

**REPUBLIC OF LEBANON
COUNCIL FOR DEVELOPMENT & RECONSTRUCTION**



**Lebanon Emergency Assistance Project
(LEAP)**

**Rehabilitation of Schools–Shelters
“LEAP-SH-SW-MEHE- Batch 1 (Lot 3)”**

Tender Documents

Volume 2 – Specifications

Part 3

Electrical Works

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SPECIFICATIONS

Part 3
Electrical Installations

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CHAPTER 1
BASIC ELECTRICAL REQUIREMENTS

CHAPTER 1
BASIC ELECTRICAL REQUIREMENTS

1 - GENERAL

1.1. RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other chapters of part 3.

1.2. SCOPE OF WORK

- 1.2.1 The scope of electrical work for the Project will include but is not necessarily limited to:

- A. Power Supply and Distribution consisting of:
- Sub-distribution and final branch circuit panelboards,
 - Cables, wires and related accessories,
 - Conduits, wireways, supporting systems and related accessories,
 - Earthing system.
- B. Lighting and Power Installations including:
- Functional indoor and outdoor lighting installations,
 - Wiring devices including all lighting switches, isolating switches, socket - outlets, plates,

- 1.2.2. Unless otherwise specified, includes the supply, installation, testing and commissioning of the complete electrical systems, equipment and materials shown on the Drawings and/or described in the Specification together with all associated ancillary work, support work and builder's work in connection.

- 1.2.3. Incoming power supply and connection will be provided by the Local Power Authority at 220/380 V to the location shown on the Drawings.

1.4. GENERAL REQUIREMENTS

1.4.1. INSTALLATIONS GENERALLY:

- A. Carry out electrical work in accordance with the Drawings, Specification and Regulations, ensuring compliance with design and performance requirements, to provide safe and protected systems with equipment readily accessible for operation, maintenance and repair
- B. Installations are to be complete, ready for operation and fully integrated and coordinated with all other work
- C. Installations are to be carried out by qualified personnel
- D. Provide accessories necessary to complete the installations, of the types specified or recommended for the purpose by the manufacturer of the equipment or accessories.

1.5. DESIGN CONDITIONS

1.5.1. Nominal characteristics of power supply and distribution are as follows:

- A. low voltage: 380 V, 3 phase, 4 wire, solidly earthed neutral
- B. frequency: 50 Hz.

1.5.2. DISTRIBUTION SYSTEMS are to be supplied or derived from the voltage system previously described, as shown on the Drawings, or as otherwise specified.

1.5.3. EQUIPMENT is to be designed for the system voltage and frequency previously described, unless otherwise specified. Special provisions are to be made for equipment sensitive to power supply frequency and voltage variations and for equipment operated at other voltages/frequencies or by direct current sources.

1.5.4. CLIMATIC CONDITIONS: equipment, including transformers, switchgear, cables, relays, lighting fixtures, motors etc., is to be designed and derated for continuous and trouble free service under the following climatic conditions:

- A. altitude: at sea level
- B. maximum ambient temperature: 40 deg. C (in the shade)
- C. minimum ambient temperature: 4 deg. C
- D. maximum relative humidity: 90 %
- E. atmospheric conditions: 1 bar

Where design and operating conditions, different from the above are required for particular equipment, they are described in the specification of the equipment concerned.

1.5.5. REGULATIONS: carry out electrical work in accordance with the current issue of the local codes of practice, local power authority regulations and IEC Regulations for Electrical Installations, where not in contradiction with the local codes of practice and regulations, herein referred to collectively as 'the Regulations'.

1.5.6. STANDARDS: unless otherwise specified, equipment and materials are to be manufactured and installed in compliance with the relevant recommendations of the following:

- IEC : The International Electro-technical Commission ISO
- : The International Standardization Organization
- EN: European Norm
- NF-USE : The French Regulation BS
- : British Standards

or other equal and approved standards, herein referred to as 'the Standards'. Local standards, where enforced and relevant, are to have precedence over the Standards.

1.6. EQUIPMENT AND MATERIALS

- 1.6.1. **AVAILABILITY:** confirm availability of equipment and materials proposed for use in the work prior to submission for approval. If, after approval, equipment or materials cease to be available, submit alternative items of equal quality and type for approval.
- 1.6.2. **ACCEPTANCE BY AUTHORITY:** confirm that proposed equipment and material characteristics where required are compatible with the requirements of the Local Power Authority or other authorities having jurisdiction and are acceptable to them. Inform the Engineer of any modifications necessary to comply with the Local Power Authority's requirements.
- 1.6.3. **MANUFACTURERS' STANDARDS:** equipment is to be the latest standard product of the manufacturer. Component parts are to be the product of a single manufacturer, unless otherwise approved and provided that components made by other manufacturers are of a standard design and are interchangeable.
- 1.6.4. **APPROVED MANUFACTURERS:** listing of approved manufacturers in the Specification does not necessarily constitute approval of their standard products as equal to those specified. As certain that listed manufacturers are able to supply equipment and material in conformity with the Specification.
- 1.6.5. **LABEL AND IDENTIFY** all equipment, instruments, control and electrical devices etc. to indicate duty, service or function, to the satisfaction of the Engineer. Labels are to be laminated plastic or anodized aluminum discs with black surface and white core with incised lettering in English or Arabic to the satisfaction of the Engineer. Alternative methods of labelling may be submitted for approval. Fix labels with non-corrodible screws to equipment, or to adjacent permanent surfaces or as approved by the Engineer.
- 1.6.6. **EQUIPMENT NAMEPLATES** are to be non-corroding, robust metal, inscribed in English, and firmly fixed to equipment at factory. Nameplates are to indicate name and address of manufacturer, model, serial number, basic characteristics and ratings of equipment and are to include elementary diagrams etc., all in accordance with the Standards.

1.7. SUBMISSIONS

- 1.7.1. **GENERALLY:** submit for approval, manufacturers' technical literature, shop and construction drawings and other information required by the Specification, before ordering equipment or materials and before executing any related work on site.
- 1.7.2. **TECHNICAL LITERATURE** is to include detailed manufacturers' specifications and original catalogues or catalogue cuts, characteristics, model number, application and operating criteria of all equipment and materials, together with other information necessary to satisfy the Engineer that proposed equipment and systems are suitable and adequate.
- 1.7.3. **SHOP AND CONSTRUCTION DRAWINGS** are to demonstrate to the Engineer that the design requirements are understood by indicating all equipment and material proposed to be supplied and installed and by detailing fabrication and installation methods proposed to be used. Shop and construction drawings are to clearly state the name and location of the work, the names of the Engineer and Contractor, submission date, cross-references to the Drawings and Specification and the specific reference number, location, service and function of each item.

- 1.7.4. LIST OF PROPOSED MANUFACTURERS of all equipment and materials, including all items for which choice of manufacturer is at the discretion of the Contractor, is to be submitted for approval.
- 1.7.5. TEST CERTIFICATES AND REPORTS: where required by the Specification, submit manufacturer's type and routine test certificates and reports for equipment and devices. Complete test results are to be submitted in clearly identified and organized booklets, indicating item of equipment, make, model, type, date of tests, type of tests, descriptions and procedures.
- 1.7.6. LABORATORY TESTS: if manufacturer's test certificates are considered unsatisfactory, then independent laboratory tests are to be carried out on equipment in accordance with the Specification and the Standards, as required by the Engineer.
- 1.7.7. SPARE PARTS SCHEDULES: submit with the Tender itemised schedules of spare parts to be provided, as required by the Specification, and state against each item the manufacturer's unit price including packaging and delivery to site.
- 1.7.8. TOOLS AND INSTRUMENTS SCHEDULES: submit with the Tender itemized schedules of tools and instruments to be provided, as required by the Specification, and state against each item the manufacturer's unit price including packaging and delivery to site.
- 1.7.9. LABELLING SCHEDULE: submit for approval, prior to installation, a schedule of all equipment and devices to be labeled and the suggested details, lettering, position and fixing methods of each label indicating its application.
- 1.6.10 SAMPLES: submit samples of all equipment and materials for approval.
Major items of equipment for which samples cannot be submitted are to be demonstrated in existing installations or by manufacturer's information, test certificates and reports.

2 - TESTS ON SITE, RECORDS, TRAINING AND MAINTENANCE

2.1. TESTS ON SITE

- 2.1.1. GENERALLY: carry out inspection and acceptance tests on site on each complete system, before final placement into service, in accordance with the Regulations and Standards, as described in the Specification and required by the Engineer.

2.2. RECORDS

- 2.2.1. GENERALLY: not later than the date of substantial completion, provide the Engineer with four copies of all approved as-installed drawings, test records, manufacturers' guarantees and warranties, operating and maintenance manuals and other records required by the Specification.
- 2.2.2. OPERATING AND MAINTENANCE MANUALS are to contain the following:
 - A. Technical description of each system and item of equipment installed, written to ensure that the Employer's staff fully understand the scope and facilities provided.

- B. Schedules (system by system) of equipment installed giving manufacturer, catalogue list numbers, model, rating, capacity and operating characteristics; each item is to have a unique code and number, cross- referenced to the diagrammatic drawings and layout drawings.
- C. Manufacturers' lists of recommended spare parts for items subject to wear and deterioration, giving expected running period and indicating specifically those items which may involve extended deliveries.

2.3. MAINTENANCE

- 2.3.1. MAINTENANCE CONTRACTS: where required by the Specification, submit supplementary proposals for annual maintenance contracts. The proposals are to:
 - A. include for maintaining the installations in efficient working order including routine and emergency service checks, adjustments, lubrication and the supply and replacement of damaged parts etc.
 - B. set out the terms of the offer, the work to be carried out, the guarantees of performance and the price of the work or part thereof for the first twelve months after substantial completion.

The proposals will not be considered as part of the Tender.

CHAPTER 2
DISTRIBUTION, SUBDISTRIBUTION & FINAL BRANCH CIRCUIT PANELBOARDS AND ATS

CHAPTER 2
DISTRIBUTION, SUBDISTRIBUTION & FINAL BRANCH CIRCUIT PANELBOARDS AND ATS

1. GENERAL

- A. ELECTRICAL WORK GENERALLY is to be in accordance with the requirements of the chapter1 of the Specification.
- B. DESCRIPTION OF WORK: panelboards for distribution and subdistribution of electric power and for protection of circuits, including fixing and supporting materials and materials for termination of feeders, sub-circuits and branch circuits.
- C. STANDARDS: panelboards generally are to comply with the requirements of IEC EN 60439-1, Factory-Built Assemblies of Low Voltage Switchgear and Control Gear. Exceptionally, they may not be factory-built nor type tested.
- D. DESIGNATIONS: panelboards are designated on the Drawings and in the Schedules as follow:
 - 1. Final branch circuit panelboards, power panelboards and subdistribution panelboards respectively, for secondary lighting and power distribution with either miniature circuit breaker (MCB) or moulded case circuit breaker (MCCB) protection on subfeeder or branch circuits, as shown on the Drawings.
- E. EQUIPMENT DATA: submit data for approval including, but not limited to, the following:
 - 1. Manufacturers' catalogues indicating specific equipment selected.
 - 2. Types of panelboards and circuit breaker characteristics including duties and ratings compensation at and above 40 deg. C ambient conditions and corresponding temperatures within the enclosures.
 - 3. Dimensions of panels and specific contents of each panelboard.
 - 4. Integrated equipment tabulations for coordinated short- circuit series combinations of circuit breakers (cascading and discrimination).
- F. TESTS AND CERTIFICATES: submit complete certified manufacturer's type test and routine test records in accordance with the Standards.
- G. APPROVED MANUFACTURERS: obtain panelboards from one of the following:
 - 1. Merlin Gerin, Telemecanique (Schneider) (France)
 - 2. Klockner Moeller (Germany)
 - 3. ABB (Germany)
 - 4. Siemens – ITE (Germany)
 - 5. Legrand (France)

2. PRODUCTS AND SYSTEMS

2.1 DISTRIBUTION, SUBDISTRIBUTION PANELBOARDS

2.1.1. GENERAL REQUIREMENTS

- A. RATED INSULATION VOLTAGE is to be in accordance with the respective Standards.
- B. PANELBOARDS are to be totally enclosed, dead front type, protection code IP 42 for indoor installations and IP 55 for outdoor installations, in accordance with IEC 529, and are to be factory designed and assembled.
- C. EARTHING BAR is to be provided in every panelboard.
- D. PROTECTION is to be fully rated throughout the systems.
- E. CIRCUIT BREAKERS are to be non-fused type.

2.1.2. PANELBOARD ENCLOSURES

- A. TYPE: general purpose type, suitable for relevant ambient conditions, flush or surface mounted as shown on the Drawings, comprising box, trim, or trim and door to approved manufacturer's standards and sizes.

2.1.3 BUSBARS

- A. TYPE: one piece, 98% pure electrolytic copper, based on maximum total temperature rise of 20 deg. C over an ambient of 40 deg. C at full continuous rating. Bolted contact surfaces are to have maximum current density not exceeding requirements of the approved standards. Aluminum is not to be used for busbars or panelboard parts.
- B. DESIGN: busbars are to be shrouded/insulated and rigidly designed so that branch circuit devices can be removed without disturbing adjacent units or changed without additional machining, drilling or tapping. Busbars are to be full size without reduction. Busbar System and blank plates are to allow installation of future circuit devices, where indicated on the Drawings.
- C. NEUTRAL BAR is to be solid and fully insulated from cabinet or box. One solder-less box type set-screw connector is to be provided for neutral wire of each branch circuit and one bolted clamp-type connector or anti-turn lug with set-screw for main incoming neutral wire. Neutral is to be fully sized and rated as for phase busbars.
- D. EARTHING BAR is to be copper, brazed to panelboard cabinet, with bolted pressure connector for main conductor and one set- screw-type tunnel terminal for each outgoing conductor, to provide secure and reliable contact with all metal parts and enclosure.

2.1.4 MOULDED CASE CIRCUIT BREAKERS (MCCBs)

- A. TYPE: tested to approved standards, totally enclosed, moulded case, constructed from high quality, high temperature resistant, tropicalized, moulded insulating materials, for normal operation at maximum temperature within enclosures at point of application, and provided with front operated single toggle type handle mechanism for manual operation of main contacts in addition to automatic operation under overcurrent and short circuits conditions. Multi-pole breakers are to have common integral trip bar for simultaneous operation of all poles. Ampere rating is to be clearly visible. All terminals are to be box lug or clamp type with set screws, suitable for copper or aluminum.
- B. MCCBs FOR SDB: To comply with IEC947-2 test sequences I, II, III, utilization category A, and are to have rated service short circuit breaking capacities to meet the electrical requirements at the panelboard location.
- C. FRAME SIZE is defined as maximum continuous current rating of circuit breaker which corresponds with its maximum trip range and which is to be related to minimum acceptable short-circuit interrupting ratings, based on fully rated interrupting duties: normal duty (N), high break (H), or current limiting (L), as specified.
- D. RESIDUAL CURRENT OPERATED EARTH LEAKAGE TRIP DEVICES (RCDs) are provided as add-on or built-in earth leakage accessories, where required and as shown on the Drawings. Protection against earth fault current, in addition to overcurrent and short-circuit protection, is to be in accordance with the Regulations. Trip current sensitivity on breakers for branch circuits is to be 30 mA, and for main breakers ratings are to be as shown on the Drawings. Circuit breakers are to include current transformer with tripping coil assembly, test button and trip free mechanism to ensure circuit breaker cannot be held closed against earth faults.

2.1.5 MINIATURE CIRCUIT BREAKERS (MCBs)

- A. TYPE: thermal magnetic non-adjustable type, tested in accordance with IEC 947.2 & IEC 898. Breaker type and short circuit interrupting ratings are mentioned on design drawings.
- B. MINIMUM SHORT-CIRCUIT BREAKING CAPACITIES are to be as shown on drawings. Contractor to check and confirm those levels (according to final equipment location: Transformers, MDBs, Panel Boards,....)
- C. CONSTRUCTION: MCBs are to be tropicalized for operation at ambient temperatures up to 70 deg. C within panelboard enclosure and humidity up to 95%, and are to be constructed from high quality, high temperature, moulded insulating materials. Guaranteed duties and characteristics are to be submitted for temperatures above 40 deg. C. MCBs and combinational devices are to be modular, of unified profile and mounted to a standard DIN rail.
- D. OPERATION: under overload conditions, thermal tripping is to provide close protection of insulated conductors. Under short- circuit conditions, magnetic trip is to operate at 5-10 times normal rated current (curve C characteristic).

Magnetic operation is to be in the current limiting region and opening time is not to exceed 5 milli-seconds.

- E. RATINGS: preferred rated currents are to be 6, 10, 16, 20, 25, 30, 40, 50, 60, 80 and 100 A, calibrated at 40 deg.C, available as 1+N, 2, 3 and 4-pole circuit breakers. Derating above 40 deg. C is not to exceed 1% per deg.C, and loading is not to exceed 70% of circuit breaker rating.
- F. RESIDUAL CURRENT DEVICES for earth leakage protective circuit breakers are to be add-on devices, or built-in and integral with the standard circuit breaker. Non-adjustable sensitivities of 30 mA, 100 mA and 300 mA are to be available for all ratings of 1+N, 2-pole and 4-pole circuit breakers.

2.2 PANELBOARDS

- A. ARRANGEMENT: to comprise set of homogeneous branch circuit breakers with unified profile and base, and one main circuit breaker or switch (as shown on drawings). Circuit breakers or other devices are to occupy modular spaces. Accommodation of contactors and split-bus arrangement or other devices is not to change regularity of standard box width.

