall be capable of handling automation and monitoring of all 12 nos. pumps and surge vessel system(At each pumping station 6 nos. pumps are provided in stage 1 and 6 nos. pumps will be provided in later stage). The vendor shall provide input / output modules for only 6 nos. pumps being provided in this stage. The input / output modules for the 6 nos. pumps of stage 2 will be installed along with the pumps in future.

Central Processing Units

(a) The central processing units (CPU) shall be a high performance processor with modular configuration suitable for real time process applications

(b) The following additional features shall be provided.

(c) Communication between CPU and peripherals shall be by an I/O bus. The individual device, interfaces shall be capable of being plugged into the I/O bus.

(d) On resumption of power following a power failure the PLC shall automatically restart its controlling function.

(e) CPU shall have a real time clock capability to accept a time synchronisation pulse from external telemetry and SCADA system and adjust its internal clock with the pulse.

(f) CPU shall have extensive self diagnostic facilities and watch dog timers to identify faults at card levels

(g) The CPU word length shall be 16 bit or more. The CPU shall have at least 50% spare capacity after commissioning of the application.

Memory Unit

(a) Memory unit shall comprise of highly reliable memory chips which are industry standard, proven design with fast random access and suitable for operation in process environments. Main memory shall be modular and facility shall be provided for the upgrading and expansion of memory to meet future demands.

(b) Not less than 50 % spare program memory and data memory space shall be provided. System initialisation and application software shall be stored in EEPROM or EPROM. Operating data shall be stored in a RAM fitted with an internal battery back up. The battery back up provided shall support the memory on loss of power for at least one month. The battery life shall be at least 2 years.

I/O Modules

(a) Standard rack mounted plug in I/O modules shall be provided. Field wiring shall be terminated in screwed terminal blocks and interconnected to the processor I/O system with prefabricated cables and plug in card type connectors.

(b) 15% extra Input/outputs of installed capacity for each type of I/Os shall be provided as spare and shall be terminated.

(c) I/O modules shall be as follows :

i) inputs shall be opto isolated

ii) filters shall be provided for noise rejection
iii) Input /output status shall be indicated by an LED
iv) all outputs shall be fuse protected and have fuse failure indication
v) the fuses may be mounted externally from the output module
vi) all the modules shall be of addressable type

(d) Analog Input Modules

They shall consist of an input isolation unit, signal conditioning unit and an analog to digital converter(ADC). In addition, the following features shall be provided:

(i) cross talk attenuation
(ii) provision for monitoring of the ADC for overflow detection
(iii) gain amplifier with high common mode rejection ratio
(iv) accuracy for analog signals shall be $\pm$ 0.5%

(e) Digital Input Modules

The following design features shall be provided.

(i) contact bounce protection
(ii) choice of type of contacts

(f) Digital Output Modules

The digital output module shall provide contact closure output by driving relays. The features to be provided are as follows :

(i) contact bounce protection
(ii) relay output to operate pump motors and motorised valve actuators
(iii) fail safe position in case of output module failure and fault indication

PID Controllers

Proportional, integral and differential (PID) algorithms or three term controllers may be used for various control functions.

The PLC shall make available for interrogation and display by the SCADA system the proportional, integral and differential constants, the set-point value and the offset value, if used, for each PID controller.

The operator shall be able to select new values for each of these parameters and these shall be displayed by the SCADA system alongside the existing values in the PLC. When the operator confirms that he wishes the new values to be implemented, the SCADA system shall first check the values for validity and then send them to the PLC where they shall overwrite the previous values.

The SCADA system shall read the new value in the PLC and update the "in use" value of the parameter on the screen.

To assist with the tuning process, the PLC shall also make available for display by the SCADA system the process variable PV value and the PID controller output OP value.

The default value shall be used if no other value has been entered through the SCADA system or if the value entered through the SCADA system has been lost.

The default values in each PLC shall be made available for interrogation by the SCADA system at all times.

Sensible and logical default values shall be inserted prior to the start of system tests. The default values at the time of handing over the plant shall be those found operationally suitable during commissioning.

Operator Selectable Parameters

Operator selectable parameters are those facilities made available through the SCADA system for the operator to control or alter the operation of the plant.

Typical operator selectable parameters are:

- set-points;
- PID parameters;
- "duty"/"standby" selection;
- "SCADA Manual" control;
- the resetting of software trips for drives, etc;
- the resetting of registers such as for drive running hours, where appropriate.

The PLCs shall make available for interrogation by the SCADA system bits corresponding to the following PLC faults:

4.10.0.1.1.1.1.1 - failure of each PLC as indicated by the PLC watchdog relay;

4.10.0.1.1.1.1.2 - failure of each I/O card;

4.10.0.1.1.1.1.3 - failure of a PLC to PLC communications link.

4.10.0.1.1.1.1.4 PLC Programming

Programming Unit

(a) 1 No. Laptop computer common for all the station shall be provided to program the PLC.

(b) The Laptop computer along with all necessary adapter, laptop carrying kit, cables, connectors and accessories shall be provided complete with proprietary PLC programming, documentation software, SCADA and UHF radio communication system engineering & application software (Licensed). The software shall provide facilities for :

(i) carrying out program revision management
(ii) insertion of comprehensive program subroutine and rung comments
(iii) search and find and search and replace 'contacts' and 'coils'
(iv) simulation functions and testing of the program by changing the status of contacts and monitoring the outputs
(v) preparation of coil and contact list and their locations and memory maps
(vi) make system backup copies while the system is online
(vii) upload and down load programs to the PLC on line
(viii) carry out on line maintenance and fault finding on the PLC, SCADA and UHF radio communication system.
(ix) Modifications in the SCADA & radio communication system configuration

Operator Interface Unit (OIU)

(a) OIU shall be provided for PLCs at wastewater treatment plants and pumping station sites.
(b) The OIU shall consist of panel mounted industrial grade unit with Coloured LCD screen (5" x 5"), tactile key pad/touch screen. It shall be environmentally protected and designed for plant room use with a 'wipe clean' finish.
(c) The OIU shall provide facilities to:

(i) Display status of Plant in a graphical and text format (i.e. running, stopped, fault etc.);

(ii) Display analog values on the appropriate graphic screen (displays shall change colour when in fault conditions or when data is suspect);
(iii) Display status and values at other sites;
(iv) Annunciate alarms associated with the area of the plant concerned including details of the time the alarm occurred (see note 1);
(v) Provide facilities for the operator to:
- adjust process set points;
- select process modes;
- provide all other facilities required for operation of the Plant;
- acknowledge alarms;
- view a journal of unacknowledged alarms;
- view a journal of the last 200 alarms acknowledged and unacknowledged.

(vii) Display process set points;
(viii) Provide real time and historic data for site parameters
(ix) Provide data archiving facilities through LAPTOP.
(x) Any additional features required to assist in the effective and efficient operation of the plants.

Security systems shall be provided to prevent unauthorised adjustment of process set points.

(d) Notes

(i) The software chosen shall have a comprehensive alarm handling capability with the ability to annunciate, acknowledge, sort and maintain a historic record of current and past alarms including details of when the alarm occurred, when it was acknowledged and when it returned to normal.

10.2.12.13 CONTROL SYSTEM

General

(a) Each pumping station (PS) and wastewater treatment system(WWTS) control system shall be based on the use of a programmable logic controllers (PLC). Remote input/output modules (I/O modules) may also be used to link remote areas of a given process. Each WWTS control panel (CP) shall be provided with its own local PC based Operator Interface Unit (OIU).

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(b) The control systems shall be designed for fully automatic operation of the pumping, treatment and disposal systems. However, in the event of failure of the automatic controls or by operator choice it shall be possible to revert to manual operation of each item of Plant independently of the PLC function.

(c) The WWTS & PS control systems shall be designed to recover fully to a normal operational state on restoration of power following a power failure without manual

intervention. This requirement includes recovery from the H.T. failure as well as the control system power failure.

(d) The control system hardware at each WWTS & PS shall comprise the following:

- PLC;
- Control system power supplies;
- OIU ;
- Field cabling interfaces;

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

(g) The equipment detailed in the aforementioned list (with the possible exclusion of the power supply) and some components of the instrumentation system shall be housed within the CP. The CP shall be located in the air conditioned control room.

Control Panel

(a) 1 No. control panel shall be provided at each pumping station for automatic operation of pumping station.

(b) Each control panel (CP) shall provide control and man machine interface (MMI) facilities for the following:

(i) Pumping stations;
(ii) Wastewater Treatment Systems ;
(iii) Monitoring of the Pressure and flows
(iv) Interface to the Wastewater Management and Control Communications System (see details later);
(v) Interface to the wastewater treatment plants

(c) 1 no. control panel shall be provided at ll final disposal outfalls (linked to pressure in ring main) for automatic operation and monitoring of the motorised valves:

(d) The control panel shall be pre-fabricated floor mounted and be environmentally protected to IP 52. It shall present a vertical front face to the operator on which shall be placed the MMI. The CP shall be designed for bottom cable entry and rear access. The external colour of panel shall be shade RAL 7032 and internal shade shall be glossy white.

(e) The CP shall provide separate areas for the PLC, internal power distribution, instrumentation, field cabling termination and for surge protection devices (SPDs). A separate instrumentation earth bar mounted on insulating supports (a 'clean' earth)

shall be provided within the CP. Instrumentation and control cable screens shall be connected to this earth.

Control Panel Power Supply

The CP primary power supply shall be derived from the LV switchboard at 240 V AC. Power for the control system shall then be derived from this source via an uninterruptible power supply (UPS).

Control System Voltages

The following voltages shall be used for the control system:

Table 10.1

Item	Voltage
Within starter enclosures	240 V AC (not UPS backed)
Instrumentation power supplies	240 V AC / 24 V DC
PLC input-output modules	24 V DC
PLC input-output circuits/loops	24 V DC

The 24 V shall be derived from the UPS backed 240 V supply within the control panel by providing a regulated DC power supply unit in redundant configuration and failure of each power supply unit shall be monitored and alarmed.

Control System Protection

(a) Short Circuit

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

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

(b) Surge Protection

Two nos. of Surge protection devices (SPD s) shall be provided for signal and power supply loop of all instruments located outside the pump house at WWTS & PS and outside control room at MBR, TBR and . In each signal / power supply loop, one SPD

shall be provided near the instrument at field end and the other SPD near the control panel end. The SPDs shall be connected to earth and shall be suitable for arresting the surge arising out of high energy static discharge / lightning strikes and protect the equipment from damage. SPDs shall provide protection through quick acting semiconductor like transorb, zener diodes, varistors and an automatic discharge and reset circuit. SPDs shall be a passive unit and shall require no power for its operation. During the lightning strike it shall clamp on the allowable voltage and pass the resultant current to the ground. The SPD shall operate without in any way affecting normal operation i.e., they should pass signal without attenuation while diverting surge currents safely to earth and clamping output voltages to specific levels. SPDs shall be of self resetting type to minimise the down time of the measurement loop. SPDs shall be weather proof casing. There should be total isolation between input, output and ground terminals. SPDs shall have a minimum surge rating of 10 kA. The SPD s shall be grouped in a specific area within the CP to ensure 'dirty' signal cables do not come into direct contact with 'clean' signal cables.

Input / Output Schedules

(a) An example of typical PLC input / output (I/O) requirements is shown in Table 10.2.

Table 10.2 Typical I/O Schedule (See note 4)

Item	PLC I/O			
	DI	DC		AC
1. Drive				
running	X			
fault	X			
available(ref note i)	X			
alarm state(ref note ii)	X			
stop		X		
start		X		
2. Motor actuated valve				
open state	X		(refer	
closed state	X			
available(ref note vii)	X			
open command		X		
close command		X		
3. WWTS & PS 6.6 kV and 415V i				

Item	PLC I/O			
	DI	DO		AO
bus section and primary feeders				
Closed	X			
Tripped	X			
4. Substation signals				
Feeder circuit breaker				
Feeder Current (three phases)				
Feeder Voltage (three phases)	X	X		
Feeder power, kW, kVA				
Feeder power factor				
Bus voltage (three phases)	X			
Transformer alarm trip				
4. Level (digital)				
high high	X			
low low	X			
5. Level (analog)				
value				
fault	X			
6. Flow (analog)				
value				
fault	X			
7. Pressure (digital)				
high	X			
Low	X			
10. Pressure (analog)				
value				

(b) Notes

(i) Available status is derived at the starter and shall be a logical AND gate of the following signals:

- starter mounted ‘manual-off-automatic’ selector switch set to ‘automatic’;

- no power failure at the starter;
- emergency stop device/s not operated;
- no drive fault.

In other words when the drive is available for use in automatic mode and when a start signal is applied the drive or device shall start.

(ii) An alarm in this context is a state that does not prevent a drive from running.

(iii) The I / O Schedule detailed is indicative only of what is required. The Contractor shall provide all I / O necessary in order to achieve the control and monitoring requirements of the Works without any additional cost .

(iv) All volt free contacts and instruments necessary to derive the aforementioned signals will be needed.

(v) The continuous valve position (0 to 100 %) shall be connected to the PLC system for the following motorised valves:

- Motorised valves on final discharge pipes

.

