Part-IV

BUILDING SERVICES

CONTRACT No. NGNDD01

INDEX

BUILDING SERVICES

Section -H1 – GENERAL, CODES AND STANDARDS

H1.1 Description of Works

H1.1.1 The DDC shall provide designs and specifications for the mechanical and electrical works described in these criteria and on the drawings.

H1.1.2 The emphasis is to explain the requirement of work, interfaces with other DDCs for achieving an efficient & safe system to the best international standards and practices. DDC shall follow acceptable standards & design procedures akin to the best systems where not explicitly mentioned.

H1.1.3 The main items of the Works shall include but not be limited to:

(a) Power supply arrangements from 33 kV to 415V Auxiliary substation and associated incoming 33 kV feeders and LV Switch Board. (see also Clause H3.4.1)

(b) Power Distribution system at 415 V or below including LV switchboard, main distribution board, bus ducting, cabling, distribution and sub-distribution boards, feeder pillars etc.

(c) Electric Supplies to various plants & equipments provided under the scope of other DDC or contractor.

(d) DG set complete with automatic mains failure (AMF) panel & associated power distribution & change over panel.

(e) Station lighting parallel redundant online UPS to feed emergency loads and power supply extension with associated control change-over panel.

(f) Automatic Power factor correction at supply point and major loads with associated control, distribution boards and protection.

(g) Water pumping systems and potable water treatment & distribution system and drainage/sewage treatment & disposal system if required

(h) Power supply extension from Main Distribution Board for Normal, Essential & Emergency services backed by DG set supply through UPS, cabling, Bus-Trunking / ducting etc. for services i.e. Building Services including air conditioning, lighting (both indoor and outdoor) etc.

(i) Cable supports, ducts and draw pits for cables to be installed by others;

(j) Fixings on the structure for equipment to be installed by others;

(k) Earthing and lightning protection;

(l) Fire fighting systems including detection, alarm and suppression etc.

(m) Lifts & Escalators-Only provisioning of structural space and architectural finishes; Equipment shall be supplied by E&M group.

(n) DDC shall detail the complete requirement for the safe, efficient & cost effective solution furnishing study report covering the options available and suggested course of action with proper reasoning.

(o) Preparation of quality assurance, testing formats, manuals and misc other

drawings.

(p) Furnishing of good for construction drawings for the contractor for all the above services excluding the shop drawings repetitive in nature.

H1.2 Other Consultants and Contractors

H1.2.1 The DDC shall make allowance for other concurrent electrical and mechanical works.

H1.2.2 DDC shall Prepare Engineering design, Technical specifications, Special conditions of contract, Bills of quantities, layouts, erection / mounting details, interface with other DDC/contractors or arising out of concurrent works, typical arrangements / schemes and lay down testing and acceptance criterion and provide schedules and costs. The submittals shall be in the form of reports, drawings, calculation sheets and schedules both in hard copy and software. The DDC shall also furnish back up materials such as codes / standards and validated accredited software programs free of cost for the employers' representative use in understanding / evaluation of the submittals. The DDC shall furnish a list and format of submittals for each area of work for the consent of the employer's representative covering the requirements stated hereto.

H1.2.3 The DDC shall prepare typical arrangements and schemes and lay-down testing and acceptance Criterion and provide schedules and costs.

H1.3 Mechanical

CIBSE	Design Guides A, B and C
ASHRAE	Design Handbooks
CIBSE	Commissioning Codes A, C, R and W
CIBSE GN 3 :	1993 Legionellosis Montreal Protocol
	Subway Environmental Design Handbook USA Department of Transportation, Urban Transportation Administration
BSRIA	Design for Maintainability
BSRIA	Condition Based Maintenance for / Buildings TN1/95
BSRIA	Decisions in Maintenance TN14/92
COSHH	Regulations (UK)
HSE EH48	Guidance Notes
HVCA	Standard Specifications for Mechanical Services in Buildings Asbestos Regulations
	Health and Safety at Work Act
DHSS	The Control of Legionella - A Code of Practice
NFPA 10	Portable Extinguishers
NFPA 22	Water Tanks
NFPA 24	Private Service Fire Mains
NFPA 101	Life Safety Code

NFPA 130	Fixed Guideway Transit Systems
NFPA 204 M	Smoke and Heat Venting
NFPA 2001	Clear Agent Extinguishing Systems
IS 1172	Code of basic requirements for water supply, drainage and sanitation.
IS 1742	Code of Practice for Building Drainage.
IS 2064	Code of Practice for selection, installation and maintenance of sanitary appliances.
IS 2065	Code of Practice ifor water supply in buildings.
IS 2470	Code of Practice for installation of septic tanks.
IS 3114	Code of Practice for laying of Cast Iron Pipes.
IS 4111	Code of Practice for ancilliary structures in sewerage system.
IS 4127	Code of Practice for laying of glazed stoneware pipes.
IS 5329	Code of Practice for sanitary pipework above ground for buildings.
IS 7740	Code of Practice for construction and maintenance of Road Gullies.
IS 12251	Code of Practice for drainage of building basements
IS 12288	Code of Practice for use and laying of Ductile Iron Pipes.
BS 1387	Spec for screwed / socketed steel tube suitable for welding / BS21 pipe threads
BS3505	UPVC pipework and jointing
BS8301	Building Drainage
BS5572	Sanitary Pipework above ground
BS6700	Supplying Water for domestic uses within buildings
BS6742	Specifications for hand held spray guns and associated apparatus

H1.4 Electrical

IEE	Regulations, 16th Edition
NFPA 70	National Electrical Code (NEC)
NFPA 101	Life Safety Code
NFPA 130	Fixed Guideway Transit Systems
NFPA 110	Emergency Standby Power Systems

NFPA 111	Stored Electrical Energy, Emergency and Standby Power Systems.
COSHH	Regulations (UK)
BSRIA	Design for Maintainability
BSRIA	Decisions in Maintenance TN 14/92
BS4066	Method of test on single vertical insulated wire or cable
BS4941	Specifications for motor starters for voltages up to and including 1000 V a.c. and 1200 V d.c. (now replaced by BSEN 60947)
BS5445 :	Part 5 - Heat sensitive detectors, point detectors containing a static element
BS5445 :	Part 7 - Spec for point type smoke detectors using scattered light transmitted light or ionisation
BS6651	Code of Practice for protection of structures against lightning
BS6425	Method for determination of amount of halogen acid gas evolved during combustion of polymeric material taken from cables

H1.5 Codes and Regulations

H1.5.1 Main Electrical Design

H1.5.1 Equipment, materials and systems shall be designed, in accordance with the latest issue of the accepted codes and standards.

H1.5.2 Electrical design shall be based on BS 7671 : 1992 "Requirements for Electrical Installations" or other internationally recognised equivalent standard approved by the NMRC examples of which are :

IE Rules & IE Act

National Building Code

ANSI American National Standards Institute

ASME American Society of Mechanical Engineers

ASTM American Society for Testing and Materials

DIN Deutsche Industrie Normen

IEC International Electrotechnical Commission

JIS Japanese Industrial Standards

NEC National Electrical Code

NEMA National Electrical Manufacturers Association

NFPA National Fire Protection Association

VDE Verband Deutsche Elektrotechniker

H1.6 Local Codes, Regulations and Standards

H1.6.1 Unless otherwise stated, the electrical system design shall be governed by all applicable local codes, regulations and standards issued by the local agencies such as:

BIS Bureau of Indian Standards

IEEMA Indian Electrical and Electronic Manufacturer's Association.

H1.6.2 The DDC shall specify the regulations laid down by local authorities i.e., Government or Municipal agencies including fire safety regulations, fire insurance regulations or other local codes and make provision so that the NMRC/ Noida-Greater Noida authorities obtains approvals from relevant authorities at appropriate stages of work. Such regulations are:

Indian Electricity Rules

Indian Electricity Act

National Building Code

Inspectorate of Lifts and Escalators

Central Pollution Control Board

U.P. Police and Fire Brigade

Central Public Works Department

U.P. State Electricity Board

National Safety Council

H1.7 Additional Codes, Standards, Specifications and Manuals

H1.7.1 In addition to local requirements, electrical system designs shall comply with the codes of practice and standards specified in herein. Local codes, regulations and standards shall take precedence where their standards or requirements are more onerous than other national standards. All codes and standards shall be submitted in the English language.

H1.7.2 The design of any one system shall be to a single code or specification. The parallel use of different codes for one particular item or component shall not be allowed.

H1.7.3 The DDC shall prepare also a **check list** based on relevant standards for ensuring conformity and uniformity in evaluation. The check list should cater for design, manufacture, supply/storage, packing, erection/ installation , testing & commissioning and operation as applicable.

H1.8 Safety and Escape

The design relating to fire safety and escape shall be in accordance with the requirements of NFPA 130 Standard for Fixed Guide-way Systems.

H1.9 Standardisation

The DDC shall, in establishing his design, follow the principles provided below in the design and specification of all plant, equipment and components:

a) Similar plant and equipment shall be replaceable/interchangeable, modular in design, adaptable and extendable.

b) The technical specifications and design criterion shall be uniform. Uniform standards for clear spaces, working clearances, protection of equipment and physical dimensions of equipment and interfacing with other systems.

c) Type testing, routine testing and endurance test shall be required under similar conditions. Evaluation shall be conducted at all stages and performance compared with acceptance criterion. Testing values shall be commensurate with reference standards.

d) Test standards and standardised equipment shall be selected or built or framed carefully, bench marked, designated and explicitly marked.

e) A standard procedure shall be followed for identification of each category of equipment explicitly (suffixing or prefixing while marking and numbering for each category of equipment).

f) Similar principles of establishing footprints of plant and equipment shall be followed.

g) The operating system shall be uniform for all systems/ sub systems.

h) Standards for maintenance planning shall be uniformly categorised.

i) Uniform standards shall be designated for procurement, replacement stocking and availability.

j) Equipment and accessories shall be provided with uniform standard spare capacity, protection.

k) Piping, cabling etc., shall be suitably colour coded for identification and categorisation for each kind of use/type.

H1.10 Manuals

H1.10.1 The DDC shall require to include suitable manuals for all Contractor-supplied equipment and systems. These would typically include the following:

(i) ***System Manuals*** - a comprehensive description of all system principles at block diagram level giving details regarding power distribution and protection scheme.

(ii) ***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.

(iii) ***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.

(iv) ***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. This shall also include furnishing of the software packages used for design of various components of work and validation of data. Source code listings with comprehensive comments shall be provided for all bespoke software together with configuration listings for all configured standard software packages.

(v) ***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.

(vi) ***Maintenance and Servicing Manuals*** - to specify requirements, 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.

H1.10.2 The User Manuals and the Maintenance and Servicing Manuals shall be prepared in both English and Hindi Languages. Other technical manuals shall be supplied in the English language only.

H1.10.3 The Contractor shall submit all Manuals for review by the Employer's Representative prior to factory acceptance tests.

H1.10.4 The Contractor shall provide 6 copies of all Manuals well in advance and explain so as to understand the manuals by the user prior to commissioning.

H1.11 Acoustic Criteria

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

- At UPS room, auxiliary substation and pumping installations- 55dB.
- Air conditioners
- Ceiling fan
- Exhaust fans
- Switch boards/Distribution/starter panels
- Motors
- DG sets
- UPS

H1.12 Technical specifications

H1.12.1 The DDC shall prepare technical, material & workman's specifications for manufacturer or supply & installation of all electrical works in style of Construction Standards Institute (CSI) of America's three part format.

- Part 1.General
- Part 2. Material products
- Part 3.Execution

H1.12.2 Specifications shall be complete in itself & shall confirm as relevant to the subject, **but not limited to, such as g**eneral requirement, service condition, protection, interfacing, design norms and specifications for Equipment, components and material, Main Distribution Boards, other panels/boards, control panels, DG sets complete with AMF & load transfer panel, battery charger, UPS & Valve regulated Battery system, FRLS PVC cables, XLPE cables, Fire survival cables etc including accessories, cable trays etc.. lightning protection, Earthing & bonding system, Energy

efficient Lighting luminaries including electronic chokes, accessories, lighting poles, automatic Power factor correction systems,air conditioning, Water pumping system

H1.13 Computer simulation

H1.13.1 The designs shall be substantiated through computerised simulation of calculations, Data verification and validation programs using standard simulation programs international accredited or indigenously developed, supported with quality verification and acceptability and shall provide input data, results and program description.

H1.13.2 **Software** for electrical load analysis, electrical system analysis like load flow, voltage drop, short circuit analysis, protection, relay co-ordination, grounding, transient stability study, cable sizing, lighting design, water flow analysis & pump design, refrigeration load analysis etc. shall be provided by DDC free of charge.

