

PART-II

ELECTRICAL AND MECHANICAL WORK

BRIEF OVERVIEW OF E & M WORKS

E00.1 General

E00.1.1. This section contains the general description of the system concepts and major components for Electrical and Mechanical (E & M) Works, interface requirements with other contractors, manufacturing, general installation, design / performance and testing requirements. Detailed Specifications for the Items and Equipment to be used in E & M Works along with specific installation, design / performance and testing requirements are given in various sections of the Technical Specifications. The Bider's attention is drawn to the General Conditions of Contract, Special Conditions of Contract, General Specifications, Bid Drawings, Pricing Schedule/Bill of Quantities and SHE manual which are to be read in conjunction with these Technical specifications.

E00.1.2. The emphasis is to explain the requirements of work, interfaces with other contractors for achieving an efficient & safe working system commensurate to the best international standards and practices. The contractor shall follow acceptable standards akin to the best available in world Metros where this is not specifically mentioned. Interface management document is also attached for reference.

E00.1.3. In this document the term "provide" shall mean "calculations, preparation of drawings for installations & maintenance, manufacture and factory testing or procurement, delivery, off-loading, installation, testing, commissioning, handover of completed works to JMRC, JMRC staff training including supply of O & M manuals & as-built drawings, interface and co-ordination with other contractors arising out of concurrent works and warranties.

E00.1.4. The design and supply of elements shall be to latest International Specifications and Standards. Approved latest local standards shall also be complied wherever necessary.

E00.1.5. Unless approved otherwise, all equipment and items shall be uniform throughout the Contract - Lots in order to minimise inventory of spares and the number of manufacturer interfaces.

E00.2 Scope of work

The works include the provision of all Building Services required in this contract, as specified below, **for stations and tunnels** and also those which are not specifically excluded. The Services covered are those, which are necessary to permit the Metro Corridor to perform its design functions in a safe and efficient manner, in compliance with the requirements of the relevant Technical Specifications and in accordance with modern Metro Railway practice. Equipment

and Systems provided shall be compliant with the relevant Technical Specifications.

- E00.2.1 The Electrical & mechanical works are to be provided as described in the scope of works which includes the Design Verification, Preparation of Working or Shop Drawings, Manufacture, Testing at manufacturer's works, Supply, Storage, Erection, Site testing and Commissioning of the works and other provisions as stipulated in GCC, SCC and other documents comprising of but not restricted to description given below.
- E00.2.2 Approved Definitive Design Documents and Construction Reference Drawings prepared by Detailed Design Consultants of the Employer, approved by Engineer, shall be supplied progressively during Works. The Contractor must develop Working / Shop Drawings and documents from the above mentioned drawings / documents, submit to DDC for reviewing and obtain written approval of Engineer prior to construction. (Refer Clause E00.20 for details).
- E00.2.3 Scope of works shall also include all Civil Works associated with Electrical System Works and making good and painting the civil works as required. These civil works shall be executed as per latest CPWD specifications and latest IS & BIS codes .
- E00.2.4 Establishing site office with documentation, communication and transport facility and maintenance of the area during implementation stage.
- E00.2.5 De-mobilisation, clearing of all temporary works and facilities after completion of job.
- E00.2.6 **Obtaining necessary permits / approval to commence works at site from local authorities.**
- E00.2.7 **Obtaining all statutory and mandatory permissions / clearances / approvals from the concerned authorities for commissioning of the complete installation including approval of the Working Drawings from Jaipur Fire Services.**
- E00.2.8 The contractor shall include the supply of entire materials in accordance with the relevant technical specifications, accompanying schedules and drawings for whole work necessary for a complete installation. Materials and components not explicitly stated in the specifications and / or bill of materials or noted on the drawing but which are necessary for satisfactory installation and operation of the system shall be deemed to have been included in the scope of work.
- E00.2.9 The contractor has to install the following systems in the station:
- (1) Electrical Systems .
 - (2) Plumbing/Hydraulic Systems.
 - (3) Fire Detection and Protection System.

E00.2.10 Scope of works for Electrical, Plumbing/Hydraulics, Fire Protection and Detection System is detailed in Clauses E00.3, E00.4 and E00.5

E00.3 Electrical works includes:

E00.3.1 Provision of (Power and Control) cables of adequate sizes from LV Main switchboards in the Auxiliary Sub Stations (ASS) to the the Sub main and other Distribution / Sub Distribution Boards / Motor Control Centres in the respective plant rooms and / or from the Switchboards / Distribution Boards to the equipment locations. This will include provision of feeder cables / bus trunking, to the plant rooms, as required. The cables shall be Medium Voltage, Copper Conductor, XLPE insulated, sheathed, armoured cables of Low Smoke and Zero Halogen and/or Fire Survival type, as specified and as required. Cables are to be laid in ground, cable trays, cable ladders, conduits or trunk ways as required, including jointing of the same with crimped sockets.

E00.3.2 Provision of Main LV Switchboards, Sub Main Switchboards, Motor Control Centres, Normal Lighting / Socket and other Distribution boards, Power Panels, Capacitor Bank Panels, Emergency Lighting Panels/Boards etc. These shall be Medium Voltage, sheet steel clad floor / wall mounted with flush mounted switchgear including Air Circuit Breakers, MCCB's, MCB / ELCB's etc. with Copper bus-bars as per configurations detailed in the specifications / drawings / BOQ including metering, relays, earthing etc.

E00.3.3 Interface and Co-ordination with the Building Management System Contractor for developing suitable control schemes for the plants and equipment (for Electrical, Plumbing/Hydraulics and Fire Systems) to be supplied in this contract. Necessary provisions in the equipment to be supplied in this contract will be required to be made by the contractor to suit BMS System.

E00.3.4 Provision of interlocks and protection schemes for the power distribution, to suit the desired operation, duly co-ordinated with high voltage side protections and protections of the individual equipment.

E00.3.5 Ascertain through liaison and interface, the adequacy of power supply feeding arrangements for ECS, TVS, Lifts and Escalators and other plants / equipment to be provided by other Designated Contractors. Provision of supply feeders for the equipment and plants supplied by other Designated Contractors.

E00.3.6 Provision of normal and emergency lighting arrangement & automatic operation as approved in all the station areas, tunnels, cable galleries, parking areas, fore court, sub-ways connecting entry / exits and other plant rooms located at ground level. This includes external cabling and provision of lighting fixtures with lamps, ballasts, control gear etc complete as required.

E00.3.7 Provision of plug and sockets or power points for power and lighting in the tunnel and station areas. Internal electrical installations including wiring in the Conduits with copper conductor, Low Smoke and Zero Halogen (LSZH) and / or Fire Survival type cables / wires including accessories etc. for lights, fans and socket

- outlets including earthing of all points.
- E00.3.8 Provision of control and small power supplies to various station equipment / panels.
- E00.3.9 Provision of Earthing System comprising of Main Earth Bus in Auxiliary Substations, Clean Earth System and Clean Earth Bus, earthing arrangements in tunnels including provision of Main Earth Terminals (MET). Co-ordination with Signalling and Telecom Contractor for arrangements within the Signal & Telecom rooms and other rooms requiring Clean Earth connection. Beyond the earth mat below the base slab level all the earthing done viz. taking risers to MET & Laying earth grid in undercroft, platform and concourse area is in the scope of work of this contract.
- E00.3.10 Provision of Lightning Protection System for any above ground structures provided at the stations.
- E00.3.11 **Supply and laying of GI Conduits with accessories for the PA system, communication, Signalling Systems or any other systems etc, as required, including the drawing of fish wires for wiring by other agencies.**
- E00.3.14 Facilities for Testing etc. at site and at the manufacturer's premises.
- E00.3.15 Erection, Testing and Commissioning of any major / minor Electrical items which may be procured and supplied by the Employer.
- E00.3.16 Provision of Tie bus Cables / Bus Trunking System/race way for connection between ASS's.
- E00.4 The Plumbing/Hydraulic Works involves:**
- E00.4.1 Provision of pumping arrangement for the raw water supply, treated water supply, sedimentation sump pumps, water treatment plants, water mains within the stations, make up water for the Environmental Control System Contractor's requirements, station drinking water supply, Fire - fighting and Sprinkler System together with the Jockey pump, Hose reel pump, Seepage and Sewage pumps etc.
- E00.4.2 Provision of automatic control & monitoring of operation of pumps, incoming supply, liquid level controllers or the equivalent arrangement based on the liquid levels in the various tanks and as per the design requirements.
- E00.4.3 Provision of the feeding arrangement of various pumps from the main incoming supply provided in the pump room. The pipelines and their accessories for seepage and sewage system will be provided by others. E&M contractor to interface.
- E00.4.4 Provision of treatment of water & storage tanks with level monitors for providing standby water supply for drinking water & toilet for staff, air conditioning, fire fighting and station cleaning etc.
- E00.4.5 For all equipment the complete system must be provided as approved.

E00.5 The Fire Protection Works involves:

E00.5.1 Provision of complete Fire Suppression System in the UG Stations and associated tunnel sections, associated tunnels and ancillary buildings / structures including hydrants, hose reels, sprinkler system, fire hose cabinets, fire mains in the tunnel, portable extinguishers, gas based panel flooding system, pipe line network with control valves for sprinklers and hydrants.

E00.5.2 Provision of complete Fire-Detection & Alarm system including monitoring and control through a fire alarm panel at Station Control Room **and status shall be provided at** OCC through SCADA including Chand pole station. This system shall have an interface for operation and control with other equipment such as ventilation / exhaust fans etc. through BMS. Provision of suitable type of detectors, Break glass units / Manual call points, illuminated signs, audio or visual display devices, auto communication, autodialing etc.

E00.6 Works Excluded

E00.6.1 The following works are to be designed, supplied, installed and commissioned by others with whom the Contractor shall co-ordinate regarding all interface requirements during Construction and Integrated testing stages.

- Lifts and Escalators for stations
- Railway Electrification and HV power supplies
- Auxiliary substations up to the provision of transformer.
- SCADA to some defined equipment provided by others
- Track work
- Rolling Stock
- Signalling, Telecommunications,
- Automatic Fare Collection
- Embedded piping works and construction of earth mat below the base slab will be done by the civil contractors.

E00.7 CONCEPT OF POWER SUPPLY DISTRIBUTION

E00.7.1 The Power Distribution System shall provide power to various electrical loads within the stations, tunnels, above ground Ancillary Buildings, parking areas and circulating areas along the permanent way except that for Rolling stock and traction power.

Power shall be supplied by the Contractor from the Main LV switchboards to all distribution positions including Switchboards / Distribution Boards / Motor Control Centres, Consumer units, and specialist services power supply isolating switches and distribution boards to all consumer points for lighting, general purpose power,

lifts, escalators, communication and signaling equipment, CCTV, SCADA, signs, Environment Control Systems and maintenance equipment.

Dual Supply is defined as Supplies from any two Auxiliary Substations at the Distribution Board with an Automatic or Manual Transfer Switch, as required. Dual power supplies must be available at the last Distribution Board feeding the final power supply cable for specified loads.

E00.7.2 **Incoming Supply:**

Electrical power will be received from the Power Utilities via 220 or 66 / 33kV Transformers at the Receiving Sub-Stations. Distribution for auxiliary services throughout the stations of JMRTS will be at 33 kV with most equipment operating through 33 kV / 415V Transformers at 415 Volts or below. All electrical equipment from 220 or 66 kV rating up to the 33 kV / 415V transformers (excluding the supply of LV Main Switchboards and Bus Duct) will be in the scope of Power Supply Contractor. Similarly the Traction Power Supplies will also be in the scope of System wide Power Supply Contractor.

The interface between the Contractor and the System wide Contractor for Power Supply shall be the Bus Duct connected to the 415 V outlets from the transformers in two/three physically segregated sub-stations on each station.

E00.7.3 **Power Supplies Classification**

Power supplies to the various systems and sub-systems is classified into four categories:

- “Emergency”;
- “Essential”;
- “Semi-essential”; and
- “Normal”

Services designated as “Emergency” shall be provided with dual supplies (as mentioned in Clause E00.7.1) with automatic changeover and in addition, shall be connected to battery backed UPS systems with a minimum capacity of 120 minutes. Changeover of supplies shall be automatic on loss of normal supply voltage. The UPS system shall prevent equipment deemed “Emergency” from seeing any perturbations in supply on changeover or loss of supplies. Also called as the “A” Category Supply.

Each station will have two source of supply that will auto-transfer on concurrent loss of supplies from any one 33 kV / 415V transformer’s circuit. The capacity of the each transformer shall be sufficient to power equipment defined as all “Emergency”, “Essential”, and some “Semi-essential” equipment.

Services designated as “Essential” shall be provided with dual supplies with automatic changeover, as above, but will not be connected to UPS. However, these shall be supplied from other ASS through Automatic Changeover System

on loss of power supplies from both the Auxiliary Substations. Also called as the “B” Category Supply.

Services designated as “Semi-essential” shall also be provided with dual supplies with automatic changeover, as above, but these will not be connected to UPS. in case of failure of power supplies from the Auxiliary Substations, if required. Also called as the “C” Category Supply.

Services designated as “Normal” should be split between the respective 33kV / 415V transformers to minimise the effect of a single transformer or switchgear failure. In the event of the loss of supply from one 33 kV / 415V transformer, loads need not be automatically transferred to the other Auxiliary Substation, but selected loads classified as “D1 Category Loads” such as normal lighting, power sockets, Chillers etc may be fed from other transformer by manual intervention. In the event of loss of feeds from 66kV or 33kV feeders,

The other category of Normal Loads designated as “D2 Category Loads” may remain off in case of power failure of the transformer to which they are connected.

E00.7.4 **Service Categories**

It shall be the Contractor’s responsibility to obtain all details from System wide Contractors to determine all their requirements for supplies and loading.

Emergency Services:

- Fire detection, protection systems, and alarms
- Telecommunications
- Signaling
- Station control rooms
- CCTV and Public Address Systems
- Security systems
- SCADA system
- Automatic Fare Collection (AFC)
- Emergency illuminated signs, exits, etc.
- Emergency lighting at station and tunnel
- Control circuits
- Any additional UPS or critical elements, identified in the station design

Essential/Semi Essential Services:

- Fire fighting pump and sprinkler pump
- Tunnel ventilation fans
- Tunnel booster fans and dampers

- Station ventilation plant and smoke extraction fans
- Air conditioning for equipment rooms, if required for continuous operation
- Lifts
- Emergency exhaust fan at station
- Station and tunnel drainage plant

Normal Services

- All other services provided under the Contract, not covered above

E00.8 Brief Description of Design Considerations for Plumbing/Hydraulics System:

The Design Criterion used for Definitive Design and preparation of Construction Reference Drawings are highlighted in this clause for the guidance of the Contractor. The Contractor must use these considerations for preparation of Detailed Engineering Design and Working Drawings. For hydraulic system (seepage, sewage and water supply systems), pumping arrangement with accessories, necessary electrical supply and control has to be provided by E&M contractor. Contractor is required to interface for the same with other designated contractors.

E00.8.1 Water Supply Arrangement

UG Stations shall be provided with water supply system for drinking water, Toilet flushing for staff, cleaning water for station, fire fighting and make up water for air conditioning.