(vii) Available status is derived at the actuator and shall be a logical AND gate of the following signals:

- Actuator mounted 'Remote -off-Local' selector switch set to 'remote';
- no power/control supply failure at the actuator;
- Torque switch (open/close) not operated;
- Thermal switch not operated.
- No single phasing at actuator

Interlocking

(a) Hard wired interlocking in starter shall be provided for safety circuits such as:

(i) Motor protection;
(ii) Run dry protection;
(iii) Emergency stop circuitry.
(iv) Pump bearing temperature very high
(v) Motor bearing temperature very high
(vi) Motor winding temperature very high.
(vii) Pump house flooding

(b) In addition drives stopped as a result of the action of hardwired interlocks, the above signals shall be individually connected to PLC in order that the PLC drive 'run' out put is removed. In case the drive trips due to any of the above signal then the respective drive shall not restart unless it is manually resetted by the operator.

(c) Soft wired interlocking is provided by the PLC for process control and for safety trips when the signal is derived from a remote source (e.g. stopping of the pumps as a result of a high high level in a downstream CWR).

Alarm Annunciation

Alarms shall be annunciated at the drive starter or switchgear panel, at the OIU and at SCADA level. Detailed list of alarms for each equipment shall be furnished by the contractor for approval of Employer.

CWR Level measurement at WWTS & PS

For CWR Level measurement 1 No. of ultrasonic type level measuring system shall be provided in each compartment.

10.2.13 CONTROL PHILOSOPHY

General

(a) The fundamental control requirements of the treated wastewater valve control system is to:

(i) Open valves in a defined relationship with the pressure in the respective ring main;
(ii) Provide information on the operation of the system to enable the operator to be aware of conditions both locally and at upstream and downstream sites as applicable;
(iii) provide facilities to permit the manual control of the system in the event of failure of the automatic controls;

(b) It is required that the pumps be controlled using a start stop method in order to effect the required flow balance whilst at all times maintaining acceptable levels within the collection sumps. In addition the selection of suitable switching levels shall limit to an acceptable value the number of start / stop cycles each pump motor is subjected to.

(c) The control modes proposed for the system are as follows:

(i) automatic mode;
(ii) semi-automatic mode;
(iii) local manual mode.

(D) THE CONTROL ALGORITHMS ASSOCIATED WITH EACH MODE OF CONTROL ARE AS FOLLOWS;

Automatic Control Mode

(a) General

(i) The automatic control mode is manually selected independently at each pumping station by the positioning of a selector switch on the control panel. This mode selection shall be accepted and retained by the control system.

(ii) Pumps for operation as duty or standby shall be manually selected by the operator from the OIU. Pumps shall accept duty or standby status if they are available. i.e. :

- The pump motor starter 'manual-off-automatic' selector switch is set to 'automatic';
- It has no faults;
- Power is available at the starter;
- The emergency stop device is not operated;
- Any associated device such as the outlet valve is similarly available.

(iii) There shall not be a limit on the number of pumps that may be selected as duty or standby however the default status shall be all pumps as duty.

(b) Pump Start Routine

(i) The pump automatic mode start routine shall be as follows:

- Permissive conditions to start
  - Suction valves are open
  - Discharge isolation valve is open
  - Discharge control valve is in throttled position
  - Common discharge header valve is in open position
  - Pump drive available
- Start sequence
  - Start pump drive and open discharge valve simultaneously
  - Duty pump fails to start, standby pump shall be started
  - When pump starts and discharge valve opens the start sequence is completed

(ii) A software based pump start 'sequence failed to complete' watchdog shall be provided. If a start sequence fails to

complete within a set time (not operator adjustable) an alarm shall be raised.

(c) Stop Sequence

(i) The pump automatic mode stop routine shall be as follows:

- close discharge valve command
- stop pump drive, when discharge valve is closed by 70% (70% close signal shall be derived using timer)
- when the pump stops, the stop sequence is complete

(ii) A software based pump stop sequence 'failed to complete' watchdog shall be provided. If stop sequence fails to complete within a set time an alarm shall be raised.

(iii) The pump shall stop immediately without going through the aforementioned sequence in case of power failure and hardwired trip condition.

(iv) The discharge valve shall close after the pump has stopped. In case power supply is not available the valve shall close on resumption of power by the AP TRANSCO or starting of the diesel generator set.

(d) Duty Rotation

(i) The automatic system shall call on duty pumps to start or stop in accordance with the dictates of the sump level control algorithm. The control system shall decide which pumps are to start or stop using the following procedure.

- If the control system requires a duty pump to start it shall select the duty pump which has been standing (not running) for the longest time and start it.

- If the control system requires a duty pump to stop it shall select the duty pump which has been running for the longest time and stop it.

(ii) In this manner usage of the pumps shall be rotated automatically. Under normal circumstances no more than a preset duty pumps shall be permitted to run. If less than the preset number of duty pumps are available and the level control algorithm requires more pumps to run an alarm shall be raised.

(iii) If a duty pump should fail (either when running or not) then the lowest numbered standby pump shall be selected and started if required to run. The pump shall now run in all respects as a duty pump until reselected manually as a standby. If a duty pump is selected as standby when it is running it shall stop.

(e) Catch Up Mode

(ii) Catch up mode is a hybrid of the automatic mode and is typically used following a prolonged power outage or some other severe disturbance to the system in order to temporarily increase the throughput of WWTS. It can be manually selected at each of the pumping station using the OIU and is then automatically applied to all the other pumping stations (only if automatic mode is selected at that station). It operates to permit the running of up to preset number of duty pumps as opposed to the normal maximum of the preset maximum number..

(f) Level Control Mode

(i) The duty pumps at a given pumping station shall be primarily controlled by the level within the wet sump

(ii) The level within each wet sump shall be monitored by an analog based instruments and digital probes. The former shall provide duty pump control commands and alarm facilities and the latter shall provide high-high and low-low hardwired switching and alarm facilities

Semi-Automatic Control Mode

(a) The operator may select this mode of operation at the CP at any pumping station. The control mode when selected shall only apply to that pumping station.

(b) In this mode the operator may start and stop 'available' pumps (i.e. pumps available for automatic control) at will by using controls on the OIU. The control commands shall be routed through the PLC. The PLC shall prevent simultaneous starts or stops and shall carry out automatically any start up or shut down routines necessary in order to start or stop a pump.

Local Manual Control Mode

(a) This mode of control will normally be used for maintenance purposes or in the event of a PLC failure.

(b) In order to start a pump in this mode the operator must go to the drive starter and set the 'automatic -off- manual' selector switch to 'manual'. The drive can then be started or stopped using the local start and stop buttons or the start / stop controls local to the drive if fitted. The operator will be required to carry the operation of discharge valves etc. manually.

(c) In this mode only hardwired interlocks shall operate to stop the drives.

(d) Valve actuators shall be operated manually at the actuator by selecting the 'local-off-remote' selector switch to 'local' and using the local controls at the valve. Additionally open and close push buttons shall also be provided for the pump discharge motorised valves on the starter panel of respective pump. These push buttons shall be active only when the automatic / off / manual selector switch is selected in manual mode.

(e) The valve closed contact shall be hard wired into the pump start circuit to prevent starting of the pump when the discharge valve is not closed.

Control System Modelling

In order to ensure that commissioning takes place on site in the most efficient manner it will be necessary to computer model the level control algorithms and demonstrate the stability of the system using theoretical flows from the treatment works and from the pumping stations with different numbers of pumps running. The model shall have a graphical interface and shall be free running (i.e. it shall be possible to set the model running and be able to observe steady state and transient operation). Facilities shall be provided to simulate pump failures, power failures etc. in order to study their effects. The model shall be demonstrated to the approval of the Engineer. All modifications and improvements to the control algorithms identified during this stage of design shall be incorporated into the Works.

Protection against Pipeline Burst

(a) A signal shall be derived in PLC from the pressure transmitter provided on common discharge header of each pumping station. This shall operate if the pressure in the line falls for a set time period below the static pressure expected at that point. This shall raise an alarm and prompt the operator to switch off the pumps.

(b) An Stay put type push button shall be provided on the control panel to switch off all pumps simultaneously in such an emergency. The device shall be covered or shrouded in some way to prevent accidental operation.

Surge Vessel Control

General

The surge protection system at each treated wastewater pumping station shall comprise of air compressors (1 duty + 1 Standby), common air receiver, a number of surge vessels and control panel with facilities for alarm annunciation and for operation and monitoring of compressors and surge vessel air inlet valves. All the surge vessels shall be connected with the common air header from the air receiver and at their base to the pumping station discharge header via the buffer manifold. The air inlet pipe to the surge vessels shall be provided with electrically / pneumatically operated valves to control air input to the surge vessels and an electrically / pneumatically operated valve to control air release from the surge vessels.

For controlling the treated water level within the surge vessels, the vessels shall be provided with common conductivity type level switches. For continuous monitoring of treated water level within the surge vessels a common capacitance type level measuring system shall be provided. A magnetic liquid level gauge shall also be provided to permit the visual monitoring of the water level in the surge vessels.

Each surge vessel shall be provided with the safety air relief valve.

The electrically / pneumatically operated air inlet valve shall be provided in the surge vessel air inlet line to permit the entry and release of air from the surge vessels. Hand operated valves shall be provided in parallel with these valves for manual control of air addition and release.

Working of Surge Vessels

The surge vessels are filled with treated water to a given level that is within a working level band. Air is added to the top of the surge vessel to act as a cushion and maintains the treated water level in the surge vessel within the working band.

During normal operation air will slowly dissolve in the treated water causing a gradual rise of the treated water level in the surge vessels. The mean working level (i.e. between upper working level and lower working level) is maintained constant by allowing more air from the compressor air receiver to enter the surge vessel.

When the pumps stop supplying treated water to the discharge header (due to normal stopping, tripping, power failure etc.) the non-return valve at the pumping station outlet will close. The treated water column continues to move away from the pumping station and in doing so will create a negative pressure in the discharge header. Treated water from the surge vessel is drawn into the discharge header in order to limit the magnitude of this negative pressure and in doing so prevent damage to the pipe work.

When treated water column reverses treated water enters the surge vessel and the air in the surge vessel is compressed providing a cushioning effect to the returning treated water column. Energy of returning treated water column is absorbed due to compression of the air.

Control Logic

The function of the control system is to maintain the treated water level in the surge vessels within the working band during steady state pipeline flow conditions. Due to the interconnection of the surge vessels and the common air header the level in each vessel will be identical.

The steady state treated water level in the surge vessel shall be maintained between the upper and lower working level settings. The upper working level shall be set initially at 200mm above the mean level. The lower working level shall be set at 200mm below the mean level. Tapping shall be provided in the surge systems for installation of spectrascan instruments for the purpose of carrying out field measurements during commissioning to confirm the transient analysis. The limits of the bands between upper and lower working levels shall be fine tuned during commissioning after carrying out the confirmation of transient analysis at site during commissioning.

The control logic for the control of the vessel treated water level shall be hardwired and carried out in the local control panel. The status of the surge suppression system and associated alarms shall be monitored by the pumping station MMI.

The logic for operation of various components in the surge suppression system is as follows:

Surge Vessel Inlet Valves

The treated water inlet valves to the surge vessels are manually operated. During normal operation all surge vessel inlet valves shall be fully open.

As a safety measure the hand wheels of the treated water inlet valves will be removed after opening and kept in the safe custody of the pumping station supervisor.

Compressor

The starting and stopping of the compressor (1 working + 1 standby) shall be automatic with a manual override facility. The compressor shall start when there is a low air pressure in the associated air receiver and stop when the required air pressure is reached. Separate pressure switches shall be provided on air receiver for starting and stopping of compressor. In case of working compressor failure, The standby compressor shall come into operation automatically. The low low pressure as detected by a further pressure switch in the air receiver shall be annunciated on the local control panel and at the pumping station MMI. The air receiver shall be provided with pressure gauge and safety relief valve.

Surge Vessel

The purpose of control is to maintain the steady state treated water level within the surge vessels between the upper and lower working levels.

Conductivity type level switches shall be provided for monitoring the following levels in the surge vessel:

Alarm level high (300 mm above mean level)

Working level high

Mean level

Working level low

Alarm level low (300 mm below mean level)

The level switches shall be provided on the 'stand pipe' of one of the surge vessels. When the level in the surge vessel reaches the 'working level high' and remains there for certain duration of time (adjustable from 0 - 20 minutes) the pneumatic / electric operated air inlet valve shall open. The valve shall close when the 'mean level' is reached.

When the level in the surge vessel reaches the 'working level low' and remains there for certain duration of time (adjustable from 0 - 20 minutes) the pneumatic / electric operated air release valve shall open. The valve shall close when the 'mean level' is reached. An orifice plate shall be provided to restrict the rate of release to ensure restoration of the mean working level within approximately 30 minutes. A silencer shall be provided on the discharge to limit the noise made by air release.

The 'level alarm high' and 'level alarm low' shall be annunciated on the local control panel and on the pumping station MMI.

In addition treated water level high high and low low alarms shall be configured on the surge vessel treated water level analogue signal. These alarms will be used when the surge vessel treated water level is being controlled by hand such as when the surge vessel containing the digital switches is taken out of service for maintenance. The high high and low low limits shall be set outside the digital alarm levels.

Manual override facilities shall be provided for operating the compressor and the air inlet and air release valves.

A non return valve shall be provided on the air inlet line to the surge vessel to prevent back flow of treated water from the surge vessels to the air receiver.