H1.14 Certification of Personnel & work

H1.14.1 DDC shall stipulate conditions for certification of personnel to execute work & certification of work through qualified and certified license holders or have competency from National / Internationally recognised agency empowered to issue, to carry out similar work or authority.

H1.14.2 DDC shall certify the design and get the designs insured from empowered authority.

H1.15 Quality control of equipment, components and material

H1.15.1 Pretender & post-tender standard program, checklist / questionnaire shall be framed by DDC to seek information from bidder/contractor to assess/ensure quality of all major equipment, components & material. Quality Assurance Programme shall ensure proper supply and use of raw materials, processes, service provision/verification/testing.

H1.15.2 DDC shall design to provide and state the **corrosion protection systems** used and the design lives of the systems.

H1.16 Spares, special tools, test equipment & training

The DDC shall stipulate list of spares, special tools, test equipment & training with recommended **stockholding** considering lead-time & other condition including those required prior to commissioning.

H1.17 Submission of drawings & details:

H1.17.1 The DDC shall Provide section drawings through the station service routes to show the adequacy to accommodate services and layout drawings showing location of all major components including the co-ordination drawing indicating all services.

H1.17.2 DDC shall prepare the all Electrical schematics, Control & interlocks diagrams, wiring diagrams, conduiting layouts, cabling layouts, General arrangement drawings for all kinds of Distribution boards incorporating Legends, abbreviations, revision numbers, material quantity sheets, BOQ item references, fixing and erection details etc. but not limited to.

H1.17.3 The DDC shall specify detailed/schematic drawings to include Combined Services Drawings (CSD), Structural/Electrical Mechanical (SEM) Drawings,

Structural drawings, Fabrication drawings, Schematic drawings, Interlock drawings, Erection drawings, Wiring drawings, As erected/finished drawings.

H1.18. **Submission of Documents**

The review study report detailing the complete requirement, options available to fulfil and suggested course of action shall be submitted within a months time from date of award for Electrical work complete with details regarding following but not limited to:

a) Electrical load

b) Space requirement for all electrical utilities including switch room, pump rooms cable ducts/shafts etc.

c) Design criteria with reference of standards and clearances as applicable and as recommended.

d) Iso-lux profile for the areas to be illuminated

e) Air conditioning criteria with reference of standards and clearances as applicable and as recommended.

f) Water pumping with reference of standards and clearances as applicable and as recommended.

g) Fire detection and suppression criteria with reference of standards and clearances as applicable and as recommended.

h) Criteria for selection of equipment and accessories with reference of standards and clearances as applicable and as recommended.

i) Norms followed

The DDC shall also submit within 2 months the calculations for load, switch gear sizing, selection, short circuit, cable sizing voltage drop, bus bar sizing, selection bus duct etc but not limited to duly validated through accredited software as required by the employer. Employer reserve the right to ask details to any of the related subject or submittal as deemed fit

DDC shall furnish take-off sheets of all the equipment and accessories and items of proposed BOQ within 3 months

DDC shall provide simultaneously the schematics, single line diagrams, wiring diagrams, fixtures details, legends , abbreviations etc. as required

DDC shall submit the tender documents i.e. specifications, BOQ, Drawings etc. as required as per decided schedule.

DDC shall furnish the reviews as required by the employer to provide the best techno-cost effective provisions for services.

The DDC shall prepare the Good for construction drawings and shall co-ordinate at all stages of execution for the approval of the drawings etc. as required.

Section H2 - MECHANICAL WORKS

H2.1 Introduction

This section contains a general description of the system concepts and major components; also sections covering definitions, requirements for interfaces with other contracts, general mechanical and electrical installation requirements, and testing requirements.

H2.2 Definitions and Abbreviations

H2.2.1 Definitions

Definitions used in these criteria are as follows:

Ancillary Rooms - the non-public areas or spaces of the stations which contain operating, maintenance or support equipment and functions.

Operations Control Centre - the operations centre that controls and co-ordinates the system-wide movement of passengers and trains and the point from which communication is maintained with supervisory and operating personnel.

Station Control Room – the local control room at the station for operational control of the station and to monitor station activities and functions relating to the movement of passengers and trains along with auxiliary and support systems.

Fireman's Control Panel - a vandal proof panel located within the unpaid/paid station concourse area comprising a mimic diagram of the station (all levels) showing fire compartmentation zones related to manual call points, fire/smoke alarms.

Noise criteria shall be based on the references in Clause F2..3.2 in conjunction with the local building control regulations.

H2.2.2 **Abbreviations**

Abbreviations used in this specification include:

DB	- dry bulb
WB	- wet bulb
rpm	- revolution per minute
LPC	- Loss Prevention Council
ESPS	- Escalator Sprinkler Protection System
MJC	- Multiple Jet Control
FAP	- Fire Alarm Panel
SCADA	- Supervisory Control and Data Acquisition
OCC	- Operations Control Centre
SOR	- Station Operations Room
FCP	- Fireman's Control Panel

H2.3 Environmental Control

H2.3.1 The DDC shall be responsible for designing all equipment including pipe work, valves, brackets, fittings, sleeves and insulation to complete the installation.

H2.3.2 The DDC shall be responsible for system sizing and shall submit calculations for approval. The DDC shall also confirm the general adequacy of the space requirements within voids or services ducts, openings, main routes etc.

H2.4 Air-conditioning of Building / Rooms

H2.4.1 DDC shall prepare technical specifications, location drawing, erection / mounting details including testing and acceptance criterion for air-conditioning systems at designated rooms to maintain temperature at 27±2°C& requisite air changes. DDC shall furnish economical design for centralised low capacity, or split type air conditioning system specifying the consideration and comparison criterion with software backed verification and design validation there off.

H2.4.2 DDC shall stipulate the dimensional requirements for space and liaise with other system wide DDCs to fix the location and provide the co-ordination layout. The technical specification shall incorporate aspects like Heat load calculation for each utility rooms/ building, Rating of sub systems like Dehumidifier, temperature control, condenser, compressor, motors, power factor improvement, evaporator, blower motor, filters, Minimum guaranteed cooling requirement, Air delivery, fresh air intake requirement, Acoustic level, electrical power requirement etc.

H2.5 Sanitation

H2.5.1 General

This section covers the requirements of the soil, waste, ventilation, mains water and cold water services installed throughout the station. The DDC shall be responsible for assessing the water disposal requirements, pipe sizing and submit calculations to the Employer's Representative. The DDC shall also confirm the general adequacy of the space requirements within voids or services ducts, openings, main routes etc. Indian Standards are to be considered, but where special considerations may apply acceptable alternative specifications are quoted in the following sub-sections.

H2.5.2 ***Water Services***

H2.5.2.1 ***Cold Water Storage Cisterns/Tanks***

Requirement for drinking water for staff, toilet flushing, station cleaning and fire fighting make up water shall be included. Cold water storage cistern/tanks shall be installed at the highest possible location within each station area. The DDC shall be responsible for ensuring all aspects of the storage requirements have been met for both domestic cold water cisterns/tanks and for certain equipment demands in addition to personnel demands.

Actual storage capacity of domestic cold water cistern/tanks shall be calculated based on providing 45 litres per head of staff present within the largest shift and an adequate provision for public toilets. This storage allowance is for guidance purposes only. Staffing figures shall be provided during the design phase.

Due to the layout of fittings it may be considered that more than one domestic cold water storage cistern/tank shall be required, therefore it is the responsibility of the DDC to clearly identify his intention and provide details for consent.

Depending upon storage capacity required and accessibility of tank location, domestic cold water cisterns/tanks shall be of suitable type and capacity. No Glass Reinforced Plastic (GRP) tanks or plates shall be used.

H2.5.2.2 ***Mains and Cold Water Pipe Installation***

The mains water and cold water services shall be installed in a neat and workmanlike manner and shall, as far as practicable, follow the contours of walls and shall be graded to ensure satisfactory drainage.

All valves and drain cocks shall be located for ease of operation and maintenance. Valves located behind panels within toilet or other areas shall be clearly identified via appropriate marking on the external face of the panel.

The station shall be provided with a minimum of three drinking fountains. These shall not be connected to the piped supply. They shall be of the chilled, bottled type with power supply from the 220 V mains.

Where urinal cisterns are installed, they shall be complete with hydraulic flow control devices, installed within the supply pipework at an appropriate location prior to cistern.

Internal mains water and cold water down service pipes, pipe fittings, tubular fittings and pipe threads shall be to Indian Standards where these meet the operational standards.

H2.5.2.3 ***Valves***

All valves used on water services shall be in accordance with the requirements of the water authority. The DDC shall be responsible to see that the requirements of the water authority are complied with in full. All valves shall be non-dezincifiable. Valves for use on mains water pipework shall be stopcocks to BS 1010.

Valves for use on cold water services for servicing purposes shall be isolation valves to BS6675.

Valves used on cold water services for isolation purposes shall be gate valves to BS 5154.

Drain valves for use on cold water services shall be screw down cock type to BS F2.79.

Ball valves shall be high pressure equilibrium pattern complying with BS 1212: Table 1, complete with arm and copper ball float complying with BS 1968: Class "B".

All single and double non-return valves shall be with screwed ends to comply with BS 2682.

H2.5.3 **Sewage System**

H2.5.3.1 **Cast Iron pipes**

Cast iron soil waste and ventilating pipes, fittings and accessories shall conform to BS 416, with approved coating providing fire and corrosion protection.

H2.5.3.2 **Soil Waste, Waste and Ventilating Pipes Installation**

All pipe runs shall be arranged to present a neat appearance and where practicable be parallel both with one another and with the building structure. All vertical pipes

shall be plumb.

Pipe work shall follow the lines of walls vertically and horizontally and shall be graded as necessary for draining and venting. The minimum clearance between a pipe and any adjacent finished building surface, fixing or pipe shall be 35 mm.

Pipe work runs shall in all cases be installed with a view to co-ordination with other services, whether provided by the DDC or not.

Careful consideration must be given to the low flow rates experienced within stations when designing suspended drainage schemes. Self cleansing velocities must be achieved, minimising potential blockages etc., therefore a normal minimum installation gradient of 1:60 should be achieved. Any flatter gradient than 1:60 must be proven by the DDC prior to receiving consent.

H2.5.3.3 **Traps**

All traps to waste fittings listed below shall be manufactured from copper to BS F2.71: Table "X". All traps shall be two piece tubular construction with minimum of 75 mm deep water seal. The joint between the waste outlet and the trap shall be made with PTFE tape and rubber sealing washer. All exposed traps within public toilets and staff rooms shall have a chromium plated finish. All other exposed traps shall have natural copper or painted finish.

H2.5.3.4 **Sanitary Fittings**

(a)	Wash Hand Basins	:	35 mm diameter two piece deep seal
(b)	Sinks	:	42 mm diameter two piece deep seal
(c)	Sanitary Disposal Units	:	54 mm waste to connect to (integral) 75 mm deep seal trap
(d)	Water Closets	:	100 mm soil pipe, trap incorporated within sanitary fitting

H2.5.3.5 **Sewage Pumping**

H2.5.3.5.1 Normally, the sewage disposal shall be by gravity flow. However, where this does not apply, then the requirements of this sub-section shall apply.

H2.5.3.5.2 The pumps shall be centrifugal type suitable for handling raw sewage. The pumps shall comply with BS 4028, BS 5316 and BS 6835: Class II.

H2.5.3.5.3 Discharge velocity shall be not less than 0.75 m/s nor greater than 1.8 m/s. The pumps shall have a stable head-flow characteristic and be suitable for prolonged running under site conditions. Hand holes shall be provided in the pump casings to facilitate clearance of obstructions. Pump bodies, covers, brackets, wear rings etc. shall be of close grained cast iron or nickel iron. Pump impellers shall be of close grained cast iron. Each pump shall be complete with all necessary fittings including isolating and non return valves.

H2.5.3.5.4 A local control panel shall be provided. On/off pump control shall be from level in the tank. The pumps shall operate in duty/standby mode. Discharge shall be through a heavy grade galvanised pipe of a minimum bore of 100 mm rising to ground level. The diverter set shall be located in a pit of sufficient size to give a minimum of 1 m clearance around equipment for access. A sump pump shall be

provided in a pit of minimum size 450 x 450 x 450 mm to cater for minor seepage from the diverter. The sump pump shall have an on/off "pear drop" control with facility for high level alarm transmission to the SCADA system. Discharge of all sewage shall be to a septic tank at ground level. Discharge shall be via a "goose neck" bend with invert above flood level to act as a safeguard against station flooding. Discharge pipe work shall be cast iron.