2.2.1. FINAL BRANCH CIRCUIT PANELBOARDS SDB- TYPE MCB

- A. INTERNAL ASSEMBLY: to comprise removable back plate or back pan of rigid construction, attached to enclosure by four captive screws through keyhole fixings, and provided with DIN rails in horizontal arrangement for single and three phase panels. Assembly is to be complete with earthing bar and one piece insulated bolt-on/comb-type phase busbar. Busbars are to be single-phase and neutral or 3-phase and neutral with spade connectors for fixing by tightening a single screw on circuit breaker. Insulation is to be high thermal rating, capable of carrying maximum short-circuit current for one second without overheating beyond acceptable limits required by the Standards. Panelboards are to comply with NFC and IEC standards. If the busbars rating exceeds 100 Amp (where the frame size of the main breaker is larger than 100 Amps), comb busbars shall not be used but still clause 2.1.3. of this specification shall apply.
- B. SINGLE PHASE TYPE PANELBOARDS are to be suitable for 240 V maximum service voltage, single-phase and neutral, with MCBs on branch circuits and main incoming.
- C. SINGLE PHASE TYPE PANEL BOARD MAIN CIRCUIT BREAKER OR SWITCH DISCONNECTOR is to be double-pole, with or without earth leakage device (RCD), as shown on the Schedules.
- D. SINGLE-POLE + NEUTRAL (1 + N) AND DOUBLE-POLE (2P) MCBs for 240 V service, are to have trip ratings between 6 A and 50 A, with ICU (n)/ICS as required in the Schedules.
- E. THREE PHASE TYPE PANELBOARDS are to be suitable for up to 415 V a.c. maximum service voltage, 3 phase and neutral, with MCBs on branch circuits and 4 pole switch disconnect or circuit breaker, main incoming, as shown in the Schedules or on the Drawings.
- F. FOUR-POLE BRANCH CIRCUIT BREAKERS are to have trip ratings between 6A and 100A, with ICU/ICS as required in the Schedules.

- G. THREE PHASE TYPE PANELBOARD MAIN SWITCH DISCONNECTOR OR CIRCUIT BREAKER is to be four-pole, with or without earth leakage device (RCD), as shown on the schedules.
- H. SHORT-CIRCUIT RATING: THREE PHASE panelboards may only have an integrated equipment (series) short-circuit rating in accordance with calculations.

3. FIELD AND INSTALLATION WORK

3.1 INSTALLATION

- A. FIXING GENERALLY:
 - Align, level and securely fasten panelboards to structure
 - Fix surface mounted outdoor panelboards at least 25mm from wall ensuring supporting members do not prevent flow of air.
 - Do not use connecting conduits to support panelboards
 - Close unused openings in panelboard cabinets.
- B. PANELBOARD INTERIORS: do not install in cabinets until all conduit connections to cabinet have been completed.
- C. WIRING INSIDE PANELBOARDS: to be neatly arranged, accessible and strapped to prevent tension on circuit breaker terminals. Tap-off connections are to be split and bolted type, fully insulated. Wiring shall be arranged on terminals and connection blocks with marking as indicated in section 16120 of the specifications.
- D. TRIM: fix plumb and square prior to painting. Fix trim for flush mounted cabinets flush with wall surface finish.
- E. PROTECTION: treat concealed surfaces of recessed cabinets with heavy field application of water-proof compound prior to installation.

3.2. INSPECTION AND TESTS ON SITE

- A. GENERALLY: carry out sample tests, as required by the Engineer, on panelboards after installation, to verify short-circuit capability of circuit breakers and busbars. Inspect conditions within panelboards and verify insulation conditions by use of a megger.
- B. CIRCUIT BREAKERS: tests are to include operation of every circuit breaker manually. Check automatic operation of selected circuit breakers, as required by the Engineer, by applying necessary short-circuit, overload and earth leakage current for tripping circuit breaker as applicable and compare with manufacturer's data/characteristic curves. Measure and report ambient temperature inside enclosure.
- C. INSULATION CHECK TESTS: carry out insulation tests on all busbars, between phases and between phases and earth/cabinet, and between neutral and earth. Record all readings, using 500 V megger for equipment on 240 V systems, and 1000 V megger for equipment on systems up to 600 V, for 1-minute, with circuit breakers in open position.

- D. ROUTINE TESTS ON SITE are to be carried out, in accordance with the Standards, on all panelboards assembled from standardized components of the manufacturer outside the works of the manufacturer.

4. AUTOMATIC TRANSFER SWITCH (ATS)

GENERAL

Automatic transfer switches complete with all accessories shall be incorporated. They shall be rated for continuous operation at the prevailing ambient temperature. They shall be rated for all classes of load both inductive and resistive. They shall be able to close on an inrush current up to and including 10 times the continuous rating of the switch and be capable of enduring 6000 cycles of operation at rated current at a rate of 6 cycles per minute without failure. The automatic transfer switch shall be interlocked to positively prevent the load from being simultaneously energized by normal and emergency power. Manual transfer switch shall also be possible.

A. ATS ACCESSORIES

Voltage sensors and time delays of 5 minutes or less shall be solid state, plug-in devices. The control relays shall be dust-covered, plug-in devices. These control accessories shall mount on a dead-front, swing-out control accessory panel to avoid shock hazard while adjusting control functions, but will swing-out exposing the wiring to facilitate servicing. A control Disconnect plug shall be provided to deenergize control circuits when control accessory panel is in the open, swing-out position. Indicating lamps and meters shall be set in a front mounted meter panel to be visible without opening doors.

B. EQUIPMENT AND OPERATION

Control accessories shall be provided to:

1. Monitor each ungrounded line with calibrated dial adjustable voltage, solid state sensors to sense a decrease of voltage below a set point, or a loss of voltage on any phase of the normal power source. Voltage sensors shall be temperature compensated for 2 percent maximum deviation over the temperature range - 25°F (- 32°C) to - 175 °F (+ 79°C).
2. Signal the engine - generator set to start in the event of a power interruption (a selected ATS). A solid-state time delay (adjustable from 0.5 to 10 seconds) shall delay this signal to avoid nuisance start-ups on momentary voltage dips or power outages.
3. Transfer the load to the engine-generator after it reaches proper voltage and frequency. A solid-state time delay (adjustable from 0.5 to 10 seconds) shall delay this transfer to allow the engine-generator to stabilize.
4. Re transfer the load to the line after normal power restoration. A time delay (adjustable from 0 to 30 minutes) shall delay this retransfer to avoid short- term normal power restoration.
5. Provide an automatic by-pass to retransfer the load from generating set to normal source if generating set output interrupts after normal source restores voltage.
6. Signal the engine-generator to stop after load retransfers to normal source. A solid-state time delay on stop (adjustable from 0.5 to 5 minutes) shall permit engine to run unloaded to cool down before shutdown (a selected ATS).

7. Provide a switch to select “with load” or “without load” to test or exercise as follows:
 - a. “Without Load” the generating set runs unloaded.
 - b. “With Load” the automatic transfer switch transfers load to generating set, after time delay, the same as it would for a normal source interruption.
8. Provide a device to electrically disconnect the control section from the transfer switch for maintenance service during normal operation.
9. Automatic Transfer switch shall be remotely actuated with the possibility of operating as automatic or manual transfer switch if the user wishes to.
10. Transfer switch shall be contactor type and shall be rated to carry 100% of rated current continuously in the enclosure.
11. Transfer switch shall have arc chutes of heat absorbing material and metal leaves for positive extinguishing of arcs. Arc chutes shall have insulating covers to prevent interphase flashovers.
12. The complete transfer shall be enclosed in a non-ventilated IP40 enclosure for installation indoors. The enclosure shall contain a swing out service panel and a key operated door lock.

C. METER AND LAMP COMBINATION

Indicating meters and lamps shall be front mounted for easy reading without opening doors. Meter and lamp combination shall provide.

1. Green (normal) and red (emergency) indicating lamps to indicate which source is supplying power to the load.
2. AC Voltmeter to measure generator output voltage.
3. AC Voltmeter, frequency meter with pointer indicator and running time to monitor electric generating set.

CHAPTER 3
CONDUITS, WIREWAYS, SUPPORTING SYSTEMS WIRES & CABLES
AND RELATED ACCESSORIES

CHAPTER 3
CONDUITS, WIREWAYS, SUPPORTING SYSTEMS WIRES & CABLES
AND RELATED ACCESSORIES

1. GENERAL

- 1.1. ELECTRICAL WORK GENERALLY:** is to be in accordance with the requirements of the chapter 1 of the Specification.
- 1.2. DESCRIPTION OF WORK:** raceways including conduits, wireways, cable trays and related installations and accessories necessary to support and protect cables, feeders, branch circuit wiring and wiring of low current systems, communications and signal cables.
- 1.3. REGULATIONS AND STANDARDS:** conduits, wireways, cables trays and fittings are to be designed, constructed and installed to give safe installation and reliable mechanical protection for wires and cables in accordance with the Regulations. Standards of products are to be as specified. Local production is prohibited if not tested and approved by a legal authority.
- 1.4. TECHNICAL DATA:** submit data for approval including, but not limited to, the following:
- A. Manufacturer's catalogues with specifications of raceways including conduits, trunking etc. and related accessories.
 - B. Samples of each type of raceway and accessory.
- 1.5. SHOP AND CONSTRUCTION DRAWINGS:** submit drawings for approval including, but not limited to, the followings:
- A. Exact routing of conduits, trunking etc. With indication of boxes, accessories and expansion joints, size of conduits and boxes
 - B. Typical assembly details of installation of trunking, trays etc.
 - C. Construction details of pull boxes.
 - D. Typical installation details including connection of conduits to metal enclosure. Connections of flexible conduits, vapour- tight installations in cold rooms, liquid tight flexible metallic outdoors etc. and earthing connections.
- 1.6. APPROVED MANUFACTURERS:** obtain conduit, wireways and related accessories from one of the following or other equal and approved:
- A. UNIVOLT (Austria)
 - B. EGA Tubes (England)

- C. DIELECTRIX (England)
- D. Siemens (Germany)
- E. Simplex (England)
- F. Decoduct (UAE)

2. PRODUCTS AND SYSTEMS

2.1. CONDUITS AND ACCESSORIES

2.1.1. RIGID & FLEXIBLE METAL CONDUIT

- A. MATERIAL: steel, cold rolled and annealed, non-threaded type, formed from continuous length of helically wound and interlocked strip steel, with fused zinc coating on inside and outside. Black enameled or hot dipped galvanized, L= 3m, screwed on both ends to NF-C-68-100. Locally manufactured conduits shall not be accepted.
- B. LIQUID- TIGHT FLEXIBLE METALLIC CONDUIT: is to have PVC jacket extruded over core.
- C. FITTINGS GENERALLY: thread less, hinged clamp type, hot dipped galvanized or cadmium plated malleable cast iron. Fittings used in corrosive atmospheres are to be specially treated.
- D. STRAIGHT CONNECTORS: one piece body, female type, hot dipped galvanized or cadmium plated malleable cast iron. Fittings used in corrosive atmospheres are to be specially treated.
- E. ANGLE CONNECTORS: of 45 or 90 degree and terminal connectors are to be as specified for straight connectors, except that body is to be two-piece with removable upper section.

2.1.2. RIGID MEDIUM GAUGE PVC CONDUIT.

- A. MATERIAL: rigid un-plasticized, could form a bend with PVC accessories, polyvinyl chloride with high impact and high temperature resistance, flame retardant, non hygroscopic and non-porous, compressive strength ≥ 750 N, to CEE 26, BS 4607 and BS 6099, DIN 49026, NFC 68-107 or other equal and approved standards conforming to IEC 423.
- B. FITTINGS GENERALLY: unbreakable, non-inflammable, self-extinguishing, moulded plastic.
- C. ASSEMBLY: conduits, boxes and accessories are to be assembled by cementing, using manufacturer's recommended products and appropriate connectors or spouts are available use smooth bore male PVC bushes and sockets.

2.1.3. FLEXIBLE MEDIUM GAUGE PVC CONDUIT

- A. MATERIAL: flame retardant, heat resistant, non- hygroscopic PVC, high resistance to impact, ribbed on circumference for flexibility.

3. FIELD AND INSTALLATION WORK

3.1. CONDUIT AND WIREWAYS GENERALLY

- A. USE: unless otherwise specifically indicated all light and power circuits, communications, signal and low current systems wiring are to be drawn inside conduits or wireways up to the various electric power consuming equipment as shown on the Drawings. Separate conduit and wireways installations are to be used for LV cables/wires normal light and power circuits, emergency light and power circuits and communication, signal and other low current systems wiring.
- B. BOXES: junction, pull and splice boxes of ample capacity are to be provided as indicated or required. Boxes are to remain permanently accessible.
- C. TOOLS AND ACCESSORIES: for forming and installing conduit and wireway systems are to be purpose made for the particular application and used in accordance with manufacturer's instructions.
- D. FIXING: conduits and wireway installations are to be concealed as much as possible.
- E. SIZES: Unless otherwise specified conduits and wireways sizes, not shown on the Drawings, are to be selected in accordance with the tables on design drawings and in relation to the number and size of conductors. Minimum size of conduit for all applications is to be 20 mm diameter, unless otherwise shown on the Drawings.
- F. MECHANICAL CONTINUITY: conduits and wireways are to be effectively joined together and connected to electrical boxes, fittings and cabinets to provide firm mechanical assembly. Earthing jumpers are to be installed on steel conduits where required to ensure effective electrical continuity irrespective of whether a protective earth conductor is required or not.

3.2. PVC CONDUITS

- A. COUPLING OF CONDUIT and/ or termination into spouted fittings are to be made watertight and permanent using special cement.
- B. TERMINATION: connect conduits terminating in switchgear, fuseboards, trunking, adaptable boxes or non-spouted enclosures etc, with smooth bore male PVC bushes and sockets.
- C. ENDS OF CONDUIT end conduit fittings are to be cleaned and jointed using PVC cement recommended by manufacturer.
- D. SEMI-PERMANENT ADHESIVE: use in joints requiring expansion couplers.

3.3. EMBEDDED CONDUITS

- A. CONDUITS IN CONCRETE SLABS: place conduits parallel to main reinforcing steel.
- B. CONDUITS IN PARTITIONS OR SIDE WALLS: horizontal or cross runs are to be avoided.
- C. PULL-BOXES are not to be used. If unavoidable, pull-boxes may be approved if located inconspicuously.
- D. CONDUITS IN FLOOR OF BEDS ON GRADE: encase in concrete, minimum thickness 50 mm or to thickness allowed by architectural detail.
- E. PVC CONDUITS IN REINFORCED CONCRETE STRUCTURES are generally to be installed after placing reinforcement and before concreting, if protected against damage, or are to be placed in grooves in formed in the concrete, if approved.

3.4. EXPOSED CONDUITS

- A. CONDUITS ON WALLS: run neatly, horizontally or vertically.
- B. SUPPORTS: use approved clamps, hangers or clips fastened by machine screws to expansion sleeves in inserts or to lead anchors.
- C. SPACING OF CLAMPS OR CLIPS for supporting steel conduits is not to be greater than:

<u>Conduit Size</u> <u>(inches)</u>	<u>Maximum Spacing of Supports mm</u> <u>meters</u>
20 (3/4)	1.5 m
25 (1)	1.5 m
32-38 (1-1/4-1-1/2)	2 m

- D. SPACING OF CLAMPS OR CLIPS for supporting PVC conduits is not to be greater than.

<u>Conduit Size</u> <u>(inches)</u>	<u>Maximum Spacing of Supports mm</u> <u>meters</u>
20 (3/4)	0.60
25-50 (1-2)	0.75
63-75 (2-1/2-3)	0.90

- E. BENDS AND FITTINGS: firmly fasten conduit at each side of bends and within 900 mm of each outlet box, junction box, cabinet or fitting.
- F. OUTLETS: do not run more than one conduit to any surface wall outlet. Install junction box on home run near to ceiling level and tap-off vertical conduit to outlet box below.

4. WIRES & CABLES

4.1 GENERAL

The section shall cover all wires and cables.

The Contractor shall supply and install all wires and cables necessary for the complete Electrical System, as indicated on the Drawings, as required, and as specified herein.

4.2 WIRES & CABLES - LIGHTING & POWER

A. Single Core Wires (NYA) Cu/PVC to IEC 227

1. This specification covers single core, PVC insulated wires, intended for internal wiring in dry locations, concealed in conduits.
2. Conductors shall be of high conductivity annealed plain copper with concentric stranded conductors, to IEC 228.
3. Minimum conductor size used shall not be less than 2.5 mm².
4. All wires for lighting and power systems pulled inside conduits shall be single core, insulated with PVC compound, of grade not less than 300 / 500 volts, to IEC 227.

B. Multicore Cables (NYY) Cu/ PVC/ PVC to IEC 502

NYY cables shall be used for supply of power to main distribution boards, secondary distribution boards, pumps, HVAC equipment and all external lighting and equipment.

This specification covers single, two, three or four core cables, PVC insulated and PVC sheathed, rated at 600V/1000 V unarmored and armored type.

Conductor shall be plain, annealed electrolytic copper, circular or sectoral stranded, conforming to the applicable requirements of IEC 228.

The insulation shall be PVC based thermoplastic material conforming to the applicable requirements of IEC 502.

The assembly shall consist of insulated conductors filled where necessary with non-hygroscopic material and covered with an additional layer of extruded thermoplastic material or non-hygroscopic binding tape.

The sheath shall be PVC based thermoplastic material, conforming to the applicable requirements of IEC 502.

Flexible cords for connection of fixtures to circuit-wiring shall have finely stranded copper Conductor with a PVC insulation, type NYFAF, 500 V grade. Connection caps shall be "3M" instead of WAGO in this case only.

Wires and cables shall be manufactured by BICC (UK), Pirelli (UK), Liban Cables (Lebanon) or approved equal.

4.3 FLEXIBLE CORDS

Cords used for water heater connections shall be of high conductivity tinned copper wires, (2.5 mm² unless otherwise indicated) insulated with ethylene propylene rubber, three cores twisted together, filled and sheathed with chlorosulphonated polyethylene (EPR CSP), 300/500 V rated, and shall withstand an operating temperature of 85 °C.

Cords used for pendant lighting points and between 220 V / 12 V transformers to lighting fixtures, shall be circular three core (1.5 mm²) silicon rubber insulated, glass fiber braided 300/500 V rated and shall withstand an operating temperature of 150 °C.

Cords used for extract fans and fan coil units shall be of plain annealed copper conductor (2.5 mm² unless otherwise indicated), PVC insulated, circular three cores twisted together, PVC overall sheathed 300 / 500 V rated and shall withstand an operating temperature of 70 °C.

Cords shall be manufactured by BICC (England), AEI (England) Pirelli (England), Liban Cables (Lebanon) or approved equal.

4.4 CONTROL CABLES

Control cables where used underground direct burial shall comprise stranded annealed copper conductor of minimum 2 mm² cross-section insulated with high dielectric polyvinyl chloride, nylon sheathed with a tape binder applied over the assembly, overall PVC jacketed Control cables shall comply with IEC 502.