Surge Suppression System Control Panel

A control panel shall be provided for operation and monitoring of the surge suppression system. The control panel shall be located in the compressor building. The panel shall comprise the following:

Incoming isolator

Compressor starter each comprising

Starter components

Automatic - Off - Manual selector switch

Status indication

Start / stop buttons for use in manual mode

Fault annunciator to indicate the following alarms as a minimum:

Surge vessel treated water level high high

Surge vessel treated water level high

Surge vessel treated water level low

Surge vessel treated water level low low

Compressor faults for each compressor as appropriate i.e fail, oil temperature high, etc.

Low air pressure in receiver

Duty / standby compressor selector

Auto-manual selector switch for surge vessel air supply

Manual controls for air inlet and air release

Indication of surge vessel treated water level

No trouble in surge system i.e power supply healthy, no trouble in compressors, level in surge vessel normal. This signal shall be connected to PLC system for pumping station start interlock.

The status, alarms and values associated with the surge suppression system shall be monitored by pumping station MMI in the control room.

Magnetic liquid level gauge

Magnetic liquid level gauge shall be provided on the surge vessel for monitoring the level locally. The magnetic level gauge shall consist of chamber and an internal float in non magnetic metallic material, compatible with the liquid. The float containing magnetic system rides on the liquid level and is coupled to an external visual indication consisting of a series of bi-colour flapper white on front side and red on the reverse side. These flappers flip over corresponding to the float movement thus changing the colour when the float rises and falls as per the treated water level in the vessel.

The magnetic liquid level gauge shall be mounted on a vessel other than that which accommodates the continuous level measuring instrument or the digital switches.

10.3 SCADA AND MIS & BACK-UP SYSTEMS

The SCADA and MIS & Back-up Systems requirements are proposed under the following paragraphs. These systems architecture shall be based around a modular PC network, utilising industry standard PCs, operating systems, networks and protocols. All software packages supplied shall be **licensed software.**

10.3.1 Local SCADA System :

(a) A local SCADA system shall be provided at all STP & pumping station

(b) Local SCADA system to be provided at each of the above mentioned pumping stations shall have Industrial PC based Server cum operator station. The SCADA system shall be interfaced with the respective plant PLC system on suitable communication port (s) and shall provide communication port for interfacing to Laptop based engineering work station whenever required for O&M activity.

(c) Local SCADA at WWTS & PS shall be interfaced on Local Area Network (LAN) to the SCADA system in Master Control Centre (MCC) at Administration Building Bhayandar

(d) Local SCADA system shall also be provided with

- 132 column alarm/event dot matrix printer (24 pin type with a speed of at least 250 LPS) with fan fold paper attachment;
- Monochrome LaserJet report printer with multiple single sheet feeder
- Steel constructed high quality computer desk with vinyl work surface and one

pedestal draw unit and one cupboard unit, the desk shall accommodate the PC and printers and permit two operators to sit side by side. The desk shall be purpose built, attractive, durable and ergonomic and it shall be sized to have not less than 50 % spare work surface when accommodating the PC and printers. The desk shall incorporate an integral power distribution system to supply equipment mounted on desk.

- full height two door metal storage cupboard with three shelves;

- 2 Nos. five castor upholstered swivel chairs.

(e) Local SCADA Software

The Contractor shall provide proprietary SCADA software for each of the local SCADA systems. The SCADA software shall be windows based. It shall have a proven track record for similar applications in the treated water industry and shall be supported within India. The software package selected shall provide facilities mentioned under “SCADA System Functionality" described later.

10.3.2 SCADA system at MBMC OFFICE Building :

(a) SCADA system shall have Hot Standby PC based SCADA configuration connected on LAN (Speed 10/100 Mbps). Whenever Hot SCADA PC system fails the Standby system shall automatically take over all operations of SCADA without any data loss or manual intervention. Thus earlier Standby PC system becomes Hot SCADA PC. When failed Hot PC system gets restored, then it shall act as a Standby SCADA PC. Process data shall be updated both in Hot as well as Standby SCADA PCs.

(b) Printers shall be provided for Alarm/Event, Report and Screen Dump Printing operations. All printers shall be connected on MCC SCADA System LAN.

(c) The MCC SCADA system shall comprise the following:

- an industrial grade personal computer (PC) based MCC SCADA shall be provided to the latest industry standard and product version available at the time of project execution for efficient and effective operation of the selected SCADA software package.

- Each of the servers cum workstations of MCC SCADA shall be provided with both diskette and CD drives. The fixed drive shall be sized to permit the operation of the system and the storage of the following:

  - in excess of 2000 historic alarms data;
  - not less than 7 months archive data;
  - plus not less than 50 % spare capacity;
  - one latest industry standard 21 in colour monitor;

- keyboard;
- mouse;

- 132 column alarm/event dot matrix printer (24 pin type with a speed of at least 250 LPS) with fan fold paper attachment;

- Multi-colour inkjet screen dump printer with multiple single sheet feeder (the printer shall be suitable for use at the local SCADA system);

- Monochrome LaserJet report printer with multiple single sheet feeder (the printer shall be suitable for use at the local SCADA system);

- Steel constructed high quality computer desk with vinyl work surface and one pedestal draw unit and one cupboard unit, the desk shall accommodate the PCs and alarm/event printer & LAN hardware and permit two operators to sit side by side. The desk shall be purpose built, attractive, durable and ergonomic and it shall be sized to have not less than 50 % spare work surface when accommodating the mentioned hardware/equipments. The desk shall incorporate an integral power distribution system to supply equipment mounted on desk.;

- full height two door metal storage cupboard with three shelves;

- 2 Nos. five castor upholstered swivel chairs;

- printer trolley/s to accommodate the report and screen dump printer.

- All required hardware, software, cabling , accessories etc. for successful implementation of networking MCC SCADA and SCADA systems at STP and WWTS & PS and for interfacing of MCC SCADA to UHF radio voice and data communication system.

(f) MCC SCADA System Software

The Contractor shall provide proprietary SCADA software for the MCC SCADA systems. The SCADA software shall be windows based. It shall have a proven track record for similar applications in the treated water industry and shall be supported within India. The SCADA system shall be the same as that used for the local SCADA systems. The software package selected shall provide facilities mentioned under " SCADA System Functionality" described later.

10.3.3 Management Information System & Back-up Station

PC based Management Information System (MIS) shall be provided at MBMC Head office. MIS shall be mainly used for configuring, generating and printing the MIS reports in the formats as required by MBMC for the treated water transmission network.

MIS report formats shall be finalised during detailed engineering stage and shall be approved by the Employer.

MIS shall help in effective management of the wastewater network. Also complete back up of all the data from MCC SCADA shall be made available to MIS PC System using UHF radio communication network. PC system provided shall be suitable to acquire, store, maintain and operate on this data from MIS and Back-up operations point of view. A UPS system, printer shall be provided as a part of MIS system.

MIS & Back-up system shall also be provided with

- Monochrome LaserJet report printer with multiple single sheet feeder

- Steel constructed high quality computer desk with vinyl work surface and one pedestal draw unit and one cupboard unit, the desk shall accommodate the PC and printers and permit two operators to sit side by side. The desk shall be purpose built, attractive, durable and ergonomic and it shall be sized to have not less than 50 % spare work surface when accommodating the PC and printers. The desk shall incorporate an integral power distribution system to supply equipment mounted on desk.

- full height two door metal storage cupboard with three shelves;

- 2 Nos. five castor upholstered swivel chairs.

MIS & Back-up system software :

MIS & Back-up system software shall be windows based. It shall have a proven track record for similar applications in the wastewater industry and shall be supported within India.

10.3.4 The proposed SCADA system shall incorporate following primary facilities :

a) Provide continuous and effective control & monitoring of all major equipment in the field.

b) Rapidly alert Employer's operation and maintenance staff for any system malfunctioning, especially those which are likely to cause disruption to the wastewater network.

c) Provide clear, comprehensive displays and printed logs of current system status.

d) Provide SCADA Display configuration, updating, alarm management, database both real time and historical management, report generation, safety tagging (if required), interlocks etc. RTU/PLC program uploading and downloading etc.

e) The SCADA system shall monitor the communications links between:

- *Each PC holding a database and each PLC linked to it;*

- *Between the SCADA PCs holding databases;*

- *SCADA PCs to radio communication system.*

These communications links shall be automatically checked at regular intervals. An alarm shall be raised in the event of a failure.

10.3.5 Software Specific Requirements

Local and MCC SCADA systems software shall take care of the following.

(a) The system shall be capable of storing real time data for one day and historic data for 120 days.

(b) The SCADA system shall manipulate the data it receives in order to prepare reports to provide the Employer with a schedule of throughput and power consumption for the period concerned on a site by site basis and system basis. The reports shall be generated on demand and automatically as required.

(c) The sample rates for archiving shall be the same as for trending. The archives shall be stored in daily files. The system shall provide capacity to store archives for 120 days. A warning alarm shall be provided to the operator to advise that archiving to disk should take place or archived data will be overwritten.

It shall be possible to:

reintroduced the data derived from archiving and view the archived data using the trend facility;

display the data using industry standard spread sheet or database software in tabular format on a third party machine;

(d) The SCADA system shall support on-line modification of database, system control programs, system pictures, trend displays. On-line software (both data and Programs) back-up shall also be possible. The system shall support third party interfacing, if any, required to make the system functional and operational as required by the Employer.

(e) The Contractor shall provide software for safety tagging. Safety tagging is required for proper operation, maintenance, testing or construction of power system, SCADA or communication equipment. This must ensure safe handling over various equipment for maintenance or the like and restoring on line after the work is completed. Control transactions issued by the operator shall be provided with acknowledgement.

(f) The database and interlock logic programs shall be down loaded from the main computer at local SCADA system or from engineering work station (Laptop) to the PLCs. Contractor shall indicate security provisions for the same.

(g) SCADA system shall be provided with error correction codes to ensure data integrity. In addition, the system shall alarm separate marginal and failure conditions based on user defined limits to advise the operator of the communication link failure.

(h) The system shall provide a scratch pad facility for the use of the operator, which may be used for temporary notes for information of shift personnel.

(i) A typical format of wiring drawing and software listing of typical application and the method of developing different types of displays like trend displays, alarm and event lists, bar charts, system diagram, reports etc. will need to be clearly specified.

(j) Software for graphic documentation shall be provided. Documentation for graphics software shall be provided for mimic and logic diagrams in ladder form/other standard form (s) for PLC logic. Access to this software shall be controlled by passwords. The software shall be used off-line and previous program over-written during loading on-line.

(k) Security features provided against spurious commands e.g. due to failure of digital output channels, communication problems (protocol) and system software failure (supervision task) will be needed.

(l) The SCADA system shall be an auto reconfiguring system on power off/on or on failure/removal of PLCs. Failure of some of PLCs shall not affect the system

response time and failure of one PLC shall not disturb the other SCADA, PLC functions. During auto-reconfiguration, no data loss shall be permitted.

(m) A "Check before execute" feature and a write-up on the same will need to be provided.

(n) It will be necessary to describe precautions taken to prevent entry of virus inadvertently or advertently in the system. The software shall include suitable memory resident latest licensed anti-virus software.

10.3.7 SCADA System Functionality :

The SCADA systems provided shall have the following functionality.

10.3.7.1 Man Machine Interface :

(a) The man machine interface (MMI) at local SCADA and at MCC SCADA shall consist of a proprietary MMI industrial computer comprising 21" colour monitor, keyboard and mouse. This shall be provided to the latest industry standard and product version available at the time of project execution. It shall be environmentally protected and designed for plant room use with a 'wipe clean' finish. The system printers provided shall also have suitable Mobile stands.

(b) The MMI shall be provided with proprietary windows based supervisory, control and data acquisition (SCADA) software. The software package chosen shall be a market leader and have a proven record of use within the wastewater industry for similar applications.

(c) The MMI shall provide but not limited to the following facilities to:

- provide colour graphic screen representation each plant area and system overviews.
- display status of Plant in a graphical and tabular format (i.e. running, stopped, fault etc.);
- display analog values on the appropriate graphic screen (displays shall change colour when in fault conditions or when data is suspect);
- display status and values at STP, other WWTS & PS,
- display seweage treatment plant status details and values;
- annunciate alarms associated with the area of the plant concerned including details of the time the alarm occurred. The software chosen shall have a comprehensive alarm handling capability with the ability to annunciate, acknowledge, sort and maintain a historic record of current and past alarms including details of when the alarm occurred, when it was acknowledged and when it returned to normal.
- display a total running hours log of local transmission pump drives;

- display summary of status of all upstream and downstream pumping stations including level in controlling sumps, number of pumps running at each station, sump high high and low low level alarms, output flow, power outage present.
- provide printing of Alarms/Events, Reports, Logs, Trends, Screen dumps etc.
- any additional features required to assist in the effective and efficient operation of the plant;
- provide security systems to prevent unauthorised adjustment of process set points.
- provide facilities for the operator to:
  - select duty and standby drives;
  - adjust process control set points;
  - select process/plant control modes;
  - provide all other facilities required for operation/monitoring and control of the plant;
  - acknowledge alarms;
  - view a journal of unacknowledged alarms;
  - view a journal of the last 200 alarms acknowledged and unacknowledged;
  - display the duty / standby drives;
  - display process set points;
  - provide real time and historic trending of local analogue values ;
  - provide data archiving of all local analogue values;
  - prepare daily, monthly and annual reports (providing the employer the details with schedule of throughput and power consumption for the period concerned on site by site basis and system. The reports shall be generated on demand and automatically);

10.3.7.2 SCADA Displays

Overview

SCADA displays shall be based on a hierarchical structure with a menu at its head. The displays shall fall into a number of categories, including the following:

- menus;
- mimics;
- tables of other operator selectable parameters;
- alarm banner;
- alarms pages;
- trends;
- I/O status pages

These are described in more detail below:

(a) The menus shall, where possible, not simply be a list of displays which can be viewed but be presented in a diagrammatic form which relates to the plant system. It is anticipated that these displays will not show any process information but that they shall facilitate movement to the appropriate display for this purpose.