H2.5.3.5.5 The septic tank shall be of the anaerobic filter type with scum box, separation chamber and filter chamber. The tank shall be below ground level and shall have convenient access from the public road. The septic tank shall conform to BS 6297: 1983 and the requirements of the Central Pollution Control Board of India.

H2.5.4 Drainage

Preferably all drainage shall be by gravity flow, but where required the pumps shall be submersible units. The pumps shall be mounted on guide rails for ease of maintenance. Each pump shall have an isolating valve and non-return valve. A local control panel shall be provided. Pump start and stop shall be from high and low level in the sump. A lifting system shall be provided for each installation together with an access hatch. A high level alarm shall be fitted to relay back via the SCADA system to the Control Centre. Discharge pipework shall be in heavy duty galvanised steel. The water shall discharge to the local surface water drainage system via a "goose neck" bend with invert above flood level to prevent back flow.

H2.6 Fire Protection

H2.6.1 **Scope of Works**

H2.6.1.1 This section covers the requirements of the Fire Protection System installed throughout the Contract.

H2.6.1.2 The DDC shall be responsible for complete fire system functioning, interlocks, pipe sizing and submit calculations for approval`. The DDC shall also confirm the general adequacy of the space requirements within voids or services ducts, openings, main routes etc.

H2.6.2 Hydrant and Hose Reels

At the Fire Valve Room an isolating valve shall be installed to control the hydrant main. The valve shall be both lockable and addressable.

Hydrants shall be mounted at end platform and centre of each platform level within equipment cabinets.

Hydrants shall be terminated with a landing valve such that the base of the valve is 300 mm from the finished floor level.

The hydrant main shall be run from the Fire Valve Room to the platform level with a spur(s) to the various hose reel positions. The hydrant main shall be run in its full extent in 150 mm pipe work. The DDC 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.

Hose reels shall be of non-kinking reinforced flexible tubing with an internal diameter of 25 mm. Hose reels should be 30 m in length and be manually operated.

Hose reels shall be typically connected to a 25-50 mm wheel operated isolating

valve.

Hose reels shall be fully recessed in purpose made cabinets or surface wall mounted standard pattern, according to design requirements.

One hose reel should be provided to cover every 800 m2 of floor space or part thereof in the ticket hall and concourse areas.

Hose reels should be sited in prominent and accessible positions at floor level, adjacent to exits or exit routes, in such a way that the nozzle of the hose can be taken into every room and within 6 m of each part of a room. The hose and nozzle should be capable of directing a jet of water into any recess area.

H2.6.2.1 **Hydrant and Hose Reel: Valves**

These shall be to the requirements of BS 5041 : Part 1. The flanged inlet shall be suitable for sufficient flow of water for fire fighting purposes.

Valve outlet shall be 65 mm instantaneous.

Landing valves shall be gunmetal to BS 5041 : Part 2.

The first stop valve on the town mains supply shall be a double flanged cast iron wedge gate valve for waterworks purposes, to BS 5163, with open and shut indicator. Other main in-line stop valves to be gear operated butterfly valves to BS 5155 with rack and pinion gearbox with open and shut indication. Each valve to be secured open with strap and padlock.

Where non-return valves (NRV) are specified on a town mains supply they shall comply with BS 5152. A pressure gauge and test valve arrangement shall be fitted on the incoming supply side of each NRV and between the non-return valve and the stop valve.

H2.6.2.2 Water Supply for Hose Reels

The DDC to ensure that, as a minimum, the water supply to hose reels should be such that when two reels in a building area are in use simultaneously, each shall provide a jet of approximately 6m in length and shall deliver not less than 30 l/min. For example, when a length of 30 m of the hose reel tubing (BS 5274) is in use with a 6.35 mm nozzle, a minimum static pressure of 1.25 bar shall be required at the entry.

The DDC shall perform water pressure tests for static pressure. Should the calculations reveal low pressure output at each hose reel, additional hose reel dual booster pumps shall be installed to provide the required pressures.

H2.6.3 Portable Extinguishers

Three types of portable extinguishers shall be used :

- 4 kg CO_2 extinguisher (carbon dioxide) - HV and Switchrooms.
- 2 kg CO_2 extinguisher (carbon dioxide) - other electrical rooms.
- 9 litre foam extinguisher - water based.

Extinguishers shall be mounted securely on purpose made brackets. All extinguishers shall be manufactured to the requirements of BS 5423: 1987.

H2.6.3.1 System Design Criteria: Portable Extinguishers

Both AFFF and CO_2 and water based extinguishers must comply with the following requirements:

(a) BS 5423: 1980/87: Specification for Portable Fire Extinguishers.

(b) Must be type tested to a pressure of 200 bar, each cylinder type being tested. the manufacturer shall supply documentation of pressure testing and results.

Portable extinguishers shall be installed in groups to cover, for instance, multiple small office facilities.

CO_2 extinguishers shall be installed in all electrical switchrooms, sub-stations, platform equipment cabinets, operations rooms and communications rooms.

H2.6.4 Alarms, Indicators and Controls

Alarms are described in the Fire Detection and Alarms Section.

H2.6.5 Power Supplies

Secured and standby supplies are described in the Power Supplies Section.

H2.6.6 Extinguishing system for electrical/electronic areas/rooms

Various equipment rooms, control rooms where electronic, electrical equipments & electrical accessories need be provided ,CO2 based automatic fire extinguishing system shall be designed.

H2.6.7 GENERAL REQUIREMENTS FOR MECHANICAL WORK

DDC shall design covering aspects like Vibration Isolation, Equipment Mounting, maintainability, removal and replacement, Equipment Identification like labeling designate equipment type, equipment function, flow direction and other such data as appropriate.

H2.6.7.1 Electrical Requirements for Mechanical Systems

The DDC shall be responsible for assessing the requirement and the design, of control panels, motor starters, isolators, conduit and wiring between the motor starters and mechanical equipment. The control panels shall serve as the point of connection for the electrical system to be designed.

H2.6.7.2 Motor Starters

AC power shall be distributed at a nominal 415/240 volts,**3** phase/single phase, 4 wire, 50Hz. Dry type transformers shall be used when voltages other than distribution voltage are required. The starters shall be grouped starters with display panels. Starters for motors shall include individual unit control transformers. Direct-on-line motor starters shall be used for motors up to and including 3.75 kW at 415 volts, 3 phase. All motors over this limit shall be equipped with reduced voltage starters of the star delta or auto-transformer, two step, closed transition type.

H2.6.7.3 Refrigerated water

DDC shall design for provision of cold & hot drinking fountains.

H2.6.7.4 Lifts & escalators

Lifts and escalators shall be provided by E & M group. DDC shall design for space for lifts(for handicapped patrons & escalators required for connection between ground - concourse-platform. DDC shall include power requirement of equipment, machinery, associated equipments & other accessories if any and the lighting arrangement of the machine room. **DDC shall liaise with SYS II DDC.**

H2.6.8 INTERFACES - MECHANICAL

The DDC shall ensure efficient interface and co-ordinate with other Contractors for interface regarding mechanical works for provision of fittings, opening, room sizes, installation sequences, working space etc.

H2.6.8.1 SCADA System Interface with Mechanical Systems

Control and monitoring of mechanical equipment shall be carried out by SCADA system supplied under a separate contract. Status information and control commands will be transferred between the Control Centre and the SCADA outstations connected to the control panels of the mechanical equipment. During the preparation of detail design the Contractor shall liaise with the SCADA Contractor/DDC, Employer's Representative Noida-Greater Noida Fire Services and other Designated Contractors to determine all requirements for response in event of fire,

Transducers shall be designed to indicate equipment operational status (e.g. on/off, open/closed, forward/reverse, over- temperature, high level etc.). The system shall also indicate fault conditions, measured operational parameters necessary to determine whether the plant is functioning correctly (e.g.. motor current, flow rate, pressure, supply voltage etc.), control inputs to enable remote operation of the plant (e.g.. start/stop, forward/reverse etc.). Where control input is required the DDC shall ensure that the status of the item of plant is monitored directly. All SCADA control shall be passive.

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. To facilitate connection work between sub-systems the DDC shall design terminal boxes and wiring to the control circuits of the appropriate units.

H2.6.9 TESTING AND COMMISSIONING

H2.6.9.1 The DDC shall stipulate all forms of test procedures applicable to the various equipment/ systems mentioned herein explicitly or as implied. DDC shall be responsible for furnishing testing & commissioning procedures including balancing of all mechanical work, Air and water system, Piping system water flows, Pumps, Fire protection equipment, Electrical distribution system, DG set, UPS, Sanitation plan, Monitoring equipment, including supervisory systems interface, sound attenuator noise suppression etc.

H2.6.9.2 Testing shall be conducted by employing procedures that shall ensure compliance with all the requirements of this Specification covered above or elsewhere explicitly or implied. Any testing or approval by the Employers' representative of prototype shall in no way absolve the DDC of his responsibility under the terms of the contract for the satisfactory service of equipment/component/fitting supplied and erected on account of design.

Section H3 - ELECTRICAL WORKS

H3.1 Introduction

This section contains a general description of the system concepts and major components; also sections covering definitions, requirements for interfaces with other contracts, general electrical installation and testing requirements, materials and workmanship criteria.

H3.2 Definitions and Abbreviations

H3.2.1 Definitions

(av) “voltage” means the difference of electric potential measured volt between any two conductors or between any part of either conductor and the earth as measured by a suitable voltmeter and is said to be ;

“Low” where the voltage does not exceed 250 volts under normal conditions subject, however, to the percentage variation allowed by the rules;

“Medium” where the voltage does not exceed 650 volts under normal conditions subject, however, to the percentage allowed by the rules;

“High" where the voltage does not exceed 33,000 volts under normal conditions subject , however, to the percentage variation allowed by the rules;

“extra high” where the voltage exceed 33,000 volts under normal conditions subject, however, to the percentage variation allowed by these rules.

H3.2.2 Abbreviations

Abbreviations used in this specification include :

HV	High voltage
MV	Medium voltage
LV	Low voltage
ac or AC	Alternating current
dc or DC	Direct current
kVA	Kilo volt-amps
kW	Kilowatts
V	Volts
A	Amps
mm	Millimetres
dB	Decibel (sound pressure level)
NC	Noise criterion
NFPA	National Fire Protection Association, USA
FAP	Fire alarm panel
BS	British Standard

EN	Euronorm Standard
ISO	International Standards Organisation
IES	Illumination Engineering Society, UK
SCADA	Supervisory Control and Data Acquisition
IS/BIS	Bureau of Indian Standards

H3.4 Electrical Equipment

H3.4.1 General

a) The DDC shall design the station power supply based on supplies from the main LV switchboard to all distribution boards, consumer units and specialist services power supply isolating switches.

b) Electrical distribution and scope of work is as explained in para-H1.1.except the auxiliary substation and LV switch board which are in the scope of other DDC/contractor.

c) This also includes the electrical lighting installations at station access roads, pedestrian walk-in, scooter & cycle with parking, Bus taxi auto rickshaw, cycle rickshaw, station and site circulation area and other site utilities for rail corridor as detailed in appendix-G

d) Equipment, cables, Boards, panels shall be **numbered for type and serial number.** Each equipment number shall be preceded by a suitable letter designation. A list may be drawn & got approved to adopt in all references.

H3.4.1.2 **Rating, Sizes and Calculations**

Power system analysis shall be provided to verify that all equipment chosen is rated for voltage, Continuous full load ampacity, fault duty to which it is exposed.

DDC shall be responsible for designing, system sizing and submit all calculations in support. DDC shall confirm the adequacy of requirement, overage, space for services, equipment and sizing there off and shall propose the best techno-cost effective solution, which will be approved by the employer.

Calculations shall be presented in software and as a minimum shall include e**quipment and component like** Batteries, Diesel fuel tank, Generator, ACB / MCCB, panel/boards, switchboards, UPS, Capacitor bank, cables, illumination, **Load Flow Analysis,** load study calculation, Switching interlocks, power factor correction, protection co-ordination, relay co-ordination, short circuit calculation, voltage drop and regulation.

H3.4.1.3 **Earthing and Lightning Protection System:** DDC shall examine the requirement and design for Earthing and Lightning Protection System in terms of relevant standards and safety norms earthing current/ resistance/ size, lightning protection, step/ touch voltages considering local soil characteristics shall be designed with validated design and calculations.