E00.8.1.1 The UG Stations shall be provided with water supply from:

- (1) Pumping station, through pipes running inside the tunnels called as "Water Mains", to be extended upto the Stations (scheme under finalization).
- (2) Bore-well at the stations.

E00.8.1.2 Water Supply System at the Station shall consist of tanks installed at ground level / elevated level for meeting the requirements of drinking water, toilet flushing, station cleaning, air-conditioning and fire storage in ancilliary building.

The tanks shall be provided with automatic level monitoring and control system with automatic operation of various pumps and control valves. Low water level status in the storage tank for fire and for air conditioning make up shall be displayed at station control room.

The storage capacity at the stations, apart from fire storage requirement, shall be provided to meet the 70% of the daily water demand of the station in general.

Actual storage capacity for domestic water is to be calculated based on providing 45 liters per head of staff present within the largest shift including drinking water and toilet flushing. For water supply storage calculation purposes the largest shift is taken as 30 persons. Cleaning water requirement is 1 Litre / Sq. M / day for

platform / concourse and entrance areas. Wastage shall be considered 10% of the total water requirement.

E00.8.1.3 The water distribution network from tanks shall be provided with pipelines for drinking, toilet flushing, station cleaning, cooling water and firefighting, with routings provided to the required locations .

E00.8.1.4 The mains shall be divided into sections by provision of valves so that water may be shut off for repairs. Wash out valves shall be provided for repairs. Air valves shall be provided where required.

E00.8.1.5 Water shall be given adequate treatment for drinking and air-conditioning make-up. For drinking water on line purifier / disinfectant shall be provided.

Chilled water dispenser with on line purifier shall be provided in offices and staff rooms.

E00.8.1.6 Status of bursting of water main inside tunnel shall be relayed to station control room & OCC through SCADA.

E00.8.1.7 Testing of the system shall be as per NBCI. The entire pipe line system shall be hydraulically tested to a pressure of 0.5 N/mm² or twice the working pressure which ever is greater for a specified period after a steady state is reached.

E00.8.1.8 Provision shall be made for pumping arrangement for the raw water supply, treated water supply, water treatment plant, water mains for the stations, make up water for the ECS requirements, station supply, fire fighting and sprinkler pumps together with the Jockey pumps.

E00.8.2 **Sewage System**

UG Stations shall be provided with the soil drainage system & sumps to suit requirements of the station.

E00.8.2.1 A sewage pit shall be provided by others to collect waste - water from toilets (WC and urinals). Sewage pit shall have minimum one-day storage capacity.

A gravity collection system shall be employed. Adequate gravity falls shall be provided for all drain pipe - work meeting local or international code requirements as appropriate.

E00.8.2.2 Diverter or ejector tank shall be provided by others in the under platform void. The capacity of the sewage ejector shall be determined from the specific sanitary fittings provided. Flow rate shall be based on concentrated use of appliances as set out in BS8301.

E00.8.2.3 A lifting system shall be provided. Access shall be provided from platform level to allow convenient maintenance. The diverter or ejector shall consist of a sealed tank with duty and standby pumps.

The pumps shall be submersible non-clog type suitable for handling raw sewage.

Discharge velocity shall be neither less than 0.75 m/s nor greater than 1.8 m/s. The pumps shall have a stable head-flow characteristic and be suitable for

prolonged running under site conditions. Each pump shall be complete with all necessary fittings including isolating non-return valves and gate valves.

E00.8.2.4 A local control panel shall be provided. On / Off pump control shall be from level in the tank. The pumps shall operate in duty / standby mode. The diverter or ejector tank shall be located in a pit of sufficient size to give a minimum of 1 m clearance around equipment for access. A sump pump shall be provided in a pit of minimum size 450 x 450 x 450 mm to cater for minor seepage from the diverter. The pump shall have an on / off "pear drop" control with facility for high - level alarm transmission to the SCADA system.

E00.8.2.5 Discharge of all sewage shall be to municipal sewer at ground level. Discharge shall be via a "goose neck" bend with invert above flood level to act as a safeguard against station flooding.

E00.8.3 **Seepage System**

E00.8.3.1 Seepage Water from station cleaning, fire fighting and other wastages shall be collected in seepage pit provided by civil contractors. **Seepage pit or sump shall have minimum 2 days storage capacity and a factor of safety of 2.0 applied to the seepage volume.**

E00.8.3.2 Discharge shall be through at least 3 pipes of 100 mm to allow emergency discharge of floodwater from the station due to fire waste water during fire. Discharge of all seepage shall be to municipal storm water drain at ground level. Discharge shall be via a "goose neck" bend with invert above flood level to act as a safeguard against station flooding.

E00.8.3.3 Not Used

E00.8.3.4 Not Used

E00.8.3.5 Not Used

E00.8.3.6 **Three submersible seepage pumps shall be installed to provide with 200 % spare capacity. One of the pumps installed in the deeper projection shall be capable of sewage pumping.**

E00.9 **Brief Description of Design Considerations for Fire Detection and Alarm System:**

The Design Criterion used for Definitive Design and preparation of Construction Reference Drawings are highlighted in this clause for the guidance of the Contractor. The Contractor must use these considerations for preparation of Detailed Engineering Design and Working Drawings.

E00.9.1 **Fire Detection**

The Fire Detection and Suppression Monitoring System (FD & SM) shall consist of Fire Control Panels, Fire Detectors and Suppression Monitoring Devices.

Fire alarms, Fire Alarm Control Panel and associated Fire Detector Device status, Fire Suppression System Equipment status, and Suppression System Alarms shall be enunciated at Central Control.

The Fire Detection System shall provide zoned alarms, local alarm annunciation, and necessary, automatic actuation of vents, fans, dampers, and Suppression Equipment as required.

E00.9.1.1 NFPA shall be used as the guiding standard for the Fire Detection and Alarm System. The system, wired in zones shall use break glass/pull type units and automatic smoke /heat detectors. The system shall be designed in an integrated manner in accordance with NFPA 72D, British Standards BS 5445 and BS 5839, EN 54, or ISO 7240 - 1, as appropriate or other Internationally recognized or local code of practice approved by the Engineer. **The requirements of Jaipur Fire Service Department shall be incorporated into the system.** The panel will contain logic circuit indicators, controls, and alarm and signaling circuits associated with a number of Detector Heads and Call Points distributed in detection zones.

E00.9.1.2 **The Manual Call Points will be of the break glass type/pull type as required. An MCP shall be located adjacent to all fire exits, and other MCPs shall be located so that one is within 30 metres of any MCP point in the Station.**

MCPs shall be positioned at a height of 1.3 m at strategic points throughout the station such that they are clearly visible from front and sides as practicable.

The operation of any call point connected to the system shall cause the station FAP to enter the ALARM State within three seconds.

E00.9.1.3 Automatic smoke and heat type fire detectors will be located in all areas. The under platform exhaust ducts shall be fitted with duct type detectors.

The audible alarms will be 150 mm and 200 mm self-interrupting type alarm bells.

E00.9.2 **Fire Suppression System**

At station provision shall be made for Hydrants / hose reels and extinguishers. A wet fire main system shall be provided to cover the Platforms and Concourse Level. Sprinkler systems shall be provided for store rooms and other enclosed spaces as required. A wet fire main shall be provided in tunnel with twin outlets at 50 m intervals with Control valves located at station end walls. Also open spray nozzle type system shall be provided on the side of platforms for fighting the under frame fire in the train.

E00.9.2.1 All piping shall be in accordance with NFPA – 13 &14, fully hydraulically designed.

The automatic sprinkler system shall conform to NFPA. Automatic Sprinkler Protection shall be provided for station concessions, storage areas, trash rooms and other similar spaces with combustible loading.

- E00.9.2.2 Sprinklers shall be of the quartzoid bulb type with standard temperature ratings. In case of above normal temperature, high temperature sprinklers suitable for the temperature condition shall be provided. Sprinkler systems shall include shut-off valves and check valves. The flow detector switch shall be monitored by the fire detection system.
- E00.9.2.3 Not Used
- E00.9.2.4 A minimum of two main fire hydrant pumps, including one standby, two main fire sprinkler pumps, including one standby together with a pressurising jockey pump for hydrant system and one jockey pump for sprinkler system shall be provided. Fire Pumps are required to deliver water at sufficient pressure to ensure a hydrant pressure as per NFPA 14 at the furthest hydrant with a flow of 2,400 liters / min. The jockey pumps shall be arranged to operate in the pressurising / duty / standby mode to ensure that the wet mains are pressurized at all times. The pumps shall be automatically operated by Deisel set in the event of a mains failure.
- E00.9.2.5 At the Fire Valve Room an isolating valve shall be installed to control the hydrant main. The valve shall be both lockable and addressable.
- E00.9.2.6 Hydrants shall be mounted at platform within equipment cabinets. Hydrants shall be terminated with a landing valve .
- The Hydrant main shall be run from the Fire Valve Room to the platform level with a spur(s) to the various hose reel positions. The Hydrant main shall be run in its full extent in 150 mm diameter pipe-work. The Contractor shall perform water pressure calculations to assess the pressure and flow at each hydrant - landing valve. The location of every hydrant shall be clearly marked.
- E00.9.2.7 Hose reels shall be of non-kinking tubing with an internal diameter as specified in codes as per technical specifications. Hose reels should be 30 m in length and be manually operated.
- Hose reels shall be typically connected to a 25 - 50 mm wheel operated isolating valve.
- Hose reels shall be fully recessed in purpose made cabinets or surface wall mounted standard pattern, according to design requirements.
- One hose reel should be provided to cover every 45 m of floor space or part thereof in the ticket hall and concourse areas.
- Hose reels should be sited in prominent and accessible positions at floor level, adjacent to exits or exit routes, in such a way that the nozzle of the hose can be taken into every room and within 6 m of each part of a room. The hose and nozzle should be capable of directing a jet of water into any recess area.
- E00.9.2.8 Portable fire extinguishers shall be provided as per provisions of National Building Code of India and shall have consent of Jaipur Fire Service authorities.

CO₂ extinguishers shall be installed in all electrical switch rooms, sub-stations, platform equipment cabinets, operations rooms and communications rooms.

E00.9.2.9 Not Used

E00.10 Equipment Control and Monitoring

E00.10.1 Different types of SCADA systems for the stations will be (1) Building Management System (BMS) to be provided by Designated Contractor for Electrical, Fire, Hydraulics, Environment Control and Tunnel Ventilation Systems (2) Non Power SCADA system to be provided by Designated Contractor for transmission of information regarding E & M and VAC Systems between Interface Terminal Cabinet at each station and the Operational Control Centre of JMRC (3) SCADA System for Power Supply System including Traction Distribution System to be provided by Power Supply Contractor.

E00.10.2 The equipment or a system comprising several components shall be controlled through suitable control regime to achieve desired operation normally automatically but with provision for manual intervention. The automatic operation shall conform to the operational, functional and overall system needs as specified in the following description.

E00.10.3 The equipment shall enable monitoring through a station control panel, located at the station control room, comprising mimic display, operator's desk for commands and warning-cum-alarm units. The contractor shall provide suitable adjustment on his equipment and interface with the BMS Contractor for achieving the requisite control and monitoring regime.

E00.10.4 The transmission of information between the Local Sequential Controllers for the equipment in the plant rooms and the station Control Panel (including the provision of Local Sequential Controllers) will be the responsibility of the BMS Contractor. However the Contractor must liase with the BMS contractor regarding cables and other connections required between the equipment and the Local Sequential Controllers through suitable cableways.

E00.10.5 The Power Distribution SCADA/BMS System display will include the status of the circuit breakers of the two/three Main LV Panels and the voltage conditions on the bus bars at the two/three ASSs. The transmission of this status information shall be wired to the interface terminal board (provided by Power System Contractor) mounted in the ASS. The contractor shall undertake wiring and terminations between his equipment and the interface board. The list of interfaces and the physical layout will be provided by the Designated Power Supply Contractor.

E00.10.6 The information Transmission between the Interface Terminal Unit for Non Power SCADA System (located at each station) and the OCC shall be carried by SCADA equipment supplied by a Designated SCADA Contractor.

E00.10.7 The equipment supplied shall be capable of providing the outputs and using the inputs at the interface terminals over voltage free contacts. The equipment on the

side of the interface receiving the information shall provide the power supply / wiring and the sending side shall provide the voltage free contacts.

- E00.10.8 The equipment supplier may propose the use of a serial data link instead of voltage free contacts. In this case the physical characteristics and data transmission protocol proposed shall conform to an internationally recognised and publicly available standard. If there is a match between the equipment supplier's proposal and the capabilities of the SCADA equipment, such serial data link may be adopted with the consent of the Engineer.
- E00.10.9 Contractor may be required to provide Cable Containment System for use of BMS Contractor, if required and instructed by Engineer.

E00.11 Interfaces

- E00.11.1 The Contractor shall ensure efficient interface and co-ordination with all other Contractors concerning Mechanical and Electrical Works.

E00.11.2 SCADA System Interface

- E00.11.2.1 Interfacing between the BMS, SCADA system and Electrical & Mechanical equipment will require co-ordination. The Contractor shall liaise with the BMS and SCADA system supplier to ensure the interfacing between each system meets the requirements of its respective specifications.

- E00.11.2.2 The transmission of data shall include both way communications i.e, from respective stations to OCC and vice-versa for status indication of equipment, fault condition, indications and alarms in OCC. Further, it should include execution commands from OCC for operation of E & M equipment at stations and its confirmation.

The control of E&M equipment, normally shall be local from the Station Control Room except where the operation is required on a system wide basis and simultaneous operation of equipment is warranted at more than one station or an emergency situation is required to be controlled from the OCC.

- E00.11.3 **Plumbing/Hydraulics, Fire Protection (Detection and Suppression) System Interface**

E00.11.3.1 Design Principles

The fire detection system shall include provisions for over-riding control of certain items of equipment to control or limit the spread of fire or smoke. These include but are not necessarily limited to air handling units, air conditioning units and fans serving a zone affected by fire or smoke conditions. To facilitate connection work between sub-systems the Contractor shall provide terminal boxes and wiring to the control circuits of the appropriate units. Terminal box shall be located in each plant room adjacent to the motor control panels taking into account all requirements for segregation of equipment and wiring.

- E00.11.3.2 **Initial Basis for Design**

During the preparation of detailed Design / Working Drawings the Contractor shall liaise with the SCADA/ECS/TVS/BMS Contractor, Engineer, Jaipur Fire Services and other Designated Contractors to determine all requirements for response in event of fire, and then subsequently provide the necessary facilities. The initial design shall assume that all Station Ventillation Fans having a capacity in excess of 1 m³/s shall be shut down by the fire detection system during smoke or fire conditions.

E00.11.3.3 The following items for each station shall be monitored and abnormal conditions shall be alarmed:

- Main station fire panel healthy.
- Fire Alarm condition.
- Zone of reported fire.
- Non synchronising clock.

E00.11.3.4 Contractor shall liase for incoming water supply through the tunnel.

E00.11.3.5 The contractor shall provide Plumbing/Hydraulics, Fire Detection and Protection System as per scope of works above, which will be controlled & monitored by BMS System. Indicative list of BMS Alarms and Controls at plant rooms, Station Control Room and OCC, to be provided for Fire and Hydraulics Systems is given as Annexure I. However, it may be noted that this list is not complete and may be modified / updated as the design of BMS System progresses. Contractor will be required to interface with the BMS contractor regarding incorporation of Control and monitoring requirements of Hydraulics and Fire Systems in the Building Management System.