(b) Mimics shall provide a single line diagram and graphical representation of the plant and are to be "active", i.e. the status of the plant and process displayed shall change in response to physical changes on the system. Mimics shall be provided for the WWTS & PS, STP , and for other auxiliary systems on each site, the control system, communication systems etc. Each mimic shall show an operationally meaningful subset of the overall system.

- Following are typical the mimic displays required for each of the sites :
  - Main and Subsystem menus;
  - Overviews of pumping, treatment and treated effluent disposal system;
  - Overview of each site/plant;
  - Detailed displays for dynamic & static information of parameters of the plant subsystem (s)
  - Overview displays with dynamic & static information of parameters of the following;

    Power Supply System;

    Control System;

    Communication System;
  - Plant/process set points displays;
  - Tabular display of plant status and values;
  - Plant system/subsystems interlock displays;
  - Running hours log for the plant drives.

- The screens shall display data commensurate with their size and the area of and number of Plant items covered.

- It shall be possible to include bar charts and trends as part of mimic diagrams or construct pictures containing only bar charts and trends.

- It shall be possible to change the colour and flash the variables and equipment symbols to indicate alarm/trip and certain pre-defined operating condition.

- A comprehensive screen navigation system shall be provided giving access to all screens via a system of menus and short cuts (i.e. it shall be possible to follow the process from one screen to another by clicking the mouse cursor on screen ‘hotspots’ to effect the move from one screen to another).

(c) When viewing the relevant mimic for a drive, valve, etc for which there is to be a "SCADA Manual” control facility, it shall be possible to open a small "SCADA Manual" control window for the item so that the item can be manually controlled and its status viewed at the same

time.

(d) Tables of operator selectable parameters, shall be provided to enable the operator to view current set point values held in the PLCs and to adjust these parameters.

(e) The alarm banner shall be permanently on view at the bottom of each screen and shall show the most recent unacknowledged alarms.

(f) Alarms pages shall be provided and shall display alarms according to alarm group and state.

(g) Trends shall be provided as appropriate and shall show, in graphical form, the variation with time of process values or the status of a drive, etc.

(h) The PLC I/O status tables are intended as an aid to fault-finding and shall show the site, PLC reference, card reference, the number of the I/O point on the card and the tag name or other identifier of the physical I/O point. For digital I/O the current value (0 or 1) shall be shown, while for analogues the value of the physical input (e.g. a value in the range 4 to 20mA or 1 to 5V) shall be shown.

(i) Date (DD MM YYYY) and Time (HH MM SS if possible 'ms') shall always be displayed at the top right corner on each of the mimic displays of SCADA system.

10.3.7.3 Invalid Entries from SCADA System

An alarm to be raised and action prevented if the SCADA operator tries to enter a process control instruction which is not valid.

10.3.7.4 Movement between Displays

It shall be possible to access displays from the main menu or from a sub-menu and to return from any display to the related menu or sub-menu.

For each mimic, easy-to-use facilities shall be provided, to toggle between the mimic and:

- a related trend;
- a related "SCADA Manual" control window;
- a less detailed "upstream" mimic of which the subject mimic is a subset;
- an adjacent mimic;
- a more detailed mimic which is a subset of the subject mimic.

Similar facilities shall be provided for moving between the different alarms pages and, if practicable, from an alarms page to the relevant mimic.

A simple means of moving to the appropriate mimic for any newly received alarm shall be provided. e.g. pushbutton on the screen/ mouse click.

10.3.7.5 "Windows" Structure of Displays

The SCADA package is to operate on a "windows" type operating system.

It is suggested that the alarm banner should be a window of fixed size and location at the bottom of each SCADA system screen.

In general all other displays shall be of fixed size and location so that they appear above the alarm banner and cannot be moved or relocated to obscure the alarm banner. The only possible exception is the "SCADA Manual" control window, where it might be necessary to provide a "click and drag" facility so that the window can be positioned clear of the item being controlled and so that, if necessary, more than one "SCADA Manual" control window can be open at any one time.

Means of automatically closing windows which are not being viewed shall be provided to prevent there being an accumulation of open windows of which the operator is unaware. It may be necessary to incorporate time delays or other features to facilitate toggling between displays. Especial attention shall be paid to the closure of each "SCADA Manual" control window to ensure that it cannot be used without the related mimic.

10.3.7.6 Display Headers and Numbering

A header and page number shall be provided for every display except the alarm banner.

The header shall indicate the site and plant to which the display relates. It shall not incorporate any project title.

The page number is required for cross-referencing with the instruction manuals. It is also desirable that an operator should be able to select a screen to be viewed by entering its number.

10.3.7.7 Frequency of Data Updating and Updating Displays

When a display is on view at any SCADA workstation, all raw and derived plant data shown on it shall be updated at intervals not exceeding one second. Database of local SCADA system shall be updated within less than or equal to 2 sec and that of MCC shall be updated depending upon approved polling time of each of the sites by the Employer. Timings of data

updating at all sites shall suit the control operations requirements of Sewerage network.

10.3.7.8 Use of Contractors' Names

No contractor's name shall appear in the displays.

10.3.7.9 Use of Mouse

If practicable, the system shall be configured so that every selection made with the mouse is achieved with just one click of the button on the mouse.

10.3.7.10 Alarm and Event Management

(a) Definitions

An "alarm" is to be an occurrence which shall be treated as follows by the SCADA system:

- It shall appear on the alarm banner until it has been either acknowledged or moved sufficiently far down the list of unacknowledged alarms by more recent alarms.

- It shall cause each SCADA system workstation to emit a short audible alarm tone to attract the attention of any operator in the vicinity.

- It shall be recorded by the alarm and event printer at the time it happens but shall not be retained as archived data unless it is also an "event". The time and date of acknowledging and resetting of each alarm shall also be recorded on the printer.

- It shall be allocated to one or more "alarm groups" so that an operator may easily determine what alarms are current for a particular physical or logical part of the operation.

In general, an alarm will correspond to an abnormal operating condition, e.g. an unusually high or low level, or to a plant failure, e.g. the failure of a drive to start or stop when it is required to do so.

There shall be three possible states for each alarm, as follows:

- an "unacknowledged active" alarm is one which represents a current alarm condition on the plant and which has yet to be acknowledged by the SCADA system operator.

- an "acknowledged active" alarm is one which represents a current alarm condition on the plant but which has been acknowledged by the SCADA system operator.

- an "unacknowledged inactive" alarm is one which did represent an alarm condition

on the plant but which has not been acknowledged by the SCADA system operator and has ceased to represent a current alarm condition on the plant.

An "event" is to be an occurrence which is to be treated as follows by the SCADA system:

- It shall be recorded by the alarm and event printer (at the time that it happens).
- It shall be allocated to an "events schedule.

Typically, the following occurrences shall be treated as events:

- a change between "duty" and "standby" devices initiated by the operator;
- the starting and stopping of each of the main pumps and of other selected major drives;
- the operation of certain important valves;

(b) Prioritisation of Alarms

Alarms shall have the following priority levels:

Level 1 - This an alarm requiring immediate attention.

Level 2 - This an alarm which requires attention within a given period of times.

Level 3 - This an alarm which requires no particular action other than acknowledgement by the operator.

(c) Alarm Banner

The following requirements shall apply as far as is practicable.

The display of each new alarm on the alarm banner shall comprise:

- alarm date (DD MM YYYY);
- alarm time (HH MM SS if possible 'ms');
- alarm description at least upto 50 characters;
- alarm tag name;
- alarm type (Low, Low Low, High, High High)
- alarm limit value
- Current value and engineering units

- state (active/inactive);

It is not essential that the whole of the display for each alarm be visible at once provided that it can all be read by horizontal scrolling of the banner.

There shall be a means of accepting alarms using the alarm banner.

The alarm banner shall display at all times at least the three most recent unacknowledged alarms for the whole system.

(d) Alarm Display for Printer

This shall comprise:

- alarm date (DD MM YYYY);
- alarm time (HH MM SS if possible 'ms');
- alarm description at least upto 50 characters;
- alarm tag name;
- alarm group
- alarm type (Low, Low Low, High, High High)
- alarm limit value
- Current value and engineering units
- state (active/inactive);
- acknowledged/unacknowledged.

Alarm printing shall be as given below :

- The system shall automatically or on demand basis print all the alarm messages in the same format as the display, on alarm printer.

- For major analog alarms, maximum/minimum value of the variable during alarm state and time interval shall also be printed.
- All the alarm messages shall be printed strictly in chronological order irrespective of type of alarm.

(e) Alarms Pages

The alarms pages shall enable current and inactive (i.e. potential) alarms to be viewed according to alarm group, level and state (i.e. active, inactive, unacknowledged and acknowledged).

(f) Colours for Alarm Displays

The following background colours shall be used for the display of alarms at the SCADA system workstations:

- "Unacknowledged active" - red;
- "Acknowledged active" - black;
- "Unacknowledged inactive" - blue;

(g) Alarm Inhibit

The SCADA system operator shall be able to inhibit the operation of any alarm. Such action shall be recorded on the alarm and event printer and shall be shown in an easily recognizable way on the alarms pages displayed by the SCADA system.

Consideration shall be given to automatically inhibiting certain alarms if other alarms are raised. For example, a power failure at a site is likely to give rise to a number of "drive failed" alarms which do not in practice reflect a true failure. Hence it may be appropriate to suppress these alarms in the event of a power failure.

(h) Specific requirements for alarm displays :

- It shall be possible to display backlog pages on demand. Should an older page be on display on CRT and a new alarm occurs, the most recent alarm page shall reappear automatically.

- All return to normal messages shall be removed by pressing ‘Alarm Reset' push button on control engineer's keyboard.

- 'Bad' inputs shall also be displayed on CRT in the area reserved for control engineer guidance messages.

- Any software and hardware faults detected by self-diagnostic checks shall also be displayed on CRT.

- The latest unacknowledged alarm shall appear in all displays in the reserved location.

- Selected alarm messages, on processing of acceptance and specified keys shall automatically bring out the relevant mimic diagrams on the screen without having to select them.

- The Contractor to indicate availability of "Alarm Guidance" facility supported by SCADA system offered.

(i) Event Schedules

There shall be schedules of events arranged in a similar manner to the alarms pages. Additionally, there shall be "events history" pages so that the history of opening and closing of important valves, the starting and stopping major drives, etc can be seen.

(j) Event Display Format

For both the printer and the events schedule, this shall comprise:

- event date (DD MM YYYY);
- event time (HH MM SS if possible 'ms');
- event description at least upto 50 characters;
- event tag name;
- event state (e.g. drive "running"/"not running" or valve "open"/"not open")

(k) Events shall be printed in chronological order. Storage shall be provided for 1000 events.

10.3.7.11 Trends

(a) Parameters for which Trends are Required

A trend shall be provided for every analogue value monitored by the PLCs and for every analogue value derived in the PLCs/SCADA from this data. Trends shall also be provided for certain events where these trends, in conjunction other analogue trends, provide the operator with a more meaningful picture of part of the operation.

Trends shall be displayed in groups of inter-related parameters for each of the site/plant.

(b) Trend Facilities

Both "real time" and "historic" trends shall be provided.

A "real time" trend shows the variation of the relevant parameter with time, the last point shown always being the current value of the parameter. It is anticipated that "real time" trends shall be entirely preformatted as regards the time span being viewed, the parameters shown, the scales used, etc.

A "historic" trend shows the variation of the relevant parameter with time during a time window, the end of which is in the past. In this case the operator shall be able to adjust the time span of the trend graph, typically between seconds, minutes, hour and month etc., and to select the start time of the graph. It shall, however, be preformatted in all other respects.

The operator shall also be able to configure "historic" and "real time" trends, with traces from a range of parameters shown together, and to:

- adjust the vertical axis calibration;
- search for data in or out of a specified range.

The sample rates for trends shall be user configurable and software settable. Contractor shall decide the timing requirements in line with process response time requirements and effective analysis of Sewerage Network.The system shall be capable of storing real time data for one day and historic data for 120 days.

10.3.7.12 Reports

The following reports shall be produced on demand and automatically on the report printer at three pumping station local SCADA and at Master Control Centre SCADA at Bhayandar.

Periodic Logs - The system shall store values of specified parameters at user configurable intervals (Contractor shall indicate minimum time for the same. This time shall be suitable to analyse the Sewerage system performance) in different groups (exact groups will be identified later).

(a) Logs shall be printed out periodically.