Number of conductors shall be equal to the maximum number of functions plus 20% spare.

Cable shall be 600 /1000V insulated and sheathed grade.

Junction boxes shall include all necessary terminal connector boards with proper labels.

Contractor shall make sure that the cross-sectional area of the conductors are sufficient to cater for the voltage drop due to the long runs involved.

Control cables where used in ducts underground or in conduits above ground shall comprise stranded annealed copper conductor of minimum 2 mm² cross- section for cables in ducts and 0.75 mm² for cables in conduits insulated with high dielectric polyvinyl chloride, and PVC sheathed. Control cables shall comply with IEC 502.

4.5 INSTALLATION OF WIRES & CABLES

All wires shall be installed in accordance with the applicable provisions of the approved codes and as indicated on the Drawings.

The number of wires and sizes of conduits indicated on the Drawings are a guide only and are not necessarily the correct number and sizes necessary for actual equipment installed. The Contractor shall install as many wires and conduits as required and necessary for a complete electrical system, and shall provide adequately for the equipment actually to be installed.

Where more than one conductor is used per phase, each phase, neutral if any and ground wires shall be run in each metallic or non-metallic conduit.

Conductors shall be continuous from outlet to outlet and no splices shall be made except within outlet or junction boxes.

At every outlet and pull box, wires and cables passing through, shall be left slack by an amount equivalent to 20 cm of cable length to allow inspection and connection to be made therein.

No cable bend shall have a radius of less than eight times its diameter.

The Contractor shall not change any circuit number, especially from a phase to a different phase. If such a change is necessary due to modification on site, the Contractor shall bring this matter to the attention of the engineer.

All conductors to be contained within a single conduit shall be drawn in at the same time.

A wire pulling compound shall be applied to conductors being drawn through conduit. Pulling compound shall be soap tone or other approved material.

Only cables forming part of a lift installation if any may be run in a lift shaft.

Wires and cables for feeders, sub-feeders, control, and branch circuit wiring shall be color coded as follows:

<u>Color</u>	<u>Conductor Function</u>	<u>Alternative Color</u>
Brown	L 1	Red
Black	L 2	Blue
Orange	L 3	Yellow
Light Blue	Neutral (N)	Black
Green/Yellow	Equipment grounding (PE)	Green/Yellow

Wire and cable sizes shall be as indicated on the Drawings; however in no case shall their size be smaller than required by the approved Code.

Unless otherwise indicated, no conductor for lighting and power wires shall be smaller than 2.5 mm².

All branch circuits for internal lighting and appliances shall be single conductor cables run inside conduits, unless otherwise indicated.

Feeder and sub-feeders shall be multi-conductor cables run exposed on cable trays or in underground ducts as shown on the Drawings.

Single cables unless otherwise specified and shown on drawings, could be fixed directly to walls or ceilings. Where 2 or more cables are run in parallel, they shall be fixed on hot dip galvanized steel perforated trays or other approved special cable supporting and protecting arrangement.

Cables shall be fixed to supporting structures with approved hot dip galvanized cast steel clamps at distances not exceeding 20 diameters.

No joints or splices shall be accepted on main feeders.

4.6 IDENTIFICATION OF WIRES & CABLES

Individual conductor or circuit identification shall be carried throughout, with circuit numbers or other identification clearly installed on terminal boards and printed on directory cards in distribution cabinets and panelboards. System shall be similar to Legrand CAB3 or approved equal.

In junction boxes, cabinets, and terminal boxes where the total number of control, indicating, and metering wires is three or fewer and no terminal board is provided, each wire including all power wires, shall be properly identified by means of a plastic, wire marker.

System shall be similar to Legrand Mémocab or approved equal.

Wires including motor leads and other power wires too large for connection to the terminal boards shall be identified by wire markers as specified above.

In manholes, hand-holes, pull boxes, junction boxes and at both terminals each cable shall be properly identified by a plastic tag located so as to be easily seen. System shall be similar to Legrand Duplix or approved equal. Wires and cables shall be identified by cable number indicated on the Drawings.

4.7 CONNECTORS AND TERMINAL BLOCKS

For the wiring of circuits consisting of wire sizes 6 mm² and smaller such as for lighting, branch circuits etc..., WAGO, self insulated pressure type connectors shall be utilized for all splices or joints. Where flexible cables (NYFAF) are used from ceiling outlet box to recessed lighting fixtures, 3M caps shall be utilized.

For the wiring of circuits consisting of wire sizes 10 mm² and larger, connectors shall be of the bolted pressure type, with a pre-insulated sleeve. WAGO or Legrand Viking shall be used. Connectors shall be manufactured from high conductivity copper, electro tin-plated.

Connector bodies shall be manufactured from Polyamide.

4.8 CABLE TRAYS AND SUPPORTS

Cable trays shall be manufactured from mild steel of a minimum thickness of 2 mm. They shall be light or heavy duty type as required with return flanges, and hot-dip galvanized finish. Bends, corners, etc. shall be specially manufactured for the purpose.

All supports and accessories like hangers, channels, bolts, nuts, cable ties, conduit clamps, shall be furnished as to function, to the manufacturers standard. Metallic elements shall be hot dip galvanized.

The contractor shall provide technical catalogues and shop drawings to illustrate the sufficiency of the supports and tray sections thickness.

The installation shall have a design assuming double at the actual load in addition to the safety factor recommended by the tray manufacturer.

Cable trays, supports, and accessories shall be manufactured by BICC (England) or approved equal.

4.9 CABLE LADDERS

Cable ladders shall be manufactured from mild steel, with hot-dip galvanized finish.

All parts like flat elbows, offset reducers, cross pieces, tee pieces, drop outs, etc., as well as accessories shall be furnished as to function, and to the manufacturers standards.

The contractor shall provide technical catalogues and shop drawings to illustrate the sufficiency of the supports and tray sections thickness.

Cable ladders, parts and accessories shall be manufactured by BICC (England), Planet-Waltham or approved equal.

4.10 CABLE GLANDS

Cable glands shall be provided at the termination of all cables at the enclosure of a distribution board or any other equipment.

Cable glands shall be indoor or outdoor type, ordinary or weatherproof according to the location of the termination, the installation standard and to the approval of the Engineer.

CHAPTER 4
WIRING DEVICES AND DISCONNECTS

CHAPTER 4

WIRING DEVICES AND DISCONNECTS

1. GENERAL

- 1.1. GENERAL WORK GENERALLY** is to be in accordance with the requirements of the chapter 1 of the Specification.
- 1.2. DESCRIPTION OF WORK:** wiring devices, lighting switches, socket outlets, cord outlets, automatic and manual lighting control equipment, dimmers, outlet boxes and plates, disconnect switches etc.
- 1.3. STANDARDS:** components are to be standard manufactured items, uniform and modular, complying with one set of approved Standards.
- 1.4. EQUIPMENT DATA:** submit data for approval, including catalogues, detailed literature, manufacturer's name, catalogue number, rating, specification, overall dimensions and special features, as applicable for each item.
- 1.5. SHOP AND CONSTRUCTION DRAWINGS:** submit drawings for approval including, but not limited to, the following:
 - A. Exact indication of position of each item and outlet box and fitting on layout drawings, with box and equipment types and sizes.
- 1.6. SAMPLES:** submit samples of each type of device for approval, unless otherwise agreed in writing by the Engineer.

2. PRODUCT AND SYSTEMS

2.1. FITTINGS

2.1.1. OUTLET BOXES AND PLATES GENERALLY

- A. SURFACE OR RECESSED BOXES are to be suitable for type of related conduit or cable system. Shapes and sizes of boxes are to be compatible standards as switches, socket outlets and lighting fixtures selected and of various types and mounting methods required.
- B. UNUSED OPENINGS in outlet boxes are to be closed with knock-out closers manufactured for the purpose.
- C. BLANK PLATES: blank plates are to be installed on outlet boxes on which no apparatus is installed or where apparatus installed does not have suitable cover for box. Blank plates for wall outlets are to be attached by a bridge with slots for horizontal and vertical adjustment.

2.1.2. MOULDED PLASTIC OUTLET BOXES

- A. TYPE: boxes and covers used with PVC conduit systems are to be heavy gauge pressure moulded plastic, minimum 2 mm thick, self extinguishing, with softening point not less than 85 deg. C. Boxes are to have provision for securely terminating conduits and are to be manufacturer's standard for required application.
- B. FITTINGS: boxes are to have brass inset threads to receive cover screws and for mounting devices or accessories, push- fit brass earth terminals, and steel insert clips to provide additional support for pendants or for heat conduction. Neoprene gaskets are to be provided for weatherproof installations.
- C. MANUFACTURERS: obtain moulded plastic outlet boxes from:
 - 1. Egatube (England)
 - 2. M.K. (England)
 - 3. Legrand (France)
 - 4. B Tichino (Italy)Or other equal and approved.

2.1.3. SWITCHES

- A. GENERALLY: quick- make, quick- break type with silver alloy contacts in arc resisting moulded base, with toggle, rocker or push- button as specified, for inductive or resistive loads up to full rated capacity, and arranged for side and/or back connection.
- B. TYPES: single, two- way or intermediate, single pole or double pole, as shown on the Drawings.
- C. GENERAL LIGHTING SWITCH: 10 A 220 V a.c., rocker operated, grid- switch with plastic plate, for indoor installations in general, unless otherwise indicated.

1. Man: Legrand or other equal and approved.
Ref: unless otherwise mentioned on drawings: One way
one gang 74010
One way greater or equal to two gang 74000
- D. PUSH BUTTON SWITCH, Ref unless otherwise mentioned on drawings:
One gang 74040
Two or larger than 74030.
- E. MANUAL SWITCH: 2 pole, for fractional single and three phase motors and appliances, to interrupt motor and induction loads, rated 20 A at 415 V a.c., toggle operated, with positive indication of on/off position of contacts.
 1. Man: Merlin Gerin or other equal and approved.
 2. Ref: [(15006 + 13392) when installed as one gang] for single phase, (15007 + 13392) for three phase (without Neutral) and (15008 + 13392) for three phase (with Neutral).

2.1.4. SOCKET OUTLETS

- A. GENERALLY: to have injection moulded plastic base with self- adjusting, non-expanding contacts to prevent permanent distortion, arranged for side and/or back connection and with screw terminals accepting at least three parallel branch- circuit wires.
- B. TYPES: general-purpose socket outlets are to conform with standard German practice concerning layout & rating).
- C. DUPLEX SOCKETS are to be mounted in parallel under one common plate with break- off feature for two-circuit connection
- D. WEATHERPROOF SOCKET OUTLETS are to be any of the types indicated, enclosed in surface mounted cast metal box and with cover comprising spring- retained gasketed hinged flap. Enclosure is to be pre-designed box and cover for type of socket outlet specified.
- E. GERMAN STANDARD SOCKET: single phase, three wire for plug with 3 mm round pins at 19 mm centers, with grounding in accordance with standard German practice and rated 10/16 A, 250 V a.c.
 1. Man: Legrand or other equal and approved. 2.
Ref: 74130 (and 74132 for UPS).

2.1.5. PLUGS

- A. TYPE: compatible with type of socket outlet specified, break resistant, of impact resistant moulded insulating material (separable construction), with solid brass pins and cord grip and of shape providing easy hand- grip for removal.
- B. QUANTITY: supply number equal to 20% of total number of each type of socket outlet supplied.

2.1.6. SWITCH DISCONNECTOR (DISCONNECTING SWITCH)

- A. RATING: 690 V, 2,3 or 4 pole, load break, short- circuit make, in accordance with IEC 947-3, utilization category 22 for heating and lighting loads, category 23 for motor circuits, and with ampere rating shown on the Drawings.
- B. DESIGN: non- fusible, air- break switch disconnect, single throw, safety type, housed in separate metallic enclosure with arc quenching devices on each pole.
- C. OPERATING MECHANISM: quick- make, quick- break, independent of operator, with external operating handle mechanically interlocked to prevent opening door unless switch is in open position. Switch disconnect is to have provision for by- passing interlock. Position of handle is to be positive and clearly indicated on cover.
- D. ENCLOSURE: General purpose sheet steel for indoor use IP 42 and weather- proof type cast- metal or sheet steel for outdoor installations IP 65 IK 08, unless otherwise required or shown on the Drawings. Locking of operating handle is to be possible in open and closed positions.
- E. MANUFACTURERS: obtain switch disconnect from one of the following of the following or other equal and approved:
 - 1. Merlin Gerin (France)
 - 2. Klockner Moeller (Germany)
 - 3. ABB (Germany)
 - 4. Siemens (Germany)
 - 5. Socomec (France)
 - 6. Legrand (France)

3. FIELD AND INSTALLATION WORK

3.1. INSTALLATION

- A. LOCATIONS: the Drawings generally show approximate locations of outlets and equipment. Exact locations are to be determined from interior finishing and detail drawings. Any condition that would place an outlet in an unsuitable location is to be referred to the Engineer. Locate switches at strike sides of doors, whether shown on the Drawings or not. In locating outlets allow for overhead pipes, ducts, variations in arrangement, thickness of finishing, window trim, paneling and other architectural features.
- B. MOUNTING HEIGHTS for outlet boxes and similar equipment are to be uniform within the same or similar areas. Mounting is to be as shown on the Drawings or as approved by the Engineer. Unless otherwise shown or instructed, mount lighting switches and socket outlets generally at 1200 mm and 300 mm from finished floor level respectively. Mount switches with long dimension vertical and operating handle, if of the toggle type, up when in the on position.
- C. SINGLE POLE SWITCHES are to switch the phase wire. Do not run neutral wire through switches having neutral shunt or bridge.

- D. ADDITIONAL OUTLETS to those shown on the Drawings are to be provided as required by equipment manufacturers for control or other wiring.
- E. EXPOSED OUTLET BOXES: securely fasten to wall with machine screws to permanent inserts or lead anchors.
- F. RECESSED OUTLET BOXES: make neat openings, to the satisfaction of the Engineer, allowing for thickness of finishing and use extension rings if required. Repair damaged finishing to original condition before installation of fittings or plates.
- G. APPEARANCE: install exposed boxes and plates plumb, square and parallel to finished wall surface. Exposed plates covering recessed boxes are to rest neatly on wall surface without gaps, and fully covering the box.
- H. GROUPED OUTLETS: arrange neatly so that use of fittings is convenient and clear.
- I. WATERPROOF AND EXPLOSION- PROOF FITTINGS: follow manufacturer's instructions for installation and connection to conduit system to fully achieve required degree of protection.
- J. DAMAGED FITTINGS: reject damaged fittings or plates with damaged finish. Protect fittings and plates against damage after installation and handed over.
- K. CONNECTION OF APPLIANCE:
 - 1. Where appliance is designed to adapt directly to outlet box, extend electrical wiring to incoming terminals inside appliance.
 - 2. Where appliance is not designed to adapt to outlet box, install connecting wiring in flexible conduit firmly fixed to outlet box cover plate and to terminal box on appliance.

3.2. INSPECTION AND TEST ON SITE

- A. VISUAL INSPECTION: fittings and equipment are to be inspected for fixing and workmanship.
- B. MEGGER TESTS are to include switch and socket outlet tests together with insulation resistance of wiring installations.
- C. OPERATION: devices are to be tested for operation and are to perform as intended at full load without any signs of heating.
- D. EQUIPMENT is to be insulation tested and observed, under full- load for not less than 3 days operation, with respect to undue heating and performance in general.

CHAPTER 5
GENERAL LIGHTING INSTALLATION

CHAPTER 5

GENERAL LIGHTING INSTALLATION

1. GENERAL

- 1.1. ELECTRICAL WORK GENERALLY** is to be in accordance with the requirements of the chapter 1 of the Specification.
- 1.2. DESCRIPTION OF WORK:** complete indoor and outdoor lighting installations including fixtures, control gear, mounting provisions, accessories and connection to circuit wiring and to corresponding lighting control equipment.
- 1.3. FIXTURE DESIGN AND STANDARDS:** the Specification and the Drawings are a guide to the selection of lighting characteristics and lighting fixtures, giving general features of construction, materials, method of installation and conditions of operation. Unless otherwise specified, fixtures are to be manufacturer's standard series, designed and manufactured for the purpose and application required, generally in accordance with the Schedule of Lighting Fixtures and complying with IEC 598 and CISPR 15.
- 1.4. DESIGN LAYOUT:** fixture layout has been determined from photometric data of specified fixtures to achieve desired level and uniformity of illumination. Reflected ceiling plans are to be checked to ensure exact positions of fixtures with respect to structural members, ducts pipes, other installations and ceiling panels/tiles, where required.
- 1.5. EQUIPMENT DATA:** submit data for approval including, but not limited to, the followings:
 - A. Detailed literature on each fixture, lamp and control gear including manufacturer's name, catalogue number, rating, material specification, overall dimensions, operating characteristics and principals.
 - B. Details of changes to standard fixtures for adaptation to condition of installation and to the Specification.
 - C. Photometric data for lighting calculations including polar light distribution curves, coefficient of utilization, glare classification, efficiency, depreciation factors etc.
- 1.6. SAMPLES:** submit fully equipped sample of each fixture type, modified if required, together with color and texture samples of each fixture.

2. PRODUCTS AND SYSTEMS

2.1. COMPONENTS AND ACCESSORIES

2.1.1. LIGHTING FIXTURE CONSTRUCTION-GENERAL

- A. **GENERALLY:** construction and wiring of fixtures are to comply with the Regulations and Standards. Fixtures are to be fabricated, assembled and wired entirely at factory. Manufacturer's name, factory inspection stamp and official quality label are to be fixed to each fixture supplied.
- B. **LIGHTING FIXTURES (LUMINAIRES):** to be manufacturer's standard, as given in Lighting Fixture Schedules shown on the Drawings, or equal.
- C. **SHEET STEEL HOUSINGS:** to be not less than 0.6 mm thick, and thicker when required by the Specification or the Standards.
- D. **SHEET STEEL REFLECTORS:** to be not less than 0.5 mm thick.
- E. **ALUMINUM REFLECTORS:** to be not less than 0.7 mm thick, unless otherwise approved.
- F. **FABRICATION:** metalwork is to be mitred, welded and ground smooth without tool marks or burrs. Flat metal parts are to be stiffened by forming grooves and edges during fabrication. Metal parts are to have finish free from irregularities.
- G. **RUST-PROOF FERROUS BASE:** ferrous metal parts are to be bonderized (treated with corrosion resistant phosphate solution) and given an approved rust-inhibiting prime coat before application of final finish.
- H. **FINISH FOR NON-REFLECTING METAL SURFACES:** approved baked enamel paint. Paint color on fixture frames and trims is to be as specified or as selected by the Engineer.
- I. **FINISH FOR LIGHT REFLECTING SURFACES:** white baked enamel paint having reflection factor not less than 85%. Mirror reflectors, where specified, are to be highly polished, anodized aluminum with reflection factors not less than 97%.