E00.11.4 **Power and Lighting Interface**

E00.11.4.1 The following items for each station shall be monitored and abnormal conditions shall be alarmed :

- Main switchboard LV incoming circuit breaker status.
- Main switchboard LV outgoing circuit breaker status.
- Protection Relay Operation.
- Incoming power lines (3 Nos) healthy.
- Dual supplies healthy; all areas.
- Emergency lighting fault status.
- UPS Status (I/O voltage, indication, and position of bypass switch & battery voltage)..

Indicative list of BMS Alarms and Controls at plant rooms, Station Control Room and OCC, to be provided for Electrical Systems is given as Annexure I. However, it may be noted that this list is not complete and may be modified / updated as the design of BMS System progresses. Contractor will be required to interface

with the BMS contractor regarding incorporation of Control and monitoring requirements of Electrical Systems in the Building Management System.

E00.11.5 **Interface with civil work**

Civil construction works of station are to be executed by a separate Civil Contractor. The E & M Contractor shall ensure efficient Interface and Coordination with Civil Contractor concerning Electrical Works, Fire Fighting, Plumbing/Hydraulics, etc on site.

Such coordination responsibility of the contractor shall include the following:

- (i) To obtain from the Civil Contractor information reasonably required enabling the Contractor to meet the construction target dates.
- (ii) The Civil Contractor will be the coordinating entity and play the major role in the interface with E & M Contractor, however the E & M Contractor present on site will also be responsible for any delay on the schedule.
- (iii) E & M Contractor will make sure that he provides the updated valid documents, for the reference of the Civil Contractor in time, where E & M Contractor requires the Civil Contractor to execute his work as per the requirement of the E & M Contractor. These documents will be the reference documents for the Interface Management being carried out by the Civil Contractor.
- (iv) Where the execution of the Civil Contractor depends upon the Site Management or information to be given by the E & M Contractor, the E & M Contractor shall provide correct and accurate information in time so as to enable them to meet their respective programs.
- (v) It is to be ensured that all provisions for access and delivery of plant is Co-ordinated with and reflected in the E & M Contractors Delivery Route Drawings. The E & M Contractor shall also ensure that all plants are delivered at the time agreed to allow openings to be left in the structure for such delivery in accordance with the Civil Contractor's programme.
- (vi) E & M Contractor must ensure that the production of Working Drawings for Services to be provided in the base slab, other slabs and structures (such as provision of conduiting, cable routing, fixture mounting, DB mounting, lightning, piping, fire fighting system and other works included in the bid) is carried out in time and approval obtained from the Engineer. A Copy of Drawings along with schedule for execution of such works must be handed over to Civil Engineering Contractor in time, to enable him to plan his activities. Further, E & M Contractor shall ensure that information required by Civil Contractor for any concreting / other works where electrical work is involved is made available him in time.
- (vii) The E & M Contractor shall conduct regular meetings with the Civil Contractor as necessary to clarify particular aspects of the interfacing

requirements of the works. He will also attend regular Co-ordination meetings convened by the Engineer for interface.

- (viii) The E & M Contractor, shall in carrying out his co-ordination responsibilities, raise in good time and provide sufficient information for the Engineer to decide on any disagreement with Civil Contractor. If the Contractor despite having taken all reasonable efforts cannot resolve such disagreement, then the decision of the Engineer shall be final.
- (ix) The E & M Contractor shall ensure the presence of his qualified and experienced Engineer (Chief Co-coordinator) during Civil construction of station to enable proper interface with Civil Contractor so as to ensure smooth completion of works.
- (x) Access will be provided to the staff of the E & M Contractor for carrying out their works and bringing materials and Equipments at the site. However the security of material and Equipments brought at the site, by the E & M Contractor is E & M Contractor's responsibility.

E00.11.6 **The Contractor shall liaise with the Power Supply Contractor for details of bus duct supply and installation, earthing and bonding scheme, joint testing / commissioning procedures and requisite scheme for protection / interlocking.**

E00.11.7 The Contractor shall provide the interface between the bus ducts and the transformer and shall allow for full and timely liaison with the Contractor for Power Supply in this regard.

E00.11.8 **Correct phase sequence (rotation) shall be determined for the transformer supplies before connection is made to the Switchboard and after any supply reconnection that may occur within the Contract period.**

E00.11.9 Provision of supply feeders for the equipment and plants supplied by other Designated Contractors.

E00.11.10 Ascertain through liaison and interface the power supply feeding arrangements for ECS, TVS, lifts and escalators and other plants / equipment to be provided by other Designated Contractors.

E00.11.11 Co-ordination with Power Supply and S & T Contractor as described in Clause E00.3.11 above regarding Earthing requirements.

E00.12.0 General Safety Requirements

E00.12.1 Wiring for all Emergency, Essential, Semi-essential and safety equipment shall consist of two separate electrical feeders through an automatic transfer switch. The electrical rating for the transfer switch shall fully accommodate the available short circuit level at the outgoing terminals of the transfer switch. Each feeder shall originate from a different source and shall be separated physically to the maximum extent possible.

E00.12.2 All plants shall be fail-safe.

E00.12.3 Cables shall not be installed either exposed or surface mounted in air plenums that may carry air at elevated temperatures during fire emergency conditions.

E00.12.4 All conductors shall be enclosed in their entirety in armour sheaths, conduits, cable trays, boxes and cabinets.

E00.13 Voltage Levels

E00.13.1 Voltage level for power equipment shall be 415V, 3-phase or 240V, 1-phase, as required.

E00.13.2 **Motors rated 0.37 kW and larger shall be rated 415V, 3-phase, 50Hz and motors rated smaller than 0.37 kW shall be operated at 240V, 1-phase, 50 Hz.**

E00.14 Acoustic Criteria

E00.14.1 Noise emanating from mechanical services installations shall not exceed the following levels:

Area	Noise Levels
At station Concourse, Platform and Ancillary rooms	55 dBA.
At the surface, when measured at the nearest property line of a residence, commercial building or industrial building:	
Urban, residential	50 dBA
Urban, mixed	55 dBA.
Urban, non-residential	65 dBA.
Industrial	65 dBA.

E00.14.2 Noise emanating from the following equipment / service installations shall not exceed 55 dB for the static machines and 70 dB for rotating machinery at a distance of 1 metre to match or exceed the relevant international standards:

- At UPS room, auxiliary substation and pumping installations
- Exhaust fans
- Switch boards / Distribution Boards / Starter Panels
- Motors

E00.15 Certification of Personnel & Work:

E00.15.1 All the workmen & supervisory staff shall be qualified and certified licence holders or have competence certificate from nationally / internationally recognised agency

empowered to issue certificate for carrying out similar work.

- E00.15.2 The methodology shall be designed to obtain certification of the work through check list and standards. The installations shall be checked by a Quality Assurance team having the representatives from Employers and Contractor's side.
- E00.15.3 The contractor shall be responsible for including all safety aspects in his protection schemes etc. correct installation, testing & commissioning.
- E00.15.4 The Contractor shall obtain prior approval for energisation from the Competent Authority in accordance with statutory regulations in force. The Contractor shall list out such statutory requirements and shall issue a certificate of compliance in above respect before energisation.

E00.16 Corrosion Protection

- E00.16.1 The contractor shall design to provide and state the corrosion protection systems used and the design life of the systems. The contractor shall show that the civil works and the electrical works have an adequate co-coordinated protection system, against all types of corrosions.

E00.17 Codes and Regulations

- E00.17.1 Codes, Regulations and Standards
- E00.17.2. Unless otherwise stated, latest applicable international / local codes, standards and regulations specified in the technical specifications, shall govern the electrical and Mechanical works.

System shall comply with the following codes of practices, standards, specifications and manuals wherever specified.

NFPA 130: 2003 - Fixed Guideway Transit Systems:

The Guides of the Chartered Institution of Building Services Engineers.

Acceptable Internationally recognised standards for this Contract are:

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BS	British Standards
BIS	Bureau of Indian Standards
DIN	Deutsche Industrie Normen
IEC	International Electro technical Commission
IEEMA	Indian Electrical and Electronics Manufacturers Association
JIS	Japanese Industrial Standards

NEC	National Electrical Code (NFPA 70)
NEC	National Electrical Code (Indian)
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
VDE	Verband Deutsche Elektrotechniker

BS 7671: 1992 "Requirements for Electrical Installations"

In case, Standards and Codes for any specific element are not defined explicitly the Specifications, Contractor may use applicable Standards or Codes from the above list with the approval of Engineer.

E00.17.3 Unless otherwise stated, the E & M System design and execution shall comply all applicable local regulations issued by the agencies listed below:

Indian Electricity Rules

Indian Electricity Act

National Building Code

Chief Inspector (Electrical) Govt. of NCT OF Jaipur, 15, Rajpur Road, Delhi - 110054.

Central Pollution Control Board

Jaipur Fire Services

Jaipur Public Works Department

Central Public Works Department

Jaipur Power Supply Utilities

Chief Electrical Inspector for Jaipur MRTS

Jaipur Administration

Municipal Corporation of Jaipur

New Jaipur Municipal Corporation

National Safety Council

E00.17.4 Any additional requirements imposed by local agencies not listed above shall be incorporated into the designs. The contractor shall prepare a checklist based on relevant standards for ensuring conformity in design, manufacture, supply / storage, packing, erection / commissioning and operation as applicable. The contractor shall obtain approvals from relevant authorities at appropriate stages of work.

E00.18 General Requirements For E & M Equipments

E00.18.1 Vibration Isolation

E00.18.1.1 Equipment producing vibrations shall be isolated from the structure by spring or rubber-in-shear vibration isolators. All piping and ductwork connected to this equipment shall contain flexible connections.

E00.18.2 Equipment Mounting

E00.18.2.1 Equipment to be mounted on the floor shall be placed on reinforced concrete equipment pads. Minimum pad height shall be 100 mm. The Contractor shall co-ordinate as necessary.

E00.18.2.2 In cases where units are ceiling suspended, the support system shall be adequately braced to ensure stability during unit start up, operation and shut down.

E00.18.3 Maintainability

E00.18.3.1 Items such as knock out panels, double doors, floor drains and access hatches shall be provided by the Civil Contractor. The Contractor shall co-ordinate with Civil Contractor as necessary.

E00.18.3.2 Sufficient clear space shall be provided around equipment to facilitate equipment removal and replacement and to allow for ease in equipment servicing. Provisions shall be made for shaft, tube and filter pull space, access door swings and removal of miscellaneous components.

E00.18.3.3. Control system schematic diagrams shall be posted in the vicinity of all control panels.

E00.18.3.4 Piping system schematic diagrams shall be displayed in each plant room.

E00.18.4 Equipment Identification

E00.18.4.1 Equipment, control devices, valves and piping systems shall be permanently labeled by the Contractor after installation. The labels shall conform to a system-wide method. This method shall identify individual equipment items and provide information regarding equipment type, equipment function, flow direction and other such data as appropriate. Identification shall be keyed to the control and piping schematics.

E00.18.4.2 Each piece of electrical equipment shall be numbered according to the number of the circuit breaker feeding the piece of equipment. Terminal cabinets shall be numbered sequentially.

E00.18.4.3 Each equipment number shall be preceded by a letter designation as follows with the approval of engineer-in-charge:

Automatic Transfer switch	ATS
Control Panel	CP
Disconnect Switch	Z
Fare Collection Power Panel	F

Generator	G
Lighting Panel boards, 415/240V	L
Motor	M
Motor Control Centre	MCC
Motor Starter	MS
Power Panel boards	P
Supervisory Termination Cabinet	STC
Switchboards	A
Switchgear	SWGR
Terminal Cabinet	TC
Transformer	TX
Uninterrupted Power Supply	UPS

E00.18.4.4 All equipment, cables and wiring shall be manufactured and installed so as to secure a service life as shown below:

Main switchboards	30 Years
Transformers	30 Years
Sub-main switchboards	30 Years
Cables	30 Years
Luminaries	20 Years
Tray, Trunking and supports	30 Years
Lightning protection	30 Years
Sub-assemblies and components	30 Years
All other equipment	Minimum 20 Years

E00.18.5 Switchboards, cables, equipment, components and all other electrical equipment shall be rated for operation in ambient temperatures of 50°C and humidity up to 75%. Suitable derating factor may be used in selection of equipment, if equipment are not designed for these conditions.

E00.18.6 In the design of switchboards an allowance of 20 – 25 % spare space capacity shall be provided for possible future expansion and all Main Switchboards shall be user friendly, modular and aesthetic design, termite and vermin proof. Spare capacity of 30% shall be provided for all cable trays, trunking, wire ways, (raceways), and brackets, for future expansion.

E00.19 SAFETY AUTHORITY

E00.19.1 The Contractor shall note that the Commissioner for Metro Railway Safety (CMRS), a Government of India Statutory Safety Authority, may inspect the Works from time to time for the purpose of determining whether the Metro Corridor Project complies with the operational and infra structural safety stipulations in accordance with the Laws of India. The Contractor shall note that CMRS approval is mandatory for commissioning the system. Notwithstanding other provisions of the Contract, the Contractor shall ensure that the Works comply with the requirements of CMRS in terms of design and quality of construction and shall assist the representatives of CMRS in carrying out their inspection duties and also comply with their instructions regarding rectifying any defects and making good any deficiencies.

E00.20 EMPLOYER'S REQUIREMENTS

E00.20.1 The Employer's Requirements establish the overall procedures to be followed by the Contractor for works under this Contract.

E00.20.2 These Employer's Requirements are divided into three sections as follows:

- (a) **General:** these apply throughout the Contract. (Annexure III)
- (b) **Design:** these apply in respect of duties relating to the design of the Temporary and Permanent Works. (Annexure IV)
- (c) **Manufacturing, Installation and Testing:** these apply to the requirements relating to manufacturing, procurement, delivery and installation of plant and equipment, and the requirements for testing and commissioning. (Annexure V).

BIDDER's attention is drawn to the General Conditions of Contract, Special Conditions of Contract, General Specifications, Bid Drawings, Pricing Schedule/Bill of Quantities and SHE manual which are to be read in conjunction with the above.

E00.21 Functional Requirements of Fire and Plumbing/Hydraulics Systems

E00.21.1 Functional Requirements for Pumping installations

- (1) Water pump installations have been designed for unmanned operation, controlled through liquid level controllers, capable of pumping the requisite amount of water to the utility or to the underground / ground / over head tanks.
- (2) The pumping installation shall withstand the corrosive effects of normal water supply, seepage water and sewage and serve for the anticipated life of the equipment. The discharge velocity for sewage / seepage pumping shall not be less than 0.75 m/sec.
- (3) The pipeline size is such that the velocity head does not exceed the normal static head except for the fire pump, which is governed by separate criteria.

The valve controls and regulating mechanisms shall be designed for automatic operation.

- (4) The pumps shall have 100% standby arrangement and the seepage pumps will have a 200% standby arrangement. The centrifugal pumps, if provided, shall be of self-priming type. The efficiency of the pump set shall not be less than 95% of the maximum theoretical efficiency possible for that type of pump.

