
Section – VIII
Employer's Requirements - General Specifications (including Appendices)

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Section – VIII

Employer's Requirements - General Specifications

1. GENERAL

- 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 Specification.
- 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.
- 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, 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”.
- 1.4 The design and supply of elements shall comply to International Specifications and Standards. Approved local standards shall also be complied wherever necessary.
- 1.5 Unless approved otherwise, all equipment and items shall be uniform throughout the Contract in order to minimise inventory of spares and the number of manufacturer interfaces. The tenderer shall constitute a competent qualified electrical team to execute the electrical Work in strict compliance to statutory rules and specifications, drawings and relevant standards.
- 1.6 Work under this contract shall be executed as given in this tender document and as required at site whether specifically shown or not. The Contractor shall carry out and complete the work under this contract in every respect in conformity with the contract documents, as per directions of and to the satisfaction of the Engineer/Employer.
- 1.7 The tenderer shall constitute a competent qualified electrical team to execute the electrical Work in strict compliance to statutory rules and specifications, drawings and relevant standards.
- 1.8 In case the work is planned to be executed through Electrical sub-Contractor, the tenderer shall assess the capabilities of the subcontractor and satisfy himself as regard to suitability, time schedule of work and quality standards of sub-contractor and furnish complete credentials viz. Willingness to quote, legal status, registration, owners /partnership, IT return, sales tax registration, past experience, solvency certificate and other information asked in ITT regarding the proposed sub-contractor/s which shall not be changed except in the cases where the change is approved by Engineer/Employer to control the quality and timely completion of work. The main bidder shall make available all the tender documents, specifications and drawings to the Sub-contractor prior to bidding to ensure quality, timely completion and understanding of work by Sub Contractors.

- 1.9 An undertaking from such sub-contractors for having received above information and related documents, having understood the Scope of Work and willing to execute the work shall be submitted at the time of submission of tender, however the employer reserves the right to reject /change the sub-contractor at any stage. Sub-contractor shall be deemed to be aware of the Site Conditions, contractual conditions, nature of work, and all the risks associated with the work. Sub-contractor shall at all times keep upon work site competent and experience person with communication and transport facility. Any instruction given to the representative shall be deemed as given to Contractor and Sub contractor.
- 1.10 No subletting by the sub-contractor shall be permitted except for specific items such as the distribution panels/board manufacture, DG set, UPS and high mast lighting subject to approval of Engineer/Employer.
2. **SCOPE OF WORK**
- 2.1 The works include the provision of all Building Services required in this contract, as specified below, for stations and also those which are not specifically excluded. The Services covered are those, which are necessary to permit the BSRP Corridor to perform its design functions in a safe and efficient manner, in compliance with the requirements of the Specifications and in accordance with modern Suburban/Metro/IR Railway practice. Equipment and Systems provided shall be compliant with the Specifications.
- 2.2 The contractor has to install the following systems in the station:
- a) Electrical Systems.
 - b) Hydraulic Systems.
 - c) Fire Detection and Protection System.
 - d) Building Management System.
 - e) Heat Ventilation and Air Conditioning Works.
- 2.3 Scope of works for Electrical, Hydraulics, Fire Protection and Detection System are detailed in Clauses 11.0, 12.0 and 13.0
- 2.4 Approved Definitive Design Documents and Construction Reference Drawings prepared by Detailed Design Consultants, approved by Engineer/Employer, shall be supplied progressively during Works. The Contractor must develop Working/Shop Drawings and documents from the above-mentioned drawings/documents, submit to Engineer/Employer for reviewing and obtain written approval of Engineer/Employer prior to construction. (Refer Clause 20 for details).
- 2.5 The contractor shall make an allowance for fire sealing of all services penetrations and gaps and liaise and coordinate with other relevant sub-contractors to ensure suitable installation.
- 2.6 Scope of works shall also include,
- 2.6.1. 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 KPWD/CPWD and contract specifications and additional specification and latest IS & BIS codes.
- 2.6.2. Establishing contractor's site office with documentation, communication and transport facility, site safety requirements, storage, material security and maintenance of the area during implementation stage for the electrical work by the Electrical Contractor/Sub-contractor.
- 2.6.3. De-mobilisation, clearing of all temporary works and facilities after completion of job.

3. PARTICULARS TO BE FURNISHED ALONG WITH TENDER

- 3.1 Tenderer and sub-contractors if any are expected to go through technical specifications, drawings and other details carefully and confirm full compliance to the same. Wherever technical specifications are not mentioned, contractor is required to follow latest national/ international standards to ensure highest quality of work.
- 3.2 In case the Tenderer finds himself unable to adhere to any of the specification/parameter, he should clearly indicate the reasons for the same in schedule of deviations with full particulars and reasons for the same and propose alternative standards as per the international practice.

4. INTENT OF SPECIFICATIONS

- 4.1 Technical specifications forming a part of this contract are intended to cover work referred above. It is not the intent to specify completely herein all aspects of design, constructional features of equipment and details of the work to be carried out, but nevertheless the intent of the specification is to ensure that the equipment and work shall conform in all respects to the relevant Bureau of Indian Standard Specifications, Codes of Practice, Indian Electricity Act, Indian Electricity Rules and other Statutory Regulations as may be applicable and to high standards of Engineer/Employer, design and workmanship. The equipment and work shall perform in continuous operation in a manner acceptable to the Engineer/Employer who will interpret the meaning of the specifications and drawings and shall have the right to reject or accept any equipment or work which in their assessment is not complete to meet the requirements of this specification and/or applicable Codes and Standards.
- 4.2 The work shall conform to all provisions of the relevant Government Legislation, Regulations and Bye- laws of the Central/Local Authorities and of any State Electricity Boards/Companies to whose system the installation is proposed to be connected. The Contractor shall give all necessary notices required under the said Acts, Regulations and/or Bye - laws.
- 4.3 The contractor shall examine the installation specifications, drawings & schedule of quantities for feasibility & safety and may suggest or ask for change required if any to provide satisfactory & safe services of the equipment designated for the station.

5. SPECIFICATIONS AND SCHEDULES

- 5.1 The technical specifications and schedule of quantities shall be considered as part of this contract and any work or materials shown in schedule and not called for in the specifications or vice versa, shall be executed as if specifically called for in both. The drawings are for the guidance of the contractor. Exact locations, distances and levels will be governed by the site conditions.
- 5.2 Special conditions of contract shall be read in conjunction with the general conditions of the contract, technical specifications, schedule of quantities, drawings and any other document forming part of this contract. For any discrepancy between the general conditions and special conditions, provisions of special conditions shall prevail. For any discrepancy between technical specifications and schedule of quantities, the most stringent shall prevail (for the purpose of Clause 5.1 above, the omission is not considered discrepancy).
- 5.3 Wherever it is mentioned in the specifications that the Contractor shall perform certain work or Provide certain facilities, it is understood that the Contractor shall do so at his own cost.

- 5.4 Where the contract technical specifications stipulate requirements in addition to those contained in the applicable Indian Standard Codes and Specifications, these additional requirements shall also be satisfied.
- 5.5 The Contractor must get acquainted with the proposed site for the works and study specifications and conditions carefully before tendering. The work shall be executed as per programme approved by the Engineer/Employer. If part of site is not available for any reason or there is some unavoidable delay in supply of materials stipulated to be supplied by the Engineer/Employer, the programme of construction shall be modified accordingly.
- 5.6 Should the tenderer wish to depart from the provisions in these technical specifications, such Departure shall be listed in a separate schedule with full particulars and reasons for the same.
- 5.7 Contractor shall get the arranged material inspected/tested as required before use and shall not move/ dispose off the material so arranged without the written permission of authorized representative of Employer.

6. **SITE CONDITIONS**

- 6.1 Tenderers, if they so desire, can, before submitting the tender, inspect the site of the work after obtaining prior approval from Engineer/Employer in order to familiarize themselves of the conditions of work prevailing at site as also quantum of statutory levies (taxes, duties etc.) applicable. No extra claim on account of lack of such knowledge shall be entertained after award of contract.
- 6.2 All equipment and work covered by this contract shall be capable of operating continuously and delivering the rated output at ambient conditions prevailing at site.

7. **STATUTORY APPROVALS**

- 7.1 Obtaining all statutory and mandatory permissions/clearances/approvals required for temporary works/contractor's establishment, from the concerned authorities to commence works at site from local authorities including BWSSB, KPTCL, BBMP, Karnataka Fire & Emergency Services, Electrical Inspectorate, etc.
- 7.2 The Contractor shall submit the required applications, drawings, etc., to the concerned statutory authorities and obtain their approval, license, permission, clearance and/or sanction. All the workmen and supervisory staff shall be qualified and certified license holders or have competency from National or internationally recognised agency empowered to issue, to carry out similar work or authority.
- 7.3 The final completion certificate shall be obtained by the Contractor from all statutory authorities to enable the Engineer/Employer to commission the equipment's/installation for utilization. The Contractor shall bear all expenditure to be incurred for getting the installations approved and obtaining the statutory approvals. The work shall not be deemed to have been completed until all the approvals etc., have been obtained by the Contractor. Fees paid by the Contractor to the statutory authorities on the name of shall be reimbursed by the Engineer/Employer on production of receipts. However, all other charges and lesioning work expenses shall be borne by the Contractor. Obtaining statutory approvals by the Contractor shall form a part of the Contractor's scope of the contract work. The Contractor shall obtain all the required statutory approvals including but not restricted to the following.

a) Electrical works

Clearance from Statutory Authorities for energizing the system after completion of work as required.

b) Fire Detection Alarm and Suppression System

Approval of fire detection alarm and suppression system layout from Local Fire Control Authorities prior to commencement of work and Clearance from Local Fire Control Authorities for energizing the systems after completion of work.

c) DG Sets

Clearance from Electrical Inspector after completion of work for energisation of the system. Permission, on behalf of Engineer/Employer, from Electric Supply Authorities to operate the DG sets. It may be noted that, the electrical installations are to be approved by the 'Electrical Inspector General' authorized by Govt. of Karnataka before energisation.

8. MATERIALS AND EQUIPMENT**8.1 Procurement of Material**

The contractor shall include the supply of entire materials in accordance with these 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. Contractor/subcontractor shall order for the approved make of material only and shall progressively forward the copy of order placed and test certificates of the material to the Engineer/Employer.

8.2 Make

All materials and equipment shall be new and of the approved make and design and as per schedule of quantities conforming to contract specifications. Employer reserve the right to choose an approved make of the material and all such rates are taken into consideration while quoting.

8.3 Samples

A list of items of materials and equipment together with samples, as required, shall be submitted to Engineer/Employer as per agreed schedule, for approval, before being used on work at least 15 days in advance. No change in samples and deviations from drawings of equipment shall be made without the written instructions of the Engineer/Employer. Approvals given by the Engineer/Employer to any samples or drawings submitted by the contractor shall not in any way exonerate the contractor from his liability to carry out the work in accordance with the terms of the contract and serving the purpose as per the standards.

8.4 Substitute Materials

Any item, which is proposed as a substitution, shall be accompanied by all technical data giving sizes, technical specifications, technical literature, particulars of materials and the manufacturer's name. At the time of the submission of proposed substitution the Contractor shall state the credit, if

any, due to the owner, in the event the substitution is approved. All changes and substitutions shall be requested in writing and approvals obtained in writing from the Engineer/Employer. However, decision of the Engineer/Employer is final and binding in this regard.

8.5 **Manufacturer's Instructions**

If manufacturers furnish specific instructions relating to the materials used in this contract covering points not specifically mentioned in this document, manufacturer's instructions shall be brought to the notice of Engineer/Employer for further instructions in the matter. Such instructions from the manufacturer shall be complied by the Contractor.

8.6 **Interchangeability**

All similar parts and/or equipment shall be interchangeable with one another.

8.7 **Material Testing**

The Engineer/Employer shall have full powers to require any material used in work to be tested by an independent agency at the Contractor's expense in order to prove its soundness and adequacy

9. **CO-ORDINATION OF WORK AT SITE**

- 9.1 The work shall have to be carried out in co-ordination and co-operation with the Building Contractor and/or any other agencies at site and shall arrange to place the conduits/inserts etc in the masonry and concrete as required, along with the progress of building works. Any hold up of the building or other works because of delay in placing the conduits/pipes/inserts etc or otherwise shall be the responsibility of the Contractor and shall make him liable for damages as may be considered and levied by the Engineer/Employer.