H3.4..1.4 **Cable Duct/Cable Trunking**: Cable sizing, cable pulling tension calculation, cable tray sizing, conduit / tray fill calculation, man holes/draw box sizes etc. shall be designed by DDC suitably taking in to account the de-ratings involved if any..

H3.4. 1.5 **Lighting System Calculations**: DDC shall submit complete lighting design calculations for indoor lighting, out door lighting through validated accredited software including Iso-lux profile, geographical distribution, optimised figures etc

H3.4.1.6 **Panel Enclosures**

All panel enclosures shall be of sturdy and robust construction to the best standards and practice to accommodate and firmly support all equipment. All holes in metal work shall be protected by substantial grommets or bushes.

H3.4.1.7 **Location and Space**

Electrical power distribution equipment shall be located in dedicated electrical equipment rooms, battery rooms, and closets. Electrical rooms and closets shall have sufficient space to house all electrical .equipment, including future units, including working clearances.

H3.4.1.8 **Safety, Protection & Interlocks**

The contractor shall equip all equipment plants with adequate safety, clearances, operational protection scheme conforming to relevant international standards and practices. The contractor shall also liaise with other designated contractors for finalising details of the cables, cable end terminations, joint testing or commissioning procedures and list out requisite scheme of protection or interlocking. The scheme shall be agreed to by the Employers representative or the engineer.

The contractor shall also provision for all requisite equipment/accessories/displays etc for the safety of operator / general public coming in accidental or normal contact (touch potential) / equipment safety as per the statutory and technical provisions. The safety schemes shall ensure that any failure does not lead to an unsafe condition.

H3.4.1.9 **Control Supply**

The control supply for the switchgear and other equipment in the station area shall be provided through UPS at 240 v,i1ph.,AC or the Building management system. The contractor shall liaise with the other designated contractors to make necessary provision in the equipment.

H3.4.1.10 **Design Considerations**

All equipment **cables, wiring** shall be designed manufactured and installed so as to secure a service life as stipulated / best available/ recommended in relevant standard of the equipment/subsystem/accessories.

The **superiority of all equipment** will be judged by, compact size, energy efficiency, life cycle costs and performance parameters.

The **service life** of the equipment is the normal life expectancy of the equipment subject to its maintenance and preservations as per the recommended maintenance practice.

All the electrical boards/panels shall be dust, termite and rodent proof, modular, extendable, metal enclosed, rigid. free standing or wall mounting, construction with adequate steel sections

Switchboards, equipment and components shall be rated operation in ambient temperatures of 50°C and humidity up to 95%. In the design of switchboards an allowance of 15-20% spare capacity(/no) shall be provided for possible maintenance and additional 15-20% for future expansion and all main switchboards shall be user friendly, modular, extendable and aesthetic design, termite and vermin proof. Spare capacity of 30% shall be provided for all cables trays, trunking, wire-ways, (raceways), and brackets for future expansion.

H3.4.2 **Power Supply System for Stations**

H3.4.2.1 The 415V power supply for various services at the stations of rail corridor shall be derived from a single auxiliary substation (ASS) 33kV/415kV, generally located at the ground level/ concourse/ platform level or under the elevated viaduct at each location. The auxiliary substation shall receive 33 kV feed through loop-in loop-out arrangement and 415 V power shall be extended through a cast resin 33kV/.415 kV, (500/ 630/1000) kVA cast resin transformer and LV switch board comprising 415 V air circuit breakers in adequate number for feeding power to the main distribution board (MDB) located at the station control centre adjacent to the Station Master's Office.

H3.4.2.2 The equipment up to & including the main low voltage switch board forms the part of supply by the Contractor for SYS II. The building contractor shall liaise with the SYS-I and SYS-II contractors for ascertaining the space requirements and establishing the acceptability of power supply schemes. The power supply distribution shall be grouped to achieve minimum outgoing feeders while maintaining the flexibility of connection to DG set supply in case of power supply failure.

H3.4.2.3 The Main distribution board (MDB) shall be designed to have sectionalised bus bars to feed the entire lighting/equipment load divided in two parts through normal supply and essential load through normal power backed with DG set supply. Accordingly the station load categorised based on supply backup is as under:

H3.4.2.4 The services shall be designated as under:

Normal

Essential

Emergency

H3.4.2.5 **Normal loads** like normal lighting (excluding emergency light outlets) of platform, station building, equipment rooms, Circulating area lighting, Seasonal loads like fans and air conditioners , **escalators** and water pumping installations such as station cleaning pump & sewage pumps if provided

H3.4.2.6 Services designated as **essential** like, essential lights, **fire fighting pumps & lifts** being fed through separate bus shall be connected the DG set through microprocessor based intelligent AMF panel after the due wake up time. Essential services shall be maintained in the event of failure of supply. On restoration of transformer supply the DG set supply shall be disconnected through interlocks and essential load shall be fed by normal supply.

H3.4.2.7 **Emergency Loads** like emergency lighting of platform, station building, equipment rooms, & circulating area emergency light, control supply, CCTV,

signage, station control room equipment supply, fire safety and security systems along with signaling, AFC and telecom shall receive normal supply extended from any of the healthy bus bars and DG set back up supply connected through UPS. For signaling, telecommunications and AFC systems, the Sys I contractor shall make provision for UPS of the requisite battery backup period

H3.4.3 **Switchgear**

H3.4.3.1 All assemblies of switchgear and control gear shall comply with EN 60 439-1 or approved equivalent.

H3.4.3.2 The clearance in front of back and side of all assemblies of switchgear and control gear shall be not less than 1.2 metres. The switchgear should be considered with fully drawn out condition.

H3.4.3.3 All **markings** shall be clear. The marking and arranging of switchgear, bus bars, connections and small wiring shall comply with an approved international standard. The identification marking on all terminals, cables and component parts shall correspond with those on the manufacturer's drawings.

H3.4.3.4 **Terminal blocks** for low voltage wiring shall be of the rail mounted type moulded from high-grade non-hygroscopic melamine having all live parts fully shrouded. Terminals shall be assembled in banks and each terminal shall be complete with marking tags to fit into moulded tag slots.Terminals for final connections for indication, instrumentation and metering circuitry shall have test probe facilities and an integral disconnecting device to facilitate testing.

H3.4.3.5 The switchgear assembly/sub assemblies or panels should be termite and rodent Free. The sub assemblies of similar equipment shall be modular, extendable and interchangeable duly painted.

H3.4.4 **Circuit Breakers and Switches**

H3.4.4.1 Circuit breakers shall comply with IEC 947-2 or approved equivalent and have the design uninterrupted current rating when enclosed and in its operating environment with a rated operational voltage as specified for the switchboard. The circuit breaker shall meet the fault conditions specified for the board.

H3.4.4.2 Circuit breakers shall be of the metal clad withdrawal isolating removable type having provision for safe maintenance.

H3.4.4.3 Low voltage air break switches shall comply with IEC 408 with an uninterrupted rated duty, and utilisation category AC 23.These shall be marked with disconnection and EMC conformity.

H3.4.4.4 Each switch shall be provided with facilities for padlocking in the "OFF" position.

H3.4.4.5 To prevent accidental contact with live parts, switches of the withdrawal chassis or insulating type shall have either fully shrouded fixed contacts or insulated cover plates.

H3.4.4.6 Miniature circuit breakers shall be in accordance with IEC 898, or equivalent. The current rating and type of unit shall be appropriate to the application with nominal voltage to earth of 240 volts. The minimum category of duty for units of 50 amperes and below shall be 3kA (M3) and for all others 9kA (M9).

H3.4.4.7 Circuit breakers shall be lockable in drawn in and drawn out positions. Circuit

breakers shall be moveable in drawn out position or drawn in position when in open state.

H3.4.5 **Contactors**

H3.4.5.1 Contactors shall comply with IEC 158-1 and shall be of the break type having an uninterrupted rated duty, a utilisation category AC 3. Contactor operating coils shall be AC suitable for the phase to neutral voltage of the supply and shall be protected by means of a low current cartridge fuse.

H3.4.6 **Metering Equipment**

H3.4.6.1 Current transformers shall comply with an approved standard and shall be compatible with, and provide the necessary accuracy, over-current factors, characteristics, performance and VA rating for the satisfactory operation of the relevant protection devices, instruments and meters. Current transformers shall be capable of withstanding the maximum short time withstand current for the value and duration specified for the assembly within which it is mounted.

H3.4.6.2 Test links shall be provided in the secondary connections of all current transformers to facilitate testing of instruments, meters and protection devices. These shall be so arranged as to ensure that the transformer secondary winding cannot be open circuited.

H3.4.6.3 Voltmeters, ammeters, frequency indicators and power factor indicators shall be digital and comply with an internationally recognised standard. The wiring to voltmeters, and the potential coils of frequency indicators and power factor indicators shall be protected by separate fuses/MCBs.

H3.4.6.4 All instruments and meters shall be completely segregated in instrument compartments.

H3.4.7 **Switchboards**

H3.4.7.1 Switchboards shall be metal clad comprising the assembly of switchgear, control gear and components indicated in the drawings and shall be floor standing of the multi-cubical type, Form4 construction, max. 2.6 m height with IP 54 degree of protection.

H3.4.7.2 The switchboard shall have a rated short time withstand current of 50kA for 1 second and a fault withstand classification of Class 3 for a supply voltage of 415V a.c. between phases at 50Hz.

H3.4.7.3 **Protection against shock** in normal service shall be achieved by the provision of barriers or enclosures both vertical and horizontal and between adjacent units to ensure segregation and prevent accidental contact with live parts, or by complete insulation of all live parts.

H3.4.7.3 **Cable terminations** shall be suitable for the size and type of cables used.

H3.4.7.4 Where armoured multi-core and Mineral insulated copper sheathed (MICS) cables terminate inside the switchboard enclosure, glanding plates or glanding brackets shall be provided for securing the cables to the switchboard. **Glanding plates**, glanding brackets and extension boxes shall be removable and shall be of adequate size for the particular cables to be terminated.

H3.4.7.5 Separate current transformers shall be provided for each protection device and

for instrumentation.

H3.4.7.6 The main bus bar & secondary bus bar for incoming supply to individual MCCBs / MCBs shall be suitably designed as per code of practice for ease of accessibility & protection. The outgoing cables from the MCCBs / MCBs shall be terminated in terminal blocks.

H3.4.7.7 **All outgoing feeders shall be protected by Residual Current Devices (RCD's) as per Rule 61A of IE Rules**.

H3.4.7.8 All components, lifting lugs, earthing studs shall conform to respective Indian Standards or IEC specifications and shall be suitable for the particular requirements of rated current, voltage, service life, making and breaking capacity and short-circuit withstand strength. Co-ordination of component matching shall be observed.

H3.4.7.9 Switch boards and panels shall be, but not limited to, such as

(i) Main distribution board

(ii) Lighting Distribution boards/panels

a) Station building supply including parking & circulating areas.

b) Platform lighting at stations.

c) Emergency lighting at station.

(iii) Pumping panels

a) Fire fighting pump.

b) Water supply pump.

c) Seepage pump panel.

(iv) Signal Telecom & AFC equipments

a) Equipment panel boards

(v) Low voltage power distribution boards

(vi) Escalator / Lift Supply

a) Escalator feeder

b) Lift feeder

(vii) Sub distribution boards

Lighting distribution and sub lighting distribution boards with multiple LED /Neon type indication to diagnose the problem so that Station manager tells the maintenance problem details very precisely to the maintenance team.

(viii) Any other board/panel including control panels etc.

However list is not exhaustive and DDC shall update the same suitably.

H3.4.7.10 Basically switchboards drawings of the switch board /distribution / sub distribution / lighting distribution boards shall include but not limited to:

a) General arrangement and schematic together with the material schedule.

b) Overall or panel dimensions. ,annunciation, alarm control, protection scheme and calculations, Remote Control contacts.

c) Layout of the front of the switch board/ lighting panel including operating gear, indicating lamps etc.

d) Foundation drawing / mounting details in case of wall mounting.

e) Scheme of interlocking and protection & interface.

H3.4.8 **Main Distribution Board**

H3.4.8.1 DDC shall prepare technical specifications, location drawings, erection details for tendering including controls testing and acceptance criterion for provision of main distribution board (MDB). Mimic display panel if provided shall provide membrane touch controlled switching panel in the control center for electrical utility loads.

H3.4.8.2 DDC shall specify the dimensional requirement for space and liaise with other system wide DDC to fix the utility loads and controls required to be incorporated with interlocking logic.

H3.4.8.3 Control Mechanism

1. Control panel shall be designed to give full **feather touch control of switching** operation though membrane touch switching mechanism, contact system, arc extinguishing device and tripping unit.