(b) The system shall generate and print the following shift reports at the end of each shift :

i. Summary of active alarms including 'bad input' summary.
ii. Status changes (valves etc.)
iii. Alarm limit changes by the operator.

(c) The system shall generate and printout (on demand or automatic -configurable) following daily reports at the end of each day :

i. Daily maximum and minimum values with time for various process parameters.

ii. Summary of predefined important alarms. A printout of persisting alarms

related to SCADA & communication system shall be printed in reverse chronological order, which will be used for necessary action.

iii. The following information shall be provided in the daily report:-

- day of week, date and time of generation;
- total quantity of treated water pumped for each pumping station;
- treated water levels in each sump at the start of the day;
- discharge treated water pressure at each pumping station at the start of the day;
- total volume of treated water discharged at the outfall sewer;
- total volume of treated water passing the flow control facility;
- power consumption in kWh at each pumping station;
- total pump running hours for the last 24 hours;
- power factor of electrical network at each pumping station at the start of each day;
- list of alarms for the last 24 hours;
- number of and total duration of power interruptions for the last 24 hours.

(d) Monthly reports shall be generated automatically/on demand basis and include the following

i. Daily maximum and minimum values with date and time.
ii. Monthly maximum and minimum values with date and time.

(d) Annual reports shall be generated automatically/on demand basis and include the following

i. Monthly maximum and minimum values with date and time.

(e) The SCADA system shall provide storage of shift report and daily report for one month and monthly report for one year.

10.3.7.13 Access Security

It shall be possible to view all the displays at any workstation without logging into the SCADA system or entering any password. This shall be described as security level 1. It shall also be possible to configure any of the user-configurable trends described in the section on trends and to print any screen without any log-in or password.

Other features of the SCADA system which enable a user to acknowledge alarms, control

plant, alter parameters, etc shall require the user to log-in and to enter a valid password. It shall be possible to provide different users with access to the system at any of the following levels:

- Level 2: level 1 access plus the facility to acknowledge alarms.
- Level 3: level 2 access plus the facility to control drives, valves, etc in "SCADA Manual" mode.
- **Level 4: level 3 access plus the facility to alter set-points, change control modes etc. and to inhibit alarms. Also to copy archived data to diskette for processing off-line and to carry out any operator actions relevant to changing the CDS for data archives.**
- Level 5: level 4 access plus the facility to perform SCADA system administrative tasks such as allocating or removing passwords, etc.

The system shall automatically revert from any of levels 2, 3, 4 or 5 to level 1 if no key stroke is entered for an operator selectable period. It is suggested that a warning prompt should be provided first.

10.3.7.14 Archiving

The Contractor shall provide facilities to enable the archiving of selected events and analogue values.

The sample rates for archiving shall be the same as for trending. The archives shall be stored in daily files. The system shall provide capacity to store archives for 120 days. A warning alarm shall be provided to the operator to advise that archiving to disk should take place or archived data will be overwritten by new data.

The Contractor shall provide facilities for the data to be transferred to a removal optical disk by the operator and for the data to be recoverable and displayed in a comprehensible format on an off line PC running industry standard spreadsheet or database software or the SCADA software. It shall also be possible to reload the software into the operator workstation and display the data using the trending facility.

It shall be possible to reintroduce the data derived from archiving to the MMI and the archived data viewed using the trend facility;

The Contractor shall provide an industrial disc drive with the MMI in order to download archive data or to upload previously stored archive data onto electronic storage media. The

disc drive shall be suitably protected against the environment and shall be covered when not in use.

10.3.7.15 SCADA System Time and Time Synchronisation

The time base used for all displays, printouts and stored historical data shall be Indian Standard Time.

In any of the systems, the time synchronisation error shall be less than +/- 10 ms. The time synchronisation shall be carried out periodically. Contractor shall decide this periodicity to meet the time synchronisation accuracy requirement mentioned above.

MCC SCADA system hardware and software shall be suitable for interfacing with external synchronisation clock

10.3.7.16 Virus Checker

An on-line network virus checker, running at all times, shall be provided on each of the SCADA system PCs.

10.3.7.17 File Transfers

Suitable measures shall be taken to ensure that file transfers does not unnecessarily slow the transfer of other data required more urgently for operational reasons.

Such measures might include:

- limiting the size of any files which need to be transferred;

- ensuring that there is always an interval between the initiation of successive file transfers which provides an adequate window for the transmission of the more urgently required data.

10.3.8 Design and Performance Requirements of Software

(a) The online Real Time Operating System (RTOS) supplied shall be proven for similar application and shall be able to support all the equipment/ peripherals.

(b) The background executive shall enable software development in background time sharing mode by two or more programmers simultaneously. It shall be possible to run / test any program without making it into an online program.

(c) Compiler if used, shall generate an optimised machine language code.

(d) The utility for copying of files from magnetic tape to disk and vice versa shall have capability to read/write in both ASCII/EBCDIC mode. It shall also have capability to read from one medium in any one mode and write on another medium in a different mode. It shall also have the capability to do a backup of disk on tape.

(e) The debugging utility shall allow for online de-bugging of programs.

(f) The display generation utility shall be of interactive type. There shall be no need to write programs for generation and maintenance of displays.

(g) It shall be possible to make system backup copy and program changes while the system is online. There shall be no need to take the system in stand alone mode for making the backup copy and program changes.

(h) Test programs shall be provided for hardware testing of CPU and other equipment. It shall be possible to test the equipment, except CPU and disks, without taking the system in stand-alone mode. Online error checking and diagnostic message facility for CPUs various equipment shall be provided.

(i) It shall be possible to do the system generation at site after any addition or deletion in memory and peripherals.

(j) Utility shall be provided for generation and maintenance of system input database. This database implemented in SCADA system shall be the master database.

(k) The data acquisition, processing and alarm monitoring/ reporting software resident in each PLC shall enable processing of raw system data including engineering unit conversion and system alarm limit checking.

(l) The control programs resident in the PLCs shall enable the execution of sequential control without interrupts to ensure security of control.

(m) The communication package shall enable data transfer between the different distributed modules through the data bus system.

(n) The operator interface software shall enable the operator to call up displays and control the system through SDU/key board.

(o) The control language shall be a user-oriented language to formulate control system.

(p) Report/display generator shall facilitate creation of reports and graphic displays in user definable formats.

(q) The report processor shall assess the system database for necessary data and initiate printing of logs and reports.

(r) The diagnostic package shall enable online or offline testing of all distributed modules as well as the data bus communication system. The online diagnostics shall run during the normal functioning of the distributed modules without interfering with the real time performance of the system. If any malfunction is detected in a module, it shall be disabled automatically and an alarm message shall be reported to the maintenance engineer.

(s) The debugging utility shall allow for online debugging of programs. The down loading utility shall enable down loading of all programs developed at programmer's works station to the respective distributed modules.

(t) Suitable communication software protocol for the communication link for communication between SCADA System and other computer system/ PLC system shall be provided.

10.4 UHF Radio Voice and Data Communication System

10.4.1 Introduction :

11.4.2 The requirement of communication network system for the SCADA system is to provide integrated data and voice communication among the WWTS& PS and the Master Control Centre. The UHF system shall be suitable for the transmission of voice and data necessary to comply with the specification. The system shall be housed in the control room at each of the pumping stations. The UHF systems at each of sites above shall be housed along with respective SCADA, MIS and PLC based systems & power supply systems.

10.4.3 Provision of AC/ DC power supply to the Voice Communication and Data Communication Equipment at all the sites will be needed along with the required power supply at each of the site locations. This shall be provided using UPS power supply proposed at each of the sites for Instrumentation & control, SCADA, MIS & Back-up and UHF radio voice & data communication systems. AC to DC and DC to DC converters required shall be taken care by the contractor. –ve polarity provision for power to the communication system at each of the sites will also need to be provided.

10.4.4 A communication system is proposed for full duplex voice and data communication among the following locations :

i) MBMC Main office
j) WWTS & PS

Antennas and antenna towers shall be provided at each site mentioned above.

The Master Control Centre (MCC) is proposed at MBMC Main office.

10.4.5 <u>Data Communication :</u>

The UHF radio communication system shall be used for data communication as below.

- MCC SCADA system shall receive the data from following sites using UHF communication system.

- WWTS & PS-II
- WWTS & PS-III
- MBR
- TBR

- Data communication among the following sites.

- WWTS & PSLocal SCADA system
- WWTS & PS-II Local SCADA system
- WWTS & PS-III Local SCADA system
- MBR PLC System
- TBR PLC System

- MCC SCADA and UHF Communication System shall communicate all the acquired data to the MIS & Back-up site PC based system.

10.4.6 Voice Communication :

UHF radio communication system shall be suitable for the following.

- Voice Communication among each of the sites

Two options are proposed for voice communication system which shall be a part of UHF voice and Data Radio communication system proposed for this project.

Voice Communication-I :

An Automatic Electronic Private Branch Exchange (EPABX) system shall be located at MCC. Telephone instruments shall be provided at each of the sites mentioned above. This shall form a voice communication private network for the Employer.

4.10.0.1.2 Voice Communication-II

UHF radio equipment then shall be provided with suitable voice interface (s) at each of the sites.

Contractor shall Design, Testing at manufacturer's works (Factory Acceptance Test – FAT), Supply, Erection and Commissioning this system and shall be fully responsible to make available uninterrupted simultaneous voice and data communication facilities proposed at each of the project sites.

This Voice Communication Option-II shall have the following;

Subscriber Interface

The communications system shall be provided with facilities to permit voice communications between the following:

- all sites;
- between a given number of hand held mobiles and each site;
- mobile to mobile.

Hand Held Mobiles :

Ten hand held mobiles shall be provided for use in conjunction with the installed system.

10.4.7 Scope of Work for UHF Radio Voice and Data Communication System:

The scope of work covers but not, limited the following.

(a) Design, Testing at manufacturer's works (Factory Acceptance Test – FAT), Supply, Erection and Commissioning of UHF voice and data Communication System integrated with EPABX system / Hand Held Mobile Based Voice Communication System, Power Supply System for communication system including all accessories with required hardware, software.

Work related to signal, power, communication cabling including supply, laying, fixing, trenching, termination & testing.

The Electrical, Civil & Mechanical works associated with these systems to meet the project requirements.

This shall be covered for the each of the main project sites/locations.

(n) Contractor shall carryout the UHF Radio Survey for voice and data communication at each of the sites in mentioned in (a) above and submit the detailed report on it for approval of Employer.

(o) Detailed design, fabrication supply, test, erection and commissioning of UHF Radio voice and data communication systems at each of the sites shall be based on this survey report.

(p) Co-ordinating, obtaining frequency/ies allocation and frequency/ies approval for the system in the name of Employer including submission of application to wireless adviser, wireless planning and coordination committee (WPC) Government of India, New Delhi for obtaining the allotment of UHF frequency/ies and an operating licence for this project. The Employer will offer assistance to the contractor in this regard.

(q) Obtaining clearances from different government/statutory/local authorities such as SACFA. with respect to the design of, siting and erection of radio towers. The Employer will offer assistance to the contractor in this regard.

(r) Supply, test and measuring equipment & maintenance tools.

(s) Supply spare modules of Voice and Data Communication system.

(t) Detailed design, fabrication, assembly, galvanising/painting, erection & commissioning and inspection of tower, antennas and antennas mounting & construction of tower foundation at each of the project sites. Contractor shall supply, erect the required hardware, and carry out related work at each of the finalised sites under this project.

(u) Design, supply, test, erection and commissioning of Lightning Arrester and Earthing System, Aviation Lamps, Daynight Obstruction Markings for tower of voice and data communication system.

(v) All work related to interfacing of voice and data communication system with instrumentation & control systems including SCADA systems at locations in a) above.

(w) Integrated testing at site of communication system with instrumentation & control system, SCADA systems at mentioned sites, power supply system, and other associated sub systems for automation at locations mentioned in a) above as a part of Site Acceptance Tests.

(x) Training of UHF voice and data communication system to Employer's personnel.

10.4.8 Design Criteria

Design criteria for voice and data communication system including power supply system shall

take into account the following.

- Reliability of performance.
- Ease of installation.
- Simplicity of operation and maintenance.
- All instruments & equipments for voice and data communication system & power supply system shall be suitable to operate & store in corresponding ranges of relative humidity & temperature as applicable to project site conditions.
- Provision of arrangements from possibility of vandalism point of view for all instruments & equipments at remote sites.
- Remote maintenance facilities for major components of the system.
- User friendliness.
- Effective and accurate decision making.

10.4.9 Mode of transmission of data

UHF Voice and Data radio communication system located at each project sites shall operate in point to point and / or point to multipoint configuration. PLC logic at each location needs upstream and downstream data communication for respective plant /process operation. Hence radio communication shall take care of this PLC data-sharing requirement among the various project sites using standard protocol.

Unique address shall be provided for each station and changed information shall be transmitted on UHF link to MCC. Only addressed station shall decode the data and other stations shall act in store and forward mode.

All data from the remote sites shall be brought at MCC SCADA that is acting as a master. Alarms from PLC at each site and from local SCADA systems shall be transmitted to MCC by report by exception.

MCC shall poll each station sequentially by transmitting its address over UHF link. Only the station whose address matches with the address transmitted by MCC shall respond and transmit data, other intermediate stations shall act as repeater using store and forward mode. Contractor shall design communication network with suitable polling cycle duration so as achieve desired system response time for effective management of Sewerage system. This shall be done in consultation with and approval from Employer/ Consultant's engineer. Polling duration shall be software configurable at any time and shall be user friendly.