10. **EMPLOYER'S REQUIREMENTS**

- 10.1 The Employer's Requirements establish the overall procedures to be followed by the Contractor for works under this Contract.
- 10.2 These Employer's Requirements are divided into three sections as follows:
- a) **General:** These apply throughout the Contract. (Appendix III to General Specifications)
 - b) **Design:** These apply in respect of duties relating to the design of the Temporary and Permanent Works. (Appendix IV to General Specifications)
 - 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. (Appendix V to General Specifications)

11. **SCOPE OF ELECTRICAL WORK**

- 11.1 The Electrical & mechanical works are to be provided as described in the scope of works which includes the Design, 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 GC/PC and other documents comprising of but not restricted to description given below.
- a) Provision of (Power and Control) adequate size cables from LV Main switchboards in the Auxiliary Sub Stations (ASS) to 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 or the UPS and DG set Rooms at the ground level as required. The cables shall be Medium Voltage, Copper/Aluminium Conductor, XLPE/PVC insulated, sheathed, armoured cables of Fire Retardant-Low Smoke and Zero Halogen (FRLSZH) type, as specified and as required. Cables are to be laid in ground, cable trays, cable ladders, conduits or trunk/Race ways as required, including glanding and termination of the same with crimped sockets.

- b) Provision of Main LV Switchboards, Sub Main Switchboards, Motor Control Centers, Normal Lighting/Socket and other Distribution boards, Power Panels, Automatic Harmonic Filter Panels, Emergency Lighting Panels etc. Distribution Board with Earth leakage Circuit Breakers, Miniature Circuit Breakers for power and light distribution including metering and earthing of the same. Metering and Indication System through digital meters as specified. These shall be Medium Voltage, sheet steel clad floor/wall mounted with flush mounted switchgear including ACB, MCCB, RCBO, RCCB, MCB, ELCB's etc. with Copper bus-bars as per configurations detailed in the specifications/drawings/BOQ including metering, relays, earthing etc.
- c) Provision of plug and sockets for power points and lighting in the station areas. Internal electrical installations including wiring in the GI Conduits with copper conductor, Fire Retardant-Low Smoke and Zero Halogen (FRLSZH) wires and including switches accessories etc. for lights, fans and socket outlets including earthing of all points.
- d) Supply and laying of GI Conduits with accessories for the PA system, communication, Signaling Systems or any other systems etc. as required, including the drawing of fish wires for wiring by other agencies. Provision of Bus Trunking System/race way for connection between various system requirements
- e) Medium voltage 1100-volt grade aluminium / copper conductor XLPE/PVC insulated and sheathed armoured cables in ground and/or in cable trays including cable termination with crimped sockets and glands or cable jointing with cable jointing kits. External cabling for lighting, street lighting and landscape lighting, provision of poles, high mast lighting, earthing and including lighting fixtures with lamps and accessories complete as required.
- f) Ascertain through liaison and interface, the adequacy of power supply feeding arrangements for Lifts/Escalators/Pumps/Generator/UPS 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. Supply, erection, testing and commissioning of generator and UPS is also included in this part. Supply, erection and commissioning of pumps is included in Fire-fighting and PHE portion. The pumps shall be automatically controlled.
- g) Control wiring from various equipment and accessories to extend the status of the supply position/ equipment position including the annunciation of critical states and control of the equipment from remote.
- h) Provision of Earthing System comprising of Main Earth Bus in Auxiliary Substations, Clean Earth System and provision of Main Earth Terminals (MET). Co-ordination with Signaling

and Telecom Contractor for arrangements within the Signal & Telecom rooms and other rooms requiring Clean Earth connection. Providing earth mat and connecting the risers to MET at required locations in Ground, platform and concourse area is in the scope of work under this contract. Earthing of various system including construction of earth pits and earthing strips, complete including the lightning protection of station building.

- i) Provision of normal and emergency lighting arrangement & automatic operation in all the station areas, parking areas, fore court, bridges 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.
- j) The contract shall include the supply of entire materials in accordance with specification and the whole of the work necessary for the complete installation as set down in this specification and with the accompanying schedules and drawings. Materials and components not specifically stated in the specifications and/or bill of materials or noted on the drawings but which are necessary for satisfactory installation and operation of the scope of work.
- k) Provision of interlocks and protection schemes for the power distribution, to suit the desired operation, duly coordinated with high voltage side protections and protections of the individual equipment.
- l) Provision of control and small power supplies to various station equipment/panels.
- m) Provision of Lightning Protection System for entire structures provided at the stations.
- n) Facilitation for various Tests at site and at manufacturer's premises like, third party test, Inspection during manufacturing, Post manufacturing test, Factory Acceptance Test, Site Acceptance Test, Integrated testing and any other tests as required.
- o) Erection, Testing and Commissioning of any Electrical items which may be procured and supplied by the Employer.
- p) Supply, Erection, Testing and Commissioning of HVAC system at station operational rooms.
- q) Supply, Erection, Testing and Commissioning of UPS and DG set for backup and emergency power supply at station.
- r) Contractor for developing suitable control schemes for plants and equipment (for Electrical, Hydraulics and Fire Systems) to be supplied in this contract. Equipment supplied by E&M Contractor shall be compatible with requirements proposed BMS to be installed. E&M Contractor shall ensure compatibility and data transmission between station equipment's and BMS/SCADA system at station (If required at OCC/BCC also) shall-interface and fully comply with Modbus TCP Standard, Vendor neutral and proven industrial communication protocol.

12. **Scope of Hydraulic Works**

- 12.1 Provision of pumping arrangement for the raw water supply, Coordination of Embedded Piping, water mains within the stations, station drinking water supply, Fire - fighting and Sprinkler System together with the Jockey pump, Hydrant pump & sprinkler system pump, drain pumps etc.

- 12.2 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.
- 12.3 Provision of the feeding arrangement of various pumps from the main incoming supply provided in the pump room.
- 12.4 Provision of pipe line network with control valves and level monitors for providing automatic operation of pump room equipment's for domestic water supply and fire-fighting system.
- 12.5 All pipe work for fire-fighting system shall be installed complete with fire stopping measures at fire walls as necessary.
- 12.6 Accessories required for complete functionality of all the equipments in the entire system must be provided.
13. **Scope of Fire related Works**
- 13.1 Provision of complete Fire Suppression System in the Stations including hydrants, hose reels, sprinkler system, fire hose cabinets, fire mains, portable extinguishers and pipe line network with control valves for sprinklers and hydrants.
- 13.2 Provision of complete Fire-Detection & Alarm system including monitoring and control through a fire alarm panel at Station Control Room and at OCC through SCADA Provision of suitable type of detectors, Break glass units/Manual call points, audio and visual display devices, gas-based flooding system for LT Panels etc. This system shall have an interface for monitoring through BMS.
14. **Works excluded**
- 14.1 The following works are to be designed, supplied, installed and commissioned by other contractors with whom the Contractor shall co-ordinate regarding all interface requirements during Construction and Integrated testing stages.
- Lifts and Escalators for stations
 - Railway Electrification OHE, (25KV AC)), HV power supplies and SCADA.
 - Auxiliary substations up to the provision of bus ducts from transformer to LV Main Switchboards
 - Track work
 - Rolling Stock
 - Signalling, Telecommunications
 - Automatic Fare Collection
 - PSD
15. **Concept of power supply distribution**
- 15.1 The Power Distribution System shall provide power to various electrical loads within the stations, Ancillary Buildings, parking areas and circulating areas along the permanent way except that for Rolling stock and traction power.
- 15.2 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 specialised services through power supply isolating switches and distribution boards to all consumer

points for lighting, general purpose power, lifts, escalators, signalling and communication equipment, illuminated signages and maintenance equipment.

- 15.3 It shall be the Contractor's responsibility to interface and obtain all details from System Wide Contractors to determine power supplies and load details requirements.

15.4 **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 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 LV main Switchboard connected to the 415V outlet of the 33 kV / 415V transformers (excluding the supply of LV Main Switchboards with Tie Bus) will be in the scope of Power Supply Contractor. Similarly, the Traction Power Supplies will also be in the scope of System Wide Traction Power Supply Contractor.

The interface between the Contractor and the System Wide Contractor for Power Supply shall be the LV switchboard connected to the 415 V outlets from the two nos. of transformers in Axillary sub-stations on each station.

15.5 **Power Supplies Classification**

Power supplies to the various systems and sub-systems are classified into two categories:

- "Emergency"
- "Normal"

All the stations will have a Stand-by Diesel Generators that will auto-start on concurrent loss of supplies from the 33 kV / 415V transformers. The capacity of the stand-by generator shall be sufficient to power, equipment's defined as "Emergency" loads.

Services designated as "**Emergency**" shall be connected to battery backed UPS systems with a minimum capacity of 120 minutes. Changeover of supplies shall be automatic on loss of supply voltage from "**Normal**" power supply source. The UPS system shall prevent equipment's deemed as "Emergency" from any perturbations in supply on changeover or loss of supplies.

Services designated as "**Normal**" shall be provided with dual supplies from the respective 33kV / 415V transformers with automatic changeover system but will not be connected to UPS and DG. In the event of the loss of supply from one 33 kV / 415V transformers, loads need be automatically transferred to the other 33 kV / 415V transformers at Auxiliary Substation of that station. The Loads designated as "Normal" will remain off in case of power failure of both the transformers.

15.6 **Service Categories**

15.6.1. **Emergency Services:**

- Fire detection and alarm system.
- Security systems
- Emergency illuminated signs, exits, etc.
- Emergency lighting at station
- Control circuits
- Air conditioning for equipment rooms, if required for continuous operation
- Any additional UPS or critical elements, identified in the station design

15.6.2. **Normal Services**

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

16. **Design Considerations for 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 Engineer/Employer Design and Working Drawings.

16.1 **Water Supply Arrangement**

- 16.1.1. Stations shall be provided with water supply system for drinking water and fire-fighting system.
- 16.1.2. Stations are designed to provide water supply from existing BWSSB (Bangalore Water Supply and Sewerage Board) distribution network and are routed via water meter to underground water storage tanks from where it shall be distributed via domestic/booster pump set, through pipes running inside the station to various locations of usage.
- 16.1.3. Water Supply System at the Station consist of tanks installed below the ground level in ancillary building for meeting the requirements of domestic utilities, drinking water, station cleaning and fire storage.
- 16.1.4. 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 domestic shall be displayed at station control room.
- 16.1.5. The storage capacity of Fire Water Tank and Service Water (Domestic) Tank at the stations are designed as per NBC 2016.
- 16.1.6. The water distribution network from Underground tanks shall be provided with pipelines for Over Head Tank, drinking water outlets and fire hydrant system with routings provided to the required locations.
- 16.1.7. 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.
- 16.1.8. Status of bursting of water from sprinklers shall be relayed to station control room & OCC through SCADA.
- 16.1.9. Testing of the system shall be as per NBC. The entire pipe line system shall be hydraulically tested to a pressure of 0.5 N/mm² or twice the working pressure whichever is greater for a specified period of 48 Hours after a steady state is reached.
- 16.1.10. Provision shall be made for standby pumping arrangement for station domestic pumps, fire hydrant and sprinkler pumps together with the Jockey pumps.

17. **Design Considerations for Fire Detection & 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 Engineer/Employer Design and Working Drawings.

17.1 **Fire Detection**

- 17.1.1. The Fire Detection and Alarm System (FDA) shall consist of Fire Control Panels, Repeater Panels, Fire Detectors, Control/Monitoring Devices and Audio/Visual annunciation equipments. Fire Alarm Control Panel shall be provided at station control room and shall be enunciated at Central Control/BMS.