2. The switching mechanism comprising of feather touch switching panel backed with operating circuit control shall operate the contact system for the purpose of power distribution. Switching mechanism through latched contacts shall operate **contact system.**

3. The **contact system** shall be designed to minimise the 'let thru' energises while handling normal currents. The contracts shall have 'self wiping' action, high resistance of erosion during interruption/operation and shall remain stable for normal service current.

H3.4.8.5 Contactor- enclosure:

The contact and arc extinguishing system shall be enclosed in insulating case and cover made of high strength, flame retardant thermo-setting material providing inter phase insulation and protection against secondary fire hazards and safety to operating personnel. Extinguishing grid plates shall be designed between the gird plates and extinguisher. .Standard design features of wiring like tied/dressed coloured wires/cables, numbering ferrules crimped lugs etc. DIN rail mounting of components, Terminal protection, Neutral links and other protections. The switching mechanism shall facilitate indication/annunciation for the status of the main contact duly displayed on mimic display panel (MDP). Specified indications shall be alarmed.

H3.4.9 **CAPACITOR BANK FOR IMPROVEMENT POWER FACTOR**

H3.4.9.1 The Capacitor Bank shall comply with IEC 60831 and other latest IEC specification beside other relevant international and Indian standards. The dedicated Capacitor Bank shall be installed in a separate cubicle at major loads in Equipment rooms, Pumping installation, Lifts & escalators Machine rooms &

other loads more than 10KW.

H3.4.9.2 The loads shall be normally of discrete cycle involving more switching operations, therefore the Capacitor bank associated with each major load shall be designed as per the switching and working requirements. The Capacitor Bank shall improve the power factor to 0.95. Capacitor bank shall get connected automatically when conditions prevail as per load to improve the power factor.

H3.4.10 **Distribution Boards**

H3.4.10.1 All main distribution boards, distribution and sub-distribution boards shall be surface mounted consisting of a sheet steel case enclosing banks of miniature circuit breakers and bases as indicated on the Drawings.

H3.4.10.2 The case shall be soundly constructed of sheet steel of not less than 1.5 mm thickness with a hinged door hung by means of internally fixed hinges of substantial construction designed to avoid the door sagging when opened. When closed, the case is to be dust proof and entirely free from external protrusions.

H3.4.10.3 Inside each case shall be fitted a table stating the circuit served under each number and the fuse rating. The table to be printed on durable material in such a manner as to be permanently legible. An engraved Traffolyte label, with black lettering on a white background, shall be fitted in the outside of each board, indicating the number of the board, the voltage, phase and service, the exact wording to be agreed with the Employer's Representative.

H3.4.11 **Uninterrupted Power Supply (UPS)**

H3.4.11.1 DDC shall design an **on-line parallel redundant Un-interrupted power supply (UPS)** system 415V, 3Phase, 50Hz, solid state type, suitable capacity complete with accessories / auxiliaries, rectifier, inverter, By-pass module, indicating instruments on the incoming / outgoing supply.

H3.4.11.2 Both the UPS shall be designed to work in parallel if required. The UPS shall be suitable for continuous qualitative and reliable operation under the ambient conditions without any adverse effect on its performance. The UPS shall have a minimum degree of protection of min.IP 31 in accordance with BS 5420 or equivalent.

H3.4.11.3 The UPS shall be with manual and solid state bypass switches and shall be complete with incoming mains isolator, input and output ammeters, voltmeters and frequency meters, power on indication and fault indication/diagnostic features. The distortion factor with linear load shall be specifically tested in addition to the load sharing of battery bank, component circuits and others. In case of any de-rating due to operating conditions, this must be specifically mentioned on the equipment.

H3.4.11.4 The UPS shall be connected with ½ hr. back up valve regulated lead acid batteries twin battery sets. The UPS shall be designed to work at 50°C at0-95%RH and built to comply with BS/IEC/ISO standards and shall be capable of sustaining overload.

H3.4.11.5 Rectifier, inverter & chargers shall work in full cross redundancy. If charger of one module and inverter of other module fail together, the load continues to get clean UPS power through the working charger and inverter. The parallel redundant

system shall have independent control circuit.

H3.4.11.6 The UPS shall be provided with fault diagnostic system, LED display/annunciation, controls, status, alarm, status, metering, monitoring system & data logger and power monitoring software for operational status locally or with a Computer from remote with RS-232 & 485 compatibility.

H3.4.11.7 UPS shall be compatible to take non-linear loads and capable to handle high crest load. UPS shall be provided with harmonics filter. The UPS Shall have input and output power factor correction features.

H3.4.11.8 UPS shall be compatible to work on 2 sources of supply with reverse phase sequence protection.

H3.4.11.9 The DDC shall design & specify for UPS the following parameters but not limited to as under: -

Output power, Input voltage, Input voltage variation, Input frequency, Output voltage AC, output voltage variation AC, Out put frequency variation, Ripple content with battery, Ripple content without battery, Impedance, Touch voltage, Phase sequence control, Reliability, Efficiency, Acoustic level, Cooling, Battery backup 30 minute on full load,

H3.4.11.10Overload duration/condition.

The Automatic change over switch shall be incorporated in UPS for selection of either source of supply. The voltage on both the incoming mains shall be continuously monitored through voltage sensing device with adjustable range, on all the three phases.

H3.4.11.11Protection

The UPS shall be suitable for taking unbalanced load and the UPS shall be provided with H class insulation.

H3.4.11.12**annunciation**

UPS system shall be designed with protection & annunciation system for monitoring Phase sequence, Overload and short circuit trip, Earth fault, Reverse power relay, Low battery voltage, Fault indication alarm through suitably designed hooter, self diagnostic annunciation system, controlled remotely/manually as per alarm and operation status available on auxiliary terminal board as extended to operation control center & station control center. The metering system shall be based on digital indication with status on auxiliary contacts. The monitoring system shall consist of comprehensive display system comprising of LED displays, touch membrane switches and 40/80-character LCD display and data logging storage for logging operational and failure events. Software controlled switching limits shall be in-built feature of the UPS. The control and metering panel shall provide for the following:

H3.7.12 **MAINTENANCE FREE VALVE REGULATED 220 V LEAD-ACID BATTERY**

DDC shall design the maintenance free valve regulated lead acid battery system, its capacity, battery rack and other accessories including tests, performance parameters & technical requirements of individual components for the cells based on the technical requirements. The systems design shall cover aspects like rating

and other particulars, Type, capacity of battery, watt hour efficiency of the battery, Construction,, electrolyte, battery stand ,marking, packing, maintenance instruments but not limited.

H3.7.13 **Diesel Generator Set**

H3.7.13.1 A DG set of suitable capacity shall provide the back up power to Emergency & Essential categories of loads as well as to the UPS. While working out capacity of DG set, provision shall be made for soft start of heavy loads such as fire fighting pumps for clipping the maximum demand during starting and running of such load.

H3.7.132 The DG set shall also be located as close to the auxiliary sub station as possible. Starting of DG set shall be controlled through automatic mains failure panel (AMF). The supply from the DG set shall be received at LV switch board provided in ASS and DG set supply shall be extended to LV MDB through a bus coupler arrangement suitably interlocked to open whenever the income supply resumes after a failure.

H3.7.13.3 The DG set shall be able to start automatically even in cold conditions to take full load within 10 seconds (wake up time) of failure of normal supply. The AMF panel shall be connected & provided with suitable interlocking arrangements to ensure automatic starting of the DG set on failure of supply from both the feeders and interlocking arrangement to avoid any incident of paralleling of normal power supply to DG set supply.

H3.7.13.4 The equipment shall be designed, to the International Standards likeBS4999, BS5000, BS5514, IEC34, or equivalent, to the latest changes and tested as per these standards and designed for low specific fuel consumption, low weight (KG) to KVA capacity ratio & less space (SQM) to KVA capacity ratio.

H3.7.13.5 DDC 's design shall include following but not limited to diesel Engine, alternater, cooling system, filtration system, starting system, automatic idle run, battery charging system, exhaust silencer system, coupling arrangemen, mounting arrangement, lifting arrangement, auto start, foundation, Power factor correction, testing & commissioning.

H3.7.13.6 Protection and annunciation system confirming to latest standards like BS/IEC or IS with soft control and touch resets shall be designed and provided comprising of Overload, short circuit trip, High temperature for cooling water trip, Alarm in case the DG set is not run for one week at a stretch, Earth fault, Reverse power relay, Low battery voltage, fault indication alarm through suitably designed hooter, Self diagnostic annunciation system

H3.7.13.7 The engine will be provided with safety protection against low lubricating oil pressure, High engine-temperature, Fail to start, Safety control trip for the DG SET, Safety control trip for Engine over-speed. Each safety device shall include LED indication, annunciation, alarm and tripping arrangement. Alarm and operation status shall be available on auxiliary terminal board so as to enable to extend alarm and operation status to operation control center & station control center. The metering system shall be based on digital indication with status on auxiliary contacts. The control system and metering panel shall include all above parameters to be monitored.

H3.4.14 CABLES AND ACCESSORIES

H3.4.14.1 General

H3.4.14.1.1 FRLS PVC and Cross linked polyethylene (XLPE) insulated single wire armoured and sheathed multi-core cables shall have copper conductors, for use at 415 volts or less, shall be 1100 volt grade, manufactured in accordance with an approved standard.

H3.4.14.1.2 All cables shall be firmly and adequately supported from cable supports for their entire length except where they run through the steel conduit or concrete encased PVC or polyethylene conduit or are buried direct in the ground.

H3.4.14.1.3 Cables shall be spaced according to Regulations, or to the manufacturer's recommendations, as appropriate for the cables to be supported, and the DDC shall take particular care to avoid sagging or stress on any cable.

H3.4.14.1.4 The DDC should clearly enumerate the method & means of supporting cables in different possible position and also white crossing roads / tracks / pavements.

H3.4.14.1.5 The cable sizes should be generally permit single cable for carrying full load current.

H3.4.14.2 FRLS PVC Power Cables

PVC power cables shall be heavy duty, 1100 V grade, aluminium /copper conductor, PVC insulated, inner sheathed, suitably armoured and overall PVC sheathed with smoke retardant properties

H3.4.14.3 XLPE Power Cables

XLPE power cables shall be heavy duty type, 1100 V grade with copper conductor. XLPE insulated, sheathed, armoured and with overall PVC sheath suitably compounded to meet FRLS properties. The core insulation shall be with cross-linked polyethylene unfilled insulation compound free from voids, of thickness as specified in IS:7098(Pt.I) or latest equivalent .The outer sheath shall meet FRLS properties mixed with chemicals for protection against rodent and termite attack.

H3.4.14.4 Fire survival cable

Fire survival cables, an improved version, FRLS cables easy identifiably colured, shall be used at critical places/or for application where circuit integrity shall be required to be maintained even under fire condition for at least one hour. The cable shall meet the critical fire resistance test conditions as for IEC 331,The test sample of finished cable shall be subjected to flame test at 750° C at rated voltage of the cable for a period of 3 hours..

H3.4.14.5 Cable accessories

The terminating kits shall be suitable for termination of the cables on an indoor switchgear or equipment and shall be of proven design, established make and shall be tested as prescribed. The straight thro' jointing kits shall be suitable not only for conditions of high humidity, for underground buried installation with uncontrolled back-fill and possibility of flooding by water.

Necessary information such as manufacturer's name, type, size, voltage grade of cable, length of cable in meters, drum No., cable code, ISI certification mark, gross weight etc. shall be printed on flange of the drum. An arrow shall be printed on the drum indicating the direction of rotation of the drum.

H3.4.14.5 **Cable handling**

Cables shall be spaced according to regulations, or to the manufacturer's recommendations, as appropriate for the cables to be supported and the DDC shall take particular care to avoid sagging or stress on any cable. The DDC should clearly enumerate the method and mean of supporting cables in different possible position and also white crossing roads / tracks/ pavements.

H3.4.15 **Cable Trunking**

H3.4.15.1 Under floor, skirting, wall trunking and high level ceiling trunking shall be in accordance with the highest standards, shall be of the steel type with steel covers and shall be hot dip galvanised or zinc plated finish.

H3.4.15.2 The lengths of trunking, bends tee sections and offsets shall be coupled together by means of fish plates and the trunking manufacturer's cadmium plated steel set screws, nuts and shake proof washers.

H3.4.15.3 At each joint in the trunking continuity shall be maintained by means of electrolytic copper links secured by brass nuts, locking washers and bolts.