10.4.10 UHF Voice and Data Communication System Requirements :

(a) General :

The Contractor shall ensure a satisfactory environment for the UHF radio equipment.

- UHF radio equipment shall be suitable for continuous operation at the site temperatures.
- The Contractor shall provide facilities to reduce effect of high power adjacent channel interference. The UHF transmitters shall have features to overcome seasonal variation of UHF radio communications performance.

(b) Details of the equipment /systems for telemetry shall include but not be limited to the following;

i. All UHF radio stations fully equipped with transmitters and receivers., multiplexers voice & data interfaces, Radio MODEM, antenna (s), tower and supporting structures and its accessories including lightning arrester and aviation lamp, RF cable and its accessories for mounting and coupling etc., Inter-connecting cable and necessary accessories. The required power supply AC or DC for each of the radio station shall be derived from the Uninterruptible Power supply System (UPS) at each of the project sites/ locations which are under the scope of the Contractor for this project.

ii. This shall provide telecommunication among the Master Control Centre and the upstream and down stream pumping stations, and MIS & Back-up site in order to access data for control and treated water management purposes. Bit error rate of 1×10^{-7} Per hub and 1×10^{-5} for end to end should be adhered.

iii. The UHF radio communication system proposed for this project shall be suitable for full duplex voice and data communication. The UHF communication system shall be multiple frequency/multiple capacity point to point and/ or point to multipoint digital radio system. System shall have single rack-mounted radio acting as a primary rate multiplexer and drop/insert digital cross connect switch to allow complete flexibility in 64 kbps timeslot assignment.

iv. Frequency bands

The UHF voice and data communication system shall be selected with UHF frequency range (300 MHz to 3000 MHz). Final selection of frequency band and power requirements shall be done depending upon the radio survey results and clearances of statutory authorities.

(c) <u>Indicators, switches and Alarms :</u>

- The UHF equipment shall possess comprehensive hardware and link performance monitoring. These shall include:

i. LED displays of equipment healthy status and link performance healthy status
ii. front panel mounted equipment controls.

- Front panel LED indicators to annunciate and indicate the status of the radio equipment as follows:

Indicators :

Transmitter Active
Transmitter A or B alarm
Transmitter A or B phase lock loop out of lock
Transmitter A or B alarm
Receiver A or B active
Power supply unit A or B failure
Receiver A or B alarm
Main power supply indicator
A and B Power supply unit ON/OFF or Auto
Select A or B side transmitter or Auto
Select A or B side receiver or Auto
Simulate A or B side transmitter alarm to initiate automatic switchover
Carrier frequency synthesizer failure
Modulator ON/OFF
Summary fault alarm

Alarms:

A side alarm condition
B side alarm condition
AC power failure

- The remote radio shall have the ability to monitor its internal operation and diagnostic parameters via a hand held terminal or personal computer plugged in to a remote radio. Frequency, transmit power and deviation shall be remotely adjustable from the master station, Repeater or Polling Remote. The terminal or PC shall be able to monitor the following functions. Contractor shall indicate parameters monitored locally and remotely.

Radio Performance Alarms :

Transmitter SWR
Transmitter forward power
Transmitter relative forward power
Transmitter reverse power
Transmitter shutdown

Receiver signal strength

Receiver shutdown

Modem frame sync

Modem BER levels

Configuration alarms :

Module not ready

Software damaged

Configuration card failure

Signaling setup error

Signaling port setup error

Loopback active

Digital Inputs

Clock Source Failure

Temperature Alarms

Transmitter temperature

Voltage Alarms

Supply voltage

Aviation Lamp Voltage Alarm

(d) Radio System Diagnostics :

The radio shall include radio diagnostics capability to permit continuous or scheduled automatic monitoring of key radio operating parameters and alarm conditions. In addition, critical radio status and alarm conditions shall be annunciated on LED indicators on the front panel of the radio.

Diagnostic software shall operate under MS Windows to enable an IBM compatible personal computer (PC) to communicate with the radio diagnostic controller via a separate RS-232 diagnostic port on the master station radio. The PC with software shall serve as a central diagnostic-reporting tool/network monitoring system (NMS) for the entire communication network.

The diagnostic package shall support communications of diagnostic data from all remote radios in the system to the master station radio over the radio's RF channel. If a repeater radio is utilised; diagnostics from all remote radios and from repeater shall be sent over the RF channel to the polling remote radio. It will not be acceptable to require a separate external communication link between the PC and the repeater radio to obtain diagnostic data at the polling remote site.

Diagnostic data transmitted over the RF channel shall use encoding techniques to ensure robust communication and eliminate the possibility of diagnostic information being misinterpreted as data being sent by the associated PLC system.

All status and alarm information obtained from the radio stations shall be displayed on CRT

screens, and shall be provided with facility for printing or archiving to data base files for future recall and analysis.

(e) UHF Antennas and Towers / Masts :

RF co-axial cables and power supply cables shall be properly guided and fixed along the height of tower/mast. RF (coaxial) and aviation lighting cables shall be installed in G. I. conduits up to 4 m height on the tower and the galvanized perforated trays there after.

(g) System Integration :

The contractor shall integrate voice & data communication system with other instrumentation and control systems, power supply system, and other associated sub systems for automation at locations and performance of the integrated network shall be functionally demonstrated to the Employer's engineer before handing over the system. System integration shall meet the project requirements.

(h) Data Communication Facility :

Multiplexer with voice & data interface shall be provided at each station as a part of UHF radio equipment.

Suitable data interface (RS-232 or RS-485) with matching standard protocol shall be provided for interfacing with PC and or PLC system (s).

Data bit rate will be 1.2 to 110.2 kbps (settable/configurable). However, maximum capacity that can be handled by the each of the channel shall be at least of 64 kbps.

(i) Voice Communication Facility :

Multiplexer with voice & data interface shall be provided at each station as a part of UHF radio equipment. 2 W voice interface shall be provided for telephone set and 2 W/4 W interface for EPABX connectivity.

2 W voice interface shall use low rate coding techniques to compress voice at 8 kbps.

Contractor shall provide voice communication facility (one voice call between two stations at a time) at each station without affecting the data transmission between stations. Contractor shall indicate maximum simultaneous voice calls that can be made among stations

Every station shall be provided with 2–Wire telephone set (s) as indicated in drawing so as to selectively dial the desired station.

To get selective calling facility a EPABX with 16 extensions and having DID (Direct Inward Dialing) shall be provided at MCC-Bhayandar.

EPABX system shall comply to the requirements of International Telecommunications Union (ITU-T) - Telecommunication recommendations and relevant National/ International applicable statutes, regulations and safety codes in the locality where the equipment will be installed. EPABX provided shall be relevant national/international telecommunications rules and regulations.

Presently it is not envisaged to connect EPABX at MCC, Bhayandar to DOT/ PSTN (Public Switched Telephone Network) but it is envisaged only for private communication among various sites mentioned under this project.

EPABX shall be suitable for:

		Capacity	Equipped
a)	Call Office (CO) analog lines	8 nos.	4 nos.
b)	Analog extensions	16 nos.	16 nos.

The required AC and DC power supply for EPABX system shall be derived from UPS system in MCC-Bhayandar.

(I) <u>EPABX System Features :</u>

EPABX system shall have following typical features.

- Automatic phone/fax switch :

EPABX shall automatically distinguish between a fax or phone call and transfer it to fax or phone extension. Contractor shall indicate no. of fax machines supported by EPABX.

- Auto Call Disconnector :

The EPABX shall fix the time of LOCAL/STD/ISD calls beyond which it will be automatically disconnected but with a pre-warning tone so that conversation can be concluded fast. The disconnection time fixation is programmable as per need.

- Remote Controlled Call Diverter with Auto Redial :

This feature shall divert the incoming calls automatically to any desired fixed phone/paging stations. So that no missing calls even though one is away or on the way. Assigned number can be changed remotely by passcode when one moves from one place to another. It shall be backed with automatic redialing upto 10 times if the caller no. is engaged.

- Accepted Table :

With this feature it shall be possible for extension (s) to make LOCAL/STD/ISD calls only to those permitted areas which are allowed. So as to achieve efficiency with misuse control.

- Defined Table :

This feature shall not allow the extension (s) to make LOCAL/STD or ISD calls to un allowed areas. So one can restrict to general area code with misuse control.

- Auto STD Dynamic Lock :

Each extension shall be provided with programmable secret code to prevent misuse and shall be backed with an option of Automatic Locking specially in an event when one forgets to re-lock. The duration shall be programmable.

- Park-N-Page/Voice Paging Port :

With this feature it shall be possible to make instant announcement to draw attention of any person (s) in the premises. Normally it is used to call him or inform instantly to attend the parked incoming call. This feature shall be executed without loosing any P&T line or any extension. It shall be possible to connect the paging port to speakers through amplifier.

- Executive Ring Extension :

It shall be possible to provide special ring facility to Senior Executive (s) to get special attention while he make internal calls.

- Direct Outward Station (Subscriber) Access :

With this feature it shall be possible to use STD/ISD facility even if one is away from his place. This feature shall be enabled only with secret password and with a special marking on call printouts.

- Remote Extension :

This feature shall allow the user at remote to become an integral extension. One can talk to number of extensions one by one in a single call itself. So that no frequent “Hold On” or Call Transferring” required.

- Remote Servicing :

It shall be possible to maintain EPABX software remotely without calling service Engineer at EPABX location.

- Multiple Trunk Grouping :

It shall be possible to divide incoming P&T lines into groups and the specific extension (s) can only be allowed to access one of these groups. The incoming landing calls shall remain unaffected.

- Direct Inward Dialling and Selective Calling facility shall be provided.

- Other features :

Memory retention even if system is off.

Emergency reporting

Flash timing of an extension

Complete secrecy

Voice guided auto attendant

All other standard features of EPABX

(m) Telephone Instrument :

Telephones instrument shall have the features but not limited to the following.

- Instruments shall be table mounted and/ or wall mounted type.
- 80 cm coiled cord on handset.
- Second line function button with visual indication of ringing line and audible tone.

- Message waiting light.
- Last number re-dialling.
- Volume control on ringer.
- Tone/Pulse switchable
- Special buttons such as “Star” (*) and “Square” (#) to activate additional services provided by PSTN.

10.4.11 UHF Radio Voice and Data Communication System/Telemetry System:

Guidelines for selection of UHF communication equipment with EPABX based voice communication facility :

(a) The basic radio system shall be modular and shall support the various multiplex or interface cards shall include 2 wire and 4 wire voice, data, ISDN, ADPCM compression and Engineering Orderwire. Dual E1 interfaces provided shall be compliant with ITU-T G.703/G.704, 2.048 Mbps standard.

Contractor shall take into account and indicate clearly the required number of interfaces to meet the voice and data requirements of this project.

(b) Capacities and Modulation :

Basic communication system shall have modular architecture to suit 4 x 64 kbps to 62 x 64 kbps timeslots and shall support both Differential Quadrature Phase Shift Keying (DQPSK) and Quadrature Amplitude Modulation (16 QAM) techniques, DQPSK shall be available in 4, 10 ,30 and 60 channel systems and 16 QAM for 30 and 60 channel systems. This shall provide a choice of increased system gain or increased spectral efficiency. Contractor shall indicate the number of channels offered by him to suit the project requirement and future expansion requirements, if any.

(c) Network Expansion :

The radio system shall provide stepped capacity increments from 4 to 10, to 30 to 60 channels simply by changing the modem module and upgrading the operating software. Within each capacity step, the number and type of circuits needed shall be selected from the plug in multiplexer module options.

The communication system proposed for this project shall have 10 channels capacity.

(d) Integral Digital Cross Connect :

A digital cross connect switch integrated with communication system shall be suitable for

routing timeslots freely between radio, multiplexer and E1 interfaces. It shall be possible to built a network of communication links with timeslots individually routed end to end. Star and daisy chain network topologies shall be supported with timeslots routed across radio links or to multiplexer interfaces whenever needed.

(e) Integrated Multiplexer :

The proposed communication system shall have a preferably a integrated multiplexer section with plug-in slots for analogue voice, data and service modules including :

- 2 wire Subscriber
- 2 wire Exchange
- 4 wire with dual E&M
- Data module with low speed, high speed and co-directional data and clock recovery options.
- ISDN basic rate
- ADPCM transcoder compression
- Engineering orderwire

Contractor shall clearly indicate the number of channels available/provided per module. All modules mentioned above may not be required for this project requirement. However brief requirement of each of the modules is described below.

- 2 Wire and 4 Wire Voice Modules :

The analogue 2-Wire line interface modules shall enable direct connection of telephone subscribers to public and private exchange systems. Analogue trunk interface cards shall provide 4-Wire circuits with E&M Signalling, with a number of options simplifying to use the modules for two way and trunk radio applications.

- Serial Data Module :

The serial data modules shall provide low-speed, high speed or co-directional interfaces. Rates shall be possible from 150 bps to 110.2 kbps async and up to 768 kbps sync. The low speed interface shall be V.24/RS-232. The high –speed interface shall be V.11/RS-422 (V.35 with pad). The co-directional interface shall be G.703. Clock recovery and co-directional check recovery options shall be available.