2.1.2. FLUORESCENT FIXTURES

- A. **LAMP HOLDERS GENERALLY:** to IEC 400, heavy duty, moulded white plastic with non-corroding spring contacts.
- B. **LAMP HOLDERS FOR INDUSTRIAL FITTINGS:** spring loaded turret type, heavy duty, dust protected.
- C. **BALLASTS GENERALLY:** to IEC 82. Only single (36 W) or two-lamp (18 W) ballasts are to be used in any one fixture. Two-lamp ballasts are to be lead-lag, series type. Equipment is to be enclosed in sheet steel casing with corrosion resistant finish.

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- D. BALLAST THERMOSETTING COMPOUND is not to soften, liquify or support combustion under any operating condition or upon ballast failure, and is to fill ballast enclosure and dampen vibrations. Temperature rise, under normal operating conditions, is not to exceed 55 deg. C above maximum ambient temperature of 40 deg. C.
 - E. BALLAST PROTECTION: each ballast is to have one-time external fuse and fuse holder rated in accordance with manufacturer's instructions.
 - F. BALLAST TYPE: electronic or electronic high frequency dimmable type, as stated in fixture description and as shown on the drawings, power factor corrected to above 0.9, having manufacturer's lowest case temperature. Sound rating is not to exceed level given in the Standards. Harmonics to IEC EN 60929, radio interference suppression to IEC EN 55015 and immunity to IEC EN 61547. The ballast shall operate at a frequency not less than 30kHz.
 - G. BALLAST RATING: ballast is to be manufactured and certified for the specific lamp it controls and for operation from nominal power supply, with voltage and frequency equal to nominal voltage and frequency of distribution network.
 - H. CAPACITORS: to IEC 566, having snap-type connectors and fastening, bolt type M8, for fixing to fixture.
 - I. STARTERS, if required, are to comply with IEC 155, and are to be selected in conjunction with respective ballast and lamp.

3. FIELD AND INSTALLATION WORK

3.1. INSTALLATION

- A. **GENERALLY:** install fixture level, aligned and parallel or square to building lines and at uniform heights as shown on the Drawings or as approved by the Engineer. Make final height adjustment after installations.
- B. **FIXTURE SUPPORT:** provide fixture and/or fixture outlet boxes with hangers, brackets and flanged bolted fittings, as necessary, to support weight of fixture. Submit details of hangers etc. and method of fastening for approval. Rigidly secure fixture mounted on outlet boxes to fixture studs. Install hooks or extension pieces, when required, for proper installation. Provide one point of support in addition to the outlet box fixture stud for individually mounted fixtures longer than 600 mm.
- C. **SUSPENDED CEILINGS:** if ceiling construction is unable to support weight of fixtures without strain or deformation, suspend fixtures directly from building structure.
- D. **SOLD CEILINGS:** coordinate dimensions of recesses in ceilings with exact fixture dimensions and structural elements.
- E. **CONTINUOUS ROWS:** arrange fixture so that individual fixtures can be removed without dismantling remaining fixtures. Provide minimum spacing between fixtures.
- F. **COVER PLATES:** install cover plates over fixture outlet box or opening in ceiling or structure when left unused.
- G. **FLUSH RECESSED FIXTURES:** install to completely eliminate light leakage within fixture and between fixture and adjacent finished surface.
- H. **VENTILATION:** keep ventilation channels free after fixture is installed, if required by the design of the fixture.
- I. **EARTH** metal frames of fixtures as described in Section 219 of the Specification.
- J. **TIGHTNESS:** ensure that enclosed fixtures are reasonably insect/ dust tight when installed, and completely weather-proof for installations subject to weather conditions.
- K. **LAMPS FOR PERMANENT INSTALLATION:** place new lamps in fixtures immediately prior to hand-over and when instructed by the Engineer. Lamps used for temporary service are not to be used for final lamping of fixtures.

3.2. INSPECTION AND TESTS ON SITE

- A. VISUAL INSPECTION: check neatness of installation, uniformity of equipment and nameplates etc.
- B. ILLUMINATION MEASUREMENTS: to be taken at selected locations, to determine level and uniformity.
- C. OPERATION: check lighting installations for operation including control and regulation equipment.
- D. ELECTRICAL DATA: measure power factor, current and voltage at start for installations with discharge lamps.

CHAPTER 06
EARTHING SYSTEM

CHAPTER 06 **EARTHING SYSTEM**

1. GENERAL

- 1.1. ELECTRICAL WORK GENERALLY** is to be in accordance with the requirements of the chapter 1 of the Specification.
- 1.2. DESCRIPTION OF WORK:** complete installations to earth every source of energy and to provide protective earthing and equipotential bonding, based on the TN-S system arrangement, including:
- A. Main earthing system.
 - B. Main earthing terminals or bars.
 - C. Electrical room earthing terminal.
 - D. Exposed conductive parts of electrical equipment.
 - E. Extraneous conductive parts.
 - F. Standby generators earthing terminal.
- 1.3. REGULATIONS AND STANDARDS:** carry out work in accordance with the following:
- A. IEC publications 364-3 and 364-41 Electrical installations in Buildings.
 - B. Latest edition of NFC 15-100 Regulations.
- 1.4. DEFINITIONS OF TERMS** used on the Drawings and in the Specification are as follows:
- A. EARTH: conductive mass of the Earth whose electric potential at any point is conventionally taken as zero.
 - B. EARTH ELECTRODE: conductor or group of conductors in initial contact with, and providing electrical connection to, Earth.
 - C. EXPOSED CONDUCTIVE PART: any part which can be readily touched and which is not a live part, but which may become live under fault conditions.
 - D. MAIN EARTHING TERMINAL OR BAR: the terminal or bar provided for the connection of protective conductors, including equipotential bonding and functional earthing conductors if any to the means of earthing.
- 1.5. EQUIPMENT DATA:** prior to ordering materials, submit data for approval including, but not limited to, manufacturer's catalogues for earth rods, connecting clamps, earthing conductors, protective conductors, bonding conductors, connectors and other accessories, exothermic welding kits and tools etc., and samples of samples conductors as requested.

1.6. SHOP AND CONSTRUCTION DRAWINGS: submit drawings for approval including, but not limited to, the following:

1. Exact location of earth pits, rods and details of installation and connection.
2. Exact routing of buried earthing conductors with indication of cross-section, depth of laying and covering.
3. Cross sectional area of all earthing, protective and bonding conductors
4. Layout and details of earthing provisions at substations, generator rooms, switchgear, distribution panelboards etc., indicating fittings used, insulation, plates and marking, passage and routing of earthing conductors, conduit, sleeves, grooves, niches etc., giving sizes and dimensions of component parts.

1.7. APPROVED MANUFACTURERS: obtain materials from one of the following:

- A. BICC (England)
- B. Copperweld (U.S.A.)
- C. Furse (England)
- D. G.E.C. (England)
or other equal and approved.

2. PRODUCTS AND SYSTEMS EARTHING SYSTEM (TYPE TN-S)

2.1. GENERAL REQUIREMENTS

- A. COMPONENT PARTS of earthing system are to include the following:
1. Earth electrode (rods, tapes etc.)
 2. main earthing terminals or bars
 3. Earthing conductors
 4. protective conductors
 5. Equipotential bonding conductors
 6. electrically independent earth electrodes for special systems with transient earth clamp (similar to ERICO TEC 100C) for connection to standard earthing electrodes (Following the recommendation of the NFC 15-100 with this respect.)
 7. Accessories and termination fittings, bonding, welding kits and other materials.
- B. EARTH ELECTRODE is to consist of one or more earth rods, interconnected by buried earthing tape or cable, which is to have a total combined resistance value, during any season of the year and before interconnection to other earthed systems or earthing means, not exceeding 3 ohm other wise use additional earth rods. Distance between two rods is not to be less than twice the length of one rod driven depth.
- C. FUNCTIONAL EARTH ELECTRODE is to be provided separately from, but interconnected to general bus collecting all the earth at the building and to other earth electrode (s) through suitably rated (470 V) spark gap. Functional earth electrodes are to be used for earthing electronic equipment (communication equipment, digital processors, computers etc.) as required by the particular Section of the Specification and recommendation of manufacturer.
- D. ALTERNATIVE EARTH ELECTRODE: other types of earth electrode may be used, after approval, including:
1. Cast iron pipes with special surround material
 2. Copper plate (s)
 3. Tape mats (strips)
 4. MAIN EARTHING BAR is to be provided at point of service entrance or main distribution room, and as described in the Specification or shown on the Drawings, to which all earthing conductors, protective conductors and bonding conductors are to be connected. Two insulated main earthing conductors are to be provided, one at each end of the bar, connected via testing joints to the earth electrode at two separate earth pits. conductor is to be sized to carry maximum earth fault current of system at point of

application with final conductor temperature not exceeding 160 deg. C for at least 5 seconds. Main earthing conductors are to be minimum 95 mm² bare copper conductor or as otherwise required by the particular Section of the B.O.Q.

5. TESTING JOINTS (TEST LINKS) are to be provided, in an accessible position, on each main earthing conductor, between earthing terminal or bar earth electrode. A bus system shall allow the disconnection of the lightning earth cable from the other earth cable in order to provide a separate test for each earth.
6. PROTECTIVE CONDUCTORS are to be separate for each circuit. Where protective conductor is common to several circuits, cross-sectional area of protective conductor is to be the largest of the conductor sizes. Unless otherwise mentioned the selection of sizes is to be in accordance with Table 54F of IEE Regulations.
7. PROTECTIVE CONDUCTORS are not to be formed by conduit, trunking, ducting or the like. Where armored cable is specified and armour is steel, it may be used as a protective conductor, if approved and if not otherwise shown on the Drawings.
8. CONTINUITY OF PROTECTIVE CONDUCTORS: series connection of protective conductor from one piece of equipment to another is not permitted. Extraneous and exposed conductive parts of equipment are not to be used as protective conductors, but are to be connected by bolted clamp type connectors and/ or brazing to continuous protective conductors which are to be insulated by moulded materials.
9. MAIN EQUIPOTENTIAL BONDING: main incoming and outgoing water pipes and any other metallic service pipes are to be connected by main equipotential bonding conductors to main earth terminal or bar. Bonding connections are to be as short as practicable between point of entry/exit of services and main earthing bar. Where meters are installed, bonding is to be made on the premises side of the meter. Cross-sections of conductors are not to be less than half of the earthing conductors connected thereto, and minimum 6 mm².
10. IDENTIFICATION: connection of every earthing conductor to earthing electrode and every bonding conductor to extraneous conducting parts is to be labelled in accordance with the Regulations, as follows:
11. SAFETY ELECTRICAL CONNECTION- DO NOT REMOVE.
12. IDENTIFICATION: protective and earthing conductors are to be identified by combination of green- and - yellow colours of insulation or by painting bar conductors with these colours, as approved.
13. IDENTIFICATION: source earthing conductor is to be identified along its entire length by continuous green/yellow insulation labelled 'earthing'.

2.2. EARTHING OF MAIN DISTRIBUTION BOARDS, PANELBOARDS, LIGHTING INSTALLATIONS AND WIRING ACCESSORIES

- A. MAIN EARTHING BAR is to be provided in location mentioned on drawings and connected to earth network by insulated conductor (size as mentioned on drawings) via testing joints.
- B. DISTRIBUTION, LIGHTING AND POWER PANELBOARDS are to be connected by protective conductors run together with incoming feeder cable, connecting earth terminals in panelboards with respective main building earthing bar.
- C. SOCKET OUTLETS are to be earthed by protective conductor looped around with the branch circuit and connected to earth terminal within socket outlet box and to which socket outlet terminal is to be connected.
- D. LIGHTING FIXTURES AND OTHER EXPOSED CONDUCTIVE PARTS of electrical installations, such as switches, heaters, air conditioning units etc. are to be connected by protective earth conductors to earthing terminals of respective panelboards.

2.3. MATERIALS AND PRODUCTS

- A. EARTH ROD: copper clad steel, 20 mm diameter, 1.2 m length, extendible as necessary (minimum 2) to obtain required earth resistance. Earth rod is to be complete with couplings, head and bolted connector of sufficient size, and number of bolted clamps to connect all cables terminated thereto.
- B. BURIED EARTH CONDUCTORS: annealed copper conductors 95 mm² cross-section.
- C. TAPS MATS: where earth rods are not likely to be used, earth electrode is to consist of parallel and perpendicular copper strip, 2.4 m apart, welded together by exothermic welds to form a grid. Tape is to be 25x25 mm strip conductor.
- D. EARTH PIT: pre-cast, square or circular section concrete hand- hole (minimum 450 mm internal diameter), with concrete cover, and extending to about 150 mm below top of earth rod. Earth pit is to be provided for each earth rod where connected to an earthing conductor. Cover is to have inset brass plate with inscription 'Earth pit-Do Not Remove.
- E. EARTHING CONDUCTORS: insulated (green/yellow) or bare copper conductor as described in the Specification for the particular application.
- F. TESTING JOINTS (TEST LINKS): copper or copper alloy, with bolted end connections, disconnectable by use of a tool, and suitably sized for earthing conductors or earth bar connection. Links are to be fixed to porcelain or other approved insulating supports. Contact surfaces are to be tinned.
- G. PROTECTIVE CONDUCTORS: single core stranded annealed copper, PVC insulated cables, having rated insulation grade compatible with circuit protected, or to be a conductor forming parts of a multi-core cable, colour coded.

- H. MAIN EARTHING BAR: hard drawn copper, 40x4 mm where formed into a closed loop, and 50x6 mm where open ended. Earth bar is to be labelled Main Earth Bar and is to be drilled, for connection of conductors, at a spacing not less than 75 mm, and is to be supplied with copper alloy bolts, nuts and washers and wall mounting insulators.
- I. PROTECTIVE BONDING CONDUCTORS: bare copper strip conductor, annealed stranded copper cable or flexible strap (flexible braid) of cross-sectional area as described in sub- section 1 hereof.
- J. EARTHING ACCESSORIES: copper or copper alloy, purpose made, of approved design, compatible with points of connection, and of adequate cross- section and current carrying capacity. Connectors and clamps are to be bolted type. Bolts, nuts and washers are to be high quality phosphor bronze or copper silicon alloys.

3. FIELD AND INSTALLATION WORK

3.1 INSTALLATION

- A. CONTINUITY: ensure that complete earthing system is electrically continuous and mechanically secure.
- B. EARTH RODS: while siting earth rods, ensure that resistance areas associated with individual rods do not overlap. Earth rods are to be located at a distance greater than 600 mm from foundations of buildings. Where rocks are encountered, a hole of sufficient size is to be drilled before lowering the rod. Conductive filler such as Marconite or Bentonite or equal filler that will not corrode, is to be provided around the rod.
- C. BURIED EARTHING CONDUCTORS are to be laid at a depth not less than 0.8 m from ground surface.
- D. EARTHING CONDUCTORS are to be following shortest path between earth rods and main earthing terminals or bars, and are to run in PVC conduit (duct) fastened to building structure by approved supports and extending 0.2 m above level, and are to be protected against mechanical damage and corrosion.
- E. PROTECTIVE CONDUCTORS: separate protective conductors, which are not part of a cable, are to be fixed on same support or drawn into same conduit as circuit conductors.
- F. PROTECTIVE BONDING: remove any non-conductive paint, enamel or similar coating at threads, contact points and surfaces and ensure that bonding is made by fittings designed to make secure bonds.
- G. PROTECTION AGAINST CORROSION: protect bolted connections against corrosion either by filling with Vaseline or coating with a special anti-corrosion compound and proper capping.
- H. CONNECTIONS: earth connections are to be readily accessible. If inaccessible earth connection is permitted, approved exothermic welding or brazing technique is to be employed.
- I. CONNECTIONS: where earth connections between dissimilar metals must be made, use bimetallic fittings and protect by coating with moisture resisting bituminous paint or compound, or by wrapping with protective tape to exclude moisture.

CHAPTER 07
LIGHTNING PROTECTIVE SYSTEM

CHAPTER 07

LIGHTNING PROTECTIVE SYSTEM

1. GENERAL

- 1.1. ELECTRICAL WORK GENERALLY** is to be in accordance with the requirements.
- 1.2. DESCRIPTION OF WORK:** air termination network, down conductors, earth termination network, bonding to prevent side flashing and accessories.
- 1.3. STANDARDS:** work is to comply with NFC17-102.
- 1.4. TECHNICAL DATA:** submit data for approval including manufacturer's illustrated catalogues with description and specification of component parts for Protective terminations, conductors, fasteners, testing joints (test links), earth rods, connectors, wall inserts and bolts and any accessories forming part of the lightning protective system.
- 1.5. SHOP AND CONSTRUCTION DRAWINGS:** submit drawings for approval including but not limited to, the followings:
 - A. Exact location and routing of roof and down conductors with indication of sleeves and types of fixings.
 - B. Exact location of earth pits and routing of interconnecting ring
 - C. Typical details of jointing and bonding.
- 1.6. AS- BUILT DRAWINGS:** provide as- built drawings and indicate nature of soil, special earthing arrangements, date and particulars of salting if used, test conditions and results obtained.
- 1.7. MANUFACTURERS:** obtain equipment, manufactured specifically for lightning protection, from one of the following:
 - A. Helita (France)
 - B. Franklin (France).