E00.21.2 **Functional Requirements For Fire Protection System**

- (1) Fire Protection **has been** provided in accordance with the NFPA 130 within the stations, tunnels and service buildings and shall comply with the requirements of Jaipur Fire Service Regulations.
- (2) The Contractor shall be responsible for the provision of the complete installation including but not necessarily limited to feeder supply storage tanks, fire pumps, sprinklers, other suppression systems including hydrant systems, pipe work, valves, brackets, fittings and sleeves.
- (3) The Contractor shall also be responsible for provision of fire detection equipment including but not limited to local fire panels with provision of output information to BMS / SCADA systems installed by others, local fire alarms, smoke detectors and fire shutter actuators.

ANNEXURE I

The following schedule of Input/Output Interfaces is provided for guidance purposes only. It is the responsibility of the contractor to interpret the entire requirements of the specification and to provide Input/Output interfaces as required which may be described separately throughout this specification.

Functions	Plant Room or Local PLC control (PLC)		Station Control Room display		OCC/SCADA
	Metering	Operation	Status	Alarm	Remote data
1. Pumps					
			Control room display for items A,B,C&D		
A. Raw water pumps 1+1 for each water treatment plant	Water treatment plant ON	Start pump	WT plant 1/2/3 ON/OFF/ Back wash		
	Liquid level in the filter water tank low	Log at PLC		Warning, goes off when tank is full	
	Manual bypass switch local or remote				
	Pump running	-	Pump 1/2	-	-
	Pump failure	Start standby	ON (OFF)	Standby pump fail warning	D(1) warning
	Standby pump fail	-		Both pump fail Alarm	D(1) Alarm
	Water level in the Filter water tank	If full, stop pumping Log at PLC	-	-	-
	Pumping completed	Alternating pumps	-	-	-

Functions	Plant Room or Local PLC control (PLC)		Station Control Room display		OCC/SCADA
	Metering	Operation	Status	Alarm	Remote data
	Hours of operation	Log at PLC	-	Not run for more than a week (Alarm)	D(1) warning
	Voltage	Log at PLC	-	No volt Warning	-
	Current	Log at PLC	-	-	-
	Energy (power factor)	Log at PLC	-	-	-
B. Filter water pumps for stations	Manual bypass switch local or remote	Start pump		Warning, goes off when tank is full & OCC warning is OFF	D(1) warning
	Pump running	-	Pump 1/2/3 ON (OFF)	-	-
	Pump failure	Start standby		Standby pump fail warning	
	Standby pump fail	Start standby		Two pump fail warning	D(1) warning
	Second standby pump fail	Start standby		Third pump fail Alarm	D(1) Alarm
	Water level in the collecting tank at the depot	If full, stop pumping Log at PLC	-	-	-
	Pumping completed	Alternating pumps	-	-	-
	Hours of operation	Log at PLC	-	Not run for more than a week (Alarm)	D(1) warning
	Voltage	Log at PLC	-	No volt Warning	-
	Current	Log at PLC	-	-	-
	Energy	Log at PLC	-	-	-

Functions	Plant Room or Local PLC control (PLC)		Station Control Room display		OCC/SCADA
	Metering	Operation	Status	Alarm	Remote data
	(power factor)				
C. Sedimentation sump pump (1+1)	Timer, two hours operation for every eight hours	Start pump			
	Manual bypass switch local or remote				
	Pump running	-	Pump1/2 ON (OFF)	-	-
	Pump failure	Start standby		Main pump fail warning	-
	Standby pump fail	-		Both pump fail Alarm	D(1) warning
	Water level in the sewage tank	If empty stop pumping Log at PLC		-	-
	Pumping completed	Alternating pumps	-	-	-
	Hours of operation	Log at PLC	-	Not run for more than a week (Alarm)	D(1) warning
	Voltage	Log at PLC	-	No volt Warning	-
	Current	Log at PLC	-	-	-
	Energy (power factor)	Log at PLC	-	-	-
D. Borewell pumps at station (1+1)	Liquid level in the collecting tank low & water mains failure	Start pump log at PLC		Warning, goes OFF when collecting tank full	D(1) warning
	Manual bypass switch local or remote			-	-

Functions	Plant Room or Local PLC control (PLC)		Station Control Room display		OCC/SCADA
	Metering	Operation	Status	Alarm	Remote data
	Liquid level in the fire tank low		Fire tank full	Warning, goes OFF when fire tank full	D(1) warning
	Pump running	-	Pump	-	-
	Pump failure	-	ON (OFF)	Standby pump fail warning	D(1) warning
	Water level in the collecting tank	If full, stop pumping Log at PLC	-	-	-
	Pumping completed	Alternating pumps	-	-	-
	Hours of operation	Log at PLC	-	Not run for more than a week (Alarm)	D(1) warning
	Voltage	Log at PLC	-	No volt Warning	-
	Current	Log at PLC	-	-	-
	Energy (power factor)	Log at PLC	-	-	-
E. Sewage pumps	Liquid level in the sewage tank high	Start pump	-	Warning, goes OFF when tank is empty	-
(1+1)	Manual bypass switch local or remote				
	Pump running	-	Pump1/2	-	-
	Pump failure	Start standby	ON (OFF)	Main pump fail warning	-
	Standby pump fail	-		Both pump fail Alarm	D(1) warning
	Water level in the sewage tank	If empty stop pumping Log at PLC		-	-

Functions	Plant Room or Local PLC control (PLC)		Station Control Room display		OCC/SCADA
	Metering	Operation	Status	Alarm	Remote data
	Pumping completed	Alternating pumps	-	-	-
	Hours of operation	Log at PLC	-	Not run for more than a week (Alarm)	D(1) warning
	Voltage	Log at PLC	-	No volt Warning	-
	Current	Log at PLC	-	-	-
	Energy (power factor)	Log at PLC	-	-	-
F. Seepage pumps	Liquid level in the seepage tank very high	Start all the three pumps	-	Warning, goes OFF when tank is empty	D(1) warning
(1+1+1)	Liquid level in the seepage tank high	Start pump	-		-
	Manual bypass switch local or remote				-
	Pump/s running	-	Pump 1/2 /3 ON (OFF)	-	-
	Pump failure	Start standby		First pump fail warning	D(1) warning
	Standby pump fail	Start second standby		Second pump fail Alarm	
	Second Standby pump fail	-		Third pump fail Alarm	D(1) Alarm
	Water level in the sewage tank	If empty stop pumping Log at PLC		-	-
	Pumping completed	Alternating pumps	-	-	-

Functions	Plant Room or Local PLC control (PLC)		Station Control Room display		OCC/SCADA
	Metering	Operation	Status	Alarm	Remote data
	Hours of operation	Log at PLC	-	Not run for more than a week (Alarm)	D(1) warning
	Voltage	Log at PLC	-	No volt Warning	-
	Current	Log at PLC	-	-	-
	Energy (power factor)	Log at PLC	-	-	-
G. Fire fighting pump	Operation of fire hose	Start the pump	-	Warning	D(1) warning
(1+1)	Hydrant pressure fall (major)		-		
	Pump running	-	Pump1/2	-	-
	Pump failure	Start standby	ON (OFF)	First pump fail warning	D(1) warning
	Standby pump fail	-		Second pump fail Alarm	D(1) Alarm
	Water level in the fire tank	Log at PLC		Alarm if low	D(1) warning
	Hours of operation	Log at PLC	-	Not run for more than a week (Alarm)	D(1) warning
H. Jockey pump	Operation of fire hose	Start the pump	-	-	-
(for fire)	Hydrant pressure fall (minor)		-	-	-
	Manual bypass local or remote	Start the pump		-	-
	Hydrant Pressure Fall (minor)				

Functions	Plant Room or Local PLC control (PLC)		Station Control Room display		OCC/SCADA
	Metering	Operation	Status	Alarm	Remote data
	Manual by-pass local or remote				
	Pump running	-	ON (OFF)	-	-
	Pump failed	-		Alarm	D(1) warning
	Hydrant pressure	Stop pump if adequate Log at PLC	-	Warning if low pressure	-
	Hours of operation	Log at PLC	-	Not run for more than a week (Alarm)	D(1) warning
	Voltage	Log at PLC	-	No volt warning	-
	Current	Log at PLC	-	-	-
	Energy (power factor)	Log at PLC	-	-	-
2. Emergency lighting					
A	NOT USED				
B UPS	Input voltage low		-	Supply failed	D(1) warning if supply fails for more than 5 minutes
	Input frequency low		-		
	Battery failed	Start second battery	ON (OFF)	Warning, Maintenance required	
	Charger failed	Start second charger			
	Inverter failed	Start second inverter			
	Control module one failed	-			
	Control module two failed	-			
	Second battery failed	-			Alarm, immediate

Functions	Plant Room or Local PLC control (PLC)		Station Control Room display		OCC/SCADA
	Metering	Operation	Status	Alarm	Remote data
	Second charger failed	-		attention to the UPS	
	Second inverter failed	-			
	Hours of operation	Log at PLC	-	-	-
	Out put bus voltage low		-	Alarm, manual fault attention	-
	UPS failed			Alarm	D(1) Alarm
C. Tunnel circuits	Voltage	-	ON(OFF)	No volt Alarm	D(1) Alarm
A,B,C or D	Current	If less than 80% of nominal value in any circuit		Lamp replacements due	
	Hours of operation	Log at PLC	-	-	-
D. Platform emergency lights	Voltage	-	ON(OFF)	No volt Alarm	D(1) Alarm
E. A,B,C or D	Current	If less than 80% of nominal value in any circuit		Lamp replacements due	
	Hours of operation	Log at PLC	-	-	-
F. Control supply	Voltage	-	ON(OFF)	No volt Alarm	D(1) Alarm
	Hours of operation	Log at PLC	-	-	-
G. Entry/exit/lighting	Voltage	-	ON(OFF)	No volt Alarm	D(1) Alarm
	Current	If less than 80% of nominal		Lamp replacements due	

Functions	Plant Room or Local PLC control (PLC)		Station Control Room display		OCC/SCADA
	Metering	Operation	Status	Alarm	Remote data
		value in any circuit			
	Hours of operation	Log at PLC	-	-	-
3. Fire Detection and Alarm System					
All Zones Public Areas	Alarm situation	Signal at FAP	-	WARNING	D (1) warning
All Zones Non Public Areas	Alarm situation	Signal at FAP	-	WARNING	D (1) warning
ALL Zones Electrical Installations	Alarm situation	Release Gas Agent	-	WARNING	D (1) warning
ALL Zones non-hazardous areas	Alarm situation	Signal at FAP	-	WARNING	D (1) warning
FAP	System fault	Fault indication	ON	WARNING	D (1) warning
	External fault	Fault indication	ON	WARNING	D (1) warning
	Processor fault	Fault indication	ON	WARNING	D (1) warning
	Device fault/Device isolated	Fault indication		WARNING at fixed interval	D (1) warning
	Voltage	Log at LDC		No volt warning	-
	Maintenance Alarm	Device fault			-
Hydrant	Low Pressure	Start Pump	ON	WARNING	

OCC INTERFACES

The following schedule of OCC Interfaces is provided for guidance purposes only. It is the responsibility of the contractor to interpret the entire requirements of the specification and to provide Input/Output interfaces as required which may be described separately throughout this specification.

	Building Services System (BMS)	Signal 1	Signal 2
	LV ELECTRICAL SYSTEM		
1.	LOW VOLTAGE POWER SUPPLIES A & B		
	Main Incoming Supply from ACC's	Healthy	Fail
	Amps	Current	
	Volts	Volts	
	Kilowatts	Kilowatts	
	VA	Volt Ampere	
	Hz	Frequency	
	PF	Power factor	
	VAR	Volt Ampere Reactive	
	Kwh	Kilowatt Hour	
	ACB's		
	Accessibility of Control from Station	Remote	Local
	Status	Open	Closed
	Control Command	Open	Close
	Fault	Trip	Cause of Tripping
	Protection Function	Read Setting	Set Parameters
	MCCB		
	Positive Status	Open	Closed
	Fault	Trip	Cause of Tripping
	Amps	Current	
	Protection Function	Read Setting	Set Parameters
	Dual Feed Auto Transfer Switches - ALL	Healthy	Fail
2.	UNINTERRUPTIBLE POWER SUPPLIES		
	UPS Power Supply at Equipment	Healthy	Fail
3.	UPS EQUIPMENT		
	Low Input Voltage Alarm	Alarm	
	Low Input Freq Alarm	Alarm	
	Second Battery Fail	Alarm	
	Second Charger Fail	Alarm	
	Second Inverter Fail	Alarm	
	Not in operation 1 week	Alarm	

	Building Services System (BMS)	Signal 1	Signal 2
	UPS Fail	Alarm	
4.	NOT USED		
5.	EMERGENCY LIGHTING		
	Emergency Lighting (all sub circuits) No voltage	Alarm	
	Tunnel Lighting No voltage	Alarm	
	Control Supply (all equipment) No voltage	Alarm	
	Entry/Exit Lighting (all sub circuits) No voltage	Alarm	
6.	EMERGENCY SIGNAGE STATUS		
	ALL sub circuits – no voltage	Alarm	
	FIRE ALARM DETECTION & SUPPRESSION		
7.	FIRE ALARM AND DETECTION SYSTEM		
	FAS -Power Healthy	Healthy	Fail
	FAS -Panel System Fault	Alarm	
	FAS -Panel External Fault	Alarm	
	FAS -Panel Processor Fault	Alarm	
	FAS -Zone Alarm - ALL ZONES	Alarm	
	FAS -Zone Fault - ALL ZONES	Alarm	
8.	FIRE FIGHTING PUMP		
	Main Fire Pump Running	On	Off
	Main Fire Pump Fail	Tripped	
	Main Fire Pump not run one week	Alarm	
	Main Standby Fire Pump Fail	Alarm	
9.	JOCKEY PUMP FOR HYDRANT SYSTEM		
	Jockey Pump Running	Alarm	
	Jockey Pump not run one week	Alarm	
9.	ESCALATOR SPRINKLER PROTECTION		
	Power Healthy	Healthy	Fail
	Panel Fault	Alarm	
	Zone Alarm - ALL ZONES	Alarm	
	Zone Fail - ALL ZONES	Alarm	
10.	DRY AGENT SYSTEMS (ALL)		
	Power Healthy	Healthy	Fail
	Panel Fault	Alarm	
	Zone Alarm - ALL ZONES	Alarm	
	Zone Fail - ALL ZONES	Alarm	