- ISDN Data Module :

The ISDN module shall provide basic rate 2B + D services.

- Dual DTI Module :

The dual DTI modules shall be suitable for 2E1, G.703/704, 2Mbps expansion ports.

- ADPCM Module :

The ADPCM module shall compress upto 62 x 64 timeslots into 32 kbps. The number of timeslots within the base band to be compressed shall be filed selectable, enabling selective doubling of channel capacity for optimum convenience and flexibility. Optional additional E1 ports support shall be indicated clearly if available.

- Engineering Orderwire Module :

A fully featured Orderwired module shall provide a low overhead voice channel for network wide communication without reducing the subscriber capacity system. All points and selective point to point DTMF calling options shall be provided and indicated clearly by the Contractor.

- Networking Management System (NMS) :

The communication system shall be provided with integrated Network Management System for local and remote management. Remote sites shall be fully monitored from a central location. NMS shall provide the following minimum facilities.

i) User-friendly software control of variable parameters
ii) Performance monitoring facilities on each module
iii) Ability to monitor performance of remote terminals from a central site
iv) Ability to change configuration of remote terminals from a central site

NMS tools shall provide network wide configuration, alarm and terminal status information and provide comprehensive network performance monitoring, error and statistical measurements. With these, communication system shall provide self diagnostics facilities to the user during operations and maintenance of the communication network. NMS shall be made available on SCADA system PCs at MCC- Bhayandar and on Laptop.

(f) Alarms :

Communication system shall have provision of external alarm reporting to relay contacts where connection to third party networks and /or control of third party equipment is required. Contractor shall indicate number of alarm outputs available and all these alarms shall be software configurable. Also opto-isolated inputs shall be provided to enable connection of alarms from other equipment. Contractor shall indicate number of alarm inputs provided.

10.4.12 Communication System Architecture :

Communication system architecture shall be modular with 19" rack mount shelf where different interface modules can be plugged in. Modular system design shall provide flexibility to customise specific needs of the Employer and simplify installation and maintenance works.

(a) Plug-in modules :

Contractor shall indicate mandatory modules, RF (radio) interface and multiplexer modules etc. as a part of the voice and data communication system.

(b) Power supply module :

The power supply provision for the communication system shall be +/- 24 VDC or +/- 48 VDC. Power supply modules in communication system shall contain facilities to monitor supply voltage and to provide system alarm inputs and outputs. Power supply performance parameters such as input supply presence and rail voltages etc. shall be accessible through NMS.

(c) System Control Module :

The communication system control module shall be the central control and timing source and shall have a digital cross connect. It shall provide timing, communications, and timeslot switching, between associated modules and between networked terminals of the communication system. The system control module shall have powerful and flexible architecture. Also software safeguards shall be built in to ensure that information is transported accurately and reliably within the terminal and across the communication network.

The control module shall have facility for storing the setup configuration of the terminal with provision of eject mechanism for current configuration transfer to replacement control module or for new feature software to be supplied.

The cross connect in system control module shall be used for interconnecting 64 kbps circuits between the 2 Mbps ports, radio section and the multiplex section of the terminal. It shall be possible to configure the cross connect through configuration software or NMS.

The control module shall have facility of two digital trunk interface ports with provision of two G.703/4 E1 interfaces to the terminal through suitable connectors which shall be mounted on rear side of the terminal.

It shall be possible to connect 2 Mbps traffic from exchange or multiplexer to the terminal via one of the digital trunk interface ports so that terminal can drop and insert allocated traffic timeslots. Inserted timeslots and those timeslots not allocated to the terminal shall be possible to re routed out of terminal via second G.703/4 interface or routed to the radio section. The clock synchronisation of the terminal shall be possible from one of the digital trunk interface ports, radio modem or an internal reference. Power fail bypass facility shall be provided on digital trunk interface ports so that if terminal ceases operation, incoming 2 Mbps traffic can be routed to the second 2 Mbps port, ensuring through traffic is not lost.

System Control Module shall have Test Port V.24 to connect to PC. The PC can be used for configuration and basic troubleshooting procedures.

(d) RF (Radio) Modules :

- Transmitter Module :

The transmission module of communication system terminal shall provide up-conversion and amplification of the intermediate frequency (IF) signal generated by the modem. Transmitter output is connected to the antenna via duplexer. The transmitter module design shall be wide band and provide stable frequency conversion and linear power amplification across the operating band. Contractor shall indicate if transmitter modules are specific to a particular frequency band.

Transmitter module shall consists of Tx logic board, synthesizer/local oscillator, up-converter, power amplifier, and circulator/low pass filter. Except logic board all other shall be enclosed in separately screened, machined aluminium to eliminate interference.

It shall be possible to enter transmitter frequency and power output level either via PC connected to the control module or via NMS. The parameters shall be stored in non volatile memory on the transmitter module. A Back-up copy shall be kept on control module in case the transmitter module is replaced.

The transmitter power shall be adjustable to minimise the power consumption and potential interference to adjacent services. Contractor shall indicate this adjustment range and steps of adjustment.

Mixer :

Here the IF signal is mixed with local oscillator frequency in a hot carrier diode balanced mixer to produce the up-converted final output frequency.

Attenuator :

The up-converted signal shall be fed to an attenuator where automatic level control is applied. This loop shall maintain the transmit power output.

Synthesiser :

Phase lock loop (PLL), Voltage control oscillator (VCO) shall be used to provide a very stable frequency to the mixer which when combined with the incoming IF, produces the required RF output frequency.

Filter :

A suitable bandpass filter shall be used to filter the attenuator output RF signal. This shall provide suppression of the local oscillator frequency, the unwanted mixer side band and spurious signals. The filter shall be broadband and shall not require any in-band retuning.

Amplifier :

The output of the filter shall be amplified by passing it through amplifier chain. The amplifier output shall be protected against VSWR, poor antenna return loss problems and intermodulation occuring from co-sited transmitters.

Performance Monitoring :

The performance monitoring shall be provided for monitoring of regulated supply voltages, forward and reverse power, heat sink temperature and the PLL loop voltage. All these values, along with status and error codes shall be stored in non-volatile memory on the transmitter module.

Test Points :

Test points or front panel connector shall be provided to have a sample of transmitted RF signal for testing and monitoring with a spectrum analyser or frequency counter. The level shall be well below the carrier.

- Receiver Module :

The receiver module of terminal shall provide low noise amplification and down-conversion of the incoming microwave signal for the modem module. The receiver shall be designed for stable, wide band operation and excellent sensitivity. Contractor shall clearly indicate if

receiver modules are specific for a particular frequency band.

It shall be possible to enter/program the receive frequency setting via a PC connected to the terminal control module or via a NMS. This information shall be stored in non-volatile memory on the Rx module.

First Filter :

The received signal shall be passed through a bandpass filter, to reduce any out-of band signals and interference that may be present. The filter shall be wide band and shall not require any tuning. Also it shall have low insertion loss to avoid degrading the receiver noise figure.

First RF Amplifier :

The signal from filter is passed to low noise RF amplifier stage of the receiver module. The amplifier shall be wide band and requires no tuning adjustment. Amplifier gain shall be controlled by an AGC.

Second Filter :

The amplified signal shall be further passed through another filter that attenuates any unwanted signals present. The filter shall have greater selectivity and higher insertion loss the first filter.

Second RF Amplifier :

The signal from second filter shall be then passed through second stage of wide band amplification.

Synthesiser :

The PLCC VCO shall provide a very stable frequency to the mixer which, when combined with incoming RF signal, produces the IF signal.

Mixer :

The amplified incoming signal shall be mixed with local oscillator frequency in a mixer to produce the down-converted intermediate frequency. The IF signal produced shall be filtered

for a high degree of rejection of any adjacent channel signals and unwanted products produced during mixing process. The IF signal shall be then amplified through IF amplifier.

Performance Monitoring :

The continuous monitoring shall be made for AGC voltages, voltage supply rails, synthesiser loop (tune) voltage and synthesiser lock status. These values, along with other status and error codes, shall be stored in non-volatile memory in the receiver module.

Test Points :

Test point shall be provided for AGC voltage monitoring/testing during installation when aligning antennas. The AGC voltage shall also be remotely accessible via the configuration or network management software.

Terminal shall be provided with suitable isolator module for RF isolation between transmitter and receiver modules enabling a single antenna to be used. The isolator shall have a series of bandpass filter sections for standard transmit/receive separations. Contractor shall clearly indicate different type of isolator modules supplied for each of the different frequency bands. The isolator module shall be housed suitably to provide mechanical protection and isolation form interfering signals.

Transmit Path :

The RF signal output from the transmitter module shall be connected to isolator module through co-axial connector. The signal shall then passed through stages of bandpass filters that removes noise from the transmitter output that may be present on the receiver frequency. Provision for operation at narrow transmit /receive splits shall be made.

Receive Path :

Stages of bandpass filters shall attenuate the transmit energy at the receiver input. And also prevent other signals from overloading the receiver. Provision for operation at narrow transmit/receive splits shall be made.

- Modulator-Demodulator (MODEM) Module :

The terminal modem module shall provide an interface between the radio section (Transmitter and Receiver modules) and digital section of the terminal. Contractor shall indicate the different types of modem modules supported by the terminal and also proposed for to meet

this project requirement. For these modem modules Contractor shall clearly indicate capacity of the radio terminal in timeslots, the modulation scheme and the occupied bandwidth.

- Multiplexer Modules (Interfaces) :

Contractor shall indicate the different types of Multiplexer modules for voice and data communication requirements. In general radio terminal shall support the following plug-in modules.

i) Voice modules for 2 wire exchange, 2 wire subscriber, 4 wire dual E&M
ii) Data modules for Data , ISDN and E1 ports connectivity
iii) Compression Module for ADPCM and E1 ports
iv) Orderwire module for supervisory facility (Engineering Orderwire)

The Contractor shall indicate the available no. of channels/circuits per module for voice and data modules.

Voice Modules :

2 Wire Exchange Module :

General Features : Following features shall be available in 2 Wire Exchange Module.

DTMF and decadic dialing support

No transformers

Programmable Rx/Tx gain

Loop or ground start trunks

Supervision detection of forward/reverse loop, tip/ring ground, ringing

On-hook audio reception for Automatic Number Identification and other applications.

Payphone meter pulse reception

Line and network balance impedances

Description:

The 2 Wire Exchange Module shall provide 2 wire balanced circuits with loop start/ground start facilities for use with 2-Wire exchange lines. The modules shall have provision for performing exchange line interface isolation functions and a CODEC circuit for A-D and D-A conversions. Surge protection and RFI suppression networks shall be provided in these modules. Contractor shall indicate the provision made for lightning protection.

It shall be possible to route the tip/ring circuit from the external device i.e. exchange to the section of 2 Wire Exchange Module which provides a completely isolated audio and signalling link between the exchange and the CODEC. The functions provided shall include transformer-less isolation, 2 - wire to 4 - wire hybrid conversion, programming of receive and transmit signal gains, loop and ground start drivers and the line state detection outputs. A special feature such as on-hook audio reception (to accommodate ANI) if available shall be indicated by the Contractor.

The CODEC shall provide A-D, D-A, and gain adjustment facilities for the incoming and outgoing voice circuits, as well as timeslot assignments, hybrid balance cancellation. The CODEC shall support either A-Law or μ- Law companding techniques, which may be set through the configuration or network management software.

2 Wire Exchange module shall be have provision to provide with correct line and line balance impedances.

It shall support pay phone metering and shall be configurable to detect tones and line reversals. The radio terminal shall provide conversion of the payphone signaling by detecting tones at the exchange interface and delivering line reversals at the associated subscriber interface, or vice versa to provide flexibility in adapting to Employer's network.

Configuration and monitoring : Setup of 2 Wire Exchange Module shall be stored in non volatile memory and back up copy is stored in the control card to ensure the correct parameters are loaded if 2-Wire Exchange module is replaced. Network management software shall allow full setup and configuration of all parameters, together with monitoring and reporting functions.

2-Wire Subscriber Module :

General Features : Following features shall be available in 2 Wire Exchange Module.

DTMF and decadic dialing support

Loop start and ground key detection

Programmable current limit and Tx/Rx gain

Selectable DC feed bridge resistance

Polarity reversal and tip open states

Zero crossing ring injection and trip detection

Subscriber payphone meter pulse injection

Line and network balance impedances

Description :

2-Wire subscriber module shall provide 2-Wire balance circuits with loop start/ground start facilities for use with 2-Wire analogue telephones and PABX trunk lines. Each of the circuits shall have provision for performing the telephone line interface functions and a CODEC to perform A-D and D-A conversions, and PCM coding. Surge protection and RFI suppression networks shall be provided in these modules. Contractor shall indicate the provision made for lightning protection.

It shall be possible to route tip/ring circuit from an external device i.e. telephone, fax etc. to the section of the 2-Wire Subscriber module and associated relay and power transistor, which perform the battery feed, on-/off- hook detection, ringing, signaling, and hybrid telephone line interface functions.

CODEC shall provide the transmit A-D and receive D-A conversions for the voice circuit, manage timeslots, receive/transmit gain setting and hybrid balance cancelling. A-law and μ-Law and A-law with even bit inversion companding shall be possible to select through the configuration or network management software.