- 17.1.2. Approval of fire detection system layout from Local Fire Control Authorities prior to commencement of work. And Clearance from Local Fire Control Authorities for energizing the systems after completion of work.
- 17.1.3. NFPA 130 shall be used as the guiding standard for the Fire Detection and Alarm System. System shall be designed in an integrated manner in accordance with NFPA 72D, British Standards BS 5445 and BS 5839, EN 54, ISO 7240 - 1, as appropriate or other internationally recognized or local code of practice approved by the Engineer/Employer. The requirements of Bangalore Fire and Emergency Services shall be incorporated into the system. The panel will contain logic circuit indicators, controls, and alarm and signalling circuits associated with a number of Detector Heads and Call Points distributed in detection zones.
- 17.1.4. Manual Call Points will be of the break glass type or controlled reset type. MCP shall be located adjacent to all fire exits and station entries. 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. MCPs shall be located within the reach of 30 metres from any point in the Station.
- 17.1.5. Operation of any call point connected to the system shall cause the station FACP to enter the ALARM State within three seconds.
- 17.1.6. Automatic smoke and heat type fire detectors will be located in all areas. The audible alarms will be 150 mm and 200 mm self-interrupting type alarm bells.
- 17.2 Fire Suppression System**
- 17.2.1. Provision shall be made for Hydrants / hose reels, sprinklers and extinguishers. Wet fire main system shall be provided to cover the Platforms and Concourse Level. Sprinkler systems shall be provided for store rooms, Parking areas and other enclosed spaces with combustible loading.
- 17.2.2. All piping shall be in accordance with NFPA – 13, 14 & 15, fully hydraulically designed. Automatic sprinkler system shall conform to NFPA-13. Automatic Sprinkler Protection shall be provided for station concessions, storage areas, trash rooms and other similar spaces 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 switch shall be monitored by the fire detection system.
- 17.2.3. Minimum of two no. of UL listed combined fire hydrant & sprinkler's pumps, including one standby together with a pressurising jockey pump for hydrant system shall be provided. Secondary power supply will be provided for all the pumps. 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 required LPM. The jockey pump 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 powered by the standby generator in the event of a mains failure at Interlock/Interchange stations and Diesel pumps are to be provided at all Non-Interlock/Interchange stations.
- 17.2.4. Hydrants shall be mounted at platform within equipment cabinets. Hydrants shall be terminated with a landing valve. Each hydrant shall be housed in a Hose cabinet of suitable size. Internal hydrants cabinets located in public areas shall fit the niche made for it to prevent unobstructed movement of the passengers.

- 17.2.5. The Hydrant main shall be run from the Plant 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.
- 17.2.6. Hose reels shall be of non-kinking reinforced flexible tubing with an internal diameter as specified in codes. Hose reels should be 45 m in length and be manually operated. Hose reels shall be typically connected to a suitable size Ball 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.
- 17.2.7. Hose reels should be located 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 and spray of water into any recess area.
- 17.2.8. Portable fire extinguishers shall be provided as per provisions of National Building Code of India and shall have consent of Bangalore Fire and Emergency Services authorities. CO₂ extinguishers shall be installed in all electrical switch rooms, sub-stations, platform equipment cabinets, operations rooms and communications rooms ABC (dry chemical powder) Type Portable chemical and foam type extinguishers shall be provided in DG Rooms.
- 17.2.9. Inert Gas based suppression system to be provided in all LT Panels and shall meet the requirements of NFPA 2001 and Montreal Protocol. Gas based suppression system completely shall be integrated with Fire Alarm & Detection System.
18. **Building Management System**
- 18.1 Building Management System (BMS) to be provided by Designated Contractor for Electrical, Fire, Hydraulics related works. 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.
- 18.2 BMS shall enable monitoring through a station control panel on operator's desk, located at the station control room comprising mimic display, for commands and warning-cum-alarm units. The contractor shall provide suitable adjustment on his equipment to meet the requirements of BMS Sub-contractor for achieving the requisite control and monitoring regime.
- 18.3 Transmission of DATA between various equipments and the station Control Panel (including the provision of Local Sequential Controllers/PLC) will be the responsibility of the BMS Contractor. However, the Contractor must liaise with the BMS contractor regarding cables and other connections required between the equipment and the PLC/Local Sequential Controllers through suitable cableways. Cables shall be of approved make and quality as described in the specification.
- 18.4 Power Distribution System display will include the status of incomer Air circuit breakers of Main LV Panel and the voltage conditions on the bus bars from both Transformers. Transmission of these status information/DATA shall be wired to the PLC panel mounted in ASS. Contractor shall undertake wiring and terminations between his equipment and the PLC panel.

- 18.5 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.
- 18.6 E & M contractor shall ensure compatibility and data transmission between systems. 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 BMS equipment, such serial data link may be adopted with the consent of the Engineer/Employer.
- 18.7 Contractor should provide the required Cable Containment System for use of BMS Contractor, if required and instructed by Engineer/Employer.
19. **Interface**
Contractor shall ensure interface and coordination with all designated contractors concerning Mechanical and Electrical works as indicated in Appendix VI
- 19.1 **SCADA System Interface**
- 19.1.1. Interfacing between the BMS and Electrical & Mechanical equipment will require co-ordination. Contractor shall liaise with the BMS system supplier to ensure the interfacing between each system to meet the requirements of its respective specifications.
- 19.1.2. 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.
- 19.2 **Hydraulics, Fire Detection and Suppression System Interface**
- 19.2.1. **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.
- 19.2.2. **Initial Basis for Design**
During the preparation of detailed Design / Working Drawings the Contractor shall liaise with the BMS Contractor, and other Designated Contractors to determine all requirements for response and then subsequently provide the necessary facilities.
Contractor shall provide 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 to be provided for Hydraulics, Fire Detection and Protection System is given as Appendix II to General Specifications. 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.

19.2.3. **Power and Lighting Interface**

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

- Main switchboard LV incoming circuit breaker status.
- Incoming power lines (2 Nos) healthy.
- UPS Status (I/O voltage, indication, and position of bypass switch & battery voltage).
- Operation and Status of DG set, battery voltage for starting.

Alarm in case DG set has not run during the last seven days. Indicative list of BMS Alarms and Controls to be provided for Electrical Systems is given as Appendix I to General Specifications. 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.

20. **General Requirements for E & M Equipments**

20.1 **Codes, Regulations and Standards**

Unless otherwise stated, 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: 2010 - Fixed Guideway Transit Systems:

The Guides of the Chartered Institution of Building Services Engineer/Employers (CIBSE).

Acceptable Internationally recognised standards for this Contract are,

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineer/Employers
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 in Technical Specifications, Contractor may use applicable Standards or Codes from the above list with the approval of Engineer/Employer.

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

Indian Electricity Rules
 Indian Electricity Act
 National Building Code
 Chief Inspector (Electrical) Govt. of Karnataka
 Central Pollution Control Board
 Bangalore Fire and Emergency Services
 Karnataka State Public Works Department
 Central Public Works Department
 Bangalore Electric Supply Company (BESCOM)
 Chief Electrical Inspector General for
 Bangalore Civic Administration
 Bruhat Bengaluru Mahanagar Palike (BBMP)
 National Safety Council

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.

20.3 **Voltage Levels**

- 20.3.1. Voltage level for power equipment shall be 415V, 3-phase or 240V, 1-phase, as required.
 20.3.2. 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.

20.4 **Acoustic Criteria**

- 20.4.1. 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.

- 20.4.2. 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
 - DG Set

20.5 **Certification of Personnel & Work**

- 20.5.1. Contractor should possess valid Electrical Contractor License (Grade-A or Class-1) issued by State Licensing Board, Government of Karnataka.
- 20.5.2. All the workmen & supervisory staff shall be qualified and certified license holders or have competence certificate from nationally / internationally recognized agency empowered to issue certificate for carrying out similar work.
- 20.5.3. 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.
- 20.5.4. Contractor shall be responsible for including all safety aspects in his protection schemes etc. correct installation, testing & commissioning.
- 20.5.5. Contractor shall obtain prior approval for energisation from the Competent Authority in accordance with statutory regulations in force. Contractor shall list out such statutory requirements and shall issue a certificate of compliance in above respect before energisation.

20.6 **Corrosion Protection**

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.

20.7 **Vibration Isolation**

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.

20.8 **Equipment Mounting**

- 20.8.1. 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.
- 20.8.2. Wherever pipe work passes through brick, block or concrete walls or floors, pipe sleeves are to be provided by the Contractor. Pipe sleeves are to be of the same material as the pipe work. Split sleeves shall not be permitted. The space between pipe work and sleeve shall be filled with an approved sealant. The sealant shall be of adequate fire rating to meet the fire rating of the wall or floor. Back plates comprising ring flanges shall be fitted over all pipes emerging through walls, floors or partitions and fixed back to the surface. Material and finish shall match the pipe work in the space. Pipe work must be dismantled if rings are omitted at installation stage.
- 20.8.3. 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.

20.9 Maintainability

- 20.9.1. 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.
- 20.9.2. 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.
- 20.9.3. Control system schematic diagrams shall be displayed in the vicinity of all control panels.
- 20.9.4. Piping system schematic diagrams shall be displayed in each plant room.

20.10 Equipment Identification

- 20.10.1. Equipment, control devices, valves and piping systems shall be permanently labelled 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.
- 20.10.2. Each part 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.
- 20.10.3. Each equipment number shall be preceded by a letter designation as follows:

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

- 20.10.4. Switchboards, cables, equipment, components and all other electrical equipment shall be rated for operation in ambient temperatures of 45°C and humidity up to 75%. Suitable derating factor may be used in selection of equipment, if equipment is not designed for these conditions.
- 20.10.5. 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.
- 20.10.6. Wherever any form of cable containment passes through a fire rated wall or floor, then suitable fire stopping to provide the same level of fire integrity as the wall or floor shall be provided, after the installation of all cables. The choice of fire stopping material shall allow for easy removal and adjustment of the space to allow cables to be removed or added during the lifetime of the buildings

without affecting the overall performance of the fire stopping material when reinstated. The fire stopping material shall be compatible with the type of cables installed through the fire barrier and due allowance shall be made in the cable calculations for any required correction factors due to the type of material used.

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

Main Switch Boards	30 Years
Transformers	30 Years
Sub-Main Switchboards	30 Years
Cables	30 Years
Luminaires	20 Years
Tray, Trunking and Supports	30 Years
Lightning Protection	30 Years
Sub-Assemblies and Components	30 Years
Other Equipment	Minimum 20 Years

21. **Functional Requirements of Fire and Hydraulics Systems**

21.1 **Functional Requirements for Pumping installations**

- 21.1.1. 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 overhead tanks.
- 21.1.2. The pumping installation shall withstand the corrosive effects of normal water supply and serve for the anticipated life of the equipment. The discharge velocity for drain pumping shall not be less than 0.75 m/sec.
- 21.1.3. 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.
- 21.1.4. The pumps shall have 100% 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.

21.2 **Functional Requirements for Fire Protection System**

- 21.2.1. Fire Protection has been provided in accordance with the NFPA 130 and other related NFPA, BS, NBC and EN Standards within the stations and service buildings and shall comply with the requirements of Bangalore Fire and Emergency Service Regulations.
- 21.2.2. Contractor shall be responsible for the provision of the complete installation including but not necessarily limited to feeder supply storage tanks, fire pumps, and sprinklers, other suppression systems including hydrant systems, pipe work, valves, brackets, fittings and sleeves.
- 21.2.3. 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 system, local fire alarms, smoke detectors and Audio-Visual annunciators.

22. **DRAWINGS & OTHER DOCUMENTS**

- 22.1 Working drawings and Particulars to be furnished by the Contractor before Commencement of Work the Contractors shall submit three sets of following drawings and technical particulars for approval of Engineer/Employer before commencement of work at site/fabrication at manufacturer's work. The

mode of submission and procedure for incorporations of comments by Engineer/Employer on such drawings, resubmission and final approval shall be as finalised at site by the Engineer/Employer.

22.1.1. **Electrical works**

1. Conduit layout for lights, fans, socket outlets and sub-mains showing size of conduit, number and size of wires in each run, location and size of accessories like junction boxes, ceiling boxes, fan hooks, draw boxes, switch boxes, bends, size and route of earth continuity conductor, mode of fixing fittings and fixtures etc.
2. GA and schematic drawings of MV Switchboards/Distribution boards prepared by the manufacturer showing name of the manufacturer, material and size of sheet steel/bus-bars/interconnections and makes and ratings of switchgear including details of protection, metering, indication, interlocks and foundation details etc.
3. Index and marking schedule for cabling, wiring and earthing including the identification tags, markers and painting of values.