	Building Services System (BMS)	Signal 1	Signal 2
	HYDRAULIC SYSTEMS		
12.	SEEPAGE PUMPS		
	Liquid level in sump high	Alarm	
	First Pump Fail	Alarm	
	Second Pump Fail	Alarm	
	Third Pump Fail	Alarm	
	Standby Pump not run 1 week	Alarm	
13.	SEWAGE PUMPS		
	Liquid level in sewage tank high	Alarm	
	Main Pump Fail	Alarm	
	Standby Pump Fail	Alarm	
	Standby Pump not run 1 week	Alarm	
14.	WATER STORAGE TANK		
	Low Level Alarm	Alarm	
15.	STAND BY BOREWELL PUMPS AT STATIONS		
	Liquid level in the collecting tank low & water mains failure	Alarm	
	Liquid level in the fire tank low	Alarm	
	Pumps Fail	Alarm	
	Standby Pump not run 1 week	Alarm	
16.	DOMESTIC POTABLE WATER		
	Pumps Fail	Alarm	
	Standby Pump Fail	Alarm	
	Standby Pump not run 1 week	Alarm	
	ECS HVAC SYSTEMS		
17.	SUPPLY AIR FANS		
	Accessibility of Control from Station Positive Status	Remote On	Local Off
	Control Command	Running	Stopped
	Fault	Tripped	
	Low Airflow - Normal/Alarm	Alarm	
	Motor Current Low/High	Alarm	
	Emergency Stop Button	Alarm	
18.	EXHAUST AIR FANS		
	Accessibility of Control from Station Positive Status	Remote On	Local Off
	Control Command	Running	Stopped
	Fault	Tripped	
	Low Airflow - Normal/Alarm	Alarm	
	Emergency Stop Button	Alarm	

	Building Services System (BMS)	Signal 1	Signal 2
	Motor Current Low/High	Alarm	
19.	STANDBY EXHAUST FANS		
	Accessibility of Control from Station	Remote	Local
	Positive Status	On	Off
	Control Command	Running	Stopped
	Fault	Tripped	
	Low Airflow - Normal/Alarm	Alarm	
	Motor Current Low/High	Alarm	
	Emergency Stop Button	Alarm	
20.	AIR HANDLING UNITS		
	Accessibility of Control from Station	Remote	Local
	Positive Status	On	Off
	Control Command	Running	Stopped
	Fault	Tripped	
	Fan Airflow - Normal/Alarm	Alarm	
	Fan Motor Current Low/High	Alarm	
	Filter - Normal/Alarm	Alarm	
	Emergency Stop Button	Alarm	
21.	MOT VOLUME CONTROL DAMPER		
	Damper	Open	Closed
22.	CHILLED WATER PUMPS		
	Low Flow - Normal/Alarm	Alarm	
	Motor Current Low/High	Alarm	
	Pump not run one week	Alarm	
23.	CONDENSOR WATER PUMPS		
	Low Flow - Normal/Alarm	Alarm	
	Motor Current Low/High	Alarm	
	Pump not run one week	Alarm	
24.	COOLING TOWER		
	Motor Current Low/High	Alarm	
25.	CHILLERS	Alarm	
	Chiller Outlet Temp High Alarm	Alarm	
	Motor Current Low/High	Alarm	
	Common Chiller Temp High Alarm	Alarm	
	Common Condensor Temp High Alarm	Alarm	
	Condensor Temp High Alarm	Alarm	
	Chiller Fail	Alarm	
	Chiller Common Alarm	Alarm	
	Chiller Temperatures	Value	
26.	REFRIGERANT MONITORING	Alarm	

	Building Services System (BMS)	Signal 1	Signal 2
27.	CHEMICAL TREATMENT	Alarm	
28.	STATION TEMPERATURES	Value	
29.	STATION HUMIDITY	Value	
30.	STAIR PRESSURISATION FANS		
	Accessibility of Control from Station	Remote	Local
	Positive Status	On	Off
	Control Command	Running	Stopped
	Fault	Tripped	
	Emergency Stop Button	Alarm	
31.	MODE CONTROL (ECS) (Subject to Design)		
	Mode Command from OCC	Command	
	Mode Confirm Receipt to OCC	Feedback	
	Mode Start Confirm from OCC	Command	
	Mode Accepted	Feedback	
	Mode In Progress	Feedback	
	Mode Successful	Feedback	
	Mode Fail	Alarm	
	Sub Mode Command from OCC	Command	
	Sub Mode Confirm Receipt to OCC	Feedback	
	Sub Mode Start Confirm from OCC	Command	
	Sub Mode Accepted	Feedback	
	Sub Mode In Progress	Feedback	
	Sub Mode Successful	Feedback	
	Sub Mode Fail	Alarm	
	Motor Current Low/High Alarm		
32.	MOTORISED FIRE DAMPERS	Open	Closed
	TUNNEL VENTILATION SYSTEMS		
33.	MOTOR CONTROL CENTRES		
	Amps	Current	
	Volts	Volts	
	Kilowatts	Kilowatts	
34.	TUNNEL FANS (ALL TEF, TVF)		
	Accessibility of Control from Station	Remote	Local
	Positive Status	On	Off
	Control Command	Running	Stopped
	Fault	Tripped	
	Emergency Stop Button	Alarm	
	Forward Airflow Low Alarm	Alarm	
	Reverse Airflow Low Alarm	Alarm	
	Airflow Status	Forward	Reverse

	Building Services System (BMS)	Signal 1	Signal 2
	Motor Overload	Alarm	
	Vibration Switch	Alarm	
	Motor Current Low/High Alarm	Alarm	
	Fan Fail	Alarm	
35.	TUNNEL VENT DRAUGHT RELIEF DAMPERS		
	Damper	Open	Closed
	Damper Command Mismatch	Alarm	
36.	TUNNEL VENT FAN DAMPERS		
	Damper	Open	Closed
37.	TUNNEL VENT TRACKWAY DAMPERS		
	Damper	Open	Closed
	Damper Command Mismatch	Alarm	
40.	MODE CONTROL (TVS) (Subject to Design)		
	Mode Command from OCC	Command	
	Mode Confirm Receipt to OCC	Feedback	
	Mode Start Confirm from OCC	Command	
	Mode Accepted	Feedback	
	Mode In Progress	Feedback	
	Mode Successful	Feedback	
	Mode Fail	Alarm	
	Sub Mode Command from OCC	Command	
	Sub Mode Confirm Receipt to OCC	Feedback	
	Sub Mode Start Confirm from OCC	Command	
	Sub Mode Accepted	Feedback	
	Sub Mode In Progress	Feedback	
	Sub Mode Successful	Feedback	
	Sub Mode Fail	Alarm	
	Control at OCC	Feedback	
	Control at SCR	Feedback	
	Control at VCP	Feedback	
	Control at LCP	Feedback	
	Control at FCP	Feedback	

1. The contractor shall consider the automation of Seepage pumps in cross passages in each tunnel section between 2 stations and sump pumps provided at the portals location from the nearest station
2. The tentative list of I/O points provided in the BMS bid are attached with these specifications for guidance purpose only.

ANNEXURE II

NOT USED

ANNEXURE III

EMPLOYER'S REQUIREMENTS - GENERAL

1. DEFINITIONS AND INTERPRETATIONS

In addition to the words and expressions defined in the General Conditions of Contract (GCC), following words and expressions shall have the meaning assigned to them except where the context otherwise requires:

"As-Built Drawings": means those drawings produced by the Contractor and endorsed by him as true records of construction of the Permanent Works and which have been agreed to, by the Engineer.

"Combined Services Drawings" (CSD): means drawings showing the locations, layouts and sizes of all services including those of other Contractors co-ordinated so as to eliminate all clashes.

"Notice": means a Notice of No Objection.

"Construction Reference Drawings": The Construction Reference Drawings are derived directly from the Definitive Design and these drawings detail and illustrate in full the Permanent Works.

"Services, Electrical, Mechanical Drawings" (SEM): means those drawings produced by the Civil Contractor / Detailed Design Consultant of the Employer showing the locations, sizes and details of openings in structural elements for Mechanical and Electrical facilities and other related contracts.

"Working Drawings": comprise the Construction Reference Drawings and Good for Construction Drawings or documents, as are necessary to amplify the Construction Reference Drawings for construction purposes and endorsed as required by the Engineer.

The Contractor shall always immediately seek advice from the Engineer in the event of conflicts between the provisions in the document.

In the event of a conflict between the provisions of the following documents the order of precedence will be:

- Employer's Requirements
- Indian and International Standards referenced herein.
- Other Indian and International Standards.

2. CONSTRUCTION PHASES

Construction shall not be commenced until the original negatives of the appropriate Working Drawings have been endorsed

- (a) By the Contractor as "Good for Construction"; and
- (b) By the Engineer / Detailed Design Consultant of Employer that he has no objections to the drawing.

The Construction Phase shall include the completion and submission of the As Built Drawings and other records as specified.

3. **SPECIFICATIONS IN METRIC AND IMPERIAL UNITS**

- (1) The Contract shall utilise the SI system of units. Codes and Standards in Imperial units shall not be used unless the Engineer has given his consent.
- (2) Conversion between metric units and Imperial units shall be in accordance with the relevant Indian Standards.

4. **WORKS PROGRAMME**

- (1) Refer Chapter 2 of GS.

5. **MONITORING OF PROGRESS**

Refer Chapter 2 of GS.

6. **QUALITY ASSURANCE**

The Contractor shall establish and maintain a Quality Assurance System for design as well as construction and the interfaces between them. Also, Refer Chapter 5 of GS.

7. **CO-ORDINATION WITH DESIGNATED AND OTHER CONTRACTORS (Also, Refer Chapter 16 of GS)**

General

- (1) The Contractor is responsible for detailed co-ordination of his design, drawing production and construction activities with those of the Designated Contractors, Civil Contractors, Utility Agencies, Statutory Authorities, Private Service Providers, Developers, Consultants and other Contractors whether or not specifically mentioned in this contract, that may be working on or adjacent to the site for the purpose of the Project. For the purpose of this Specification, all of the above parties shall be referred to as Interfacing Contractors. The Contractor shall note that there are other Contractors, consultants, etc. which the Employer will engage from time to time with whom the Contractor shall have to similarly co-ordinate. Such co-ordination responsibilities of the Contractor shall include the following:
 - (a) To provide all information reasonably required by the Interfacing Contractors in a timely and professional manner to allow them to proceed with their design or construction activities, and specifically to meet their contractual obligations.
 - (b) To ensure that the Contractor's requirements are provided to all other Interfacing Contractors before the cut-off dates as identified in the IMP (Interface Management Plan)
 - (c) To obtain from the Interfacing Contractors information reasonably required to enable the Contractor to meet the drawing submission dates.
 - (d) Where the execution of the work of the Interfacing Contractors depends upon the site management or information to be given by the Contractor, the Contractor shall provide to such Interfacing Contractors the services or

correct and accurate information required to enable them to meet their own programme or construct their work.

- (e) To attend regular co-ordination meetings convened by the Engineer with the Interfacing Contractors. The Contractor shall conduct separate meetings with the Interfacing Contractors as necessary to clarify particular aspects of the interfacing requirements of the Works. The party who convenes the meeting shall prepare minutes recording all matters discussed and agreed at the meeting.
 - (f) To ensure that copies of all correspondence, drawings, meeting minutes, programmes, etc. relating to the Contractor's co-ordination with the Interfacing Contractors are issued to all concerned parties and two (2) copies issued to the Engineer no later than two (2) calendar days from the date of such correspondence and meetings.
- (2) The Contractor, shall in carrying out his co-ordination responsibilities, raise in good time and provide sufficient information for the Engineer to decide on any disagreement between the Contractor and the Interfacing Contractors as to the extent of services or information required to pass between them. If such disagreement cannot be resolved by the Contractor despite having taken all reasonable efforts, then the decision of the Engineer shall be final and binding on the Contractor.
- (3) Where an Interfacing Contract is yet to be awarded the Contractor shall proceed with the co-ordination activities with the Engineer / Employers nominated representative for this purpose until such time when the Interfacing Contractor is available. The Contractor shall provide the Interfacing Contractor with all information necessary to enable the Interfacing Contractor to follow-on and proceed with their co-ordination.
- (4) The cut-off dates as defined in the IMP are the latest dates for the Contractor to pass information to the Interfacing Contractors in order for them to complete their design submissions to the Engineer. Any claim of additional costs by the Interfacing Contractors as a result of the Contractor's failure in adhering to these dates shall be borne by the Contractor. The Contractor shall note that the information exchange is an iterative process requiring the exchange and update of information at the earliest opportunity and shall be carried out on a regular and progressive basis so that the process is completed by the cut-off dates..

Dedicated co-ordination team

- (5) The Contractor shall establish a dedicated co-ordination team, led by a Chief Co-ordinator in Jaipur reporting to the Contractor's Site Agent. The primary function of the team is to provide a vital link between the Contractor's construction teams and the Interfacing Contractors.
- (6) The Chief Co-ordinator shall assess the progress of the co-ordination with Interfacing Contractors by establishing lines of communications and promote

regular exchange and updating of information so as to maintain the Contractor's programme.

- (7) The complexity of the Project and the importance of ensuring that work is executed within time limits require detailed programming and monitoring of progress so that early programme adjustments can be made in order to minimise the effects of potential delays.
- (8) During the course of the contract, information will be obtained in a number of ways. These may include direct inspection, regular site meetings, the obtaining of progress reports and the use of turn round document to obtain design and programme data. Turn round document shall be issued to the Interfacing Contractors to be returned giving the current positions on their programme.

Construction Interface

- (9) Construction interface will be necessary throughout the duration of the Works commencing from the time the Contractor mobilizes the Site to the completion of the Works. Construction interface will overlap design interface, involving cast-in and buried items such as pipes for electrical and mechanical services, supports, brackets, plinths, ducts, service buildings, openings, cableways, trenches etc. that are to be incorporated at the early stage of the construction up to provision of attendance during the testing and commissioning stage.
- (10) The Contractor shall ensure that there is no interference with the Works of the Interfacing Contractors and shall maintain close co-ordination with them to ensure that his work progresses in a smooth and orderly manner. The Contractor shall carry out and complete the Works, or any part thereof, in such order as may be agreed by the Engineer or in such revised order as may be requested by the Engineer from time to time. The Contractor shall, unless otherwise provided, be liable for and shall indemnify the Employer against all costs, charges, expenses and the like resulting from failure of the Contractor to co-ordinate the Works as specified.
- (11) The Civil Contractor will prepare a station Co-ordinated Installation Plan (CIP) for the station on room-by-room basis covering the period of Designated Contractor access. The CIP shall allow adequate time periods for each Designated Contractor to install their plant and equipment in the station areas. The CIP shall be agreed with and signed off by each Designated Contractor and then submitted to the Employer.

8. SURVEY AND SITE INVESTIGATIONS

The datum used for the Contract shall be Mean Sea Level Datum

9. CLIMATIC CONDITIONS

The following indicative information on climatic conditions in Jaipur is derived from the India Meteorological Department

TEMPERATURE:

Daily Maximum and Minimum temperatures during Winter, Summer and Rainy season (ever recorded):

	Max	Min
Winter (November to February)	29.1 °C	8.2 °C
Summer (March to June)	40.3 °C	16 °C

10. **CONTRACTOR'S PROJECT ORGANISATION**

- (1) The Contractor shall have a competent team of Managers, Engineers, Technical staff etc so as to complete the work in a satisfactory manner as per various requirements of the contract.
- (2) A control room with round the clock radio communication or telephone switch board links with all safety offices, works sites, site offices, off site offices, Engineer's site office.
- (3) The designations of the various project organisations team members shall be approved by the Engineer before adoption so as to avoid any duplication of the designations with those of the Employer or the Engineer.

ANNEXURE IV
EMPLOYER'S REQUIREMENTS - DESIGN

1. INTRODUCTION

- (1) The Employer's Requirements – Design, specify the procedural requirements for the preparation of design verification of the Permanent and Temporary Works.
- (2) In addition to the express requirements herein, the Contractor shall, whenever the Engineer so requests, provide information and participate in discussions that relate to design matters.
- (3) **The Contractor shall establish an office for his design team at the Site in Jaipur. The design team shall function from this office.**
- (4) The Contractor shall submit his Quality Assurance Plan as required for the design required by the Contract.