2. PRODUCTS AND SYSTEMS COMPONENTS AND ACCESSORIES

2.1. TECHNICAL REQUIREMENTS

- A. **LIGHTNING WITH PROTECTIVE ROD.** Lightning protection based on the following principles:
The lightning Protective Rods works when the lightning approaches the ground, a brush discharge is initiated at the lightning conductor, the Protective Rod will urge the brush discharge to propagate in the direction of the direction of the descending leader after a long transition phase. The Protective Rod initiation advance permits to reduce the required time for the formation and continuous propagation of the ascending discharge and brings thus a higher efficiency for the lightning capture.
- B. **DOWN CONDUCTORS** every down conductor has to have test link above ground for testing earth termination network, has to be protected against corrosion for 0.3 m above and below ground level, has to terminate in an earth electrode and has to be insulated with PVC or polyethylene (5 mm thick) from test link to electrode connection point.
- C. **EARTH TERMINATION NETWORK:** earth electrodes are to be interconnected and buried with the top at least 1 m below ground surface and minimum 0.6 m from the foundations. All electrodes are to have resistance to earth (in ohms) not exceeding, tested with test link removed and before bonding to other services or other earth electrodes. Combined resistance to earth of whole network is not to exceed 5 ohms.
- D. **COMMON EARTHING:** earth termination electrodes are to be interconnected in a ring around the structure and bonded to earth electrode of protective earthing system, forming a common earth ring of total resistance value to earth below the lower value of any of the two systems.

The protective rod shall have a 3 meters stainless steel mast to which additional mast units could be attached. The height of the tip of the protective rod shall be minimum 3 meters higher than any other object of the project.

The radius of protection R_p shall cover the whole project with the specified safety margin.

2.2. MATERIALS AND COMPONENTS

- A. **ROOF CONDUCTORS:** bare, high conductivity, annealed copper strip, 25 x 3.0 mm.
- B. **OPERATION OF THE PROTECTIVE ROD**
The Protective Rod tip plays a triple role:
- Collect the energy necessary to power the electrical device contained in the cylinder,
 - Emit the brush discharges created by the high-voltage pulses,
 - Capture the lightning current to convey it to the ground.
- The metal disc is the upper part of the external air gap designed to convey the lightning current from the tip to the ground. The metal cylinder contains the electric device of the Protective Rod

system that generates the brush discharges. The pole serves to fix the Protective Rod for installation. The connecting clamp must be fixed to it, together with the down conductor.

- C. Rod solid copper with roll formed threads at base, bronze nut, cast gun metal terminal base of appropriate thickness and low resistance, and any other accessories for rigidly mounting to surface.
- D. EARTH ROD: unless otherwise indicated on the drawings to be 20 mm diameter, 2.4 meter long, high strength, low carbon steel core of high tensile strength (600 N/mm²), grade 43 A of BS 4360, with 99.99% pure electrolytic copper molecularly bonded into steel core, 0.25 mm minimum thickness. Driving head is to be high strength steel. Couplings are to be long length silicon bronze, grade CS101 of BS 2874, internally threaded. Threads are to be rolled onto rod to ensure uniform layers of copper and strength.
- E. INSPECTION (EARTH) PIT: precast concrete construction, of dimensions shown on the Drawings, with heavy duty cover and brass plate engraved 'Earth Pit Below' inset in cover. One pit is to be provided for each earth rod.
- F. TEST LINKS: two- bolt split- coupling, copper alloy, made to join two ends of down conductor specified. Plate indicating position and number of electrodes is to be fitted above each test link.
- G. BONDING CONDUCTORS: high conductivity, bare annealed copper tape, 20x3.0 mm minimum dimensions, or 70 mm² soft drawn stranded copper cable.
- H. ACCESSORIES including supports, joints, fasteners, clamps, bonds, test links etc. are to be copper or copper alloy and specially manufactured for the purpose. Clamps and connectors are to be specifically designed and sized for clamping and connecting to the various shapes and surfaces of bonded metalwork. Bimetallic connectors are to be used between different materials. Galvanized or plated steel nails, screws and bolts will not be accepted on copper installations.
- I. FLEXIBLE BONDING STRAPS: flexible annealed copper braid, 25x3.5 mm, suitable for bonding flat surfaces, cut to length required and with drilled flat terminals for bolted connections. Special bimetallic alloy terminals are to be provided for joining to aluminum conductive parts.

3. FIELD AND INSTALLATION WORK

3.1. INSTALLATION

- A. SUPPORT ROOF AND DOWN CONDUCTORS using fasteners spaced at not more than 400 mm centers horizontally and vertically, and fixed by anchor bolts or lead inserts with machined screws.
- B. BENDS IN CONDUCTORS are not to be less than 200 mm radius and are not to exceed 90 degree turn.
- C. DOWN CONDUCTORS are to follow most direct path between air terminals and earth pit. Re-entrant loops are not permissible. Tight angle bends may be allowed where absolutely necessary at edge of roof, whereby length of loop in relation to distance between its start and end is kept below eight times. Direct path is to be through an air space in a non-combustible, non-metallic duct with net cross-section 15 times area of conductor.
- D. MECHANICAL PROTECTION OF DOWN CONDUCTORS: provide asbestos cement or PVC pipes underground, starting 0.3 m below ground and to a height of 1.2 m above ground. Test link is to be positioned 1.3 m above ground.
- E. BOND EXPOSED METAL PARTS OF STRUCTURE to lightning protective system if clearance between any element of lightning system and metal part is less 1800 mm or the distance allowed by the Standard, whichever is smaller.
- F. INSPECTION (EARTH) PIT is to extend 150 mm below top of earth rod. Cover earth rod connector with suitable protective compound which can be easily removed for inspection. Connector is not to be covered with backfill material and is to remain clean.

3.2. TESTS ON SITE AND RECORDS

- A. RESISTANCE TO EARTH of each termination electrode and the network and of the complete bonded installation is to be measured during the dry season and checked against specified resistance.
- B. ELECTRICAL CONTINUITY of conductors, bonds etc. is to be checked.
- C. RECORDS: submit the following:
 - 1. Actual layout and specification of components of the system
 - 2. Nature of soil and characteristics and any special earthing arrangement
 - 3. Test conditions and results.

CHAPTER 08
FIRE ALARM SYSTEM

CHAPTER 08 **FIRE ALARM SYSTEMS**

Part 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Design, engineering, procurement, installation, testing and commissioning of a complete fire alarm and detection systems as shown on the drawings and/or as specified herein and in accordance with the requirements of the Contract Documents. Work includes but is not limited to the following:

1. Main Fire Alarm Panel
2. Repeater Panel
3. Automatic and Manual Detectors.
4. Alarm Horns
5. I/O Unit
6. Power Supply
7. Control Elements
8. Voice evacuation system

1.2 REFERENCES

- Lebanon
- A. Lebanon Civil Defense
 1. Relevant publications
 - B. National Fire Protection Association
 1. Relevant Publications

1.3 SUBMITTALS

- A. Product Data: Submit to the Engineer for information only in accordance with requirements of the Contract Documents copies of Manufacturer's data on Fire Alarm and detection systems including but not limited to diagrams and instructions for installation, operation and maintenance, and also include standard or typical riser and wiring diagrams.
- B. Shop Drawings: Submit to the Engineer in accordance with the requirements of the Contract Documents for the Fire Alarm Systems. Include details showing equipment/device locations and connecting wiring of entire fire alarm and detection systems. Include wiring diagrams and riser diagrams.
- C. Sample: Submit to the Engineer in accordance with the requirements of the contract documents, samples of fire alarm system including accessories for approval.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements

1. Fire Alarm Contractor shall be of first grade approved by the Civil Defense.

1.5 SYSTEM DESCRIPTION

A. Fully automatic fire detection and alarm system as described in detail in this section and as shown on the drawing shall be provided. The offered system should be able to monitor, control and graphics for all points and functions.

B. Smoke Control Mode Operation of HVAC Equipment:

1. Provide and install all required wiring, controllers, control elements, installation, sensors, making good, coordination with mechanical and HVAC contractor and other trade to allow for the complete execution of fire control mode as approved by the Engineer and Civil Defense. In response to signal from fire control panel start smoke control system as per required control sequence, approved by the Civil Defense.
2. Stop all equipment (AHU's, Economizer fans, TEF, KEF, etc.) which does not related to smoke control system.
3. Open entrance doors automatically and start smoke exhaust system.
4. Provide smoke detector in supply duct and stop AHU fan in case of smoke.

C. Fire Alarm for Fire Fighting Equipment: Furnish and install complete with all required wiring, conduits, master/control elements/interface units and all necessary equipment and connection to provide visual and audible fire alarm signals in the sub and main fire alarm panel.

The interface of the fire alarm and detection system to firefighting equipment shall be fully connected, tested, commissioned, functional in all respects and fully coordinated with mechanical works and as approved by the Engineer and the Civil Defense.

D. In addition, provide spare volt free contacts for all interfaces (fire pump, fire jockey, water tank level, generators, sprinkler systems, FM200 System, etc...)

Part 2 - **PRODUCTS**

2.1 MANUFACTURERS

A. Fire Alarm Equipment:

1. Simplex - USA
2. Edwards - USA
3. Gent - UK
4. Siemens – Germany
5. Honey Well - Lebanon
6. Approved equal.

B. The products and manufacturers specified herein, are specified for the purpose of establishing minimum quality standards. Products equal in quality to, or better than those specified, will be acceptable. The decision of acceptability rests with the Engineer.

2.2 MATERIALS

A. General

1. Provide a complete high quality intelligent, analogue, addressable central fire alarm and detection system which shall be composed of fully electronic-operated hardware of the latest technology in the field to achieve maximum facilities in identifying the source of fire outbreak in its very early stages and minimum alarm annunciation of false fire phenomena.
2. The capacity of the system shall be sufficient to perform all functions specified in the Contract Documents plus 20% spare capacity.

B. The system shall include but not be limited to the following:

1. Automatic fire detectors.
2. Manual alarm stations.
3. Alarm horns.
4. Digital data communication networks.
5. Central data processing/output unit.
6. Main Fire Alarm operating terminal (system console).
7. Colour graphic display terminal.
8. Remote mimic display panels.
9. Repeater panel (Remote annunciator)
10. System printer.
11. Power supplies/back up batteries.
12. Auxiliary equipment and wiring.

C. Furnish and install all required wiring, controllers, control elements, installation, sensors, making good, coordination with mechanical contractor and other trade to allow for the complete execution in fire control mode for HVAC system as specified elsewhere and for building automation system monitoring and control according to BMS schedules specified in Section 15976.

D. Furnish and install separate fire alarm, visual and audible, panels for firefighting system as specified hereafter including all required wiring, interface units, master elements, etc. This panel to be software interfaced with the main fire alarm panel to monitor all signals from main fire alarm panel. Refer to fire fighting specification and coordinate with fire fighting contractor. The panel shall be approved by the Civil Defense.

E. The product shall be compatible for operating with BMS and coordinate with BMS equipment manufacturer and BMS Contractor.

2.3 SYSTEM HARDWARE CONSTRUCTION

A. Automatic Fire Detectors:

1. Includes photoelectric smoke detector, temperature rate-of-rise with maximum limit heat detectors and linear smoke beam detector and multi-sensor type smoke detectors. Any of the detectors shall fit in the same detector base so that only the detector head could be changed at any time without changing the base or disconnecting any wiring.
2. The base or the detector head shall be equipped with integrated hermetically sealed module for individual addressing and more intelligent signal processing with built-in alarm indicator. The base shall be supplied with a removable dust cover to protect the contact area during installation and construction phase of the building.
3. The detectors provided shall be characterized by the following features as a minimum:
 - a. The detector shall be of plug-in design for installation in pre-wired bases, with a built-in mechanism which allows mechanical locking of an installed detector head.
 - b. The detectors shall be of impact proof material and vibration proof when fitted to the bases, with corrosion proof contacts.
 - c. The detectors shall be protected against transient interference and its response behaviors must not be affected by the changes in operating voltage.
 - d. Reversed polarity or faulty zone wiring shall not damage the detector.
 - e. The response sensitivity of each detector shall be field-adjustable to one of at least three predetermined (factory calibrated) levels. It shall be possible to test the sensitivity of a detector in the field. Sensitivity of a detector can be tested and adjusted through the software of the system.
 - f. The response (activation) of a detector shall be clearly visible from outside by a flashing light of sufficient brightness.
 - g. A built-in integration circuit shall allow the suppression of brief deceptive phenomena.
 - h. The detector shall be designed for fast and simple cleaning and with a built-in barrier to prevent entry of insects into the sensors.
 - i. The detector shall be inserted into or removed from the base by a simple push twist mechanism to facilitate exchange for cleaning and maintenance.
 - j. The detector shall connect to the local control unit via a fully supervised two wire feedback loop circuit (class A wiring).
4. In addition to the previous features the different types of detectors shall be specifically specified according to the following:
 - a. Multi-sensor Smoke Detectors:
 - i) The multi-sensor analog detector shall use a light scattering type photoelectric smoke sensor and a fixed temperature type heat sensor to sense changes in air samples from its surroundings. The detector shall continually monitor any changes in sensitivity due to the environmental effects of dirt, smoke, temperature, aging and humidity. Separately mounted photoelectric detectors and heat detectors in the same location are not acceptable alternatives. Detector sensitivity shall be adjustable and shall be unaffected by changes in temperature, humidity and barometric pressure.
 - ii) The smoke entry windows of the detector shall be suitable for local air current patterns, and shall be installed within safe location as recommended by the manufacturer.

- iii) Detector operation shall incorporate a time delay, response integration circuit to minimize false alarms of smoking with built-in facility to isolate or connect this circuit according to the need of the protected room.
- iv) Detectors shall be of plug-in design for installation on pre-wired bases.
- v) A built-in indicator in the detector base shall indicate detector operation in alarm conditions.
- vi) The detectors shall be designed to provide satisfactory service without any harmful effects for prolonged and continuous periods with the following conditions:
 - vii) Ambient temperature: 0°C to 45°C
 - viii) Relative humidity: 5% RH Continuous without condensation.
 - ix) Smoke detectors and accessories in the explosion-proof areas shall be intrinsically safe type.
- b. Heat Detectors: Heat detectors shall be semi recessed or surface mounted, solid state with combination fixed temperature and rate of rise detection operating in temperatures above 58° C or rate of rise of 10° C/minute. They shall have removable protective cover to enable thorough cleaning and have the sensors protected against mechanical damage. A built-in indicator in the detector base shall indicate detector operation in alarm conditions.
- c. Photoelectric Smoke Detectors: Provide intelligent photoelectric smoke detectors. The analog photoelectric detector shall utilize a light scattering type photoelectric smoke sensor to sense changes in air samples from its surroundings. The detector shall continually monitor any changes in sensitivity due to the environmental effects of dirt, smoke, temperature, aging and humidity.
- d. Optical Smoke Detectors: Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:
 - i) Factory Nameplate: Serial number and type identification.
 - ii) Operating Voltage: 24 VDC, nominal.
 - iii) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.
 - iv) Plug-In Arrangement: Detector and associated electronic components are mounted in a module that connects to a fixed base with a twist locking plug connection. Base shall provide break-off plastic tab that can be removed to engage the head/base locking mechanism. No special tools shall be required to remove head once it has been locked. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the at the control unit.
 - v) Each sensor base shall contain an LED that will flash each time it is scanned by the Control Unit (one every 4 seconds). In alarm condition, the sensor base LED shall be on steady.
 - vi) Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
 - vii) Each detector shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5% obscuration for photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, but shall indicate a "Wrong Device" trouble condition.
 - viii) The detector's electronics shall be immune from false alarms caused by EMI and RFI.
 - ix) Addressability: Detector includes a communication transmitter and receiver in the mounting base having a unique identification and

- capability for status reporting to the FACP. Sensor address shall be located in base to eliminate false addressing when replacing sensors.
- x) Removal of the detector head for cleaning shall not require the setting of addresses.
 - xi) Type: Optical smoke detectors shall be of the photoelectric type.

B. Addressable Manual Alarm Call Points:

1. The manual call point shall be electrically compatible with the standard range of automatic detectors so that it can be connected directly into a supervised two-wire zone of the control units for feedback loop circuit (class A wiring).
2. The manual call point shall be of streamlined and flat appearance permitting its use as flush mounted unit as approved by the Engineer.
3. The unit cover must be secured against unauthorized removal. Every removal of the cover must release an alarm.
4. All inscriptions, texts and marks must be on the manual call point front plate, not on the glass, so that the glass can easily be replaced anywhere. The glass must be secured in the cover against falling out.
5. The manual call point shall be designed for fail-safe operation. The alarm contacts shall be of self-cleaning design to prevent failure after a prolonged period of inactivity.
6. The call point shall have a built-in lamp, automatically confirming its actuation, and it shall be possible to test the call point without destroying the seal or removing the cover.
7. The call point alarm actuating mechanism shall be equipped with strain limits, preventing permanent deformation of P.C.B. and contacts.
8. The manual call point shall be equipped with a self-holding device to maintain the alarm condition until reset by an authorized person.
9. The manual call point housing shall accommodate the sealed electronic circuit for an individual address system.
10. The manual call point must be designed to permanently withstand corrosion, as defined by international standards.

C. Transformer/Rectifier/Battery Units for door closer and door opener devices

1. Fire door closers will be provided and installed for the doors specifically identified on the door schedule. These fire door closers will each incorporate a 24 volt dc electromagnet which, when energized, shall hold the door open. Power for all door closers within a specific fire alarm zone group shall be derived from a common transformer/ rectifier/battery unit.
2. The transformer/rectifier/battery assembly shall be housed in a common enclosure with hinged lockable cover and fixed shrouded terminal blocks for all outgoing wiring. The batteries shall be enclosed in a separate compartment. An earthed electrostatic shield shall be provided between transformer primary and secondary windings.
3. In the event of an alarm, the appropriate fire alarm relay shall interrupt the supply to the associated electro-mechanical door closer, hence allowing the doors to close automatically.
4. The power unit battery bank shall be of the sealed lead-acid recombination type, and maintenance free, to provide a minimum of 1 hour standby at the output rating specified. The charger shall be constant voltage type with self-protecting current limit and output voltage controlled within $\pm 2\%$ of nominal voltage irrespective of $\pm 6\%$ input voltage variation, and rated for 24 hour recharge. A "charge healthy" LED, and floating load terminals shall be provided.

5. Provide at each electro-magnetic door closer location, a flush pattern, momentary action push button station for manual release of adjacent door closer (or pair of door closers in double door locations) in the positions as agreed by the architect. Stations shall be designed to break contact when pressed and re-establish contact when released. The push button shall be within flush brass or satin stainless steel front plate type or white plastic to suit area, labelled 'DOOR RELEASE' in both English and Arabic lettering.
6. The final connection to each electro-mechanical door closer, shall be via a flush mounted single gang junction box with overlapping cover plate located directly above the door transom mounted device, with circular flexible insulated and sheathed cable making back entry into device. All electro-magnetic devices and associated controls shall be earthed.
7. Door openers: Doors provided with door openers as per door schedule shall open the doors in case of a fire signal received from fire alarm panel. Necessary power supply shall be provided to each device. Coordinate with architectural specification drawing and door schedule for the details of the door opener doors requirement.