22.1.2. **Fire Detection Works**

1. Layout drawings showing details of detectors, response indicator units, local and main control units, speakers, amplifiers and fire control room etc.
2. Conduit layout for all components of fire detection and PA systems.
3. Details of fire detection cable routing showing size, type, and number of cables and mode of installations.
4. GA and schematic diagram of main control panel, amplifier racks etc.
5. Approval of concerned authority as required of layout/working drawing prior to commencement of works.

22.1.3. **DG Sets**

1. Fully dimensioned layout and sectional drawings of DG sets and associated accessories in the plant room, based on actual dimensions.
2. GA and schematic drawings of AMF panel including manufacturing details, makes of Components, details of cabling and earthing etc.
3. Details of civil works including fully dimensioned drawings of foundations with sections for D.G sets, floor trenches for pipes and cables, cut-outs for exhaust pipes, fuel piping etc.
4. Fully dimensioned drawings of piping layouts with support details for exhaust, raw water cooling and fuel systems and all associated ancillary works.

22.1.4. **UPS**

Fully dimensional layout and other schematic, cabling, earthing, control and protection drawings including manufacturing, fixing, foundation and installation details etc.

22.1.5. **High Mast lighting**

Fully dimensional layout and other schematic, cabling, earthing, control and protection drawings including manufacturing, fixing, foundation and installation details etc.

22.2 **Manuals, As Built Drawings and Other Documents**

22.2.1. **Manuals**

The contractor shall provide/produce 5 copies of manuals in bound term as approved by the Employer for all Contractor-supplied equipment and systems. These would typically include the following:

a) System Manuals

A comprehensive description of all system principles at block diagram level giving details regarding power distribution and protection scheme.

b) User Manuals

Broken down into as many sub-sections as may be necessary and providing sufficient information to enable non-technical staff to fully exploit the facilities of each system.

c) Workshop Manuals

Installation and circuit descriptions, full schematics, circuits, wiring diagrams, mechanical construction drawings and itemized parts list to enable all maintenance rectification and setting-up to be carried out.

d) Equipment Room Manuals

All wiring diagrams and circuits, protection scheme, equipment layout, terminal and cable listing and including such external equipment as may be necessary for completeness.

e) Maintenance and Servicing Manuals

To specify procedures and servicing intervals for planned preventive/condition maintenance and in addition to convey sufficient information on equipment principles and practice to enable first line fault diagnosis and rectification by technician staff.

f) Commissioning Test procedures and Test Values

Shall cover commissioning test procedures for all the equipment and the final test values of the equipment on load, without load, protective earthing and avoid surprised failures.

g) Condition Monitoring Manual

Shall cover the condition monitoring procedures, yardsticks, equipment wise condition norms etc. to facilitate monitoring of equipment and avoid surprised failures.

22.2.2. The User Manuals and the Maintenance and Servicing Manuals shall be prepared in both English and Kannada Languages. Other technical manuals shall be supplied in the English language only.

22.2.3. Contractor shall submit all Manuals for review by the Engineer/Employer prior to factory acceptance tests and the Contractor provide 3 copies of all Manuals well in advance and explain so as to understand the manuals by the user prior to commissioning.

22.3 Other documents

The Contractors shall supply three sets of hard copies of the following after completion of work: Work shall not be deemed complete till this requirement is satisfactorily complied with. Two reproducible copies of such drawings shall also be submitted separately.

22.3.1. Electrical works

a) As built conduit layouts for lights, fans, socket outlets and sub-mains showing sizes of conduits, numbers and sizes of wires in each run, locations and sizes of accessories like junction boxes, ceiling boxes, fan hooks, draw boxes, switch boxes, bends, sizes and routes of each continuity conductor etc.

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- b) As built layout of lights, fans, socket outlets, switch boards, rising mains, bus ducts external lighting etc.
 - c) As built details of cable routing drawings showing size, type and number of cables and mode of installation including wiring index plan.
 - d) As built details of earth pits and earthing conductors with markings and earth resistance values.
 - e) As built GA and schematic drawings of MV panels, distribution boards, rising mains, bus ducts etc. showing material and size of sheet steel/bus bars/inter connections and make and rating of switch gear including details of protection, metering, indication and interlocks etc. In addition to this, laminated diagram, interlocking schematic etc for LV Switch Boards and DB's, shall be pasted on inner side.
 - f) Results of commissioning test like insulation resistance, earth resistance, polarity, earth continuity and other tests as required and specified. The contractor shall be required to carry out all tests required as per specifications with his own equipment and at his own cost and in case the tests results are not within permissible values, take necessary remedial action at his cost to bring them to desired levels.
 - g) Technical literature and test certificates as required together with field test results and manufacturers test certificates.

22.3.2. **Fire Detection**

- a) As built layout drawings showing details of detectors, speakers, MCB's, MCP, amplifiers, fire control room etc.
- b) As built conduit and cabling drawings for all components of fire detection and PA system
- c) As built GA and schematic drawings of MCP, amplifier racks etc.
- d) Technical literature, test certificates and operation and maintenance manuals as required.

22.3.3. **DG Sets**

- a) Technical literature and Operation and Maintenance manuals for D.G Sets and auxiliaries.
- b) DG Logic Control Panel schematic and circuit drawings.
- c) As built completion drawings of the installation at site. These drawings shall include but not limited to the approved shop drawings duly amended to indicate as built parameters.
- d) A list of recommended spare parts with catalogue numbers to facilitate procurement.

22.3.4. **UPS**

As built fully dimensional layout, schematic and shop drawings, cabling, earthing, control and protection drawings including manufacturing, fixing, foundation and installation details etc.

22.3.5. **High mast lighting**

As built fully dimensional layout, schematic and shop drawings, cabling, earthing, control and protection drawings including manufacturing, fixing, foundation and installation details etc.

22.4 **Test Certificates**

Contractor shall furnish 3 copies (bound, as approved by the Engineer/Employer) of certificates for the type-tests, routine-tests as per the relevant Standard Specification for every equipment component/ fitting either at the manufacturer's works or in a laboratory approved by the Engineer/Employer, and the cost thereof shall be borne by the Contractor. Test certificates of

successful prototype tests shall be furnished within a month of completion of the prototype test and routine test certificates after passing of the equipment/ component/ fitting by the Engineer/Employer on inspection.

23. SAFETY AUTHORITY

23.1 The Contractor shall note that the Commissioner for Metro/Railway Safety (CRS/CMRS), a Government of India Statutory Safety Authority, may inspect the Works from time to time for the purpose of determining whether the BSRP Corridor Project complies with the operational and infra structural safety stipulations in accordance with the Laws of India. The Contractor shall note that CRS/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 CRS/CMRS in terms of design and quality of construction and shall assist the representatives of CRS/CMRS in carrying out their inspection duties and also comply with their instructions regarding rectifying any defects and making good any deficiencies.

24. SAFETY REGULATIONS

24.1 The Contractors shall, at his own expense, arrange for safety provisions as per safety codes of Indian Standards Institution, Indian Electricity Act and such other Rules, Regulations and Laws as may be applicable, as indicated below, in respect of all labour, directly or indirectly employed in the work for performance of the Contractors' part of this agreement.

24.2 While the Indian Electricity Rules 1956, as amended up to date, are to be followed in their entirety, particular attention is drawn to the variation clauses indicated in Appendix 'C'. Any installation or portion of installation which does not comply with these rules should be rectified immediately.

24.3 It shall be ensured that the control switches and distribution boards are duly marked, the distribution diagrams of sub-stations are prominently displayed, and the sub-station premises, main switch rooms and D.B enclosure are kept clean. Particular care should be taken to prevent the sub-station being used as store for inflammable materials, broken furniture, waste materials etc.

24.4 No inflammable materials shall be stored in places other than the rooms specially constructed for this purpose in accordance with the provisions of Indian Explosives Act. If such storage is unavoidable, it should be allowed only for a short period and in addition, special precautions, such as cutting off the supply to such places at normal hours, storing materials away from wiring and switch boards, giving electric supply for a temporary period with due permission of Engineer/Employer shall be taken.

24.5 Rubber or insulating mats should be provided in front of the main switch boards or any other control equipment of medium voltage and above.

24.6 Protective and safety equipments such as portable fire extinguishers rubber gauntlets or gloves, earthing rods, line men's belt, portable artificial respiration apparatus etc. should be provided in easily identifiable locations. Where electric welding or such other nature of work is undertaken, goggles shall also be provided.

24.7 Necessary number of caution boards such as "Man on Line, don't switch on" should be readily available in easily identifiable locations.

24.8 Standard first aid boxes containing materials as prescribed by the St. John Ambulance Brigade or Indian Red Cross should be provided in easily identifiable locations and should be readily available.

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- 24.9 Periodical examination of the first aid facilities and protective and safety equipments provided shall be undertaken and proper records shall be maintained for their adequacy and effectiveness.
- 24.10 Charts (one in English and one in regional language) displaying methods of giving artificial respiration to any recipient of electrical shock shall be prominently displayed at appropriate places.
- 24.11 A chart containing the names, addresses and telephone numbers of nearest authorized medical practitioners, hospitals, Fire Brigade and also of the officers in charge shall be displayed prominently along with the First Aid Box.
- 24.12 Steps to train supervisory and authorized persons of the Engineer/Employer staff in the First aid Practices, including various methods of artificial respiration with the help of local authorities such as Fire Brigade, St. John's Ambulance Brigade, Indian Red Cross or other recognized institutions equipped to impart such training shall be taken, as prompt rendering of artificial respiration can save life at time of electric shock.
- 24.13 All new recruits should be given such First Aid Training immediately after appointment.
- 24.14 All supervisory and authorized persons of the Engineer/Employer staff should be deputed for refresher course in First Aid Training periodically.
- 24.15 Electrical wiring and control switches should be periodically inspected and any defective wiring, broken parts of switches which will expose live parts, should be replaced immediately to make the installations safe.
- 24.16 No work shall be undertaken on live installations, or on installations which could be "energized" unless dedicated trained person is present to immediately isolate the electric supply in case of any accident and to render first aid, if necessary.
- 24.17 No work on live L.T. bus bar or pedestal switchboards should be handled by a person below the rank of a licensed Wireman and such a work should preferably be done in the presence of the Contractor's Engineer/Employer.
- 24.18 When working on or near live installations, suitably insulated tools should be used, and special care should be taken to see that those tools accidentally do not drop on live terminals causing shock or dead short.
- 24.19 The Electrical Switchgear and distributions boards should be clearly marked to indicate the area being controlled by them.
- 24.20 Before starting any work on the existing installation, it should be ensured that the electric supply to that portion in which the work is undertaken is preferably cut off. Precaution like displaying "Men at Work" cautions boards on the controlling switches, removing fuse carrier " from theses switches and these fuse carriers being kept with the person working on the installation, etc. should be taken against accidental energization. "Permit to Work" should, be obtained from the Engineer/Employer. No work on H.T. main should be undertaken unless it is made dead and discharged to earth with an earthing lead of appropriate size. The discharge operation shall be repeated several times and the installation connected to earth positively before any work is started.
- 24.21 Before energizing an installation after the work is completed, it should be ensured that all tools have been removed and accounted, no person is present inside any enclosure of the switch board etc. any earthing connection made for doing the work has been removed, "Permit to Work" is received

back duly signed by the person to whom it was issued in token of having completed the work and the installation being ready for re-energizing and "Men at Work" caution boards removed.

- 24.22 In case of electrical accidents and shock, the electrical installation on which the accident occurred should be switched off immediately and the affected person should be immediately removed from the live installation by pulling him with the help of his coat, shirt, wooden rod, broom handle or with dry cloth or paper. He should be removed from the place of accident to a nearby safe place and artificial respiration continuously given as contained in BIS. Code and Standard prescribed by St. John Ambulance Brigade or Fire Brigade.
- 24.23 While artificial respiration on the affected person is started immediately, help of Fire Brigade and Medical Practitioner should be called for an artificial respiration should be continued uninterrupted until he recovers or medical help is availed.
- 24.24 These instructions should be explained in English & Kannada.