2. REQUIREMENTS DURING CONSTRUCTION PHASE

Detailed Design Consultants appointed by the Employer has prepared Definitive Design and Construction Reference Drawings. The Employer will supply a copy of the Definitive Design and Construction Reference Drawings in a phased manner to the Contractor.

- (1) The principal requirements relating to design during the Construction Phase are the production of Shop / Working Drawings, preparation of technical submissions related to Detailed Engineering from the Definitive design Documents supplied by the Employer, the compilation of the Final Design and the production of the As-Built Drawings.
- (2) Working Drawings shall be prepared as required under the Contract. They shall be endorsed by the Contractor as being in accordance with the Construction Reference Drawings.
- (3) The Contractor shall endorse the submissions required under the contract that "all effects of the design comprising the submission on the design of adjacent or other parts of the works have been fully taken into account in the design of these parts"
- (4) The Final Design is the design of the Permanent Works embodied in:
 - (a) The latest revisions of the Working / Shop Drawings;
 - (b) The calculations, and
 - (c) Such other documents as may be submitted by the Contractor at the request of the Engineer to illustrate and describe the Permanent Works.
- (5) The Contractor shall maintain all records necessary for the preparation of the As-Built Drawings. Upon completion of the Works or at such time as agreed to or required by the Engineer, the Contractor shall prepare drawings which, subject to the Engineer's agreement, shall become the As-Built Drawings. The Contractor shall endorse all such drawings, as true records of the construction of the Permanent Works and of all temporary works that are to remain on the site.

3. WORKING DRAWING SUBMISSIONS

- (1) The Working Drawings shall be derived directly from the Definitive Design and Construction Reference Drawings and shall detail and illustrate in full the Permanent Works.
- (2) Prior to any Working Drawings Submission, the Contractor shall prepare a full list of Working Drawings in order to demonstrate, to the satisfaction of the Engineer, that such Working Drawings will be sufficient in extent to cover the construction of the whole of the Permanent Works.
- (3) Prior to submission of the proposed Working Drawings, the Contractor shall endorse the appropriate original paper drawings as "Good for Construction". If the Engineer so requires, the endorsed original shall be submitted to the Engineer who shall, if he has no objection to the contents of the submission, further endorse the original by stating that he has no objection to the proposed Working Drawings. On the endorsement by the Engineer, the original will forthwith be returned to the Contractor as the Working Drawings.
- (4) Only the Working Drawings endorsed as in 3 (3) above or those that the Engineer has expressly stated as not requiring his endorsement shall be issued to the Site. The Construction of the Works shall be strictly in accordance with these Working Drawings.
- (5) The Contractor shall finalise details of the proposed method of construction and submit such finalised details to the Engineer for review. The proposed method shall have no adverse effects on the partially completed Permanent Works and shall ensure the Works are statically and, if appropriate, aerodynamically stable.
- (6) As-Built Drawings, endorsed by the contractor shall be submitted to the Engineer for agreement.

4. DESIGN SUBMISSIONS - REVIEW PROCEDURES

- (1) Submissions of Design Data shall be made to and reviewed by the Engineer. **Submissions shall also be reviewed by detailed Design Consultants of the Employer.** The form and details of the review shall be as determined by the Engineer and will not release or remove the Contractor's responsibility for the design under the contract.
- (2) The issue of a Notice shall be without prejudice to the issue of any future Notices.
- (3) The Contractor shall, prior to the submission of the Design Data, obtain all required and / or statutory approvals that relate to that submission including, where appropriate, the approval of the Concerned Government Authorities and utility undertakings, and demonstrate that all required approvals have been obtained.

5. DESIGN SUBMISSION PROGRAMME

- (1) The Contractor shall prepare the Design Submission Programme, which is to set out fully the Contractor's anticipated programme for the preparation, submission and review of the Submissions and for the issue of Notices in relation thereto.
- (2) The Design Submission Programme shall:
 - (a) Be consistent with and its principal features integrated into the Works Programme, and show all relevant Key Dates;
 - (b) Identify dates and subjects by which the Engineer's decisions should be made;
 - (c) Make adequate allowance for periods of time for review by the Engineer and other review bodies;
 - (d) Make adequate allowance for the design and development of specialist works;
 - (e) Include a schedule identifying, describing, cross-referencing and explaining the Design Packages into which the Contractor intends to divide the Drawings; and
 - (f) Indicate the Design Interface and Co-ordination periods for each Designated Contractor.
- (3) The Contractor shall submit the Design Submission Programme to the Engineer within fifteen (15) days of the date of issue of Letter of Acceptance, and thereafter up-dated versions thereof at intervals of not more than one (1) month throughout the Design Phase.

6. CALCULATIONS

- (1) Unless otherwise required by the Engineer, calculations relevant to the Working Drawings shall be submitted for review with the respective Design Packages or Submissions. The Engineer may require the submission of applicable software including in house software programmes / worksheets developed by the Contractor, computer input and programme logic for its review prior to the acceptance of the computer output.
- (2) The Contractor shall prepare and submit a comprehensive set of calculations in a form acceptable to the Engineer. Should the design of the Permanent Works be revised thereafter and such revision renders the calculations as submitted obsolete or inaccurate, the contractor shall prepare and submit the revised calculations
- (3) Calculations to be included as part of the submission herein shall comprise the up-to-date calculations in respect of the Construction Reference Drawings and such further calculations which the Contractor has prepared during the production of Working Drawings.
- (4) The Contractor shall submit all calculations necessary to support proposals relating to the construction methods.

7. DOCUMENTS REQUIREMENTS

- (1) Drawings shall be prepared generally to A1 size and to ISO AO size where appropriate.
- (2) The Contractor shall submit 6 copies of his design and / or drawings for review by the Engineer. After receipt of "No Objection" from the Engineer' or his representative, the Contractor shall submit 6 copies of design and / or drawing for the use of the Engineer.

ANNEXURE V

EMPLOYER'S REQUIREMENTS - MANUFACTURING, INSTALLATION AND TESTING

This Employer's Requirements establish the overall procedures to be followed by the Contractor for works under this contract relating to manufacture, procurement and delivery of plant and equipment and their installation, testing and commissioning.

1 **MANUFACTURING**

1.1 **Management**

The Contractor shall establish procedures and controls that govern the procurement, integration, manufacture, testing, quality assurance and delivery of plant, equipment and spares to be supplied under the Contract. This shall include the administration and supply of spare parts and warranty in accordance with the Contract. The Contractor's Manufacturing Management Plan shall be submitted to the Engineer for his review within 45 days of the Date of Commencement.

1.2 **Procurement Management**

The Contractor's management systems and procedures shall incorporate a procedure for materials procurement, sufficient to assure technical and quality controls consistent with those of this contract. The Contractor's management system shall be auditable for materials sources, lot numbers, serialised equipment, etc.

1.3 **Manufacturing and Production Management**

The Contractor's manufacturing and production management system shall encompass all points of receiving raw material and components, processing, fabrication, assembly, testing and all points of in - process inspections. The Contractor shall submit manufacturing data as part of the Manufacturing Management Plan, which shall contain:

- A brief description of all inspection hold points and test points, and a correlation with the Programme Schedule;
- A delivery schedule of each item of equipment to match installation plan
- Manufacturer's Qualifications: The equipment manufacturer shall show at least ten years of continuous and current experience in the design, assembly and testing of similar equipment as being offered complying with the bid specifications.

1.4 **Testing**

- A comprehensive testing programme shall be provided by the Contractor that shall include complete equipment, their subsystems, components and material to assure conformance with the Specifications. The purpose of the comprehensive testing programme shall be to:
- Substantiate performance characteristics;

- Ensure operational compatibility;
- Complete equipment verification and acceptance requirements; and
- Complete all reliability, maintainability and safety demonstration requirements.

1.5 **Quality Assurance and Controls**

The Contractor's Management Systems shall emphasize quality assurance and controls. The programme shall be adequate to ensure an acceptable level of quality of the equipment supplied. The concept of total quality assurance shall be based on the principle that quality is a basic responsibility of the Contractor's organisation, and shall be evidenced by:

- Firm procurement and job performance specifications;
- Firm procedures for transmission of information and data to their Subcontractors and ensuring their compliance;
- Adequate testing to ensure repetitive product conformity to design requirements; and
- Total programme of surveillance and verification of physical performance and configuration accountability.

Adequate records shall be kept by the Contractor to provide evidence of quality and accountability. These records shall include results of inspections, tests, process controls, certification of processes and personnel, discrepant material, and other quality control requirements.

Inspecting and testing records shall, as a minimum indicate the nature of the observations made, and the number and types of deficiencies found and action proposed to correct deficiencies. Also, records for monitoring work performance and for inspecting and testing shall indicate action taken for the correction of deficiencies.

1.6 **Shipping**

The Contractor's Manufacturing Management Plan shall provide for the proper inspection of equipment to ensure satisfactory completion of manufacturing and testing / check prior to shipment. All shipments shall be adequately prepared to preclude damage during shipment. .

1.7 **Handling, Storage and Delivery**

The Contractor's Manufacturing Management Plan shall provide for adequate work and inspection instructions for handling, shipping, storage, preserving, packaging, packing, marking, and shipping to protect the quality of the equipment and to prevent damage, loss, deterioration, degradation or substitution thereof.

Handling procedures shall include the use of special crates, boxes, containers, transportation vehicles, equipment and facilities for materials handling.

Means shall be provided for protection against deterioration or damage to equipment in storage.

2. INSTALLATION

2.1 Installation Plan and Programme

The Installation Plan shall show how the Contractor proposes to organise and carry out the Installation and complete the whole of the Works within the stipulated time. The Contractor shall submit the Plan for the review by the Engineer at least 30 days prior to the start of Installation on Site.

The Contractor shall attend weekly planning meetings with the Engineer to finalise the work detail, commencing 4 weeks prior to the start of Installation on Site.

2.2 Method Statement

The Method Statement shall be submitted to the Engineer for review at least 30 days prior to the installation activity commencing On-Site. This shall show in particular the loadings and modes of transport of the items of equipment and the routing used as they are taken to their final locations.

Prior to proceeding with installation, the Contractor shall submit for the Engineer's consent five copies of detailed drawings showing all installations including dimensions, supports, hardware, installation methods, and all other pertinent data.

The manufacturer's rigging or erection instructions shall be carefully followed. The Contractor shall make certain that the installation of all supports, gaskets, hardware, etc., are accomplished with precision and ensure exercise of extreme care so as to assure safe, accurate and trouble-free installation. Installation shall be undertaken in the presence of the Manufacturer's Field Service Representative.

Equipment that is improperly installed shall be removed, checked / tested and reinstalled. Any damage caused due to improper installation and removal shall be rectified before reinstalling at no extra cost.

Contractor shall submit the Installation Testing Plan (ITP) for major E & M items (e.g. Panels etc.) for approval by Engineer and installation and testing shall be carried out according to approved ITP.

2.3 Contractor's Resident Staff

The Contractor shall ensure that a qualified representative of the manufacturer is available on-Site for the duration of the On-Site Works during normal working hours and installation period and on-call to arrive on Site within 60 minutes at all other times.

Manufacturer's Representative shall support the Contractor's Representative during the Installation and Testing phase of the Works.

The Contractor's Representative shall have sufficient authority to progress the Contractor's work on Site. The Contractor's Representative shall be competent and qualified to act on behalf of the Contractor, and provide upon request information that may include:

- Current progress of the Works;
- Planned work for the next 5 weeks;
- Audit and inspection reports;
- Health and safety information; and
- Documents and records pertaining to the Works.

2.4 Drawings and Records

1 General

The Contractor shall provide 3 copies of all drawings in A3 size, bound into circuit books.

The Contractor shall ensure that, at each equipment location, an as-built copy of the following Site documentation is provided.

- Power supply arrangement;
- Earthing & bonding arrangement; and
- Cable circuit information.

2 Cable Records

The Contractor shall ensure that the as-built cabling infrastructure is fully documented and accurate at the time of substantial completion of the Section. The documentation shall include:

- Schematic of the cable routes;
- Location of cable joints;
- Cable types;
- Installed dates;
- Test data before and after installation; and
- Core plan indicating the circuit and function of each core.

The Contractor shall be responsible for adding to all of the Combined Services Drawings the cable installation details and for the timely supply of these marked up drawings to the Engineer for overall co-ordination.

3. MATERIALS

- (1) Materials and goods for inclusion in the Permanent Works shall be new.
- (2) Certificates of tests by manufacturer, which are to be submitted to the Engineer, shall be current and shall relate to the batch of material delivered to the Site. Certified true copies of certificates may be submitted if the original certificates could not be obtained from the manufacturer.

- (3) Parts of materials, which are to be assembled on the Site, shall be marked to identify the different parts.
- (4) Materials which are specified by means of trade or proprietary names may be substituted by materials from a different manufacturer which has received the consent of the Engineer provided that the materials are of the same or better quality and comply with the specified requirements.
- (5) Samples of materials submitted to the Engineer for information or consent shall be kept on the Site and shall not be returned to the Contractor or used in the Permanent Works unless permitted by the Engineer. The samples shall be used as a means of comparison, which the Engineer shall use to determine the quality of the materials subsequently delivered. Materials delivered to the Site for use in the Permanent Works shall be of the same or better quality as the samples, which have received consent.

4 TESTING AND COMMISSIONING

4.1 General

The Contractor shall perform all forms of test procedures applicable to the system and shall conduct factory, site installation and acceptance tests.

The commissioning activity shall include a period of the Integrated System testing followed by a period of Trial Running and inspection by the CMRS and a period for staff training and familiarization

4.2 Test Programmes and Procedures

Unless agreed in writing by the Engineer, personnel engaged on testing shall be independent of those personnel, responsible for, installations of the same equipment.

All Test equipment shall carry an appropriate and valid calibration label. They shall be periodically checked for calibration accuracy

All reports of Tests shall be signed by the Contractor.

The Contractor shall present a comprehensive Testing and Commissioning Programmes within 3 months from the Date of Commencement of works.

All Test procedures shall be submitted at least 30 days prior to conducting any Test. Test procedures shall show the extent of testing covered by each submission, the method of testing, Acceptance Criteria, the relevant drawing (or modification) status, and the location.

Test Procedures shall be amended, as required, by the Contractor during the currency of the contract to reflect changes in system design or the identification of additional testing requirements.

The Employer, the Engineer and/or any of their staff shall have the facility to monitor all Tests and have access to all Test records.

All costs associated with Testing shall be borne by the Contractor, unless otherwise specified, including the services of any specialised personnel or independent assessors.

The Contractor shall also bear any expenses incurred due to re-testing caused by defects or failure of equipment to meet the requirements of the Contract in the first instance.

In the event of any tests being performed in countries other than India, the Contractor shall give sufficient notice to the Engineer / Employer for witnessing the tests. The cost of the Engineer's visit shall be borne by the Employer.

The Contractor is reminded that, at some point, the traction system will be energized and that additional precautions for the safety of staff and co-ordination of activities after "power-on" shall be anticipated in his installation, testing and commissioning programmes.