D. Addressable Control Module (Control Element):

1. The addressable control module shall be designed to convert specific signals on an addressable detection line from the control unit into control functions to actuate other modes as specified elsewhere.
2. The output contact of the addressable control module shall be rated for 0.5A and 220 VAC.
3. The addressable control module shall have an input for a connection of an external contact to provide a confirmation signal to be sent back to the control unit via the detection line after the control function has been carried out.
4. The addressable control element shall be connected to the control unit via a fully supervised two-wire circuit.
5. The control function to be assigned to the addressable control element shall be programmable at the control unit.
6. The addressable control module shall have a built-in response indicator lamp to flash during activation.
7. The addressable control module shall have screw less terminals with built-in strain limits to prevent permanent deformation of the terminal and weakening of contact pressure.
8. The addressable control module shall operate reliably between 0°C and 60°C and up to 95% relative humidity.

E. Alarm Devices:

1. Local alarm horns shall be flush, suitable for wall or ceiling, mountings, of suitable construction to match the interior design and as approved by the Engineer. Fully electronic, low voltage, low power consumption, matching the system and of rated sound level within 85 db at 1 meter and 800 Hz continuous tone.
2. General alarm horns shall be fully electronic of combined visual/audible alarm horn and alarm flash light in a weather proof protective housing for out-door areas. The horn shall be of multi-tone switchable facility where different tones could be selected within the device provide continuous, intermittent or siren tones at a rated sound level within 105/115 db at 1 meter and 1000 Hz.

F. Main Fire Alarm Control Units:

1. Autonomous control units, operating as substations to a higher hierarchical system level in a communication network type system.
2. The control unit shall basically consist of the following elements:
 - a. Free standing style enclosure or wall mounted

- b. Display and operating terminal (panel)
 - c. Plug-in control and data communication modules
 - d. Mains and standby power supplies
 - e. System interconnected terminals
3. The control units shall be of high quality, modular design by means of plug-in cards allowing later expansion and exact tailoring of detection zones and control outputs to a building's requirements.
4. The control units must be microprocessor based and controlled by a programme contained in non-volatile memory (ROM or EPROM).
5. The control units shall allow adaptation to specific building requirements by entry of user data via a built-in keyboard provided on the operating panel.
6. All specific user data must be field-programmable through the same built-in keyboard and must be buffered (safeguarded) by a permanently soldered-in Lithium battery on the microprocessor board. This shall maintain the user data even when the microprocessor board is removed from the unit.
7. It shall be possible to operate a substation control unit using either free assignment of conventional zoning or addressable detector systems with zones (software assigned zones per line).
8. All detection circuits must be monitored against open/short circuits and ground faults.
9. It shall be possible to connect detection circuits in feedback loop class A configuration.
10. Each control unit shall be designed to be operated with the main operating and display terminal at the building security room as shown on the drawing.
11. The control unit shall be capable to process and evaluate incoming signals from addressable devices such as automatic detectors, manual call points, etc. via two wire feedback loop circuits.
12. The addressable detector line circuits of the substation control units shall have the following characteristics:
 - a. Each plug-in addressable line board shall be equipped with not more than 4 line circuits.
 - b. Each addressable detector line circuit shall be working independently in order to maintain full autonomous operation in case of trouble in one of the line circuits.
 - c. Each addressable line module shall have its own microprocessor based circuit, working independently from the central processor board located in the control unit (emergency mode in case of microprocessor failure).
 - d. The address assignment shall be determined automatically by the control unit due to the physical/geographical position of the detector bases along the two wire line circuit.
 - e. The base electronics must be fixed and all assignments of zones and positions shall be programmed at the control unit.
 - f. It shall also be possible to generate "zones" consisting of a single detector only.
 - g. It shall be possible to determine the exact alarm or trouble device address (location) at the substation control unit by means of a numerical display.
 - h. The accurate detection device address shall comprise the line number, device number and programmed zone number.
 - i. The detectors shall be exchangeable without needing to re-programme the control unit or the user data.
 - j. It shall be possible to put individual control elements on the line (contact outputs) to perform specific automatic functions related to an affected detection zone.
 - k. It shall be possible to operate manually the individual control elements (contact outputs) on the line via the keyboard terminal on the control unit.

G. Central System Data Display and Operating Terminal:

1. General requirements:

- a. It shall be possible to connect the following peripheral devices to the central data processing unit:
 - i) System main display and operation terminal (system console).
 - ii) Printer.
 - iii) Synoptical view board (mimic panel).
 - iv) Digital input/output device(s).
- b. The data peripheral devices shall automatically display and log alarm and change-of-status messages received from the satellite control units.
- c. The peripheral devices shall allow complete supervision and operation of the entire fire alarm system by the operator.
- d. All input devices and all connections between CPU and peripheral units shall permanently be supervised.
- e. The function of the system main terminal, including the display LED Monitor itself, shall automatically be supervised. Any malfunction shall trigger a fault signal.
- f. Basically, all alarm and change-of-status functions shall be displayed on system main terminal and logged on printer.
- g. All communication between the system operator and the fire alarm system shall be routed via the system main terminal.
- h. The system main terminal (system console) shall provide optimal conditions for successful intervention by means of rapid and simple processing and displaying of all necessary data in plain text and graphics.

2. Alarm display mode on the system main terminal (system console):

- a. The system main terminal shall consist of the following elements:
 - i) A self-contained basic operating unit equipped with optical indicators for the basic essential signals and with dedicated function buttons for main system operation.
 - ii) A colour LED monitor.
 - iii) Touch screen for extended system operation.
 - iv) A keyboard that shall be used only for special system operation or programming only.
- b. The self-contained basic operating unit shall be installed in a housing next to the colour LED monitor unit.
- c. The colour LED display shall be divided into 3 ifelds, such as.
 - i) System summary (overview) field:
System user name, time and date, current basic status function and a "navigation aid" for operation (where am I, where have I been?) shall be indicated in this field.
 - ii) Data display field:
All system events and relevant instructions shall be displayed in plain text or graphics in this field.
 - iii) Dialogue field:
System operation shall mainly be derived from this field.
Only the instructions presently valid for the various operating steps shall be indicated here. Commands shall be selected by touching the screen to the corresponding command on the field.
- d. The high resolution colour LED shall comply with the following minimum requirements:
 - i) Screen size: minimum 350mm (14inches) diagonally
 - ii) Screen capacity: minimum 24 lines with 80 characters per line.
 - iii) 8 basic colours

- e. The following key information (signals) received from the associated substation control unit(s) shall be displayed on the system main terminal's basic operating unit by dedicated optical indicators:
 - i) alarm
 - ii) status
 - iii) fault
- f. The dedicated optical alarm indicator(s) shall be flashing initially and shall become steady when the alarm has been acknowledged.
- g. The following status information of the system main terminal itself shall be displayed on the basic operating unit by dedicated optical indicators:
 - i) System main terminal in operation
 - ii) System main terminal at "fault"
 - iii) System operating "enabled"
 - iv) System operating "disabled"
- h. All alarm signals shall basically be displayed on the system main terminals.
- i. An optical indication shall be activated on the system summary field when the display field is full, advising the operator that more alarms are present in the memory.
- j. Displays of lower priority signals shall be overridden automatically by messages of higher priority.
- k. A message with higher priority shall be background coloured to ensure that this specific message will be reliably noticed.
- l. When an alarm condition is cleared (reset), the display of that alarm shall be automatically deleted from the screen.
- m. Un-acknowledged alarms shall distinctively be marked next to the alarm message on the screen.
- n. To improve functional clarity, a static method of representation shall be chosen for marking symbols in the data display field.
- o. It shall be possible to assign specific customer plain text of minimum 70 characters per system event.
- p. The system (CDP unit) shall have the capability of storing full alarm information for all data points in the system.
- q. Detectors and/or actuators as referred to in the operating dialogue, shall be identified exclusively by their geographical location. No technical code shall be used to identify system elements neither on system main terminal nor on printer.
- r. The alarm message information per zone and/or device shall contain the following:
 - i) Time of day
 - ii) Date
 - iii) Type of alarm
 - iv) Origin of alarm, indicated by area/floor/room
 - v) Description of affected alarm location
 - vi) Counter-action to be taken

It shall be possible to assign the following basic functions and/or criteria originating from all or a freely selectable number of substation control units to be processed by the system main terminal. Possible assignments are:

 - i) Fire alarm and/or
 - ii) Plant monitoring (technical alarm)

3. General system operating mode:

- a. The system main terminal shall be able to supervise and operate all autonomous units (e.g. satellite control units) belonging to the fire alarm system.
- b. The following dedicated function buttons shall be available on the system basic operating unit:

- i) Buzzer off: silences the system main terminal's internal buzzer
 - ii) Acknowledge: performs an acknowledgment action on the substation control that sent the alarm, fault or change-of-status message
 - iii) Reset: performs a remote reset action on a particular satellite control unit or on system-wide basis
 - iv) Keyboard: for password entry, programming and operation.
- c. The stand-alone basic operating unit shall be installed in a housing next to the colour LED monitor unit.
- d. The system operating concept shall give the operator nearly identical sequences in the processing and operation of events for the criteria: Fire, Extinguishing, Gas and Plant Monitoring.
- e. The hierarchical operating organization shall comprise operations depending on event-related action (e.g. alarm acknowledgment). These actions shall be imperative and event-independent (e.g. zone on/off) and shall be arbitrarily selectable by the operator.
- f. The basic event-related operation shall require not more than a few function keys on the system basic operating unit.
- g. The extended system operating procedure shall be based on a user- adaptive, screen-oriented dialogue in the manner of menus and tasks. By selecting the correct menu, marking symbols on the screen's dialogue field, a message, command, program etc. shall be selected accordingly. The instructions that are valid for the next operating step shall be indicated in the dialogue field.
- h. It shall be possible to display all events in plain text or in colour graphics selectively on the same system main terminal screen. Text or graphic selection shall be made in the dialogue field.
- i. For quick and clear recognition, the number of messages displayed in the data field shall be restricted. However, the number of messages available below or above the currently displayed area shall always be found in the system summary (overview field).
- j. No knowledge of technical codes shall be necessary for system operation. All messages and instructions needed for system operation shall be indicated in plain text and/or graphics.
- k. A keyboard shall be provided to form part of the system main terminal(s) for the following purposes:
 - i) Entry of password for protected operating functions.
 - ii) Setting of time of day and date
 - iii) Assignment of password and operator's access level.
 - iv) Edit and modify system basic data, configuration parameters, program parameters, etc.
 - v) Edit and modify the system's plain customer text and messages, especially:
 - description of substation control unit location
 - description of affected alarm location
 - counter-actions to be taken
 - special operator advises
 - etc.
 - vi) Assigning function keys "on" or "off" on the keyboard, allowing control of auxiliary relays in an addressed substation control unit.

H. System Event Printer:

1. The system printer shall log all change-of-status, alarm and fault messages, along with time of day and date.
2. Each message shall be printed in one line or two and shall contain a reduced plain text related to the zone and/or device location.

I. Colour Graphic Display Terminal

1. General requirements:

- a. The colour graphic display terminal shall basically be used for displaying the pictorial part of a fire alarm message.
- b. It shall be possible to display all events in plain text and in colour graphics selectively on the same system main terminal screen. Text or graphic selection shall be made in the dialogue field.
- c. Facilities shall be provided to generate schematics and pictures in an easy and fast manner so that no excessive training will be demanded of the personnel.

2. Display mode and programming facilities:

- a. The colour graphic terminal shall allow the interactive (real time) display of all alarms, fault conditions and specific status events (e.g. zone off) in the entire fire alarm system.
- b. The events to be displayed on the graphic unit shall allow identification of their origin by:
 - i) Location of substation control unit
 - ii) Zone and/or device location
 - iii) Originating source
 - automatic detector
 - manual call point
 - building services (plant monitoring)
 - iv) Priority of alarm/fault condition
- c. The graphics presentation shall have a minimum of four hierarchical levels:
 - i) Area overview
 - ii) Building overview
 - iii) Floor overview
 - iv) Room/area overview.
- d. Selection and activation of a certain graphics display shall be either automatic (event driven) or on manual request by menu selection using input unit.
- e. Picture generation shall be effected by means of a digitizing tablet with drawing device and a versatile interactive picture-editing program.
- f. The picture-editing program shall easily allow to add any desired alphanumeric text and pre-defined graphic symbols to each picture.
- g. The system shall have a standard repertoire of at least 8 colours, 9 line types and 15 area shade styles to choose from.
- h. The system shall allow selection from 64 pre-defined symbols.
- i. It shall be possible to store at least 350 different pictures.
- j. Graphic pictures, zone allocation, text and symbols shall be stored in a resident RAM memory and shall be backed-up by a floppy disk memory.
- k. It shall be possible to compose, modify or edit the graphic schematics, text, symbols and zone allocations on-site without jeopardizing the fire alarm system operation.

J. Remote Synoptical View board (Mimic Board):

1. General requirements:

- a. The synoptical view board (mimic board) shall be able to show the entire area(s) and all buildings to be protected on one board by means of LED indicators.
- b. The view board system shall contain the following two main parts:
 - i) Synoptical viewboard with LED indicators
 - ii) Signal decoder unit with LED driver (connectable via "modem" to the central fire alarm control system)

2. Synoptical Viewboard Design:

- a. The synoptical viewboard shall display in a pictorial way all required information within the fire alarm system.

- b. The information shall be presented by means of Light Emitting Diodes (LED) and be announced by a built-in audible device (e.g. buzzer).
- c. The area layout shall be printed on the board and shall be of suitable size to show clearly all floors, rooms, external area, exit routes, and other features of the protected area.
- d. The following status of the fire alarm system shall be indicated:
 - i) Alarm originating from automatic detector(s)
 - ii) Alarm originating from manual call point(s)
 - iii) Fault in any circuit component.
- e. Red LEDs shall be used to indicate fire alarms and amber LED's shall be used for fault alarms.
- f. Incoming alarms shall be indicated by a flashing light, acknowledged alarms by a steady light of the LED.

K. Programmable Signal Decoder Unit with LED Driver:

- 1. The programmable signal decoder unit shall be microprocessor controlled and connectable either to the central data processing unit or as an autonomous unit into the loop network.
- 2. In the loop network configuration, the signal decoder unit shall be completely autonomous and remain fully operational in case of breakdown of the central data processing unit.

L. Repeater Panel (Remote Annunciator Panel):

- 1. Programmable panel shall provide remote annunciation and control using an 80 character, back-lit, alphanumeric, LCD readout. Information is presented in clear, descriptive English language and includes: point status (alarm, trouble, etc.), alarm type (smoke detector, manual station, etc.), number of system alarms, supervisory conditions, and troubles, and a custom location label.
- 2. Alarm, Supervisory and Trouble conditions are also indicated by dedicated LEDs and a tone-alert. Each condition has a dedicated acknowledge push-button switch that silences the tone-alert but leaves the LED on until all conditions in that category are restored to normal. Switch operation is either globally or individually acknowledgeable, determined by the control panel operation. Repeated operation of the appropriate acknowledge switch will scroll the LCD display showing activity in the sequence of occurrence. The tone-alert also sounds to indicate the operation of any of the pushbutton switches.
- 3. Notification appliances can be deactivated by pressing the "ALARM SILENCE" switch. Pressing the "SYSTEM RESET" switch restores the system to normal operation. When system activity is normal, the LCD displays the time, and "SYSTEM IS NORMAL".
- 4. Four programmable "CONTROL" switches and associated LEDs are included. Typical applications include: manual evacuation, door holder release bypass, elevator capture bypass, etc. All switches on the annunciator are controlled by the "ENABLE" key switch with a key is removable only in the disabled position.

M. Power supply units:

- 1. The system components shall have a self-contained power supply unit to operate on a mains power of 220VAC, -15% to +10%, 50 Hz, for each of the following:
 - a. Central data processing unit
 - b. System main terminal (system console)
 - c. Signal decoder unit (synoptical board)
- 2. Each power supply unit shall contain suitable over-voltage protection to prevent any malfunction or damage due to power line surges (e.g. lightning).

3. Each self-contained unit shall be equipped with a built-in standby battery of nominally 24VDC, rated to maintain operation for 24 hours after mains power failure.
4. Upon loss of mains power, the power supply unit shall automatically revert to battery power, and the system shall remain fully operational.
5. When the battery voltage drops below 20VDC of nominally 24VDC, a fault indication shall be provided on the system main terminal.
6. A signal shall be generated on the system main terminal if a power supply unit is operating under emergency battery power.
7. When the AC power is restored, the power supply unit shall automatically revert to normal operation without requiring any manual restoring procedure.
8. The power supply battery unit shall automatically be maintained in charged condition by a built-in short-circuit proof charger.
9. The load shall automatically be switched off when the voltage drops below 19V, to protect battery cells from being damaged by complete discharge.
10. Maintenance free sealed lead acid type batteries shall be used for the emergency power source.
11. Each power supply unit and charger circuit, including all fuses, shall be entirely supervised. Any malfunction or blown or missing fuse shall result in a fault indication on the LED system terminal.

N. Furniture for computer and printer:

The Contractor shall furnish with 2 nos. of desks for installing the processor, monitor and the printer, 2 nos. of chairs shall be furnished for the operator. Furniture design, material shall be subject to approval of Engineer.

O. Emergency Voice Evacuation:

1. Voice Alarm: Provide an emergency communication system, integral with the FACP, including voice alarm system components, microphones, amplifiers, and tone generators. Features include:
 - a. Amplifiers comply with UL 1711, "Amplifiers for Fire Protective Signaling Systems".
 - b. Multiple single alarm channels permit transmission of different announcements to different zones or floors automatically or by use of the central control microphone. All announcements are made over dedicated, supervised communication lines.
 - c. Status annunciator indicates the status of the various voice alarm speaker zones and the status of fire fighter telephone two-way communication zones.
2. Speaker: Speaker notification appliances shall be listed to UL 1480[□]
 - a. The speaker shall operate on a standard 25VRMS or 70.7VRMS NAC using twisted/shielded wire.
 - b. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
 - c. The speaker shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for General Signaling.
3. Manual Voice Paging
 - a. The system shall be configured to allow voice paging. Upon activation of any speaker manual control switch, the alarm tone shall be sounded over all speakers in that group.
 - b. The control panel operator shall be able to make announcements via the push-to-talk paging microphone over the pre-selected speakers.
 - c. Facility for total building paging shall be accomplished by the means of an "All Call" switch.