25. **CLEANING, FINAL PAINTING AND MARKING**

- 25.1 All exposed steel work not actually embedded shall be painted as instructed. The Contractor shall be required to clean all equipment under erection as well as the work area and site at regular intervals to the satisfaction of the Engineer/Employer. In case the cleaning is not up to the satisfaction of the Engineer/Employer the same shall be got done at the Contractor's cost by the Engineer/Employer.

25.2 **Stage of Debris at Site**

Debris and wastes like cable cut pieces, conduit pieces etc. shall be stored only in an identified and approved location at site and shall be periodically disposed, so that the site is maintained clean and tidy.

26. **WORKMANSHIP**

Good workmanship is an essential prerequisite to be complied for this work. Skilled workers under competent supervision shall carry out entire work in the most workmanlike manner by skilled workers under competent supervision.

27. **CERTIFICATION OF WORK**

- 27.1 The methodology shall be framed mutually agreed to certify the work, through checklists, standards progressively. The installations shall be checked by a quality assurance team of the contractor and approved by the Engineer/Employer.
- 27.2 The Contractor shall enlist the equipment assemblies/ sub-assemblies/ components accessories and other movable components on successful installation and commissioning of the equipment.
- 27.3 The prior approval for energisation from the competent authority shall be obtained as per the statutory regulations in force. The Contractor shall be responsible for all safety aspects included and approved.

28. **MAINTENANCE DURING DEFECTS LIABILITY PERIOD**

- 28.1 The Contractor shall maintain the entire work covered in this contract as free of cost and specified electrical work as mentioned in BOQ during the defect's liability period of 24 months.
- 28.2 Contractor shall establish an office for the purpose with communication facility so as to facilitate communication for reporting failures and liaison with maintenance staff manning at the station round the clock. Contractor shall ensure early restoration /rectification/replacement to the satisfaction of

Engineer/Employer. The Engineer/Employer in case of the delay as deem fit shall be empowered to carry out the maintenance at the risk and cost of the Contractor.

29. **TRAINING & DEMONSTRATION FOR OPERATING AND MAINTENANCE PERSONNEL**

- 29.1 The Contractor shall provide training to Operation and Maintenance staff for a period as per Employer Requirement regarding Operation and Maintenance of all equipments and systems installed. All training materials required for the intended training should be supplied by the contractor.
- 29.2 Prior to final inspection or acceptance, instruct designated operating and maintenance personnel in the operation, Setting/adjustments and maintenance of all equipment and systems.
- 29.3 Explain to O&M personnel to their complete understanding, all procedures necessary to operate and maintain all equipment and systems on a continuous basis.
- 29.4 Review the contents of the O&M Manuals with O&M personnel with complete detail to explain all aspects of the Manual and the operation and maintenance of all equipment and systems.

30. **APPROVED MAKES-Refer Technical Specifications.**

The Contractor shall arrange to provide all equipment/ accessories as required for the work as per the approved list of the makes as specified in the Technical specifications unless the change is approved by the Engineer/Employer in case of non-availability or better substitute in writing as per Para 5.4 above.

31. **SITE OFFICE**

The Electrical Contractor/Sub contractor shall provide at his own cost all preliminary provisions stipulated in General Conditions of Contract and Special Conditions of Contract (all parts) as approved by the Engineer/Employer, Safety Provisions and Material stacking space. All costs for the above provisions are deemed to have been included in the bid.

32. **ORGANISATION**

The Contractor/Sub contractor shall provide at his own cost Qualified Site Engineer/Employer with minimum staff as approved by the Engineer/Employer at site and maintain an all-time team at its headquarter office for prompt liaison. Necessary details as asked in formats be furnished regarding electrical team or the sub-contractor proposed for the work

33. **TIME SCHEDULE**

It is desirable that all the electrical works are completed one month prior to the date of completion. Contractor/sub-contractor shall be liable for penalty for such delay as stipulated in General Conditions of Contract and Special Conditions of Contract (all parts).

The submittals of Contractor/sub-contractor at construction stage shall include the following but not limited to:

The Contractor shall within 15 days of award of Contract submit his time schedule, which shall be binding on him. However, employer reserves the right to amend /modify any of the dates in the interest of the work. Contractor/sub-contractor shall propose the inspection/delivery dates as per mutual agreement. However, the employer reserves the right to advise the advance date to expedite the work or modify/amend as per the employer's convenience. Contractor / Sub Contractor shall take in to account all such Considerations while quoting for offer.

Appendix I

Alarm and Controls for Electrical Systems

(This list is not exhaustive; the Contractor shall include more items as per the system requirement and also interface with BMS contractor to finalise the Input/output for BMS)

Plant Room or Local digital control (LDC)		Station Control Room		OCC / SCADA
Metering / Monitoring	Operation	Status	Alarm	Remote Data
1. DG set				
Incoming HT supply to ASS 1&2 transformers OFF	Bus couplers OFF, start DG set, load breaker ON	Starting the DG set	Warning, Supply failed	D (1) warning
Start command from control panel	Start DG set with load breaker OFF, load breaker ON		-	-
Start command from Local or remote			-	-
DG set running		ON (OFF)	-	-
Incoming HT supply to ASS transformers ON	DG set OFF, Bus couplers ON		-	-
DG set failed to start or tripped			Alarm	D (1) Alarm
Hours of operation	Log at LDC	-	Not run for more than a week (Alarm)	D (1) warning
Starter battery voltage	If low Log at LDC		Warning, Maintenance required	D (1) warning
Lube oil level	If low Log at LDC			
Fuel oil level	If low Log at LDC			
Radiator water level	If low log at LDC			
Output voltage	Log at LDC	Within range, indicate on load	Alarm, if out of range	D (1) Out of range alarm
Output frequency	Log at LDC			
2. 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	-			
Second charger failed	-		Alarm, immediate attention to the UPS	D (1) Alarm
Second inverter failed	-			
Hours of operation	Log at LDC	-	-	-
Output bus voltage low		-	Alarm, manual fault attention	-
UPS failed			Alarm	D (1) Alarm

Appendix II

Alarms and Controls for Hydraulic and Fire Systems

(This list is not exhaustive; Contractor shall include more items as per the system requirement and also interface with BMS contractor to finalise the Input/output for BMS)

Plant Room or Local digital control (LDC)		Station Control Room		OCC / SCADA
Metering / Monitoring	Operation	Status	Alarm	Remote data
1. Fire Fighting Pumps (Hydrant & Sprinkler System Pumps)				
Operation of fire hose	Start the pump	Pump 1/2 ON (OFF)	Warning	D (1) warning
Hydrant main/ Sprinkler main pressure fall (major)			Hydrant/ Sprinkler pressure fall (major)	
Pump running	-		-	-
Pump failure	Start standby		First pump fail warning	D (1) warning
Standby pump fail	-		Second pump fail Alarm	D (1) Alarm
Manual bypass local or remote	-	-	-	-
Pumping completed	Alternating pumps	-	-	-
Hours of operation	Log at LDC	-	Not run for more than a week (Alarm)	D (1) warning
Voltage	Log at LDC	-	No volt warning	
Current	Log at LDC	-	-	-
Energy (power factor)	Log at LDC	-	-	-
2. Jockey pumps for Fire Fighting System (one jockey pump for fire system)				
Operation of fire hose	Start the pump	-	-	-
Hydrant main/ Sprinkler main pressure fall (minor)		-	-	-
Manual bypass local or remote			-	-
Pump running	-	ON (OFF)	-	-
Pump failed	-		Alarm	D (1) warning
Hydrant pressure	Stop pump if adequate, Log at LDC	-	Warning if low pressure	-
Hours of operation	Log at LDC	-	Not run for more than a week (Alarm)	D (1) warning
Voltage	Log at LDC	-	No volt warning	-
Current	Log at LDC	-	-	-
Energy (power factor)	Log at LDC	-	-	-
3. Standby Pumps for Fire Fighting System (Hydrant & Sprinkler System)				
Pipe pressure fall (high)	Start the pump		Warning	Warning
Manual bypass local or remote		-	-	-
Pump starting	ON (OFF)	-	Warning	D (1) warning
Pump failure		Start standby	Main pump fail warning	
Standby pump fail	-		Both pump fail Alarm	D (1) Alarm
Hours of operation	Log at LDC	-	Not run for more than a week (Alarm)	D (1) warning
Voltage	Log at LDC	-	No volt Warning	-
Current	Log at LDC	-	-	-
Energy (power factor)	Log at LDC	-	-	-

Functions	Plant Room or Local digital control (LDC)		Station Control Room		OCC / SCADA
	Metering Monitoring /	Operation	Status	Alarm	Remote data
4. Fire Detection and Alarm System					
Detector Public areas	Alarm situation	Signal at FAP	-	WARNING	D (1) warning
Detector Electric installation	Alarm situation	Release gas agent	-	WARNING	D (1) warning
Detector non-hazardous area	Alarm situation	Signal at FAP	-	WARNING	-
FACP	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 isolated / Device fault	Fault indication	ON	WARNING at fixed interval	D (1) warning
	Voltage	Log at LDC		No volt warning	-
	Maintenance Alarm	Device fault		WARNING	-
	Battery voltage	Log at LDC		WARNING	-
FACP	Detection platform in / concourse	1. Audible & visual alarm 2. Alert station staff 3. Alert line controller 4. Initiate operation of public address system 5. Initiate fire suppression system 6. Illumination of station entry sign 7. Initiate fire closure door 8. Initiate smoke extraction measures	ON	WARNING	D (1) warning
MCP	Operation of MCP	Signal at FAP	ON	WARNING	-
Sprinkler	Rise in temperature	Start pump	ON	WARNING	D (1) warning
Hydrant	Low Pressure in pipes	Start pump	ON	WARNING	

Appendix III

Employer's requirements - General

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/Employer.

"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": 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/Employer.

The Contractor shall always immediately seek advice from the Engineer/Employer 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.

1. 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/Employer / 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.

2. SPECIFICATIONS IN METRIC AND IMPERIAL UNITS

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

3. WORKS PROGRAMME

-
- (a) The Contractor shall prepare and submit his Works Programme and three-month Rolling Programme and the detailed requirements
 - (b) In compiling its Works Programme and in all subsequent updating and reporting, the Contractor shall make provision for the time required for co-ordinating and completing the testing, commissioning and integrated testing of the Works, including, inter alia, design co-ordination periods during which the Contractor shall co-ordinate its Design / Working Drawings with those of Designated Contractors, review procedures, determining and complying with the requirements of all Government Departments and all others whose consent, permission, authority or licence is required prior to the execution of any work.

4. **MONITORING OF PROGRESS**

Contractor shall submit to the Engineer/Employer in duplicate copies, Monthly Progress Report (MPR) describing the progress and current status of the Works. MPR shall address the matters set out in the Works Programme.

MPR shall be submitted by the end of each calendar month. It shall account for all works actually performed from twenty sixth day of the last month and up to twenty fifth day of the current month.

It shall cover progress and current status relating to construction.

A fortnightly meeting to monitor the progress of the project shall be convened by the Engineer/Employer. Contractor's site Incharge and site Incharges of all interfacing Contractors may also attend the meeting. Engineer/Employer shall also be present in the meeting.

5. **QUALITY ASSURANCE**

Contractor shall establish and maintain a Quality Assurance System for design as well as construction and the interfaces between them.

6. **CO-ORDINATION WITH DESIGNATED AND OTHER CONTRACTORS**

General

1. 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. 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/Employer 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/Employer 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/Employer 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/Employer 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/Employer 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/Employer. 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

1. Contractor shall establish a dedicated co-ordination team, led by a Chief Co-ordinator in Bangalore reporting to the Contractor's Site Incharge. The primary function of the team is to provide a vital link between the Contractor's construction teams and the Interfacing Contractors.
2. 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.
3. 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.
4. 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 around document to obtain design and programme data. Turn around document shall be issued to the Interfacing Contractors to be returned giving the current positions on their programme.

Construction Interface

1. 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.
2. 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/Employer or in such revised order as may be requested by the Engineer/Employer 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.
3. 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.