H3.4.16 **Cable Tray**

H3.4.16.1 Cable tray shall be perforated full wrap around type not less than 1.5 mm thickness mild steel hot dip galvanised finish.

H3.4.16.2 The cable tray shall be of sufficient width to take the cables without crowding and shall allow for future additions to the proportion of 25% of present requirements. Double stacking of cable shall not be allowed except where specifically agreed by the Engineer.

H3.4.16.3 The cable tray shall be fixed to purpose made galvanised steel brackets that shall in turn be fixed to the structure. The brackets shall be hot dip galvanised. Acceptance test for each support fixture may be laid down to avoid any loosening or hanging of support structure. No supporting structure or bracket of fixing material should have sharp edge or abrasive effect on cable.

H3.4.16.4 The fixing brackets shall rigidly support the cable tray and shall provide a clear space between the structure and/or obstructions and the back of the cable tray.

H3.4.17 **Conduit**

H3.4.17.1 PVC or Steel conduit and fittings shall comply with BS 4568 or approved equivalent specification and shall be screwed classification.

H3.4.17.2 The class of protection against corrosion shall be as scheduled. Class 2 conduit and fittings shall have black enamelled finished and Class 4 shall be hot dipped galvanised.

H3.4.17.3 Conduit boxes and covers shall have a minimum degree of protection as indicated in the table:

Location		Against Corrosion	Enclosure	Surface/ Concealed
1	Outside buildings	Class 4	IP44	Surface
2	Plant rooms and service ducts	Class 4	IP41	Surface
3	Switch rooms	Class 4	IP41	Surface
4	Ceiling voids	Class 4	IP41	Surface
5	Below ground	Class 4	IP44	-
6	Store rooms	Class 2	IP41	Surface
7	All other locations	Class 2	IP41	Concealed

The minimum size of conduit shall be 20 mm.

H3.4.17.4 To satisfy requirements for earth fault loop impedance, the layout of conduit, trunking and ducting and routing of cables shall ensure that the maximum circuit lengths allowable are not exceeded. DDC shall indicate maximum & typical values.

H3.4.17.5 Bending of conduit shall be done without the use of heat using a bending tool that complies with the British Standard appropriate to the conduit material.

Draw-in boxes shall be provided in conduit at the following maximum intervals:

Straight run	8 m
Run with one or two bends	6 m
Run with three bends	4 m
Run with four bends	2.5 m

No conduit shall be under mechanical stress.

H3.4.17.6 Where conduit is cast in-situ it shall be securely fixed before concrete is poured. As soon as shuttering is removed it shall be checked for freedom from blockage and continuity.

H3.4.17.7 At expansion and settlement joints suitable provision shall be made in conduit, trunking and ducting to allow for movement of the structure. For trunking and ducting purpose-made expansion couplings shall be used.

H3.4.17.8 Temporary plugs shall be fitted to open ends of conduit and ducting to prevent ingress of water and solid material.

H3.5 Sub-main Distribution

H3.5.1 General

H3.5.1.1 The DDC shall design and make provision for 415 Volt distribution systems with associated protection switch gears and LV connections to the LV Switch board in auxiliary substation, to main distribution board and further to other distribution and sub-distribution boards.

H3.5.1.2 The DDC shall design the equipment including cabling, metering, power factor correction and connections to control cables, etc.

H3.5.2 **Technical Requirements**

The switchboards shall be designed to incorporate the following principles:

a) Normal power shall be available from the two 33kV/415V transformer supplies on the basis of one as the main supply and then other as a live standby supply at LT panel in auxiliary substation.

b) There shall be voltage sensing with automatic changeover switches by phase failure detection.

c) Correct phase sequence (rotation) shall be determined for both transformer supplies before connection is made to the LT panel switchboard and after any supply reconnection that may occur within the contract period.

d) The LT panel shall provide outgoing power to main distribution board provided in the station control room.

e) Metering shall include:

f) Mains incoming power V, A, and PF and Energy Meter for each in-comer on the main distribution board.

g) Incoming power V, A and Energy Meter for each in-comer on the distribution board to identify energy consumption for the purpose of energy conservation.

h) Automatic power factor correction shall be provided through capacitor banks located in the plant room and connected to the main distribution board via an adequately rated circuit breaker.

i) Correction shall be in two or three steps with PF= 0.95 lagging or better. The system shall ensure that a leading PF does not occur.

H3.6 Power Supplies

H3.6.1 **General**

H3.6.1.1 DDC shall design for power to be supplied from the main LV switchboard to all distribution positions including distribution boards, consumer units and specialist services power supply isolating switches.

H3.6.1.2 The principle of dual power supplies shall extend to the last distribution board feeding the final power supply cable.

H3.6.1.3 Power shall be provided to all services such as communications and SCADA systems, lighting and general power distribution boards, consumer units, and all items of power equipment supplied under system wide contracts such as escalators, lifts and CCTV camera points.

H3.6.2 **Technical Requirements**

H3.6.2.1 The DDC shall include for cables between the sub-main LV switchboards and the

main LV switchboard, to distribution boards, to consumer units and to local plant isolators. The cables shall be adequately rated for normal and fault withstand current in accordance with the highest protection device settings.

H3.6.2.2 The distribution system shall safely and adequately provide outgoing power to all LV power consuming positions.

H3.6.2.3 Full allowance shall be made for liaison with other equipment suppliers requiring electric power.

H3.6.2.4 Allowance shall be made for the provision of 25% spare capacity in switchboards, cables and wire-ways.

H3.6.3 **Distribution System Design**

The following feeders shall be provided from the man distribution board located at the station control room.

a) Emergency lighting

b) Signal, Telecom and AFC feeder

c) Station building & platform lighting supply

d) Watering Pump feeder

e) Pump feeder for emergency fire fighting /sprinkler pumps

f) Lifts

g) Escalators

h) Circulating area lighting

i) Seasonal loads

The power distribution for each of the above feeder breakers is set out as

H3.6.4. **Emergency lighting**

Separate emergency lighting feeder shall run from central bus connected to DG set backed supply and shall supply through UPS to emergency lighting loads of platforms, concourse, DG set room, signage and station control supply t to station control centre and various panels.

H3.6.5 **Signal, Telecom & AFC feeder**

H3.6.5.1 This feeder feeds the emergency load of signal, telecom, AFC system and related equipments. One panel is envisaged in the designated equipment room housing any of the above equipment. Incoming power supply through two separately located cables from the MDB shall be received in this panel. The outgoing to each equipment or equipment rooms or accessory/ancillary shall be drawn through an individual switch housed in the above said panel. . For the Air-conditioning load of these plant/equipment rooms powers, a separate Air-conditioning feeders is envisaged from the above panel.

H3.6.5.2 The backup UPS shall be connected to the designated equipment along with the power supply feeder to the panel.

H3.6.5.3 It will be the responsibility of SYS I contractor for taking power supply from this panel to all the work areas and equipment related to his supply or provisioning.

The building contractor shall provision for cable trays / trunking or means to carry these cables. The building contractor shall be required to liase with SYS I contractor for ascertaining the panel design, provisioning of feeders, other design matter, location and mounting / erection details.

H3.6.5.4 The cables from auxiliary sub stations to MDB shall be normal, non-fire survival cable as the UPS is proposed to be located alongside each of the equipment in the respective equipment rooms. However, it is also a fact that DG set supply is available at the main bus of MDB through ACB provided in LV switch board. This power needs to be carried uninterruptedly to the respective equipment.

H3.6.6 **Station building & platform lighting supply**

The entire load of the station shall be divided into two and shall be connected to different bus bars of MDB and each platform and concourse shall be provided a lighting distribution board to feed platform light load in two normal light circuit and one emergency light circuit further distributing loads in different phases through sub distribution boards so as to minimise the impact of failure on feeder or bus. Similarly the lighting load of station building shall be subdivided for lighting, power sockets equipments supply etc. to avail similar benefit. The second normal lighting circuit shall be charged through essential feeder in case of prolonged power failure.

H3.6.7 **Watering Pump feeder**

Watering pump panel shall also receive supply from both/single the bus bars so as to ensure availability of power supply for pumps

H3.6.7 **Pump feeder for emergency fire fighting /sprinkler pumps**

The fire fighting pumps, station cleaning, sewage pumps(if any) shall be connected to DG set backed supply.

H3.6.8 **Lifts**

The lift load shall be connected to normal supply but one of the lift on demand can be connected to UPS supply to evacuate trapped handicapped person in case of fore at the station.

H3.6.9 **Escalators**

Escalators shall be divided and connected to normal supply through two different feeders to minimise the impact of supply/feeder failure and services shall not be available in case normal power is not available.

H3.6.10 **Circulating area light**

Circulating area lighting shall be divided in two parts and connected to normal supply through two different feeders to minimise the impact of supply/feeder failure and services shall not be available in case normal power is not available.

Parking area for cycle/ auto rickshaws, cycles /motor cycles & car & bus parking areas shall be illuminated through normal power extended.

H3.6.11 **Seasonal load**

Seasonal load like Air Conditioners and fans required in summer shall be separate

from normal load and shall be subdivided in two parts with above view with control at station control centre to switch off when not needed.

H3.7 Earthing and Bonding

H3.7.1 General

H3.7.1.1 Earthing and bonding shall be designed by the DDC in accordance with BS 7671: 1992 or approved equivalent in order to protect persons and equipment from the effects of an electrical fault anywhere in the system.

H3.7.1.2 Earthing shall be designed to allow safety equipment to operate properly and to maintain touch voltages below 50V in the event of a short circuit in any part of the system. The extent and adequacy of the system must be established and suitable testing method laid down for ascertaining and then accepting the system as a sound and adequate one.

H3.7.1.3 All the criterion shall be incorporated by DDC strictly in conformity with this Specification, relevant rules, Regulations and Codes of Practice including the following:

i) Indian Electricity Rules 1956 as amended up to date.

ii) Indian Standard Code of Practice for Earthing IS:3043-1987.

iii) Regulations laid down by the Chief Electrical Inspector.

iv) Regulations of the Electricity Supply Authority concerned.

v) Regulations for crossing of Railway tracks- 1987.

vi) Indian Standard Code of Practice for electrical wiring installation: IS:732-1989

H3.7.1.4 Earthing shall be designed to ensure the following:

a) Compliance with regulations

b) Safety of passengers and staff from the possibility of high potential to structural earth potentials

c) Correct operation of breakers and tripping devices and maintaining loop impedance to a accepted value

d) Equi-potential bonds to ensure touch voltages (between conducting components accessible to persons) during a fault condition do not exceed 50V.

H3.7.1.5 The DDC shall design an earth bar in each of the substations to meet the requirements of the System wide Contractors. The DDC shall liaise and co-ordinate closely with the System wide Contractors to select the most suitable locations around the station to locate the earth electrodes. An independent earthing system shall be provided for computer equipment, signaling and telecommunication equipment.

H3.7.2 Technical Requirements

H3.7.2.1 Main Earth

The main earth shall be derived from a main earthing bar in the plant room which in turn shall be connected to a local earthing network of low impedance (less than one ohm unless otherwise authorised by the Employer's Representative).

H3.7.2.2 **Main Equipotential Bonding**

Incoming services to the stations in metal pipe or armoured cable shall be fitted with isolating joints as close as possible to the point of entry. On the station side of the joints, the pipe/armour shall be bonded to the main station earth bar with earthing cables or tapes. On the incoming side the pipe/armour may, with agreement between the NMRC/Noida-Greater Noida authorities and the utility be connected via a diode and switch to the stray current mitigation bus.

H3.7.2.3 **Supplementary Bonding**

H3.7.2.3.1 All sinks, wastes, and all metallic plumbing connections to sanitary equipment shall be bonded to earth by means of 6mm earth cable.

H3.7.2.3.2 All ceiling space equipment shall be bonded in agreed positions and the final bond taken to the local sub-distribution board earth.

H3.7.2.3.3 Layout of earthing electrodes should be such as to have distinction between equipment, neutral and lighting earth electrodes in addition to permit access for future testing / maintenance or replacement.

H3.7.2.3.4 The earthing bus design should also provide visual distinction between equipment and neutral earthing.

H3.8 Lightning Protection

H3.8.1 General

H3.8.1.1 Due to the high annual incidence of thunderstorms, and the concentration of people at stations, lightning protection shall be designed for all buildings and structures.

H3.8.1.2 The lightning protection system for the surface structures of the station shall include air tapes and down conductors and earth rod/mat system. Bonding to metal features such as steel chimneys and fan grilles shall also be included.

H3.8.2 Technical Requirements

H3.8.2.1 Lightning protection shall be designed to a high standard in accordance with local regulations (or a recognised approved standard such as BS 6651: "Protection of Structures Against Lightning").