2 Wire Subscriber module shall be have provision to provide with correct line and line balance impedances.

It shall support pay phone metering and shall be configurable to detect tones and line reversals. The radio terminal shall provide conversion of the payphone signalling by detecting tones at the exchange interface and delivering line reversals at the associated subscriber interface, or vice versa to provide flexibility in adapting to Employer's network.

Configuration and monitoring : Setup of 2 Wire Subscriber Module shall be stored in non volatile memory and back up copy is stored in the control card to ensure the correct parameters are loaded if 2-Wire Exchange module is replaced. Network management software shall allow full setup and configuration of all parameters, together with monitoring and reporting functions.

4 Wire Dual E&M Module :

General Features : Following features shall be available in 2 Wire Exchange Module.

600 or 900 Ohm line impedance

Dual E and dual M supervision circuits

Solid state E1/M1/M2 circuits

Dry relay contact E2 circuit

Programmable Tx/Tx gain

Description :

4-Wire E&M module shall provide 4-wire circuits, each circuit providing dual E and dual M signaling. It shall be possible to route voice frequency input circuits through isolation/impedance-matching transformer and apply to the CODEC. RFI filtering shall be applied to all input and output lines. 4-wire interface shall support two modes of operation for E&M signaling. Passing through mode shall pass signaling detected on the M lead at one end of the link, to the E lead at the other end of the link. Intercepted mode shall enable radio terminal to interpret signaling for conversion to another format.

CODEC shall be provided for A-D and D-A conversions for the incoming and outgoing circuits. It also shall incorporate gain adjustment, time slot assignment. A-Law, A-Law with even bit inversion or μ- Law

shall be possible to select through the configuration or network management software.

Each circuit of 4-Wire dual E&M module shall have two solid state M input lines and one relay E output line. The M inputs are normally asserted by grounding the M Lines, but link and strap options shall be indicated by the Contractor.

Contractor shall also indicate support for payphone metering.

Setup information shall be stored in non-volatile memory. A backup copy shall be stored in the control card to ensure the correct parameters are reloaded if E &M module is replaced. Network management software shall allow full setup and configuration of all parameters, together with monitoring and reporting functions.

Data Modules :

The radio terminal shall support the Serial Data Module with following features.

Low-speed interface3

V.24 interface, upto 10.6 kbps sync. 110.2 kbps async

ITU-T Rec. V.120

High speed interface

V.11/V.35 interface, sync.

8 to 786 kbps data rates

64 kbps co-directional interface

G.703, 120 Ohms twisted pair interface

2 MHz clock recovery interface

To clock radio terminal from external input

Accept 2.048 MHz TTL

Accept G.703, 120 ohm balanced or 75 ohm unbalanced inputs

Co-directional clock recovery interface

64 kbps G.703 twisted pair interface

Clocks the radio terminal from 64 kbps input

Contractor shall indicate how many data interface channels are supported by a single serial data module.

Low speed Interface :

The low-speed interface shall provide two Rs-232 circuits with rates to 9600 bps sync or 110.2 async based ITU-T recommendation V.120. It shall be possible to combine multiple low speed circuits onto a single 64 kbps timeslot using the radio terminal cross-connect facility.

High Speed Interface :

The high speed interface shall provide a single RS-422/V.11/V.35 sync circuit operating upto 768 kbps based on direct mapping of time slot bits. It shall be possible to assign multiple 64 kbps timeslots to carry this high speed data.

Co-directional Interface :

Co-directional interface shall provide one 64 kbps G.703 interface.

2 MHz Clock Recovery Interface :

This interface shall allow the radio terminal to be clocked by an external 2 MHz input.

Co-directional Clock Recovery Interface :

The co-directional clock recovery interface shall provide a 64 kbps G.703 interface and clock recovery, enabling the radio terminal to be clocked by the 64 kbps input.

ISDN Module :

The following minimum features shall be available in ISDN module.

Provide four ISDN BRA NT/LT-U interface circuits.

2B+D with 2B1Q coding

2 x 64 kbps B timeslots for voice or data

1 x 64 kbps D-channel for signaling or packet information

Loop terminator (LT) or network Terminator (NT) versions.

EMC compatibility

Power feed over-current and over-temperature protection

B1, B2 and 2B+D transparent loopbacks on command

D-channel concatenation to increase available bandwidth

The ISDN module shall allow service providers to extend the range of ISDN services using a radio terminal network to create a generator bridge between an ISDN telephone exchange and customer NT devices. It shall provide ISDN basic rate access in the 2B+D format. The B-channels, B1 and B2 are used for voice/data and the D-channel for signaling. The ISDN circuits in a module shall be available in LT (master) or NT (Slave) versions and operate using 2B1Q coding.

Diagnostic and line feed status, transversal filters and non-linear echo cancelling facilities shall be available in the module. Protection devices to prevent damage due to transients and electrostatic discharge shall be provided. Contractor shall also indicate provision of protection against lightning strikes or other transient voltage disturbances. The ISDN power feed shall be protected against over current and temperature conditions.

Dual 2 Mbps Expansion Ports Module

This module shall have dual 2 Mbps, G.703/G.704 expansion ports and on-board digital cross connect.

This module shall provide two additional E1 ports for applications requiring more than the two ports which are standard on radio terminal control module. The on-board digital cross connect shall provide switching of individual 64 kbps timeslots and shall be completely non-blocking.

This module shall provide drop/insert mode allowing grooming off to the radio link, multiplex interface, or to other 2 Mbps ports on radio terminal.

Also this module shall provide termination mode where two 2 Mbps ports terminate two E1 traffic channels,. Individual timeslots can be selected and switched to the radio link, multiplex interfaces, or to the other 2 Mbps ports on radio terminal.

Compression Module: ADPCM

This module shall have minimum following features.

32 kbps ADPCM transcoder module

Conform to ITU-T rec. G.721

Transcode upto 60 timeslots

Dual 2 Mbps G.703/G.704 expansion ports

Ability to bypass ADPCM coding non-voice traffic

Full rate two timeslot or optional signal timeslot signaling compression modes

The ADPCM transcoder module shall allow up to 60 PCM coded voice circuits at 64 kbps to be compressed to 60 ADPCM circuits at 32 kbps. The compressed timeslots are paired into 64 kbps timeslots ready to be sent over the radio link or out on 2 Mbps port, effectively doubling the subscriber capacity of the network. The compression method shall conform to ITU-T recommendations G.721. Inputs to the ADPCM transcoder module.

Signaling :

The ADPCM transcoder module shall offer the compression options for associated digital R2 signaling traffic (timeslot 16) to handle upto 60 timeslots.

Full speed, 2 bit mode :

Which passes only A and B signaling bits. The decompression process inserts user definable static values into C and D bit positions at the output.

Full speed, 2 timeslot mode :

Which uses two bearer timeslots to transfer all four signaling bits at full rate, but reduces the number of subscriber circuits available from 60 to 510.

Half-speed, 4 bit mode :

Which passes all signaling bits for each 2 Mbps stream in alternate multifunctions, resulting in half the normal signaling rate.

Engineering Orderwire Module (EOW) :

This module shall have following minimum features.

8, 16, 32 or 64 kbps digital voice omnibus

Handset and loudspeaker options

2-wire telephone interface with DTMF selective calling

4-wire E&M telephone interface

Dual G.703 64 kbps co-directional voice interface ports for terminal-to terminal connection

The EOW module shall provide a low-overhead voice channel for network-wide communication during equipment installation, commissioning and maintenance.

EOW module shall allow both DTMF selective calling and general (all station) calling. A general call shall alert all EOW module in the network by sounding a buzzer. A selective call shall alert only the specified EOW module. Once the selective call between two modules is established, further selective calls may be made to add more stations to the conversation.

Contractor shall indicate combinations/options available for EOW such as 2-wire interface, an analogue 4-wire interface with E&M signaling, two digital co-directional voice ports and a loudspeaker handset combination are provided.

Orderwire services shall be possible to bridge between otherwise independent radio networks via 4-wire or co-directional ports. This enables DTMF selective and general (all station) calls to be made from one network to another.

For 2-wire interface requirement if any, of ring generator shall be clearly indicated by the Contractor.

Contractor shall indicate whether Single Chassis Protected Terminal or Dual Chassis Protected Terminal is offered. The offered design for this project shall ensure reliability and availability requirements of radio network as indicated alongwith other requirements in design criteria.

10.5 Cabling Systems

The Contractor shall provide all required cabling and support systems to complete interconnect the instrumentation & control, SCADA, and communication systems including

their interconnections and also connection of these systems to the motor control plant.

The Contractor shall carry out all cabling work including terminations for interfacing of third party SCADA at STPs to the MCC SCADA. For this contractor shall co-ordinate with third party SCADA contractor in case he needs information of this system.

10.6 Earthing System

(a) The arrangement of earthing for functional and protective purposes shall be provided at each of the sites mentioned under this project for instrumentation & control systems and power supply systems to ensure correct operation of equipment or to permit reliable and proper functioning of installations. The earthing quality shall be such that continuity resistance of the earth return path through the earth grid should be maintained as low as possible and in no case greater than one ohm. For designing of earthing system, the Contractor may be required to carry out the soil resistivity measurements.

(b) The earthing scheme shall conform to the latest available Indian/International standards such as IS:3043 as per the Electricity Rules. A separate earth pit for signal earth shall be provided by the Contractor.

LIST OF APPROVED MAKES FOR INSTRUMENTATION AND CONTROL SYSTEM

ULTRASONIC IN TYPE FLOW ME SYSTEM	Accusonic U.S.A (Ageion s Danfoss (Ultraline, Pune) Rittmeyer (J.S.K Engg, Mu	
ULTRASONIC TYF MEASUREMENT	Endress and Hauser Millitronics (Toshniwal) Krohne (Forbes Marshall)	(E&H)
CAPACITANCE LEVEL ME SYSTEM	Endress and Hauser Toshniwal Bro. Pvt. Ltd. Pune Techtrol	(E&H) (TOSHNIWAl

CONDUCTIVITY LEVEL SWITCH	Pune Techtrol	
	Endress and Hauser	(E&H)
	Toshniwal Bro. Pvt. Ltd.	(TOSHNIWAI
	Pepperl & Fuchs	(P&F)
PRESSURE MEASUREMENT S	Rosemount (I) Ltd.	(ROSEMOUN
	Foxboro	
	Druck (MTL Instruments P\	(DRUCK)
	Rittmeyer (JSK Engg)	
	Yokogawa	
	Asea Brown Brovery	(ABB)
PRESSURE SWITC	Indfoss India Ltd.	(INDFOSS)
	Switzer Instruments Co.	(SWITZER)
	Varma Trafag Inst. Pvt. Ltd	(VARMA)
TEMPERATURE S	Masibus Process Instrume	(MASIBUS)
	Lectrotek	
PRESSURE INDIC	Bells Controls Ltd.	(BELLS)
	General Instruments Co.	
	Manometer India Ltd.	(MANO)
	Forbes Marshall, Pune	
INSTRUMENTATIC CONTROL CABLE	Delton, Faridabad	
	Asian Cable Corporation of	
	Cable Corporation of India	
	TCL cables, Delhi	
	Udeypyro cables, Lonavala	
PROGRAMMABLE CONTROLLER	Allen Bradley	
	Tata Honeywell	
	Siemens	

	Schneider	
LOCAL CONTROL	Sai Technologies	
	Allen Bradley	
	Siemens	
	Schneider	
	Tata Honeywell	
DIGITAL PANEL IN	Masibus	
	ABB	
	Yokogawa Blue Star Pvt. L	
SURGE PRC DEVICE	Rittmeyer (JSK Engg.)	
	MTL Instruments	
	Pepperl & Fuchs	
	Erico (JSK Engg.)	
PANEL ENCLOSUI	Rittal	
	Enclotek	
COMPUTER	Compaq	COMPAQ
	Hewlett Packard	HP
	International Business Mac	IBM
RESIDUAL C MEASUREMENT	Hach	
	Rosemount	
	Polymetron	
	Great Lakes	
SCADA SYSTEM	M/s Metso Automation, Ca	
	M/s ABB Ltd. India	
	M/s SIEMENS Ltd., India	
	M/s ALSTOM Ltd., India	

	M/s Yokogawa Blue Star India
RADIO COMMU SYSTEM	Digital Microwave C (DMC), USA
	M/s MDS
	M/s MOTOROLA India
EPABX SYSTEM	M/s ACCORD Communica
	M/s SIEMENS Ltd.
	M/s TATA Telecom
	M/s PANASONIC Ltd.
	M/s BPL Ltd.
UNINTERRUPTIBL POWER SUPPL SYSTEM	M/s APLAB Ltd.
	M/s TATA Libert Ltd.
	M/s HIREL Electronics Pvt.
	M/s L&T Ltd.
	M/s ENERCON Systems P
BATTERIES	M/s CHLORIDE Industries
	M/s AMARA RAJA Batterie
	M/s EXIDE Ltd.
	M/s Standard Batteries Ltd
	M/s Sab Nife
POWER CABLES	M/s ASIAN Cable Corporat
	M/s Universal Cables Ltd.
	M/s RPG
	M/s Polycab
	M/s Fort Gloster Industries
	M/s FINOLEX Cables Ltd.
COMMUNICATION CABLES	M/s Universal Cables Ltd.
	M/s RPG
	M/s Polycab
	M/s Fort Gloster Industries