7. SURVEY AND SITE INVESTIGATIONS

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

Appendix IV

Employer's requirements - Design

1. INTRODUCTION

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

2. REQUIREMENTS DURING CONSTRUCTION PHASE

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 Engineer/Employer from the Definitive Design Documents supplied by the Contractor, 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. 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. 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/Employer to illustrate and describe the Permanent Works.
5. Contractor shall maintain all records necessary for the preparation of As-Built Drawings. Upon completion of the Works or at such time as agreed to or required by the Engineer/Employer, Contractor shall prepare drawings which subject to the Engineer/Employer's agreement shall become the As-Built Drawings. 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. 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/Employer, 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/Employer so

requires, the endorsed original shall be submitted to the Engineer/Employer 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/Employer, 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/Employer 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. Contractor shall finalise details of the proposed method of construction and submit such finalised details to the Engineer/Employer 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/Employer for agreement.

4. DESIGN SUBMISSIONS - REVIEW PROCEDURES

1. Submissions of Design Data shall be made to and reviewed by the Engineer/Employer. 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/Employer 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. 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. 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/Employer's decisions should be made;
 - (c) Make adequate allowance for periods of time for review by the Engineer/Employer 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. Contractor shall submit the Design Submission Programme to the Engineer/Employer 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/Employer, calculations relevant to the Working Drawings shall be submitted for review with the respective Design Packages or Submissions. The Engineer/Employer 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. Contractor shall prepare and submit a comprehensive set of calculations in a form acceptable to the Engineer/Employer. 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. Contractor shall submit all calculations necessary to support proposals relating to the construction methods.

7. DOCUMENT REQUIREMENTS

1. Drawings shall be prepared generally to A1 size and to ISO AO size where appropriate.
2. Contractor shall submit 3 copies of his design and / or drawings for review by the Engineer/Employer. After receipt of "No Objection" from the Engineer/Employer' or his representative, the Contractor shall submit 3 copies of design and / or drawing for the use of the Engineer/Employer.

Appendix V**Employer's requirements - Manufacture, 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.

1.0 MANUFACTURING**1.1 Management**

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. Contractor's Manufacturing Management Plan shall be submitted to the Engineer/Employer for his review within 45 days of the Date of Commencement.

1.2 Procurement Management

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. Contractor's management system shall be auditable for materials sources, lot numbers, serialised equipment, etc.

1.3 Manufacturing and Production Management

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. Contractor shall submit manufacturing data as part of the Manufacturing Management Plan, which shall contain:

- A brief description of all inspection holds points and test points, and a correlation with the Programme Schedule;
- GAD, QAP and GTP shall be approved by Engineer/Employer prior to commencement of Manufacturing.
- 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 tender 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 compliance 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

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

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

Contractor's Manufacturing Management Plan shall provide for adequate work and inspection instructions for handling, shipping, storage, preserving, 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.

2.1. INSTALLATION**2.2. 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. Contractor shall submit the Plan for the review by the Engineer/Employer at least 30 days prior to the start of Installation on Site.

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

2.3. Method Statement

The Method Statement shall be submitted to the Engineer/Employer 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/Employer's consent three 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. 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/Employer and installation and testing shall be carried out according to approved ITP.

2.4. **Contractor's Resident Staff**

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.

Contractor's Representative shall have sufficient authority to progress the Contractor's work on Site. 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.

2.5. **Drawings and Records**

a) **General**

Contractor shall provide 3 copies of all drawings in A1/A3 size, bound into circuit books.

- 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.

b) Cable Records

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.

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/Employer for overall co-ordination.

2.6. 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/Employer, 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/Employer 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/Employer 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/Employer. The samples shall be used as a means of comparison, which the Engineer/Employer 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.

2.7. TESTING AND COMMISSIONING**2.7.1. General**

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 CRS/CMRS and a period for staff training and familiarization

2.7.2. Test Programmes and Procedures

Unless agreed in writing by the Engineer/Employer, 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.

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/Employer 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. 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/Employer's visit shall be borne by the Employer.

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.

2.7.3. **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.

2.7.3.1. **Type Tests**

Unless agreed otherwise, type tests certificates from an accredited laboratory acceptable to Engineer/Employer 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/Employer. Contractor shall identify in his tender 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 Factory Acceptance Test (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.

2.7.3.2. 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/Employer'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/Employer at least 30 days in advance of carrying out any such Test. Engineer/Employer will then determine which, items if any, may be accepted based on previous supply or experience. Factory Acceptance Test (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/Employer 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 also include, verification of software used in such application.

2.7.3.3. Installation Tests

2.7.3.3.1. Prerequisites for Installation

Prior to installation, 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/Employer for review prior to Installation.

2.7.3.3.2. Inspection

The inspection shall verify that equipment has been installed as per the procedures and design that have been reviewed and consented by the Engineer/Employer 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.

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.

2.7.3.3.3. Installation Tests

Installation tests shall be carried out by the Contractor for each sub-system 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, 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.

2.7.3.4. Partial Acceptance Tests (PAT)

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

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

2.7.3.5. 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.

2.7.3.6. Integration Tests

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

Following satisfactory completion of these Tests, Contractor shall prepare the installation for formal demonstration in the presence of the Engineer/Employer.

2.7.3.7. System Acceptance Tests (SAT)

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

2.7.3.7.1. 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/Employer for review.
- All PAT shall be completed and test records submitted to the Engineer/Employer 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/Employer for review at least 30 days before the commencement of the SAT.

2.7.3.8. Integrated System Tests.

- a) Before the commencement of integrated tests, the contractor shall complete his own internal tests. The contractor shall submit list of specifications for integrated tests to the Engineer/Employer for accordance approval prior to commencement of the tests.
- b) Contractor shall submit to the Engineer/Employer 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.

2.7.4. Batches, Samples and Specimens

- 2.7.4.1. 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/Employer there is sufficient proof that the other specified conditions applying to the batch apply to all of the material delivered over this period.
- 2.7.4.2. 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.
- 2.7.4.3. A specimen is the portion of a sample that is to be tested.
- 2.7.4.4. Samples shall be of sufficient size and in accordance with relevant Standards to carry out all specified tests.
- 2.7.4.5. Samples taken on the Site shall be selected by, and taken in the presence of, the Engineer/Employer 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/Employer.
- 2.7.4.6. 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.

2.7.4.7. Samples shall be delivered by the Contractor, under the supervision of the Engineer/Employer, 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/Employer.

2.7.4.8. 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.

2.7.4.9. Additional samples shall be provided for testing if in the opinion of the Engineer/Employer:

- 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/Employer and/or his authorised representative.

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

2.7.5. **Testing**

2.7.5.1. 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/Employer. Where the laboratory is not appropriately equipped and/or staffed for some tests, or if agreed to by the Engineer/Employer, 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/Employer; and
- (b) Particulars of the proposed laboratory are submitted to the Engineer/Employer for his consent.

2.7.5.2. In-situ tests shall be done in the presence of the Engineer/Employer.

2.7.5.3. Equipment, apparatus and materials for in-situ tests and laboratory compliance tests to be carried out 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/Employer. 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.

2.7.5.4. 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 2.4.3.1 above and particulars of the laboratory proposed should be submitted to the Engineer/Employer for consent prior to the testing.

2.7.5.5. Attendance during tests including that by the Engineer/Employer, the Contractor and the Designer shall be as laid down in the Quality Assurance procedures.

2.7.6. **Compliance of Batch.**

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- 2.7.6.1. The results of tests on samples or specimens shall be considered to represent the whole batch from which the sample was taken.
- 2.7.6.2. A batch shall be considered as complying with the specified requirements for a material if the results of specific tests for the specified equipment comply with the specified requirements of the equipment.
- 2.7.6.3. If additional tests are permitted or required by the Engineer/Employer but separate compliance criteria for the additional tests are not stated in the Contract, the Engineer/Employer 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 equipment.

2.7.7. 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/Employer 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.

2.7.8. Testing, Commissioning & Validation

2.7.8.1 Testing, Commissioning and Validation Plan

The Contractor shall be required to submit the Testing and Commissioning Plan which shall include a schedule of tests with the identified standards to which the tests are to be carried out. The Contractor shall update the Plan as necessary. The Plan shall include the following:

- a) A detailed description of the testing and commissioning philosophy and the testing & commissioning process including the demonstration of a successful interfaces with other systems.
- b) Details of the testing & commissioning organization to be set up by the Contractor, including staff responsible for testing & commissioning activities.
- c) Descriptions of methods and procedures for testing & commissioning, procedure for the set up of all test equipment with necessary supporting documentation.
- d) Details of the testing & commissioning schedule, management and coordination requirements.
- e) Details of how safety shall be addressed for all personnel and equipment during testing and commissioning.
- f) Details of all testing & commissioning standards and guidelines that the Contractor shall follow.

The Contractor shall submit test specifications for all tests including integrated tests to the Engineer/Employer for acceptance prior to the commencement of the tests.

The Contractor shall perform testing and commissioning of all the fire protection system.

The Contractor shall provide all necessary facilities, labours, instruments, materials, inert gas, fuel and power to carry out such testing and commissioning to verify and validate that the installation meets the requirements.

2.7.8.2 Hydrostatic Test

All hydrostatic tests shall be conducted for a period of 48 at two (2) times the specified working pressure. The Contractor shall record all test figures together with schedules of pipe lengths and shall note that testing will be witnessed by the Engineer/Employer. A pressure drop of not more than 3% after 48 hours will be acceptable.

2.7.8.3 Tests of Acoustic and Vibration

- a) Sound level readings and vibration tests shall be conducted in DG, fan and pump rooms during construction of the works and at any other time as desired by the Engineer/Employer.
- b) Sound level readings shall be taken with correctly calibrated octave band sound level meter at designated spaces as desired by the Engineer/Employer.

2.7.8.4 Electrical Test

The following tests shall be carried out to the satisfaction of Engineer/Employer:

1) Verification of polarity

To ensure that all fuses and single pole control devices are connected to the live conductor only.

2) Insulation resistance tests

Insulation resistance tests shall be carried out at 240V single phase and at 415V three phase circuits for:

- i) Line to line
- ii) Line to earth
- iii) Neutral to Earth
- iv) Line to Neutral

3) Earth Continuity Test

- 4) The test shall be carried out by means of a line-earth loop test or neutral earth-loop test in accordance with IEE regulations

- 5) Battery capacity of the FDA system shall be tested by tripping the AC supply (normal and emergency) and by setting the entire system under alarm condition. Time period for which the battery can support the system shall be recorded.

2.7.8.5 Test at Manufacturer's Factory and On Site

The tests at Manufacturer's factory shall include all tests in accordance with the relevant standards and any tests called for by the Engineer/Employer to ensure that the Plant being supplied meets the requirements of the Specification. For material / equipment not covered by any standard or

specifically mentioned in this Specification, the tests shall be done as agreed by the Engineer/Employer.

The Contractor shall supply and install all materials, supplies, labour and equipment/instrument required for testing at site. The Contractor shall make preliminary tests and prove the Works as satisfactory. The Contractor shall notify the Engineer/Employer well in advance to be present for final testing of all materials / equipment. The Contractor shall replace defective Works with new Works for defects identified/disclosed by tests or, if required by the Engineer/Employer. The Contractor shall conduct tests in stages if so, directed by the Engineer/Employer to facilitate work of others.

For all pipe work, all necessary testing junctions and bends shall be supplied & installed and sealed off or removed as directed by the Engineer/Employer.

2.7.8.6 Site Tests during Construction

- a) The pressure tests shall be carried out on site in convenient sections during the construction of the Works.
- b) Before the tests are carried out, the Contractor shall remove connected equipment and components which are liable to be damaged under test, and shall provide and fix all necessary gauges, blanking flanges etc.

2.7.8.7 Preliminary Commissioning Checks

- a) The Contractor shall ensure that all equipments are thoroughly cleaned, lubricated and checked for serviceability immediately before setting to Works. The Contractor shall pay particular attention to the removal of building debris from the pipe work systems.
- b) The Contractor shall pay special attention to the need to thoroughly flush out all pipe work systems to ensure that all foreign matters are removed.
- c) The Contractor shall inspect and check all automatic controls and safety devices for serviceability before the working fluid or electricity is applied to the system.