H3.8.2.2 Concrete structures shall employ roof tapes (air tapes) while steel structures may use the structural steelwork frame as a collector and as a down conductor system. Vertical finials over 400mm shall not be required.

H3.8.2.3 The DDC shall pay particular concern regarding penetration of the roof fabric for connecting of roof tapes to structural steelwork and for the bonding of steelwork at the joints to ensure a low resistance earth path.

H3.8.2.4 The down conductors or the connecting wires of lighting electrodes to lighting earth

electrodes to lightening earth should be at least 1.5m away from any power / control /

telecom cable.

H3.8.2.5 The DDC shall provide concrete earth inspection pits complete with concrete

covers.

H3.8.2.6 The lightning conductor and earthing system shall be designed to conduct lightning discharges without damage or injury to personnel, structures or the conductor system.

H3.8.2.7 The earthing system shall consist of copper or stainless steel earth mats, or a network of specially drawn copper-clad steel rods bonded together, to give the necessary low impedance for an effective system.

H3.8.2.8 Test facilities shall exist for disconnecting down conductors at earthing points to allow testing of the individual earthing points.

H3.8.2.9 Where aluminium tapes are employed great care shall be exercised in protecting the system components from electrolytic corrosion due to dissimilar metals being in contact with each other. Special bi-metallic connectors shall be employed at junctions of copper and aluminium conductors. Copper air and down conductor tapes shall be PVC sheathed.

H3.9 Lighting

H3.9.1 General

H3.9.1.1 General lighting shall be provided in all areas of the station. The DDC shall make suitable provision for light fittings, cable runs, and associated accessories.

H3.9.1.2 The deliverable shall include detailed design in tabular form, drawings and isometric charts generated by suitable software packages. The minimum, maximum level of lighting and other suitable parameters shall be mentioned. This shall include behaviour of luminaires, lighting levels for different service life. The optimisation shall be based on life cycle costing basis.

H3.9.1.3 Each lighting panel shall consist of two separate and distinct sections or two separate panels for normal and emergency lighting. The normal lighting section shall feed the 80- 85% by two lighting circuits in accordance with the scheme of lighting indicated in the Specification. The emergency lighting section shall feed the15-20%lighting circuit covering the emergency lights, which are provided with electronic ballast capable of working on 230 V AC. These lights are also distributed on all the three phases for their normal operation.

H3.9.2 **Technical Requirements**

H3.9.2.1 Lighting within the stations shall be to a high standard. Lighting requirements at stations are described in Appendix E

H3.9.2.2 The type and quality of fittings and their luminous intensity shall relate to the space being illuminated. Light level shall be uniformly distributed throughout the station and shall be designed such that glare, dark recesses and areas of poor lighting levels are avoided.

H3.9.2.3 At station entrances passengers enter passages from sunlit streets and graduation of lighting levels shall be provided.

H3.9.2.4 Escalators and stairways shall be well illuminated and sub-divided to provide at least minimum prescribed emergency levels of illumination in case of no normal power supply as detailed in the power supply scheme.

H3.9.2.5 Concourse and ticket hall areas require a reduced level of lighting except at ticket machines, automatic fare collection (AFC) gates and tops and bottoms of escalators and stairs.

H3.9.2.6 The lighting intensity at platform level shall be compatible with that of train vehicle, reducing in intensity at platform ends, particularly the leading end, thus reducing glare to the driver on entering the station. Lighting shall provide a continuous run adjacent to platform such that the threshold of the platform edge is well illuminated.

H3.9.27 Glare shall be avoided while design of the lighting by the correct choice of location, number fitting type, luminance and shielding of luminaries.

H3.9.2.8 Luminaries in control rooms shall be positioned so that no reflected glare from dials or monitor screens interferes with the operator's vision.

H3.9.2.9 Lighting switches shall be rated for 20 amperes, and shall have white moulded plastic operating rocker bars. The switches shall be mounted on adjustable steel grids, enclosed in pressed steel boxes finished electrolytic zinc plate.

H3.9.2.10 Station lighting in public areas, e.g. platforms, concourse, etc. shall be arranged in banks and switched remotely by means of contactors with self diagnostic identification to indicate failure in the sub-circuit.

H3.9.2.11 Surface mounted switches shall have standard surface type plates in all locations except plant rooms where stove enamelled aluminium finished plates shall be provided. An earthing terminal shall be provided in each switch box and on the grid.

H3.9.2.12 Splash proof lighting switches shall be rated at 5 amperes and housed in galvanised cast iron or impact resistant moulded plastic enclosures providing the minimum degree of protection compatible with IP 44.

H3.9.3 Time switches.

H3.9.3.1 Spring reserve 24 hour dial time switches shall be suitable for operation on a 220 volt 50Hz ac supply and shall be driven by a self-starting synchronous motor with a spring reserve mechanism which shall enable the clock to continue to function for a period of at least 30 hours after interruption of the supply. Separate motor and switch terminals shall be provided. Switch contacts shall be rated at 20 amperes.

H3.9.3.2 The time switch shall be fitted with a 24 hour dial complete with one set of ON and OFF levers. A selective day omitting device shall also be provided. The time switch shall be provided with an "ON-OFF" by-pass switch to completely over-ride pre-set switching functions.

H3.9.3.3 Spring reserve - solar dial time switches shall be suitable for operation on a 240 volt 50Hz ac supply and shall be driven by a self-starting motor with a spring reserve mechanism which shall enable the clock to continue to function for a period of at least 30 hours after interruption of the supply.

H3.9.3.4 Separate motor and switch terminals shall be provided. Switch contacts shall be rated at 20 amperes.

H3.9.3.5 The time switch shall be fitted with a 24 hour dial complete with one set of ON

and OFF levers. A selective day omitting device shall also be provided. The time switch shall be provided with an "ON-OFF" by-pass switch to completely over-ride pre-set switching functions.

H3.9.3.6 For safety reasons, where lighting switches occur in different phases they must be separated by a distance of not less than 2.0 m unless phase barrier type switches are used. This type of switch is only to be used when shown on the drawing or on the specific instruction of the Engineer.

H3.10 Emergency Lighting

H3.10.1 General

H3.10.1.1 An emergency and escape lighting system shall be provided in accordance with the requirements of the NMRC/Noida-Greater Noida authorities, the fire department and internationally accepted practice.

H3.10.1.2 The design shall for emergency lighting covers the detailed design, of a working system. Emergency lighting shall be provided in all public areas

H3.101.3 **Technical Requirements**

Lighting within the stations shall be to a high standard. Lighting requirements at stations are described as Under:

Level of Illumination adopted for Rail Corridor Stations

Sr.	Activity area	Illumination	
		Normal	Emergency
		(Lx)	(Lx)
	Passenger area		
1	Circulating area	30 - 50	5-8
2	Entrance hall	200	5-30
3	Mezzanine	200	5-30
4	Concourse	250	5-37.5
5	Booking counters	300	5-45
	Ticketing machines	(Localized)	
	Time table		
6	Passenger staircase / subw a	100 - 150	5-22.5
	from Ground to Mezzanine		
7	Escalators	250	5-37.5
8	Platforms (General)	200	5-30
	Platforms (Edge)	250	5-37.5
	Operation areas		
1	Control room	500	75
2	Equipment rooms	300	5-45
	and other operation area	or 200	5-30
3	Store room	150	5-22.5
	Battery room		
	Cable distribution room		
	Void area		
1	Void area	5 lux min.	5

Service Illumination *will be working condition Level*

Above illumination levels are indicative,DDC shall not be limited to above.

H3.11 General Power

H3.11.1 General

H3.11.1.1 Low voltage ring main circuits of 240 volts single phase shall provide a small power supply throughout the station.

H3.11.1.2 Switched sockets shall be of robust materials and positioned in the following areas :

H3.11.1.3 Platform Concourse spaced at a distance of 15m along the back walls of column supports, at a height of 350mm above finished floor level. These units shall be backed by earth leakage protection devices, 30mA rated.

H3.11.1.4 All other areas spaced to the design requirements with type and height to suit the application.

H3.11.1.5 Heavy duty single phase, and three phase 30A/32A power outlets shall be provided for workshops and maintenance areas on ring or radial circuits.

H3.12 SCADA Interfacing

H3.12.1 General

H3.12.1.1 Monitoring of all electrical equipment shall be carried out by the SCADA system supplied under the another Contract. Status information shall be transferred between the Control Centre and the SCADA outstations connected to the electrical equipment. Interfacing between the electrical system components and the SCADA system shall require detailed co-ordination between the respective DDCs. The DDC shall liase with the contractor for the EST Works to ensure the interfacing between the mutual systems meets their joint and individual specification requirements.

H3.12.1.2 All electrical equipment shall be provided with monitoring facilities for connection to the SCADA system. Transducers shall be provided to indicate equipment operational status (e.g. on/off, forward/reverse, over-temperature, power demand, etc.), and fault conditions.

H3.12.1.3 Lighting and LV power shall be controlled locally or at the Main Distribution Board, and not via the SCADA control system. All SCADA interfaces shall be passive with sufficient auxiliary controls shall be made available for measurement of metering parameters.

H3.12.1.4 Transducers for measured operational parameters (or "analogue signals") shall provide an output of 4-20mA output over the full operating range of the input variable. Particular attention shall be paid to correct scaling of the transducers to ensure that the full output range corresponds to the maximum expected operating range of the measured variable. For instance, 4-10 mA shall correspond to a supply voltage range of, say, nominal +/-25%, not 0 to 100%.

H3.12.1.5 The equipment to be monitored is listed below. The DDC shall compile and submit for consent a list of the proposed monitoring and control signals for each item of plant, copied to the EST contractor.

(a) Fire Detection and Alarm Interface

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

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

(b) Power and Lighting Interface

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

a) LV Main Distribution Board incoming circuit breaker status.

b) LV Main Distribution Board outgoing circuit breaker status.

c) Protection relay operation.

d) Incoming power lines (2 No) healthy.

e) Dual supplies healthy; all areas.

f) Emergency lighting fault status.

g) UPS Status (I/O voltage, indication and position of bypass switch).

h) Power distribution circuit faults one for each group of loadings at the local level.

i) Services Annunciation Panel for lifts, fire fighting panel supply, control centre supply, escalator supply, pumps supply, DG Set status.

j) Water level annunciation.

k) Equipment status annunciation.

H3.13 Water Supply System

A suitable water supply system shall be provided at each station for meeting the passenger, staff & operational requirement of water i.e. as drinking, flushing, fire fighting & station premises washing etc. comprising of **under ground static tank** suitably chambered to receive water in fire fighting tank to overflow to raw water tank and get collected after treatment in treated water chamber/tank. The water for daily drinking, toilet flushing & station cleaning water shall be stored in overhead tank.

H3.13.1 Water Pumping System

H3.13.1.1 A water pumping system comprising of 2/3 automatically controlled bore well pumps shall be designed to supply water to under ground static tank.

H3.13.1.2 Submersible type bore well pumps of staggered capacity working for 4-5 hours a day at head of 40-50 meter head shall be installed to pump required water.

H3.13.1.3 2/3 suitable booster pumps automatically controlled through self-priming & level actuated switches, shall be designed for secondary pumping installation to pump treated water to overhead tank.

H3.13.1.4 2/3 suitable booster pumps automatically controlled through self-priming & level actuated switches, shall be provided for secondary pumping installation to pump raw water through water treatment system to treated water tank. The water treatment system shall be complete with al accessories and back wash pumping system if required, suitably designed to meet daily requirement

H3.13.1.5 Pump sets for fire fighting and jockey pumps etc., with requisite stand-by units shall be located in a pump room provided at ground/concourse level including that for sprinkler system if provided for.

H3.13.1.6 Standby pumps, identical to the installed one, shall be installed with automatic control to work alternatively to ensure reliability of water supply.

H3.13.1.7 The operation of all pumps shall be controlled automatically through level actuated limit switches and status monitoring with remote controlled facility for the pumping installations shall be provide at station managers room with requisite facility for alarm for any in-operative pump for 7 days.

H3.13.1.8 Status of operations, ON/OFF, Fault alarm, water level of tanks shall be provided for all pumps with Station manager for monitoring.

H3.13.1.9 Station washing system with gravity water shall be provided at all the stations of Rail corridor. However wherever necessary, an automatically operated water hydrants shall be provided for station washing by suitable twin controlled Ejecto-pumps, pressure tank, pressure switch and air volume control systems. DDC shall furnish the optimal design.