4.3 **Sequence of Tests**

The sequence of tests shall be:

- Type tests;
- Factory acceptance tests (FAT) or works test;
- Installation tests;
- Partial acceptance tests (PAT):
- Functional tests;
- Integration tests;
- System acceptance tests (SAT);
- Integrated Tests;
- Tests on completion.

4.4 **Type Tests**

Unless agreed otherwise, type tests certificates from an Recognised/reputed laboratory, acceptable to Engineer, should be provided for all equipment supplied under this contract, Should the Contract include any equipment not previously proven in service or of any modified design the Contractor shall undertake the thorough testing of the units at pre-production stage to the satisfaction of the Engineer. The Contractor shall identify in his bid any equipment in this category, or equipment that differs significantly from that already in service elsewhere.

Type tests including prototype shall be performed prior to full production and before FAT.

Type testing shall be used to confirm that the proposed equipment is fit for purpose in the environmental conditions specified and meets the requirements of the Specifications..

4.5 **Factory Acceptance Tests (FAT)**

Works Tests shall include but not be limited to:

- Physical inspection
- Dimension check
- Electrical check
- Calibration
- Operational performance
- Full Load test
- Flash-over test
- Insulation test
- Any other test required as per relevant standards or codes

A Factory Test Plan shall be submitted for the Engineer's review within 3 months from the Date for Commencement of the Works.

All materials, components, sub-assemblies, unit assemblies (including software, cables and wiring) shall be subject to testing and certification. Notification of these Tests shall be submitted to the Engineer at least **30 days** in advance of carrying out any such Test. The Engineer will then determine which, items if any, may be accepted based on previous supply or experience

The FAT shall demonstrate that each sub-system and the System meet its functional specification.

No equipment or software shall be delivered to the Site until the Contractor has demonstrated to the satisfaction of the Engineer that the equipment or software conforms to the Specification by carrying out the FAT.

Where necessary, interfaces shall be represented by simulation.

Where processor based equipment is to be used, the Works Tests shall include also verification of software used in such application.

4.6 **Installation Tests**

A. **Prerequisites for Installation**

Prior to installation, the Contractor shall ensure that equipment delivered to Site has not been damaged in transit and that their dimensional accuracy has not been impaired.

Designs for the Sections under test shall be completed and submitted to the Engineer for review prior to Installation.

B Inspection

The inspection shall verify that equipment has been installed as per the procedures and design that have been reviewed and consented to by the Engineer and that equipment is correctly located and labelled.

The inspection shall verify that any false feed, temporary wiring and redundant items have been removed and that equipment is correctly protected against interference, damage and deterioration.

The Contractor shall maintain inspection records to demonstrate that each item of equipment has been inspected and found to be satisfactory, and attach to this record a detailed list of any discrepancies found and remedial work carried out.

As defects are rectified, these shall be recorded on the appropriate inspection record.

C. Installation Tests

Installation tests shall be carried out by the Contractor for each subsystem following Installation, but before Functional tests, to demonstrate that the installation has been carried out correctly and equipment is properly housed and fixed.

During and on completion of an installation, the Contractor shall undertake testing of all cables, wiring and equipment, instrumentation and protection devices, in a progressive sequence and in accordance with the overall-testing programmes. These tests shall culminate in Functional Tests to verify the correct operation of all apparatus and, where appropriate, correct response to the respective control commands or monitored function.

D. Partial Acceptance Tests (PAT)

Installation work shall be completed and inspection records submitted to the Engineer for review before the commencement of each PAT.

The PAT Plan shall be submitted for the Engineer's review at least 30 days before the commencement of each PAT.

E. Functional Tests

The functional tests of the PAT shall be carried out on installed equipment before System Acceptance Tests (SAT) to demonstrate that the Section of the Works operates correctly in accordance with the Specifications.

The functional tests shall sequence through all required operations to prove that the System performs in accordance with the Specifications and that the Local configuration data (for example, control tables) is correct.

Where necessary, input conditions shall be simulated.

The functional tests shall be specified and carried out by the Contractor's personnel independent of design and installation.

F. Integration Tests

Partial Acceptance Test (PAT) shall include integration tests to integrate the various subsystems of the System and demonstrate correct operation of all internal and external interfaces.

Following satisfactory completion of these Tests, the Contractor shall prepare the installation for formal demonstration in the presence of the Employer's Representative.

G. System Acceptance Tests (SAT)

The Contractor shall prepare and organise a comprehensive programme of Tests to demonstrate to the Engineer that all systems, sub-systems and apparatus defined under the Contract meet the specified performance requirements in all respects.

Prerequisites for SAT

The requirements that shall be satisfied before the commencement of the System Acceptance Tests (SAT) are:

- All documentation for the Safety Report shall be submitted to the Engineer for review.
- All PAT shall be completed and test records submitted to the Engineer for review.
- Employer's staff shall be given a training course in the System as defined in the Section on Training herein.
- Facilities for the maintenance of the System shall be in place.

The SAT Plan shall be submitted to the Engineer for review at least 30 days before the commencement of the SAT.

H. INTEGRATION SYSTEM TESTS

The Contractor shall submit to the Engineer requirements and procedures, in respect of the Contractor's scope of work, for Integrated System Tests in conjunction with the Designated Contractors to demonstrate that the complete system provided under the Contract is fully operational and meets the specified performance criteria. The conducting of these Integrated System Tests, by the Contractor and the Designated Contractors, shall include a period of Test running.

4.7 BATCHES, SAMPLES AND SPECIMENS

- (1) A batch of material is a specified quantity of the material that satisfies the specified conditions. If one of the specified conditions is that the material is to be delivered to the Site at the same time, then the material delivered to the Site over a period of a few days may be considered as part of the same batch if in the opinion of the

Engineer there is sufficient proof that the other specified conditions applying to the batch apply to all of the material delivered over this period.

- (2) A sample is a specified quantity of material that is taken from a batch for testing and which consists of a specified amount, or a specified number of pieces or units, of the material.
- (3) A specimen is the portion of a sample that is to be tested.
- (4) Samples shall be of sufficient size and in accordance with relevant Standards to carry out all specified tests.
- (5) Samples taken on the Site shall be selected by, and taken in the presence of, the Engineer and shall be suitably marked for their identification. An identification marking system should be evolved at the start of works in consultation with the Engineer.
- (6) Samples shall be protected, handled and stored in such a manner that they are not damaged or contaminated and such that the properties of the sample do not change.
- (7) Samples shall be delivered by the Contractor, under the supervision of the Engineer, to the specified place of testing. Samples on which non-destructive tests have been carried out shall be collected from the place of testing after testing and delivered to the Site or other locations as instructed by the Engineer.
- (8) Samples that have been tested may be incorporated in the Works provided that:
 - The sample complies with the specified requirements;
 - The sample is not damaged; and
 - The sample is not required to be retained under any other provision of the Contract.
- (9) Additional samples shall be provided for testing if in the opinion of the Engineer:
 - Material previously tested no longer complies with the specified requirements; or
 - Material has been handled or stored in such a manner that it may not comply with the specified requirements.

Unless agreed otherwise, all Tests shall be carried out by the Contractor in the presence of the Engineer and/or his authorised representative.

Attendance on Tests, including that by the Employer, the Engineer and/or their authorised representative, and the Contractor, shall be as laid down in the Quality Assurance procedures.

4.8 TESTING

- (1) The Contractor shall be responsible for all on-site and off-site testing. All appropriate laboratory tests shall be carried out in the Contractor's laboratory at

site, unless otherwise permitted or required by the Engineer. Where the laboratory is not appropriately equipped and/or staffed for some tests, or if agreed to by the Engineer, tests may be carried out in other laboratories provided that:

- (a) They are accredited for the relevant work to a standard acceptable to the Engineer; and
 - (b) Particulars of the proposed laboratory are submitted to the Engineer for his consent.
- (2) In-situ tests shall be done in the presence of the Engineer.
 - (3) Equipment, apparatus and materials for in-situ tests and laboratory compliance tests to be carried out by the Contractor shall be provided by the Contractor. The equipment and apparatus shall be maintained by the Contractor and shall be calibrated before the testing starts and at regular intervals as directed by the Engineer. The equipment, apparatus and materials for in-the situ tests shall be removed by the Contractor as soon as practicable after the testing is complete.
 - (4) The Contractor shall be entitled in all cases to attend the testing carried out in the Employer's or other laboratories, to inspect the calibration certificates of the testing machines and to undertake the testing on counterpart samples. Testing of such samples shall be undertaken in laboratories complying with Clause 4.8 (1) above and particulars of the laboratory proposed should be submitted to the Engineer for consent prior to the testing.
 - (5) Attendance on tests, including that by the Engineer, the Contractor and the Designer shall be as laid down in the Quality Assurance procedures.

COMPLIANCE OF BATCH

- (6) The results of tests on samples or specimens shall be considered to represent the whole batch from which the sample was taken.
- (7) A batch shall be considered as complying with the specified requirements for a material if the results of specific tests for the specified properties comply with the specified requirements for the properties.
- (8) If additional tests are permitted or required by the Engineer but separate compliance criteria for the additional tests are not stated in the Contract, the Engineer shall determine if the batch complies with the specified requirements for the material on the basis of the results of all tests, including the additional tests, for every properties.

4.9 Records Of Tests

Records of Tests, carried out shall be kept by the Contractor and a report along with all Test results shall be submitted to the Engineer no later than 15 days after completion of the Test. In addition to any other requirements, the report shall contain the following details:

- Material or part of the Works tested;

- Location of the part of the Works;
- Place of testing;
- Date and time of tests;
- Technical personnel supervising or carrying out the tests;
- Equipment used and method of testing;
- Readings and measurements taken during the tests;
- Test results, including any calculations and graphs;
- Specified acceptance criteria;
- Other details stated in the Contract.

5. MAINTENANCE

During the Defects Liability Period maintenance will be conducted by the contractor including all consumables will be in his scope.

The Contractor shall provide a maintenance support plan that shall include such items as:

- Procedures for maintaining each item, unit / equipment including routine survey, periodical overhaul and test running,
- Technical manuals,
- Initial provision of spares, facilities, test equipment and tools, jigs and fixtures.
- Training requirements.
- Procedures for removal and replacement of components.
- Periodic running of equipment and machines, which would otherwise deteriorate because of non-operation for more than a week.
- Manpower plan required for maintenance.

On commencement of Revenue Services the Contractor shall deliver to the Employer, copies of all such manufacturing drawings, schedules and software for all components, as well as all such As Built Drawings, as shall have been amended or updated.

6 MANUALS

The Contractor shall produce manuals for all equipment and systems supplied. These shall include, but may not necessarily be limited to, the following:

- System Manuals - A comprehensive description of all system principles at block diagram level.
- Operating/User Manuals - broken into as many sub-sections as may be necessary and providing sufficient information to enable non-technical staff to

exploit fully the facilities of each system.

- Workshop Manuals - installation and circuit descriptions, full schematics, circuits, wiring diagrams, mechanical construction drawings and itemised parts list to enable all maintenance rectification and setting-up to be carried out.
- Software System Manuals - for each software package and each piece of equipment which incorporates programmable devices and for which bespoke software has been prepared specifically for this application. Source code listings with comprehensive comments shall be provided for all bespoke software together with configuration listings for all configured standard software packages.
- Equipment Room Manuals - all wiring diagrams and circuits, equipment layout, terminal and cable listing and including such external equipment as may be necessary for completeness.
- Maintenance and Servicing Manuals - to specify requirements, procedures and servicing intervals for planned preventative maintenance and in addition to convey sufficient information on equipment principles and practice to enable first line fault diagnosis and rectification by technician staff.

The Operating / User Manuals and a summary (suitable for use at technician level) of the Maintenance and Servicing Manuals shall be prepared in English language. Other technical manuals shall be supplied in the English language only.

The Contractor shall submit all Manuals for review by the Engineer prior to Factory Acceptance Tests.

The Contractor shall provide 4 controlled copies of all Manuals for the use of the Engineer.

The Contractor shall maintain all Manuals in an up-to-date condition throughout the Contract Period.

7 SPARES, SPECIAL TOOLS AND TEST EQUIPMENT

7.1 General

During the Defects Liability Period, the Contractor shall provide free of cost all materials including consumables, unit exchange spares and emergency spares required for maintenance (routine and breakdown) of the Electrical and Mechanical Systems (EMS). The Contractor shall supply the spares, materials, jigs and fixtures not later than 4 (four) weeks before the commissioning of revenue services. A list of such spares and materials required for maintenance during the Defects Liability Period (to be provided free of cost by the Contractor) and if this list is found insufficient then the same needs to be augmented for preventive and corrective maintenance of all the equipment supplied under the contract without any extra cost.

If these spares are not consumed during the Defects Liability Period, these shall become the property of the Employer at the end of Defects Liability Period.

7.2 Tools and Test Equipment

The Contractor shall provide free of cost six weeks before start of trial running, special tools and test equipment which are essential for day to day use in both corrective and preventative maintenance and for workshop use in the overhaul of all modules and units likely to be required over the full service life of the installation. The Contractor shall submit a schedule of all tools and equipment with details of calibration and supplier along with the bid and if this list is found insufficient then the same needs to be augmented for preventive and corrective maintenance of all the equipment supplied under the contract without any extra cost.. These tools and test equipment shall become the property of employer at the end of DLP.

7.3 Spares List

The Contractor shall submit during the period of the contract **a schedule of spare parts** required for EMS duly indicating, for each item of spares, its description, part number, drawing number, lead time, shelf life and number of units required for the ten years (beyond DLP) as well as for the expected life of EMS, principal as well as secondary sources of supply and also the unit price of each spare with **Escalation clause**. If this list is found insufficient then the same needs to be augmented for preventive and corrective maintenance of all the equipment supplied under the contract.

This schedule shall include all types of consumable, unit exchange and emergency spares. The Contractor shall also advise upon recommended inventory having regard to the lead time of the respective items.

The Employer shall, during a period of ten years (beyond DLP), purchase as many parts as required by him, at the rates indicated in this schedule.

If during the period of ten years, the Contractor / Manufacturer intends to discontinue the manufacture of spare or replacement parts for the EMS the Contractor shall immediately give notice to the Employer of such intention. The Employer shall be given the opportunity of ordering at reasonable prices such quantities of such spare or replacement parts as the Employer shall reasonably require in relation to the anticipated life of the EMS.

In the event of Contractor failing to supply the spare parts in accordance with this Clause, he shall in respect of each item of spare, furnish free of cost to the Employer, the drawings, specifications, patterns and other information to enable the Employer to make or have made such spare parts. The Employer shall be entitled to retain the aforesaid drawings etc., for such time only as is necessary for the exercise by the Employer of his rights under this clause and the drawings, if the Contractor so requires, shall be returned by the Employer to the Contractor in good order and condition (fair wear and tear excepted).

Under such circumstances, the Contractor shall also grant to the Employer, without payment of any royalty or charge, full right and liberty to make or have made spare or replacement parts as aforesaid and for such purposes only to use, make and have made

copies of all drawings, patterns, specifications and other information supplied by the Contractor to the Employer pursuant to the Contract.

The Contractor will so far as it is reasonably able to bind his Sub Contractors to conform with the requirements of this Clause and shall, prior to entry into any sub-contracts, provide the Employer with full details of any Sub Contractor who will not so conform in which event the Employer may direct the Contractor to seek an alternative Sub Contractor.