2.7.8.8 Commissioning

When the various installations have been completed and the preliminary commissioning checks carried out, the Contractor shall set to work, regulate and calibrate all systems in the entire installation. Special attention shall be paid to the following items:

- a) That all valves, switches and controls etc. are regulated and capable of proper operation and in the case of isolation valves that they are capable of tight shut off.
- b) That all instruments are correctly calibrated and read accuracy
- c) That all services are tested in accordance with the details in the relevant clauses of the Contract specifications and relevant standards.
- d) Pumps, pressure reducing sets, etc. shall be operated to ensure that all control systems are functioning correctly and are properly set, sequenced or interlocked.

2.7.8.9 Performance Tests

- a) After the Works have been completed, the Contractor shall be required to carry out or assist in carrying out the performance tests.
- b) Performance tests for all installations shall be carried out to demonstrate that they function in

accordance with the intent of the Contract Specification.

- c) Should the performance tests prove that the equipments do not comply with the requirements of the Contract Specification, the Contractor shall be responsible for the rectification, modification or replacement of the equipment and/or system as required by the Engineer/Employer.

2.7.8.10 Final Acceptance Tests

- a) Following commissioning of the entire installation, the Contractor shall carry out final acceptance tests in accordance with a programme to be submitted to the Engineer/Employer for Notice of Clearance.
- b) Should the results of the acceptance tests show that plant, systems and/or equipment fail to perform to the efficiencies or other performance figures as given in the Contract Specification, the Contractor shall adjust, modify and if necessary, replace the equipment without any additional cost implications to the Employer in order that the required performance be obtained
- c) Where acceptance tests are required by the relevant authorities having jurisdiction, these tests shall be carried out by the Contractor, the proposal for which shall be submitted to the Engineer/Employer for Notice of Clearance.

2.7.8.11 Integrated Testing and Commissioning (ITC)

- a) Before the commencement of integrated tests, the Contractor shall complete his own local tests. The Contractor shall submit test specifications for integrated tests to the Engineer/Employer for Notice of Clearance, prior to the commencement of the tests.
- b) The Contractor shall coordinate with the civil works and System Working Contractors in preparing an integrated system test plan to test all the points/installations. All testing tools and manpower required for the tests, which will be witnessed by the Engineer/Employer shall be provided by the respective Contractors. The integrated system test plan shall at least include:
 - 1) The scope of the integrated testing,
 - 2) The objective of the tests and the associated design and operating criteria to be proved / demonstrated,
 - 3) The pass / fail criteria of the test,
 - 4) The inter-dependency and interaction with all systems supplied and those supplied by other interfacing contractors and their integrated testing programme.
 - 5) The systems / equipment required to be completed by other interfacing Contractors for each test,
 - 6) A schematic diagram of the integrated tests in the sequence they are to be carried out,
 - 7) A narrative explaining the integrated testing process and methodology, with cross-reference to the schematic diagram,
 - 8) The write-up format explaining the test basic
 - 9) Estimated duration of the contractor's involvement in each test.

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- c) The contractor shall generate or emulate data signals for the points/installations being tested. Emulation shall be used only if real time signal generation is not possible or impracticable.
 - d) On completion of tests or test cases, both interfacing contractors shall endorse the test records for submission to the Employer. Where a failure is recorded in any test cases, the interfacing contractors shall reschedule another test regardless if where the fault or defect lies.
 - e) The contractor shall be responsible for taking the lead in conducting the ITC of Fire Alarm system, clean gas system, pre-testing the activation and re-setting the associated Fire Alarm devices and panels of the clean gas room.
 - f) Fire Alarm tests:
 - 1) Active Voice communication system.
 - 2) AMS
 - 3) AFC gates
 - 4) M&E SCADA
 - 5) ECS/HVAC
 - 6) Fire Roller Doors if any
 - 7) Lifts & Escalators
 - 8) Door Access Control systems & Security systems
 - 9) Power supply & Traction
 - 10) Signaling, Telecommunication & PSD
 - g) Clean gas test including VESDA system

The Objective of the clean gas test are to verify and validate the correct sequences and operations of the clean gas test system within a clean gas protected room in the event of fire alarm within protected area.

2.7.8.12 Integrated Factory Acceptance Test (IFAT)

The contractor shall undertake an Integrated Factory Acceptance Test which will be held in the manufacturer's factory. Such IFAT shall be done in the presence of the Employer.

A 100% input/output check simulated data may be used subject to the approval by the Employer. The contractor shall be responsible for planning, programming, coordinating, preparing, managing and executing the IFAT.

This IFAT will be the final proving of the interface design prior to onsite interface tests and commissioning. The contractor is required to coordinate and agree on the schedule of IFAT and provide input in the preparation of IFAT plan & procedures.

The contractor shall provide the Testing, Commissioning & Validation certificate after the successful installation, Testing & commissioning, Validation of the systems in accordance with the applicable standards and the contract documents.

2.8. MAINTENANCE

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

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- Operating and Maintenance Instructions which describe the procedures for operating and maintaining each item, unit / equipment and which will include all technical data for its operation, routine inspection/survey, routine maintenance, periodic overhaul, test running & procedures for removal
 - Replacement of components and test running.
 - Parts catalogue along with Pricelist and Recommended List of Spares for One Year's operation and for 10 Years of Operation after Defects, Liability Period.
 - List of Special Tools, Material Handling Equipments, Jigs and Fixtures required for dismantling & assembling and test/diagnostic equipment for Performance Monitoring/Maintenance.
 - List of M&P, T&P, Testing Instruments, Material Handling Equipments, Jigs & Fixtures etc. required for Maintenance to be submitted.
 - 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.

- 2.8.1. During the defect liability period the contractor shall maintain all the assets on the lines of a Comprehensive Maintenance Contract which will include replacement/rectification of defective equipment/component. Contractor is also required to carry out all the preventive maintenance schedules, specified by the manufacturers. The consumables required for undertaking preventive maintenance schedules shall be supplied by the contractor. The contractor shall be responsible for preventive as well as corrective maintenance. The infrastructure including T&Ps, M&P, Testing Instruments, Material Handling Equipments, Jigs & Fixtures and ladder etc. are to be arranged by the contractor for Maintenance during Defect Liability Period. Contractor shall furnish a List of M&Ps, T&Ps, Testing Instruments, Material Handling Equipments, Jigs & Fixtures, Exchange Spares, Rotational Spares, and Components and Consumables along with quantities to be kept in premises during Defects Liability Period.
- 2.8.2. Contractor shall establish an office for the purpose with communication facility so as to facilitate communication for reporting failures and liaison with maintenance staff manning Metro round the clock. The supervisor in-charge of contractor should be provided with mobile communication facility to ensure his presence at the site within 2 hours of reporting. Contractor shall ensure restoration /rectification/replacement within 4 hrs. for attending to Defects / Failures of Minor Nature and 8 hrs. For attending Defects / Failures of Major Nature to the satisfaction of Engineer/Employer. The Engineer/Employer in case of the delay as deem fit shall be empowered to carry out the maintenance at the risk and cost of the Contractor. The Contractor shall carryout Corrective Maintenance at any time during 24 hrs. X 365 days based on the occurrence of failures / breakdowns.
- 2.8.3. **The work of Full-Service Maintenance shall be carried out as follows: -**

Full-Service Maintenance of the LV System & Fire Fighting works executed by the Contractor under this contract during the Defects Liability period, during which, the Contractor shall be responsible for maintenance of the installation to achieve the Uptime stipulations including providing all consumables and spares as described hereunder. This shall be provided by the contractor at no

extra cost and is deemed to be included in the quoted rates for the installation. Consumables required for Operation System alone shall be provided by the Employer I.e. Diesel, Oil for DG Set Operation. However, Items required for Testing & Commissioning will have to be provided by the contractor.

2.8.4. ROUTINE MAINTENANCE

2.8.4.1. Submit a schedule for routine maintenance which shall include the Manufacturer's recommendations and / or common Engineer/Employer practice (for all plant and equipment). Any comment / instruction given by the Engineer/Employer - in - Charge vis - a - vis the maintenance schedule shall not absolve the contractor of his obligation to properly and fully maintain all the Systems at all times.

2.8.4.2. Plant and equipment history card shall be maintained by the Contractor which shall give full details of equipment and frequency of checks and overhaul.

2.8.4.3. Submit Weekly status report to the Engineer/Employer - in - Charge.

2.8.5. REPAIRS

All equipment that requires repairing shall be immediately serviced and repaired. All replacement parts and labour shall be supplied promptly.

2.8.6. MANPOWER

2.8.6.1. Adequate number of manpower shall be provided including relief personnel for satisfactory maintenance.

2.8.6.2. Duty allocation and Roster control shall be the contractor's responsibility but shall be subject to the approval of the Engineer/Employer - in - Charge.

2.8.6.3. The Contractor shall furnish the bio-data of all the personnel whom he proposes to deploy for the maintenance work for the approval of the Engineer/Employer - in - Charge. The Contractor shall deploy only those personnel who are approved by the Engineer/Employer - in - Charge. Such approval shall not absolve the Contractor of his obligations of proper conduct and performance of his personnel.

2.8.6.4. The Engineer/Employer - in - Charge shall have the right, without assigning any reason whatsoever, to ask the Contractor to remove from the Site any person, regardless of his having been approved earlier by the Engineer/Employer - in - Charge and replace with another suitable person approved by the Engineer/Employer - in - Charge.

2.8.7. SHUT DOWN

2.8.7.1. No routine shut downs shall be permitted.

2.8.7.2. Contractor shall carry out Preventive Maintenance during Non-Operational hours with prior permission of the Engineer/Employer - in - Charge. Corrective Maintenance to be carried out as and when failures/ defects occur any time during 24 Hrs. X 365 days.

2.9. MANUALS AND TEST CERTIFICATES

2.9.1. MANUALS

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.

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

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

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

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

2.9.2. TEST CERTIFICATES

Contractor has to carry out all type tests, acceptance tests, special tests, routine tests and commissioning tests as per IS, other codes, specifications, etc., as required by Engineer/Employer. Contractor shall furnish 3 copies (bound, as approved by the Engineer/Employer) of certificates for the type tests, routine-tests carried out as per the relevant Standard Specification for every equipment /component/ fitting either at the manufacturer's works or in a laboratory approved by the Engineer/Employer, and the cost thereof shall be borne by the Contractor. Test certificates of successful prototype tests shall be furnished within a month of completion of the prototype test and routine test certificates after passing of the equipment /component/ fitting by the Engineer/Employer Representative on inspection. The type test to be witnessed will be on the sole discretion of the Engineer/Employer.

Type tests may not be required in those cases where the Contractor can produce certified evidence that the required Type Test has been performed successfully on identical equipment and produced in a factory where the equipment to be supplied under the contract is to be manufactured, provided the Type Test has been carried out and witnessed by recruiting Test agencies. The final decision regarding acceptability and acceptance of the Type Test, certificate produced shall rest with Engineer/Employer.

- Contractor has to carry out Type Test / produce Type Tests certificates (for identical items) for all Major Equipment like, Pumps, Electric Panels, Switchgears, Cables as applicable whether

specifically mentioned in the Specifications or not. Employer has a discretion to ask for Type Testing of any Equipment (Item)/ Type Test Certificate of Identical Equipment

- Type Tests which will be witnessed by Engineer/Employer will be decided solely by the representative.
- The costs of all testing are to be included in the rates except for expenses of travel and boarding of Engineer/Employer.

Contractor has to record the Type Tests for all equipment and submit it in 3 copies to the Employer. Further, the Test certificates for Acceptance Tests, Special Tests, Routing Tests and Commissioning Tests, which will be performed in the presence of Engineer/Employer has to be submitted in 3 copies. However, this will not absolve the Contractor of the Complete System to be made functional in all respects. An Integrated Testing & Commissioning shall be done for the complete System specified.

2.10. SPARES, SPECIAL TOOLS AND TEST EQUIPMENT

2.10.1. General

During the Defects Liability Period, the Contractor shall provide free of cost all materials (Excluding consumables) unit exchange spares and emergency spares required for maintenance (routine and breakdown) of the Electrical and Mechanical Systems (E&M). Contractor shall supply the spares, materials, jigs and fixtures not later than 4 (four) weeks before the Completion Date. A list of such spares and materials required for maintenance during the Defects Liability Period (to be provided free of cost by the Contractor) are to be furnished in the tender offer.