- d. Horns in the area to be paged shall be disabled when the live paging is activated.

P. Fire Fighters Telephone:

1. Firefighter's phone: Provide a supervised, two-way communication system between the Command Center main fire alarm control panel and emergency phone jacks.
 - a. The firefighter's phone system shall be capable of handling single or simultaneous conversations with all phones connected into the system. As many as six (6) phones shall be able to be connected into the active conversation.
 - b. The phone system circuits shall be designed to prevent static, hum or other interference for clear, intelligible two-way conversation between all phones of the system.
 - c. The phone system circuits shall be supervised, such that the FACP shall be able to differentiate between whether a handset has been plugged into the emergency phone jack and whether the circuit has a shorted wire.
 - d. The system shall indicate to the person attempting to use a remote phone, by a beeping busy signal, that the signal is being received at the control unit and that the lines are intact.
 - e. The act of plugging a handset into an emergency phone jack or removal of any phone from its normal hook position shall cause an audible and visible indication at the control unit. Picking up of the master phone and acknowledgement of the phone circuit shall silence the tone and allow for direct two-way communications.
 - f. The act of unplugging handsets in use and replacement of remote phones to their normal supervisory functions.
 - g. (Optional) Provide emergency phone jacks for installation in each elevator car by the elevator contractor. Required wiring from elevator controls to each elevator car shall be furnished and installed by the elevator contractor.
 - h. Provide emergency phone jacks as shown on the plans. Each jack shall be mounted on a stainless steel single gang plate with the words "Fire Emergency Phone" screened on each.
 - i. Provide a minimum of ten (10) pluggable emergency phones included within a storage cabinet.
2. Telephone Hand Sets: High-impact plastic handset, heavy-duty coil cord, and hook switch; connected to the FACP by means of dedicated, supervised communication lines. Handsets have a dynamic receiver and a carbon transmitter, operating on 24V DC.
3. A black master telephone handset with flexible-coiled self-winding five (5) foot cord shall be provided and recessed within a protective unit- mounted enclosure at the command center.
4. Cabinet: Flush or surface-mounted as indicated, 18-gage, minimum, painted steel with a latched hinged door with trim labeled "Fire Fighter's Phone". Size to accommodate handset and cord.

Q. Fire Door Monitoring

1. Fire door position (close or open) to be monitored with a suitable switch contact (magnetic switch contact) incorporated in the fire alarm system.
2. Position of all fire doors to be indicated in the MFACP.
3. Separate printer has to be provided giving activation details of the fire door as shown on the drawings.

2.4 SYSTEM OPERATION

A. Central Fire Alarm Control System:

1. The entire automatic fire detection system shall be designed as a centralized data communication and processing system. This shall be achieved by connecting all substation control units (local control units) throughout the building and areas via serial data lines to the central fire alarm control system in ring by a two pair 0.6mm dia - twisted pair shielded cables or as recommended by the system manufacturer and subject to international standards, Civil Defense and Engineer's approval.
2. Any alarm signal raised at a substation control unit shall be repeated at the central control system.
3. The central control equipment shall be able to process and adequately evaluate signals generated by other substation control unit(s).
4. The overall system (network) architecture shall be based on the principle of distributed processing. This means that each substation control unit shall remain autonomous (independent) in evaluation, annunciation, alarming and control in case of interrupted communication between the substation control units and the central control system.
5. All messages received by the central control system from substation control units shall be automatically processed and presented to the operator by means of an adequately (latest state-of-the-art) designed terminal concept that prevents misinterpretations of displayed system data and false manipulation of commands.
6. The system shall be multi-microcomputer based and shall be designed to ensure the high reliability and availability necessary for life safety systems.
7. The system shall be of modular design and consist of standardized hardware and software packages only.
8. It shall be possible to expand and modify the system at a later date with minimum changes and investments in such a way that already existing system modules are not affected.
9. It shall be possible to announce any communication and transmission faults in all point-to-point network at the substation control unit and central fire alarm main terminal.
10. All the substation Control Units shall be connected to the central control system with a loop network configuration. In case of failure of a loop device, this device shall automatically be by-passed, and all other parts of the system shall remain fully operational.
11. Data transmission among devices in the loop shall not be affected in case of single breaks or shorts. This requires bi-directional, full-duplex oriented data traffic, complying with class A line supervision. Communication troubles shall be announced at the affected device(s) and at the system main terminal(s).
12. In case of any fault in the microprocessor of the master panel or disconnection from sub-panels to the main panel, the system shall work on the basis of regenerative network. The regenerative network must be capable of generating critical system functions in the event that the master has failed or if any of the data lines are severed.
The network, upon failure of the Master or severed data line will sense the missing remote controllers or field panels and regenerate itself into a system. Each segment that has been regenerated is a full operating system capable of passing individual device or zone information to or from other remote field panels for operation of appropriate output devices and events.

B. System Software Configuration:

1. The system software shall be modular in organization and structure so that it can be easily adapted to changing customer requirements.
2. The system software packages must be highly standardized.

3. At least the following standard software modules shall be incorporated, forming altogether the fire alarm system software:
 - a. Operating program
 - b. System data base (process image)
 - c. Network monitoring and control
 - d. Display priority control
 - e. Command priority control
 - f. Output message generator
 - g. Peripheral drivers
 - h. Text/graphic editors
 - i. "Help" facility
 - j. Service assistance
 - k. Diagnostic
 - l. Auxiliary programs
4. The system software packages shall be resident in the central data processing unit (CDP).
 - a. A comprehensive text editing program shall be provided for easy editing of user text.
 - b. A comprehensive picture editing program shall be provided for easy graphics editing operations.
 - c. A comprehensive parameter editing program shall be provided for easy editing of automatic system command functions.
5. It shall be possible to assign to each incident different customer plain text for day and night system operation.
6. For plant monitoring contacts (for smoke control mode) it shall be possible to assign a different plain text for active and inactive status of the signal (contact).
7. All system incidents shall be chronologically recorded in the system history file, together with date and time for subsequent reports.
8. All logs in the system history file shall be retrievable, assorted according to the following parameters:
 - a. alarm/trouble/status
 - b. fire/plant monitoring
 - c. time and/or date
9. It shall be possible to add to each alarm message information relating to the cause of the alarm prior to storing the message in the history file.
10. It shall be possible to trigger pre-defined command and/or control functions automatically upon active system events.
11. Automatic time-dependent command and/or control functions shall be pre-definable.
12. Access to system operating functions shall be protected by a password.

C. Alarm Organization Facilities (Alarm Verification):

1. The alarm organization shall be field programmable. Programming inputs shall be via simple numeric code by using the keypad on the substation units and main operating terminal. Control unit functions and programming shall follow guided operations via flashing keys or display.
2. It shall be possible to assign the following identification to each zone:
 - a. Automatic detector(s)
 - b. Manual call point(s)
 - c. Technical alarm contact(s).etc.Furthermore, it shall be possible to allocate any zone to one of the following alarm functions:
 - Day and night mode operation (two-stage alarm)
 - Cross-zoning concept
 - Alarm pulse memory concept (alarm confirmation)

3. Alarm initiation for the day mode shall be organized as follows:
 - a. Prompt Alarm Level (P.A.L.): is the prompt alarm annunciated at the following units simultaneously:
 - i) The detection device (visual).
 - ii) At the main operating terminal and substation control units (visual and audible).
 - iii) Monitor at the building management room (plain text).
 - iv) Printer at the building management room (plain text).
 - v) Mimic display panel at the remote mimic panel (visual and audible).No other outputs shall be released in this level. P.A.L. shall only be activated by a signal from any automatic fire detector.
 - b. Acknowledged Alarm Level (A.A.L.): If P.A.L. is acknowledged, only audible signals at the annunciated control panel shall be expired and the alarm level becomes the A.A.L. All system alarm status remain ON until reset.
 - c. Local Alarm Level (L.A.L.): Simultaneous activation of P.A.L. + audible alarm devices of the signaled field. L.A.L. shall be initiated automatically upon the expiry of a preset check-up time or promptly upon receiving a signal from duct mounted detector or by using a manual station in the signaled field.
 - d. Emergency Alarm Level/Evacuation Alarm Level (EAL): Simultaneous activation of E.A.L. + all alarm devices of the system + signal transmission to specific authorities (e.g. Fire Brigade). E.A.L. can be initiated only manually at the building management room.
4. The signals initiated by an automatic detector shall only activate the prompt alarm level (P.A.L.) which, if acknowledged within a pre-set time (T1), shall be transformed to the acknowledged alarm level (A.A.L.) which in turn shall durate till initially be reset before the expiry of second pre- set time (T2). Upon the expiry of T2 the local alarm level (L.A.L.) shall be spontaneously triggered. However, any manual fire alarm station distributed in the building shall promptly activate the local alarm level without waiting for the lapse of T2. If the security supervisor conifrms a ☐ false fire phenomena and reset the system before the expiry of T2, L.A.L. shall not be initiated and A.A.L. shall be cancelled automatically. If checking up showed a real fire outbreak, the security supervisor shall actuate the nearby manual station to promptly activate the L.A.L. or a manual switch at the building management room to activate the emergency alarm level (E.A.L.) if the spot of danger is out of control.
5. Control outputs related to the defined alarm levels shall be provided by the field control element in the form of voltage free contacts for HVAC controls as shown on the Drawings and speciifed in "DIVISION 15".
6. In the night mode of operation of the control units, and main terminal, a local alarm shall be given without delay, releasing immediately the actuation of the object's audible circuits.
7. The switchover from day to night mode shall be programmable up to switchovers.
8. It shall be possible to program the control units for cross-zoning function in such a way that the response of only one particular zone will result in an internal alarm, while the response of the second zone will initiate the local alarm response.
9. It shall be possible to program the control units for pulse storage function in such a way that the first response of an automatic detector is immediately reset, with no alarm initiated. Should a second response of the same zone or detector occur within a fixed time, an internal or general alarm response shall be initiated.

Part 3 - EXECUTION

3.1 GENERAL

- A. Furnish and install a complete fire alarm and detection system, fully connected, tested, commissioned and functional in all respects.
- B. The manufacturer shall clearly state the types of communication and protocol to be used as well as the standards with which they comply.
- C. Prior to completion of the Works submit to the Engineer a comprehensive narrative report, in both English and Urdu, explaining in detail, and in "lay" terms, the general purpose and functional characteristics of the Fire Alarm and Detection Systems of the building and the associated operation of the building's mechanical fire protection systems. The Report shall deal with the operation and maintenance of all such systems and the fire drill procedures and escape routes to be followed in order to evacuate the building in case of fire.

3.2 WIRING

- A. Wiring shall be as per the manufacturer's recommendations and shall meet with international standards and Engineer approval.
- B. The wiring of the detection circuits and alarm devices as well as the main loop of the addressable fire alarm system to compose a digital data network. Any special cables required by the system manufacturer shall be included as required without any additional cost.
- C. All exposed raceways of fire alarm system shall only be galvanized steel conduits of 25mm min. diameter.

CHAPTER 15
TELEPHONE INSTALLATIONS WITH E-PABX SYSTEM

CHAPTER 15

TELEPHONE INSTALLATIONS WITH E-PABX SYSTEM

1. GENERAL

1.1 ELECTRICAL WORK GENERALLY is to be in accordance with the requirements of the chapter 1 of the Specification.

1.2 DESCRIPTION OF WORK: complete telephone distribution network including private telephone exchange system (EPABX) including, but not limited to, the followings:

- A. Main Telephone Terminal Frame (MDFs)
- B. Secondary telephone distribution boxes.
- C. Telephone cables.
- D. Telephone outlets (as part of the structured wiring system).

1.3 REGULATIONS AND STANDARDS: telephone installations are to comply with the requirements of PTT and the relevant CCITT recommendations and the Electronic Industries Association / Telecommunication Industry Association Standard EIA/TIA- 568 "Commercial Building Telecommunication Wiring Standard" or ISO/IEC- 11801 "Information Technology – Generic cabling for customer premises" as for the material installed.

1.4 EQUIPMENT DATA: submit data for approval including complete technical data and manufacturer's catalogues for all equipment and materials.

1.5 SHOP AND CONSTRUCTION DRAWINGS: submit drawings for approval including, but not limited to, the following:

- A. Detailed system schematic diagram
- B. Detailed layout of all equipment in rooms, including elevations
- C. Exact routing and layout of all cabling and wireways
- D. Typical installation details of cabinet (s), boxes, and other equipment.

2. PRODUCTS AND SYSTEMS

2.1 TELEPHONE DISTRIBUTION COMPONENTS

- A. MAIN DISTRIBUTION FRAME (MDF) is to be of size suitable for ultimate capacity of telephone network. All internal lines individual telephone distribution boxes are to be connected to MDF. Terminals are to be identified by reusable numbered tags corresponding to respective lines and extensions. Proposed numbering scheme is to be submitted for approval. Lines are to be connected by quick clip Insulation Displacement contact (IDC). Soldering will not be allowed. Patching inside MDF between telephone operator section and telephone backbone section shall be using factor tested patch cords IDC-IDC.
- B. SECONDARY TELEPHONE DISTRIBUTION BOXES:
steel or metal alloy, general purpose enclosures, for surface or concealed mounting, of size and at location shown on the Drawings, dust- proof, IP 42 protection for indoor mounting to IEC 529, with tamper- proof screwed covers.
- C. TERMINAL BLOCKS: plug- in quick connect type rated to EIA/TIA 568 or IEC 11801 Category 5, for 100 Mbps transmission speed. Blocks are to be of the insulation displacement connector (IDC) method. Conductors are not stripped, but forced into a terminal strip containing sharp inside edges that pierce the insulation and make solid connection. The wire is to be held tightly between the metal contacts, forming a gas tight seal. All connections are to be made using a special punch down tool. Provide a spare tool to the user for future wiring additions and alterations. Patching between blocks to be via twisted pairs (jarretieres).
- D. CONDUITS AND RACEWAYS are to be provided in accordance with Sections 16118 of the Specification.
- E. TELEPHONE SYSTEM CABLES are to be 100 ohm unshielded twisted pair (UTP) to EIA/ TIA- 568 or IEC 11801 category 5 wiring standard. Cables are to be four- pair to telephone outlets (RJ45 CAT5) and multi-pair CAT5 composite media cables for backbone distribution. Indoor cabling is to be polyethylene insulated, tinned solid copper conductors, twisted into pairs, color coded and gray PVC sheath. Minimum diameter of conductor is to be 0.6 mm.
- F. MULTI-PAIR CABLES for installation in duct banks, outdoors are to be non- hygroscopic, waterproof, polyethylene insulated, tinned solid copper conductors, minimum 0.6 mm diameter, twisted into pairs, color coded, with wrapping of aluminized polyester tape, PVC tape, aluminum or copper sheath and PVC over- sheath.
- G. CABLE RATING: cables are to be rated for maximum operating voltage of 150 V, with insulation resistance of 10,000 megaohm/km, and tested at 500 V d.c. applied core- core and core- earth.
- H. TELEPHONE OUTLETS (refer to section 16740) are to have modular grid box and cover plates similar to other socket outlets and switches described in the Specification. Jacks are to be modular unshielded 8 positions RJ 45 CAT.5 compatible with RJ11 & RJ12 plugs.

3. FIELD AND INSTALLATION WORK

3.1 INSTALLATION

- A. EQUIPMENT INSTALLATION ON SITE is to be limited to fixation and inter- wiring of various items of the ready made equipment.
- B. CABLES are to be run on cable trays, in conduits above suspended ceilings, in walls or under floors in a manner to protect them from physical damage and excessive heat, and to permit ease of accessibility for servicing and modifications. Fixing accessories are to include two- piece plastic clamps, galvanized screws, wall base- holders and fibber- plastic inserts or raw- bolts, subject to the approval of the Engineer.
- C. CONDUITS: in accordance with the Specification.
- D. EARTHING: provide interference- free earthing as necessary.
- E. TOOLS: use only proper tools for all installations work particularly in making connections.
- F. SUPERINTENDANCE: carry out installations under the direct supervision of a qualified technician, licensed by and trained at the factory.

3.2 MISCELLANEOUS ITEMS

- A. SPARE PARTS AND TOOL KITS are to be provided as per the manufacturer's recommendations for electronic boards, IDC connection modules, telephone outlets, board extractors, cleaning kits, test stations, digital multimeter and battery testing kit.

3.3 MEASUREMENT

- A. **Main Distribution Frame (MDF);** shall contain but not limited to all items listed below:
 - 1. Connections (patching) between primary and secondary part of the MDF using twisted pairs (jarretières) length as necessary through horizontal & vertical cable management.
 - 2. All necessary accessories for ventilation, fixing, complete labeling of all modules and cables, cable and cord horizontal and vertical management for whole MDF.
 - 3. 8 pair disconnection module CAT5 with quad channeled wire guides above and by pairs below (4 modules for each 25 pairs cable, 3 modules for each 3x4 pairs cable and 13 modules for each 100 pairs cable):
 - 1) **Primary Part:**
 - a) 42 disconnection modules (4 modules spare) for 3 incoming 100 pairs cables from PSTN.
 - b) Three-pole surge protection module. Line continuity with 3-pole voltage surge arrestor, two

PTC (positive temperature coefficient) current surge protections, lines are earthed after fail-safe voltage surge arrestor has tripped. Surge protections are mounted on the 42 modules above.

2) Secondary Part:

- a) 42 disconnecting modules (4 modules spare) for cables up to consumer voice access points and general services PABX.
- 4. Distribution frame 2x65 pitches with 2 wall attachments brackets fitted with 2 rails 250mm apart, channel shaped aluminum rails with a depth of 90mm with module attachment every 16mm, extruded aluminum trunking with cover and open rings for jump ring cords.
- 5. Cover for distribution frame made from Lacquered steel with lockable full door.
- B. **Telephone (voice) network consumer access point type "T1"** shall consist of a shock resistant polystyrene enclosure with a twist-lock lid, profile for fixing IDC CAT5 modules, 1x10 way PCB earth strip and 1x8 pairs CAT5 IDC modules.
- C. **Telephone (voice) network consumer access point type "T2"** shall consist of a shock resistant polystyrene enclosure with a twist-lock lid, profile for fixing IDC CAT5 modules, 1x10 way PCB earth strip and 3x8 pairs CAT5 IDC modules.