H3.13.1.10 **Fire fighting pumps:-**Pumps shall be provided for fire fighting system at each station as stipulated in national building code with suitable & reliable design to arrange water at required pressure, velocity with stand by pump driven with alternate source like DG set.

H3.13.1.11 **The following pumps may be required but not limited to.** DDC shall design the water pumping system as per international standards and practices.

-set of Bore well pumps, where required

-set of booster pumps to pump from sump/under ground tank to elevated tank

-Fire fighting pump with jockey for hose reel system

-Fire fighting pump with jockey for sprinkler system if provided

-Seepage /sewage disposal pumps if provided

H3.13.2 Technical requirement

H3.13.2.1 An energy efficient, cost effective system shall be designed taking into consideration the yield, head, discharge, installation depth, bore/delivery dia , Piping length and reliability with guarantee to work consistently at **same efficiency**

H3.13.2.2 **Pump** shall be robust, corrosion free, low power to weight ratio, compact, noise free and vibration less in operations .

H3.13.2.3 A **pump house**, to control primary pumping locations of bore well, shall be provided at station level near the load center. Another pump house shall be provided at ground level to house centrifugal pumps, booster pumps, fire fighting pumps & other pumps and control. Pump house shall be equipped with lifting arrangements suitable to each kind of pump housed.

H3.13.2.4 Separate & individual **control panels** shall be provided with status regarding working & electric supply with indications of voltage, current, energy meter, power factor meter along with protection.

H3.13.2.5 Adequate **space** shall be kept near the pumping installation for obstruction free supervision and easy removal in case of failure, dismantling /assembly, repair, unit spares, storage & tool room.

H3.13.2.6 The pumps NPSH shall always be lower than the atmospheric NPSH to avoid cavitation due to vapourisation.

H3.13.2.7 The motor shall be over rated over BHP of the pump or in line with internationally accepted norms..

H3.13.3 Design considerations

a)Water demand aspects like peak hour water requirement, No. of Hrs. of pumping, Realistic water demand

b)Hydrological aspects like Ground water occurrence, Different type of rock formation, Water bearing properties, Static water level, draw down water level, Draw down level, recuperation time(yield),Average depth of water table in well during peak time, Frictional losses in pipe line, fittings, valves, Quality of water, Type of starter, protection and monitoring devices

As per NFPA recommendations, a fire fighting system shall be designed by DDC with water supply requirement of Q lpm continuously for no.of hours for n no. of hose reel workings/ Sprinkler system.

While submitting design parameters DDC Shall specify discharge, Static head, Dynamic head, Speed of liquid, Specific weight of liquid assumed, Efficiency of coupling, Efficiency of transmission, Motor efficiency, Pump efficiency, Designed Pump capacity, Spare motor capacity adopted, Available range of capacities, Selected capacity, Formulae used for discharge frictional head & pump capacity, Operational interlocks

H3.13.4 Piping System

A colour scheme, material scheme and sizes, their control and metering system shall be stipulated by DDC. The piping material &sizes shall be specified for each service for low friction loss & anti corrosive. DDC shall stipulate the Piping control scheme for various water lines/circuits through timer switches to avoid wastage.

H3.13.5 Pump operation scheme

H3.13.5.1 Primary pumping operation system

DDC shall design complete pump operation scheme and interlocks for satisfactory automatically operated pump including requisite electrical & mechanical protection as recommended in various standards, NFPA or IEC.The Status of water level in the tank and that of the pumps for operation or standby shall be reported to Station Control Room. The normal operation of pump shall be automatically controlled by liquid level controller at different levels and remote control operation by Station Control Room.

H3.13.5.2 Secondary pumping operation system

Suitable water pump operational scheme shall be designed by DDC for pump operation control for pumping water from ground static tank level to overhead tank.

H3.13.5.3 Pumping operation & controls for fire fighting Pumps

The pump operation scheme shall be designed as per the NFPA's recommendation/ Noida-Greater Noida authorities fire service requirements.

H3.13.5.4 ***Automatic level controller:***

Mechanically activated switch, suitably designed to directly control pumps shall be provided .

- The float type switch non-sensitive to turbulence /rotation.
- The float should be of non- corrosive material.
- The calibration should be precise and simple.

The level actuated switch should have multifunctional, multi-level, ready adjustable design to provide complete status of the water level and control circuit for automatic pump operation.

H3.13.6 **SCADA monitoring**

Provision of extra contacts should be available for relaying operating status of the equipment such as pumps to the Station Manager. All the fault alarms, status to be relayed to the panel at Station Manager ‘s room through a RS 485/232 network. In case of pumping applications the level of water in the ground tank, toilet and station sump should be displayed to the panel at Station Manager ‘s room. The water level of mid section sump should also be relayed to the OCC.

H3.13.7 **Switching control procedures**:

A designated person shall keep informed of operating conditions affecting the safe & reliable operation of the system and shall maintain a suitable record showing operating changes.

H3.14 Fire Detection and Alarms

H3.14.1 **General**

The fire detection and alarm system, wired in zones (to be agreed with the Employer’s Representative), using break glass units and automatic smoke/heat detectors shall be provided in accordance with NFPA 72D, British Standards BS5445 and BS5839, EN 54, or ISO 7240-1, as appropriate, or other Internationally recognised or local code of practice approved by the Engineer.

H3.14.2 **Technical Requirements**

H3.14.2.1 The fire alarm control system shall comprise a fully automatic station fire alarm panel, specialist mimic display panel, specialist interfaces for the purpose of plant and equipment control and further electronic interfaces to detection systems in machine rooms and remote locations.

H3.14.2.2 The main station **fire alarm panel** (FAP) shall be located in the station operations room (SOR) and repeater panel(s) located as necessary to guide staff in evacuating passengers and for the fire brigade to accurately assess the source of the fire and the physical routes for combating it.

H3.14.2.3 The station fire alarm system panel shall be equipped with monitoring/relay points to relay status and alarm messages to the SCADA system. The DDC shall provide relay points for the following but not limited to:

1. FAP healthy signal.
2. Fire alarm condition.

3. Fire zone of such alarm condition.
4. Fire condition link to public address automatic messaging.
5. Non-synchronising clock.

H3.14.2.4 These relay signals shall be connected to the station communications equipment under the EST Contract.

H3.14.2.5 The station fire alarm panel (FAP) shall provide alarm and fault monitoring to analogue addressable detection loops.

H3.14.2.6 The station FAP shall provide continuous status information distinguishing between system faults and operation of call points/detectors together with identifications of the zone involved.

H3.14.2.7 **Automatic detection** of a fire shall be by:

- point type;
- rate of heat rise (with fixed temperature element); and
- twin ionisation chamber smoke detectors.

H3.14.2.8 Automatic fire detectors shall be analogue addressable type using the latest algorithm principles for accurate indication of normal condition, detector condition, pre-alarm and alarm indications.

H3.14.2.9 The operation of an automatic detection device shall be indicated on the appropriate section of the fire alarm indicator panel.

H3.14.2.10 **Manual reporting** of a fire shall be by break glass contacts strategically positioned in the means of escape routes and this shall also be indicated on the appropriate section of the fire alarm indicator panel.

H3.14.2.11 The station FAP shall utilise current pulse transmission techniques for two way transmission of data and command signals between the fire alarm processor and the field devices. The processor shall be capable of polling all field devices on a loop within three seconds.

H3.14.2.12 The response to alarms from various combinations of the detectors, flow switches or manual call points shall, via the dedicated microprocessor, initiate performance of such other functions as may be required. Such functions shall be:

a) Alert station staff.
b) Alert line controller.
c) Initiate operation of fire suppression equipment.
d) Initiate operation of automatic public address system message.
e) Release smoke stop doors held open.
f) Allow any emergency exit fastenings to open on transmission of the evacuation signal.
g) Initiate illumination of the station no entry signs, on transmission of the evacuation signal (via the SOR and Telecommunications).
h) Initiate closure of fire shutters.

H3.14.2.13 All detector and bell circuits shall be continuously monitored and a fault on either shall be indicated on the main fire alarm panel in the appropriate zone section.

H3.14.2.14 Where automatic fire detectors are required in ducts in which there is continuous air movement up to 25m/s, they shall comprise a perforated outlet tube across the inside of the duct at 90^{o} to the air flow and leading out to the expansion chamber containing an ion-chamber detector. An extension tube shall return air to the duct for continuous sampling.

H3.14.2.15 The station FAP shall control detection to all designated areas of coverage including remote equipment locations.

H3.14.2.16 The detection system via the station FAP shall interface with the station pre-action sprinkler system and escalator sprinkler system as provided.

H3.14.2.17 Generally the DDC shall provide **zoning** such that a logical sequence is followed which is easily transferable to either or both of a computer based building information management system or a mimic display panel.

H3.14.2.18 The station fire alarm panel shall be fully analogue addressable. The station FAP shall be capable of full "stand alone" operation.

H3.14.2.19 Each loop shall support a combination of analogue sensors and output devices, these being ionisation smoke detectors, optical smoke detectors, rate of rise heat detectors, fixed temperature or analogue temperature detectors, addressable interfaces for input from call points and external equipment, or addressable volt-free outputs to other systems. Other detector types may be fitted according to specific local requirements. Each cable loop shall be of any length up to a maximum acceptable length of 1.2 kilometres for the connection of input and output devices.

H3.14.2.20 **Actuation of call points**, smoke or heat detectors shall be identified by panel indications giving the loop number and device address of the device as well as the fire zone. A text message shall simultaneously be displayed to identify the location. A facility shall be provided for the entry of data by authorised personnel on site.

H3.14.2.21 The station FAP shall incorporate orange indicators covering system fault, device fault, external fault, processor fault and device isolated.

H3.14.2.22 The station FAP shall be self checking, and shall identify contamination of any device or malfunction of any part of the system in such a way that fire alarms are not confused with fault indications. The loss of failure of any device or sounder shall be identified and presented as a fault within 60 seconds.

H3.14.2.23 A facility shall be provided to isolate any loop mounted single device or group of devices on a temporary basis, this shall cause the illumination of a warning indicator on the panel which shall remain illuminated until all loop devices are again operating normally.

H3.14.2.24 The station FAP shall interface with the Station Centralised Clock System, provided by the EST DDC to ensure uniform time throughout the System.

H3.14.2.25 **Repeater panels** shall be fitted where required to enable a member of staff to operate the fire panel remotely from a position regularly used as either remote rendezvous point or station control point. Controls shall be provided on repeater

panels to perform basic panel functions at the remote location. Controls shall include the silencing of alarms, acknowledgement of alarms, display of alarms received and panel reset to normal status. The reset function only shall be protected by key access.

H3.14.2.26 Presentation of information, legends and controls shall be similar to that of the station FAP.

H3.14.2.27 Repeater panels shall possess an internal buzzer that shall operate in all cases of fire and fault, and the ability to operate monitored alarm sounders. The buzzer shall be capable of being accepted remotely.

H3.14.2.28 The repeater panel shall incorporate integral batteries that shall be capable of full panel function for a period of 24 hours in "monitoring" mode. In the event of an alarm condition at the end of the 24 hour period the batteries shall be capable of full panel, mimic and sounder functions for a further 30 minutes.

H3.14.2.29 **Manual call points (MCP)** shall be provided in designated areas to allow the manual initiation of a fire alarm. An MCP shall be located adjacent to all fire exits, and other MCPs shall be located so that one is within 30 metres of any point in the Station.

H3.14.2.30 MCPs shall be positioned at a height of 1.3m at strategic points throughout the station such that they are clearly visible from front and sides as practicable. The operation of any call point connected to the system shall cause the station FAP to enter the ALARM state within three seconds.

H3.14.2.31 MCPs shall be manufactured in bright red compliant material, measuring appx. 85 x 85mm with 50mm overall depth. Operation shall be via a plastic membrane (non breakable) with wording on method of operation in white lettering. The MCP cover shall be etched in black lettering in Hindi and English "FIRE", the lettering measuring 10mm high.

H3.14.2.32 Where MCP are mounted externally, in outside weather or where intrinsically safe operation is required, an MCP rated to IP 66 shall be utilised.

H3.14.2.33 Care shall be taken in designing for areas identified as requiring intrinsically safe fire detectors, these items shall be connected to the addressable loop via the appropriate addressable module units.

H3.14.2.34 Each sprinkler system fire hydrant and hose reel shall be fitted with a flow sensing switch. This switch shall be of the automatic type with baffle and clamp sized according to the pipe-work to which it is fitted.

H3.14.2.35 The pneumatic time delay fitted to the switch shall be set to 20 seconds to avoid actuation by pressure surges.