If the Contractor fails to provide spare or replacement parts as described in this Sub-clause and these are available from the Contractor's Sub Contractor, the Employer shall have the right to obtain such spare and replacement parts from the Sub Contractor or any other supplier and any additional cost incurred by the Employer shall be recoverable from the Contractor.

If due to up gradation or advancement in technology any new type of models versions or design of spare parts are developed in future, the same shall be plug – compatible and space-compatible with regard to original design and installation of EMS.

Where the Contractor considers that any equipment that would be supplied, and which he considers cannot be economically or technically maintained by the Employer (e.g. computer processors) then such items shall be identified and proposals made for the maintenance of such equipment through OEM's.

The Contractor shall:

- submit to the Engineer a list of spares required for the life of the System.
- Base the spares calculations on the reliability and availability data and the criticality of the equipment.
- Submit to the Engineer for review the calculations and spares list.
- Submit to the Engineer a Cardex system for easy identification of spares.

The Spares list shall:

- Be grouped by subsystem, test equipment and special tools as applicable for stocking identification.
- Have detailed description with drawing references and correlation with the maintenance manuals.

7.4 Second Sourcing

The Contractor shall identify principal and second-source suppliers that can supply the systems and sub-system spares listed. The Contractor shall make the second-source supplier information available to the Engineer at the time of submission of the final design / working Drawings.

7.5 Long Lead Times

The Contractor shall identify the lead times for all spare parts. Parts with long lead times shall be identified as such to the Engineer in the spares list.

7.6 Routine Change

In the event that any item of the supply requires to be routinely changed or calibrated, regardless of whether it appears in the spares list or not, it shall be identified to the Engineer together with the routine change interval.

7.7 Shelf Life

In the event that any of the spares identified have a particular shelf life or special storage requirement, this shall be made known to the Engineer with the submission of the spares list, including the necessary action for disposal or storage.

7.8 Identification and Configuration Control

All spare equipment identified on the spares list, shall conform to Identification and Configuration Control requirements established by the Contractor for the equipment provided under the Contract..

7.9 Testing of Spares

The Contractor shall ensure that all spares are correctly calibrated, tested and labeled prior to their delivery. Test certificates for all equipment shall be submitted to the Engineer.

7.10 Delivery

Approved spares, special tools and test equipment shall be supplied prior to commissioning.

8 EQUIPMENT IDENTIFICATION

All equipment and materials supplied shall be indelibly labeled or otherwise identified to show its identity, type, version, function, location, rating or limitation as appropriate.

Removable modules shall have the same indelible labeling on the fixture to which the module is attached. The label shall be adjacent to the module or prominently marked on the module and shall not be obscured.

Labels shall conform to a unified system and shall conform to the requirements of the Engineer.

Where any hazardous situation could arise due to fluctuating voltage level, air pressure, maladjustment, mal-operation, etc., then prominent warning labels shall be provided to denote the same.

In general, all labels shall be in both English and Hindi languages. Where appropriate, such labels shall conform to accepted National or International Standards or as approved by the Engineer.

9 TRAINING AND TRAINING AIDS

9.1 Training Objective

The Contractor shall be required to arrange technology transfer to the Employer's staff in respect of design, manufacture, construction, handover, operations and maintenance of the plant and equipment provided under the Contract. These staff will include the Employer's management, operation, technical and instructional staff. The Contractor shall train, or arrange training for, the Employer's staff who shall be nominated by the Employer. This shall require the Contractor to train the Employer's Staff:

In sufficient detail so that the staff can appreciate, understand and monitor the technical, operational, maintenance, management and business aspects of the system.

Thoroughly so that the staff can operate, maintain and manage the system.

The Contractor shall train or shall arrange training for the Employer's staff at all levels, covering all aspects of the operation, maintenance and management of the System. Of primary importance is the training of Employer's Training Staff, whose responsibility will be to provide support to the Training Instructors during the in-depth start-up training that will take place prior to and during initiation of trial running. These Employer's Training Staff will also be responsible for implementing on-the-job training and skill enhancement training programmes for the Employer's staff after commencement of trial running.

9.2 Training Periods

The Contractor shall propose appropriate Schedule of training to be provided. All training courses will be conducted in English or in Hindi should the Contractor have available suitable training staff fluent in Hindi.

9.3 Training Instructors

The training instructors provided by the Contractor shall be fully qualified and experienced electrical and mechanical engineers, who have a good knowledge of the English language. They should have experience of training engineers or technicians of the level stated on similar topics or will be fully familiar with the Equipment supplied or installed.

Before any of the Contractor's training instructors is appointed the Contractor shall submit a detailed curriculum vitae for each training instructor for the approval of the Engineer.

Should, in the opinion of the Engineer, any of the Contractor's training instructors not be considered to be competent or not to have a suitable qualification, experience and attitude or aptitude for carrying out the training courses for whatever reason, the Contractor shall remove the said person and replace him as soon as possible with an acceptable substitute.

Where the Employer's staff is attached to the Contractor for the purposes of training, all such trainees shall be properly supervised and monitored by a qualified training supervisor to ensure that each trainee has the best opportunity to benefit from the theoretical and practical experience.

9.4 Training Courses

The training courses shall be programmed in phase with the progress of manufacture and installation to ensure that trainees are present during all stages of the manufacture, installation and commissioning of the Plant and Equipment, which will form the subject of the training. The Contractor shall ensure that the courses fully encompass all aspects of the basic design, manufacture, installation, commissioning and maintenance of the Plant and Equipment with maximum effort being directed at instructions in the maintenance of the installations.

The training shall be structured in modular format, each module shall be capable of being delivered independently or together with other modules of a similar theme.

The Contractor shall provide a training plan that shall include as a minimum:-

- (1) Schedule of training course;
- (2) Objectives;
- (3) Syllabus;
- (4) Format of course;
- (5) Training facilities required or to be provided;
- (6) List of training materials and documentation;
- (7) Examination procedures;
- (8) Training Instructors' qualifications; and
- (9) Course evaluation methods.

The Contractor shall make full and appropriate use of multi-media and computer techniques in the design and delivery of training packages. This shall include all necessary teaching aids as well as technical literature, manuals, photographs, drawings, video and films, models and all other instructional materials as may be necessary for the training of the personnel. Such materials, other than videos, films and reproducible materials prepared specifically for the trainees, shall be retained by the Contractor at the end of each training programme.

The Contractor shall provide all training material that shall include as a minimum:-

- Course agenda;
- Objectives;
- Lesson plans;
- Outline presentations;
- Equipment/ Software manuals.
- Training aids including that on the video film media; and
- Computer based training requirements.

9.5 Training Equipment

In general, the Contractor shall use Equipment specifically set aside for training purposes. However, he may use, for the training of the Employer's staff, subject to the agreement of the Engineer, Equipment being installed, tested or commissioned when no other such Equipment is available. The Contractor shall not use for this purpose spare parts from assemblies.

9.6 **Monitoring**

Throughout the training programmes, the Employer and the Engineer shall have free access to all training sessions to monitor the progress of the trainees and the Contractor's training instructors.

To ascertain that the objectives of the courses have been achieved, the Contractor shall set periodical theoretical and practical tests for the trainees. The results of these tests together with a report on the trainees' general attitude, ability, technical knowledge, aptitude and attendance record shall be forwarded at regular intervals to the Employer, who may also require the submission of additional reports in special cases.

Methods for monitoring progress shall include; but will not necessarily be limited to:

- (a) Theoretical tests and systems of assessment;
- (b) Practical test pieces and objective systems of assessment;
- (c) Progress reports.

Records of the progress of trainees shall be kept up-to-date and shall be made available to the Employer for examination when required.

Copies of the records of individual trainees, showing all test results and reports of progress, shall be sent to the Engineer on completion of each training course.

9.7 **Training Location and Facilities**

The training shall be carried out at such locations where the greatest benefit for trainees may be gained. This may be at places of manufacture, assembly or testing, or at such other locations as may be necessary. All places of training shall be decided subject to the Engineer's consent. Details of the facilities to be provided shall be included with the detailed training programmes submitted by the Contractor.

10 **PACKAGING AND STORAGE OF PLANT AND MATERIALS**

10.1 **Shipping and Storage**

The Contractor shall be responsible to prepare, protect and store all equipment and materials so as to safeguard them against loss or damage from repeated handling, climatic influences and all other hazards arising during shipment or storage on or off the site.

The Contractor shall provide secure and covered storage for all equipment and materials except, as otherwise agreed by the Engineer, as being suitable for open storage.

10.2 **Crating**

Each case, crate or package shall be of robust construction and suitable for the intended purpose. Packaging materials that are likely to suffer deterioration in quality as a result of exposure to environmental conditions likely to be met during transit from the factory of origin to the Site shall not be used. The contents of each case, crate or package shall be protected against the harmful effects of ingress of water by enclosing within a heavy-duty waterproof membrane, and adding a suitable desiccant substance (e.g. silica gel) to the case, crate or package.

Each case, crate or package shall be legibly and indelibly marked in large letters with the address, Contract number, 'right way up', opening points and other markings like "fragile" etc. as necessary to permit materials to be readily identified and handled during transit and when received at Site.

Each case, crate or package shall contain a comprehensive packing list showing the number, mark, size, weight and contents together with any relevant drawings. A second copy of the packing list shall be enclosed in a watertight enclosure on the outside of each case, crate or package. Distribution of additional copies of each packing list shall be in accordance with the requirements of the Engineer.

All items heavier than 100kg shall be marked on the outside of the case to show the gross and net weights, the points for slinging and where the weight is bearing.

Care shall be taken to prevent movement of equipment within containers by the provision of bracing, straps and securing bolts as necessary. Bags of loose items shall be packed in cases and shall be clearly identified by well-secured metal labels on which the quantity and name of the part and its index or catalogue number have been stamped.

Details of cases, crates, packages, containers, etc., intended to hold important or delicate items of equipment or materials shall be submitted to the Engineer for acceptance.

10.3 General Precautions

Spare parts shall be suitably packed for storage over an indefinite period without deterioration and shall be clearly identified, showing full name and part number, without any need to unwrap packaging. Electrical and other delicate items or equipment shall be cocooned.

Cable ends, cable entry points into equipment and other similar terminations and openings shall be sealed or blanked off to prevent the ingress of dirt or moisture.

Tube ends and other similar openings shall be thoroughly cleaned and then blanked off to prevent ingress of dirt or moisture. Flanged ends shall be protected by adhesive tape or jointing material covered by a properly secured wooden blank not smaller than the flange itself. Plain tube ends shall be closed off with bungs or plugs of suitable materials firmly fixed in position.

Particular care shall be taken to prevent damage to, or corrosion of, shafts and journals where they rest on timber or other supports that may contain moisture. At such points wrappings impregnated with anti-rusting compositions shall be used, of sufficient strength to resist chafing under the pressures and movements likely to occur in transit.

Care shall be taken to minimize risk of damage to ball and roller bearings and any fragile material in transit.

10.4 Packaging Procedures

All Packaging procedures shall be submitted to the Engineer for acceptance.

The Contractor shall remove all empty cases, crates, or packages from the site within (1) one week of their being emptied and dispose them off in an environment friendly manner.

11 Equipment Protection

All equipment shall be capable of short-term continuous operation, without the benefit of air conditioning or forced cooling, at the extremes of environmental conditions likely to be encountered. All equipment shall be capable of continuous operation in its normal environment and achieve its stated service life.

It is a basic requirement that the minimum of equipment shall be mounted on the line side. Any line side equipment shall be limited to essential rail connected apparatus such as track circuit termination units or point equipment. All other equipment shall in general be mounted in equipment rooms provided at each station or in easily accessible plant rooms.

Equipment and location cases shall be fully protected against the ingress of dust, water and the accumulation of moisture due to condensation.

The Contractor shall be responsible for ensuring that his equipment and systems are not adversely affected by the modified environmental conditions caused by the localised heat or vapour emissions or moisture from other adjacent equipment whether provided under the contract or otherwise.

12 Electromagnetic Protection

All equipment and systems supplied shall be able to withstand without fault, power supply surges, interference and transients as may be caused by lighting circuits, power and traction supplies, switching effects, and lightning. The Contractor shall provide anti-surge devices and any other protective devices required to fully protect the Equipment and the system against such effects.

The Contractor shall make due allowance and provision in its design for the high magnetic and electric fields likely in the vicinity of train traction and power supply systems; for the high magnetic and electric fields likely, due to high voltage (non-railway) power supply cables running parallel and near to the track and stations, and any other effects to be expected.

The Contractor shall provide shielding and filtering of Equipment so as to ensure that any conducted or radiated interference is eliminated or reduced below the level of susceptibility of other equipment or domestic or industrial appliances in the vicinity of the railway which have been designed, manufactured and operated in accordance with current recognised standards. The Contractor shall declare the emission standards proposed for use in the installation.

The emission standards shall be maintained whilst Equipment is in the normal operating state and additionally whilst being maintained or under test. For example, access doors that are normally closed but opened to permit maintenance, testing or adjustment, shall not form part of any essential electromagnetic screen.

The Contractor shall be responsible for ensuring that the operating frequency of any Equipment supplied under the Contract is compatible with any frequency used or planned for use by existing railways connecting with or adjacent to the new installation.

The system shall comply with relevant National and International standards with respect to:

- Electromagnetic compatibility;
- Corrosion protection;
- Noise criteria.

13. Maintainability

Systems shall be designed to maximize their availability during traffic hours.

Systems architecture and technology shall be such as to minimize the amount of maintenance required and to facilitate rapid fault rectification. To this end, designs shall, in general, permit and confine these activities to three levels only, namely:

First level, with all main sub-systems exchangeable on a unit or modular replacement basis.

Second level, at the Workshop for overhaul or repair of non-exchangeable items.

Third level, component repair. However, in general, equipment shall be modularised to the level where it is more economical to dispose of a faulty module than to repair it.

The location of a faulty unit or module shall, where at all feasible, be self revealing through built-in monitoring/indicating features.

The replacement of a unit or module in the field shall not require any compensating adjustment to associated equipment to secure the specified performance.

The average failure diagnostic time after arrival of maintenance personnel on site shall not exceed 15 minutes.

The average failure repair and check-out time after replacement parts are available on site shall not exceed 15 minutes or such longer period as may be agreed by the Engineer.

In consideration of the above, preference will be given to system concepts which minimize the number of failure prone equipment which may be located remote from central facilities and/or be difficult to access.

Where built-in indicators or meters are provided for maintenance or for fault location purpose, then any associated adjustments of controls shall be located so that they can be manipulated and the results observed by one person simultaneously.

Any test points or facilities for adjustments involving safety critical functions shall be protected against unauthorised access.

14. KEYS AND LOCKS

The Contractor shall provide, for all cubicles, cabinets and panels, a means of locking appropriate to the location. All locks shall conform to a system suited to meet the requirements of the Engineer.

15. MANAGEMENT OF CONFIDENTIAL INFORMATION

Systems suppliers providing software shall ensure that the programs have built-in security procedures and systems to permit management to restrict access to specific portions of the programs or operation thereof, and/or to appropriate staff levels or departments. Any attempted unauthorised access shall be arranged to be identified through an alarm system.