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

2.10.2. Tools and Test Equipment

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. Contractor shall submit a schedule of all tools and equipment with details of calibration and supplier along with the tender.

2.10.3. Spares List

Contractor shall submit along **with the tender a schedule of spare parts** required for E&M system 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 Defect Liability Period) as well as for the expected life of E&M system, principal as well as secondary sources of supply and also the unit price of each spare with **Escalation clause**.

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 Defect Liability Period), 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.

The Employer may require the Contractor to enter into a Maintenance Contract with the Employer for the EMS provided under the Contract under terms and conditions to be mutually agreed.

If due to up gradation or advancement in technology any new type of model's 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.

Contractor shall:

- Submit to the Engineer/Employer 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/Employer for review the calculations and spares list.
- Submit to the Engineer/Employer a Cardex system for easy identification of spares.
- The Spares list shall:
 - Be grouped by sub-system, test equipment and special tools as applicable for stocking identification.
 - Have detailed description with drawing references and correlation with the maintenance

manuals.

2.10.4. **Second Sourcing**

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/Employer at the time of submission of the final design / working Drawings.

2.10.5. **Long Lead Times**

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

2.10.6. **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/Employer together with the routine change interval.

2.10.7. **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/Employer with the submission of the spares list, including the necessary action for disposal or storage.

2.10.8. **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.

2.10.9. **Testing of Spares**

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

2.10.10. **Delivery**

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

2.11. **EQUIPMENT IDENTIFICATION**

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

Removable modules shall have the same indelible labelling 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/Employer.

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 Kannada, English and Hindi languages. Where appropriate, such labels shall conform to accepted National or International Standards or as approved by the Engineer/Employer.

2.12. TRAINING AND TRAINING AIDS**2.12.1. Training Objective**

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.

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.

2.12.2. Training Periods

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

2.12.3. Training Instructors

The training instructors provided by the Contractor shall be fully qualified and experienced electrical and mechanical Engineer/Employers, who have a good knowledge of English language. They should have experience of training Engineer/Employers 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/Employer.

Should, in the opinion of the Engineer/Employer, any of the Contractor's training instructor 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 staffs are 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.

2.12.4. 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.

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.

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.

2.12.5. 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 approval of the Engineer/Employer, 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.

2.12.6. Monitoring

Throughout the training programmes, the Engineer/Employer 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 trainee's 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/Employer on completion of each training course.

2.12.7. 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/Employer's consent. Details of the facilities to be provided shall be included with the detailed training programmes submitted by the Contractor.

2.13. PACKAGING AND STORAGE OF PLANT AND MATERIALS

2.13.1. Shipping and Storage

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.

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

2.13.2. 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/Employer.

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/Employer for acceptance.

2.13.3. 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.

2.13.4. Packaging Procedures

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

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.

2.14. 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.

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.

2.14.1. **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. Contractor shall provide anti-surge devices and any other protective devices required to fully protect the Equipment and the system against such effects.

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.

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. 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.

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.

2.15. **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/Employer.

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.

2.16. 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/Employer.

2.17. 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.

Appendix VI

Employer's requirements – Design and construction Interfaces

1.0 Interfaces

1.1 The Contractor shall interface the detailed design, installation and commissioning of the E&M works with that of other contractors, principally the Contractors for the Civil works other Designated Contracts as defined in the General Conditions of Contract. The Contractor shall keep the Engineer/Employer fully informed in respect of such interfaces, such information being given to the Engineer/Employer in a manner and form and at such intervals as stated in the Contract or as required by the Engineer/Employer.

1.2 Interfacing Parties:

- i) **Contractor for Elevated Viaduct and At- Grade (Civil Works)**
This contract provides the complete design and construction of the Elevated and At-Grade section of Corridor-2, BSRP.
- ii) **Architectural Finishes & E&M works**
- iii) **DDC for Power Supply & Traction**
Detail design Consultancy Contract for Power Supply Receiving, Distribution System, OHE Traction Electrification and SCADA System.
- iv) **CC for traction power contractor**
This contract provides for Supply, Erection Testing and Commissioning of OHE traction power, traction & auxiliary substation equipment, AC and DC switchgear, transformers and rectifiers, auxiliary power equipment and power cables and power SCADA system.
- v) **E&M Contractor**
This contractor will provide LV supply for entire E&M load through 33 kV/ 440 v Auxiliary Transformer via LT bus duct/Cable terminated to E&M's Main Distribution Board (MDB) in ASS room.
- vi) **Elevators**
This Contractor will design, manufacture, install and commission all lifts in the stations.
- vii) **Escalators**
This Contractor will design, manufacture, install and commission all escalators in the stations.
- viii) **S&T for signaling works**
This contract provides for signaling and automatic control systems including equipment in Station Control rooms, Station Equipment Rooms, telecom Equipment Room, S&T UPS Rooms, Signal maintenance Rooms in Interlocked stations with points and crossings and OCC, Train mounted control equipment, independent telephone exchanges including automatic switching centers and exchanges, main trunk cables, direct telephone lines, communication equipment, emergency telephones, closed circuit television, radio communication, Passenger Announcement, passenger Information Display system, co-axial cable arrangement and all non-power SCADA system. Line side signals in the platforms of interlocked stations, track mounted beacons and Emergency stop plungers in platforms also form part of the contract.

ix) **TEL for telecommunication works**

This Contract provides for independent telephone networks including automatic switching centers and exchanges, main trunk cables, direct telephone lines, communication equipment, emergency telephones, closed circuit television, radio communication and all non-power SCADA system.

x) **AFC for automatic fare collection works**

The contractor shall interface with designated contractors (e.g. Building service / Civil contractor / Electrical contractor /signaling train control and communication contractor), Agencies (government or private), UPS contractor, consultants and other sub / local contractors etc. to ensure smooth execution of works.

xi) **DDC for Signages**

This Contract provides for design, manufacture, supply, installation, Testing and commissioning of all Signages at Stations.

xii) **RS for Rolling Stock**

This Contract provides for Design, Manufacture, Supply, Testing & Commissioning of Rolling Stock.

2.0 INTERFACE RESPONSIBILITIES

- 2.1 The responsibility for specification and provision of the requirements for the works, which interface with Designated Contractor's equipment, are tabulated below.
- 2.2 This Appendix describes the interface requirements between the Contractor and other Designated Contractors which includes Architectural finishes, E&M Works, DDC's, POWER SUPPLY & TRACTION, ELEVATORS, ESCALATOR, S&T, TELECOMMUNICATIONS, AFC, PSD, RS, and DDC/DM contractors.
- 2.3 This shall be read in conjunction with the relevant clauses of the Employer's Requirements and Outline Specifications. The E&M Contractor shall be responsible for ensuring that all requirements of the specifications pertaining to interfaces of E&M system are properly satisfied.
- 2.4 This outlines the interfacing requirements during the execution of the Works. However, the requirements herein specified are by no means exhaustive and it remains the E&M Contractor's responsibility to develop, update and execute jointly an Interface Management Plan after the commencement of the Works and throughout the execution of the Works to ensure that,
- a) All interface issues between E&M and the Designated Contractors are satisfactorily identified and resolved.
 - b) All the construction tolerances at the interface shall meet the requirements of the respective specifications relating to the interface points.
- 2.5 Where details of the E&M design are required to enable the Designated Contractor to implement interface works, the E&M Contractor shall provide the Designated Contractors with the necessary information including, but not limited to, those described in the summary table appended to this requirement. The level of information provided shall be in sufficient detail to enable the Designated Contractors to design and / or construct the required interface works.
- 2.6 The E&M Contractor will provide all information in developing the Interface Management Plan. The IMP will be prepared in conjunction with the Designated Contractors to cover all aspects of the implementation of the interface works required. The IMP will define the interface works necessary to complete all the works in this contract and is not limited to those listed in the summary table attached.

- 2.7 The IMP shall be fully conforming to the Works Programme and shall, in respect of the Contractor and each of the Designated Contractors, show and be in logical agreement with Key Dates and Works Areas Handover Dates. The IMP shall indicate dates for the commencement and completion of each principal activity on the Site by each contractor, and delivery and installation of principal items of equipment.
- 2.8 The IMP shall be submitted by the Contractor to the Engineer/Employer, in a preliminary form, within **sixty (60) days** of the date of Commencement of Work. Thereafter, the IMP shall be updated by the Contractor at regular intervals of not exceeding twenty-eight (28) days, agreed with Designated Contractors and submitted to the Engineer/Employer. Should it appear to the Engineer/Employer that the progress of the Works, Works Programme or the Three-Month Rolling Programme does not conform to the IMP, the Contractor shall be required to revise all such programmes and plans such that they do reflect the progress of the Works, are mutually consistent and conform to other provisions of the Contract.
- 2.9 The Contractor shall review the details of interface works and notify the Engineer/Employer of any amendments to the summary table required in the process of his works. Unless such requests are reviewed without objection by the Engineer/Employer, the Contractor shall design and construct the works in accordance with the provisions outlined.
- 3.0 **SCOPE OF WORK OF INTERFACE MANAGEMENT PLAN (IMP)**
- 3.1 The information and scope of works to be provided by the E&M Contractor shall include but are not limited to those outlined in the attached summary table. This table only defines those tasks at the interface point and is not a complete itemization of the Scope of Work.
- 3.2 The E&M Contractor shall identify all access and attendance required for completion of E&M works in accordance with the contract requirements to enable the Designated Contractors to complete those activities defined under the summary table attached to this interface specification in a timely manner. Such access and attendance shall include the provision of lighting for the station works and safety provisions such as safe access and egress to all parts of the works required to complete the survey and marking out works for a limited number of Designated Contractor's staff.
- 3.3 Where E&M Contractor works are identified as failing to meet the requirements of the contract and which will impact the Designated Contractor's works, the E&M Contractor shall submit the proposed remedial measures to the Engineer/Employer for review and shall copy the same to the Designated Contractors.
- 4.0 **Scope of Work of Interface with Civil Works**
- 4.1 E&M works and architectural works of a station are to be executed by Civil Contractor. The Contractor shall ensure efficient interface and Coordination with both the Contractor concerning Electrical Works, Fire Fighting, Hydraulics, etc. on site.
Such coordination responsibility of the contractor shall include the following:
- 4.2 To obtain from the other Contractor information reasonably required enabling the E&M Contractor to meet the construction target dates.
- 4.3 The Contractor will be the coordinating entity and play the major role in the interface with E&M Contractor and will also be responsible for any delay on the schedule.
- 4.4 The E&M Contractor will make sure that he provides the updated valid documents, for the reference of the other Contractor in time, where the Contractor requires the other.
- 4.5 Contractor to execute his work as per the requirement of the Station Contractor. These documents will be the reference documents for the Interface Management being carried out by the Contractor.
- 4.6 Where the execution of the other Contractor depends upon the Site Management or information to Be given by the Contractor, the Contractor shall provide correct and accurate information in time so

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- as to enable them to meet their respective programs.
- 4.7 It is to be ensured that all provisions for access and delivery of plant is Co-ordinated with and Reflected in the Contractors Delivery Route Drawings.
- 4.8 The 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, firefighting system and other works included in the tender) 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 other Contractor in time, to enable him to plan his activities. Further, Contractor shall ensure that information required by other Contractor for any concreting / other works where electrical work is involved is made available him in time.
- 4.9 The Contractor shall conduct regular meetings with the designated 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.
- 4.10 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 with other Contractor. If the Contractor despite having taken all reasonable efforts cannot resolve such disagreement, then the decision of the Engineer shall be final.
- 4.11 The Contractor shall ensure the presence of his qualified and experienced Engineer (Chief Co-Ordinator) during civil construction of station to enable proper interface with other Contractor so as to ensure smooth completion of works.
- 4.12 Access will be provided to the E&M & Architectural Contractor staff for carrying out their works and bringing materials and Equipment at the site. However, the security of material and Equipment brought at the site, by the Designated Contractor is station Contractor's responsibility.

Appendix VII

Likely Vendor's List

- 1) Likely Vendor's list as per Particular Specification (Technical Specification E&M) Annexure-1