CHAPTER 10
DATA SYSTEM

CHAPTER 10 **DATA SYSTEM**

Part 1 - GENERAL

1.1 PURPOSE

- A. The Purpose of this document is to describe in detail the passive system design and to define the minimum required specification for system component in term of performance and characteristics.

1.2 APPLICABLE DOCUMENTS

- A. The cabling system described in this specification is derived in part from the recommendations made in industry standard documents. The list of documents below is incorporated by reference:
1. This Technical Specification and Associated Drawings
 2. © 2009 BICSI® Telecommunications Distributions Methods Manual, latest edition.
 3. ANSI/TIA/EIA-568-B.1 Commercial Building Telecommunications Cabling Standard 2001.
 4. Commercial Building Telecommunication Cabling Standards (ANSI/TIA/EIA-568-B.2)
 5. Optical Fiber Cabling Components Standard (ANSI/TIA/EIA-568-B.3)
 6. ANSI/TIA/EIA-569-B Commercial Building Standard for Tele- communications Pathways and Spaces 2003.
 7. ANSI/TIA/EIA-606-A Administration Standard for the Tele-communications Infrastructure of
 8. Commercial Buildings 2002.
 9. ANSI/TIA/EIA-607-A Commercial Building Grounding and Bonding Requirements for Telecommunications 2002.
 10. ISO/IEC 11801 Generic Cabling for Customer Premises.
- B. Other standards that contain requirements pertaining to the safety of and access to private and public telecommunications networks include:
1. ANSI/NFPA 70 The National Electrical Code®, current edition.
 2. IEEE C2-2002 National Electrical Safety Code (NESC®) current edition.
 3. FCC Part 68 Code of Federal Regulations, Title 47, Telecommunications.
 4. UL 1459 Underwriters Laboratories Standard for Safety—Telephone Equipment.
 5. UL 1863 Underwriters Laboratories Standard for Safety—Communication Circuit Accessories.
 6. IEEE 802.3-2002 (10 Gigabit Ethernet for fiber)
 7. IEEE 802.5 (Token Ring)
 8. ANSI FDDI
 9. ATM at 155, 622 and 1.2Giga
 10. ANSI/TIA/EIA 854 (1000 Base Tx)
 11. ISO/IEC 8802.3 (all equivalents to IEEE 802.3)
- C. If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents; the contractor is responsible to determine and adhere to the most recent release when developing the proposal for installation.

1.3 SYSTEM DESCRIPTION

- A. As a standard configuration, the system design is based on a star topology which means that each end user point will be directly connected the patch panel. Each work area communications outlet contains minimum one Category 6a jack, terminated using Category 6a horizontal cables, pulled and terminated on Category 6a insulation displacement connector fixed in a patch panels located in SDR. Patch cords/equipment cords are used to connect each jack to the appropriate service connector. Generally, high pair Category 6a cables are also employed for analog voice connectivity that is used for non-IP communication services such as fax, K-net or emergency use. Zip twin multi-mode fiber optic cables are used as backbone/riser cables for connection between MCCR and SDR's within the school.

1.4 DESIGN ASSUMPTIONS

- A. The cable infrastructure design is assuming that MCCR and BCCR will be connected through a twelve (12) cores OM3 Multimode Fiber Cable. Zip twin multi-mode fiber optic cables used to connect the edge switch of each SDR to core switch running through a vertical shaft shown in the drawings to MCCR. Those fibers are terminated in a multi ports Fiber Patch Panel.
- B. For the Horizontal Distribution, Category 6a cable shall be used to connect end user point to the patch panel in SDR and to switch through patch cord with the same cable category.
- C. For the External Link, the Internet Service Provider (ISP) is responsible for lying Single Mode Fiber Optic Cable connected and terminated in each MCCR in order to provide all services to the building. Moreover, the ISP shall provide the internet service as well as the connectivity to the MOC exchange to supply voice services (E1 and DID).
- D. The transmission performance of a cabling system depends upon the characteristics of the horizontal cable, connecting hardware, patch cords, equipment cords, work area cords, cross-connect wiring, the total number of connections, and the care with which they are installed and maintained. The development of high-speed applications requires that cabling infrastructure be characterized by transmission parameters such as insertion loss, PSNEXT loss, return loss, and PSELFEXT which are considered in this design document to comply with applications and services that will be supported in the UTA package.
- E. The cable Infrastructure solution is based on international standards to provide bandwidth needed to accommodate estimated numbers of occupants and any future expansion in order to avoid any congestion. Furthermore, Infrastructure is designed to maximize the Return on Investment (ROI) to owners in terms of reducing administrations, integrations, and future expansion cost.
- F. The Cable infrastructure design is assuming compliance to the following:
1. Redundancy
 2. Security
 3. High Availability
 4. Scalability and Expandability
 5. Quality Assurance

Part 2 - **PRODUCTS**

2.1 **BACKBONE CABLING**

- A. Backbone cabling is the part of the entire cabling system which provides the connection between MCCR and SDRs in a star topology that shall have no more than two levels of connection.
- B. Fiber Optic cable shall be used for the backbone interconnection between MCCR Fiber Patch Panel and SDR Fiber Patch Panel to provide a high speed and bandwidth required for data transfer between SDR and MCCR and shall accommodate growth and changes in service requirements without the installation of new cables.
- C. In order to obtain the flexibility in meeting the variety of application requirements, The Contractor shall use the hierarchical star topology in the Backbone Cabling wherein each SDR patch panel is directly connected to the MCCR patch panel.
- D. Fiber cable specification
 - 1. The Contractor Shall provide an OM3 50/125 microns Graded Index Multimode Fiber Optic Cable with laser optimized source at wavelength of 850 nm and 1310 nm which shall support 10G Base-S in the link between MCCR and SDR. Moreover, cable shall be an Indoor, Non- Conductive LSZH, tight-buffered, rodent and moisture resistance cable and shall be UL rated of OFNR (Riser).
 - 2. The cable shall consist of LSZH Outer Jacket (125 micron) bounding an eight (8) tight-buffered (50.-micron fiber subunits each is surrounded by armed strength members and LSZH jacket which shall support 10Gbit transmission speed in a distance up to 500 m. If cables are to be longer than 500m, then single-mode fiber shall be used.
 - 3. The fire performance of the fiber cable shall be according to the following specifications as per standards mentioned below:
 - a. Fire resistant cables shall be tested according to IEC 60332.3C and shall withstand:
750 °C for 180 min. with excess loss < 1.0 dB / 0.6 m
1000 °C for 120 min. with excess loss < 3.0 dB / 0.6 m
1100 °C fire resistant cables shall withstand
1100 °C for 30 min. with excess loss < 3.0 dB / 0.6 m
 - b. All cables shall be halogen-free. Halogen content and corrosivity shall be tested according to IEC 754-1 and IEC 754-2.
 - c. The oil resistance properties shall be demonstrated by testing according to IEC 811-2-1, clause 10.
 - d. Mud resistant cables shall have an outer sheath suitable for installation and operation in contact with mud. Mud resistant sheaths are normally not flame retardant.
 - 4. The fiber cables shall have an operating temperature range of -10°C to +70°C. The mud resistance properties shall be demonstrated by the following test procedure: Test specimens from the outer sheath shall be immersed in the actual Mud at 70 °C and tested for elongation at break, tensile strength, volume swelling and weight increase after 14, 28 and 56 days. Requirements:
 - a. Elongation at break: +40 %
 - b. Tensile strength: +40 %
 - c. Volume swelling: +20/-0 %
 - d. Weight increase: +15/-0 %

Flamme Retardant	IEC 60332-1
Fire Retardant:	IEC 60332.3C
Low Smoke Opacity	IEC 1034 1/2
Acid Gas Emission	IEC 754-1

Table 1: Fiber Cable Fire Performance

E. Fiber Performance

1. The performance requirements for the supplied Optical Fiber channels shall assume that each Optical Fiber channel employs a single optical wavelength in one transmission window only. The main parameters that shall be used for performance testing are the Link Attenuation and Bandwidth.
2. For the link attenuation, the cable shall be tested in at least one direction at both 850nm and 1300nm in accordance with ANSI/EIA/TIA-526-14A Method B and shall be suitable for operation according to IEEE 802.3z (Gigabit Ethernet) on distances exceeding 300 m at 1300 nm.
3. The link attenuation calculation of the Optical Fiber Cable shall be based on the following constant values in addition to the parameters mentioned in table 2:
 - a. 0.75 dB Connector Loss/Connector
 - b. 0.3 dB Splice Loss/Splice
4. Accordingly, the attenuation test results shall be less than 2.8 dB @ 850 nm wavelength and 0.4 dB @ 1300 nm wavelength including the cable attenuation; Connector insertion loss and splice insertion loss as summarized here under:

Cabling Subsystem	Link Channel Max Length (m)	Attenuation of a Multi-mode (dB/Km)	
		850 nm	1300 nm
Building Backbone	300	2.8	0.4

Table 2: Maximum Link Attenuation

5. Moreover, the Multimode Optical Cable return loss shall not exceed 20 dB @ both 850 and 1300 nm wavelength.

F. Fiber Connectors

1. An LC pigtail shall be used for the Fiber Optic connectors with a factory polished for low insertion loss and low back reflection and shall be 100% optically tested for premium performance.
2. The connector shall meet the requirements of TIA/EIA-568-B.3 and shall comply with IEC 61754 which define the limit of loss that cable shall not exceed as mentioned here below:

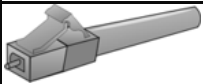
Connector	Insertion Loss	Repeatability
 LC	0.15db(SM) 0.10 dB (MM)	0.2 dB

Table 3: Types of Optical Connectors

3. The connection shall have the following typical performance:

		Insertion Loss	Return Loss
		850nm / 1300nm	850nm / 1300nm
50/125	Mean	0.3 / 0.2	27 / 29
	Limit	0.75 / 0.75	20 / 20

Table 4: Connector Performance

4. The Connection shall comply with the following mechanical and environmental test:

PARAMETER	TIA/EIA Fiber Optic Test Procedure	IEC 61300 Series Test Method	SEVERITY
Attenuation	171	3-4	n/a
Return Loss	207	3-6	n/a
Mating Durability	21	2-2	500cycles
Impact	2	2-12	8 drops at 1,5m
Plug Cable Retention/Side Pull	6	2-4	66Nat 0 degree 6,6Nat90 degree
Strength of Coupling	185	2-6	33N
Plug Cable Flexing	1	n/a	+(-)90 degrees,,5kg 100 cycles
Plug Cable Twist	36	2-5	+(-)2,5 revolutions,15 N
Cold	188	2-17	- 10c,96Hours Sample Functioning
Heat	4	2-18	+60 C 14days, Sample Functioning
Humidity	5	2-19	+40C,90-95%RH 96 Hours Sample Functioning
Thermal Cycling	n/a	2-22	-10C to +60C 5 cycles
Vibration	n/a	2-1	10-55Hz, 30min/each axis

Table 5: Fiber Connector Mechanical Test

G. Fiber Patch Panels

1. Rack mount fiber patch panels shall be used in the SDR and MCCR facilities to connect the fiber cables to the active devices via fiber patch cords.
2. Contractor shall provide a twenty four (24) Ports Duplex Modular Patch Panels for MCCR and Twelve (12) Ports Duplex Modular Patch Panels for SDR to suit LC adapters in order to meet the full cabling system requirement of buildings Network. The Contractor shall terminate each fiber cable serving SDR & MCCR at a patch panels. The patch panels shall meet ISO/IEC 11801, EN 50173 and TIA/EIA 568 warranted component specifications and standards.
3. Contractor shall provide a 19" inch standardized chassis rack-mounted Patch Panels complete with black metallic box type modular structure, mounting screws, bend limiting clips for the cables and patch cords, cable-ties, rear port identification kit, and front built-in label kit including clear plastic holders and laser printable paper. The patch panel shall have mounting stud that accept splice trays or blown fibers. The patch panel shall have an internal routing option for providing strain relief and to maintain proper bend radius for pigtails and patch cables. It is recommended to use Color coded adapters for Multimode and Single Mode backbone fibers.

4. Moreover, Fiber Patch Panels shall have cable management, fiber

management and slack storage for fiber cables to ensure that the maximum allowed bend radius is not exceeded. All connectors and adaptors must be provided with dust caps.

H. Fiber Patch Cord

1. Fiber Patch Cords are to be used to connect active devices to the fiber backbone. Optical patch cord shall be Duplex 50/125j.m OM3 type with connectors adapted to the fiber cabinet and the active devices used. (They shall be single mode, if single mode fiber is used) Fiber patch cords shall be Duplex type, with a keying system to avoid connector mismatch and shall be tested for insertion loss in accordance with TIA/EIA-455-171.
2. Fiber patch cords shall meet the following performance:
 - a. Ultra Physical Contact (UPC) ifnish for singlemode: Insertion loss: 0.40dB. maximum, 0.20 dB typical, Return loss: minimum 55db.
 - b. Physical Contact (PC) ifnish for Multimode 50 micron: Insertion loss. 0.50dB maximum, 0.30 dB typical, Return loss: minimum 20db.
3. All fiber jumpers will include their FOCIS document and individual attenuation test results from the factory.

2.2 HORIZONTAL CABLING

- A. Horizontal cabling is the portion of cabling system that extends from the End User outlet/connector to the horizontal Patch Panel in the SDR and shall include but not limited to the following components:
 - 1. Horizontal copper cable connecting each point directly to the Patch Panel of the area or floor
 - 2. Patch cords in the SDR.
 - 3. Patch cords in work area
- B. The Contractor will be responsible for pulling and terminating cables following all omani and International codes, accepted industry standards and the manufacturer's instructions. The Contractor must work closely with the electrical contractor to ensure that the pathways are installed correctly and that they will allow for proper installation of the cabling system. Visual inspections and upon completion of the project test results will be used to verify proper installation practices were followed.
- C. In order to comply with Owners and Unified Technology Architecture (UTA) requirements, the horizontal cabling type used in the Project shall be Category 6a (Cat 6a) cables. The contractor will be responsible for pulling the copper cable from patch panel located in the nearest SDR within the floor to service device and end user outlet.
- D. The system is planned to reduce on-going maintenance and accommodate future equipment and service changes. Accommodating a diversity of user applications is considered in the design in order to reduce or eliminate the probability of requiring changes to the horizontal cabling as user needs evolve.
- E. The Contractor shall ensure the distance limitation from SDR to work area outlet, which shall not exceed the 100 m distance. This distance shall include the length of SDR patch cords (5 m), the total length of cords in work area (5 m) and the horizontal run (90 m).
- F. The supplied Category 6a cables shall be used for the associated connecting hardware, jumpers, patch cords, equipment cords, and work area cords and shall meet all applicable requirements including the transmission and color code specifications mentioned in ISO 11801:2002. Furthermore, Cable shall meet the transmission and color code specifications in that standard.
- G. Grounding and bonding shall meet the requirements and practices of applicable authorities or codes. In addition, telecommunications grounding/bonding shall conform to ANSI/TIA/EIA-607 requirements and as per requirements mentioned in Section 3.0 Clause 3.8.
- H. CAT6a Cable Specification
 - 1. In addition to the applicable requirements of ANSI/ICEA S-90-661, ANSI/TIA/EIA 568-B.2 and UL 444, cables shall meet the specification mentioned in those documents and as per the requirements and specifications mentioned in this document.
 - 2. The Contractor shall provide CAT 6a Cable for the horizontal cabling which shall allow 500 MHz Bandwidth over 100 m of copper cabling and shall consists of 4 insulated conductor pairs with a twist length selected by the manufacturer to assure compliance with the transmission requirements of the TIA/EIA and ISO Standards and can be terminated in RJ-45 Connector. Each pair shall consist of 2 solid conductor commercially pure, annealed bare copper and shall meet the requirements of ASTM B 3 except that requirements for "Dimensions and Permissible Variations" are not applicable. The conductors shall be per ASTM B 258 except for dimensions. Each copper conductor shall be insulated 100% with Teflon FEP Fluor- polymer resin, but may include FEP concentrate color additives.

There shall be no splices of the insulated conductor. The core, consisting of 4 insulated conductor pairs, shall be protected with an overall thermoplastic covering generally referred to as an "outer jacket." The jacket shall be LSZH, and shall meet and maintain the physical and mechanical requirements of ASTM D4565 for the expected life of the cable.

3. The ultimate breaking strength of the cable, measured in accordance with ASTM D4565, shall be 400 N (90 lbf) minimum. Twisted-pair cables shall withstand a bend radius of 30 mm at a temperature of $-20^{\circ}\text{C} \pm 1^{\circ}\text{C}$, without jacket or insulation cracking, when tested in accordance with ASTM D4565, Wire and Cable Bending Test. Cables shall have an operating temperature range of -20°C to 125°C in accordance with UL

444. Pulling tension should not exceed 25 LBF or that which is recommended by the cable manufacturer.

I. CAT6a Cable Performance

1. All pairs must have impedance of 100 Ohms, with a tolerance of ± 12 ohms. Insulators in standard Blue/White, Orange/White, Green/White, Brown/White colors must cover the conductors.
2. The cable shall meet the general and environmental specification as mentioned here below:
 - a. 1.0-100MHz Impedance (ohms) 100 ± 12
 - b. 100-350MHz Impedance (ohms) 100 ± 15
 - c. 350-750.0MHz Impedance (ohms) 100 ± 22
 - d. 1.0-750.0MHz Delay Skew (ns/100m) ≤ 25
 - e. Pair-to-Ground Capacitance Unbalance (pF/100m) ≤ 330
 - f. Max. Conductor DC Resistance 20oC (ohms/km) 93.8
 - g. Resistance Unbalance (%) ≤ 3
3. The maximum application frequencies shall be based on required permanent link and channel characteristics, and shall not be indicated by the maximum specified frequency for the cabling. In the following table, the Minimum or Maximum requirements for attenuation, NEXT loss, Power Sum NEXT loss, ACR, Power Sum ACR, Return loss and Power Sum ELFEXT are shown as per cable requirements of FCD ISO/IEC 11801 standard for discrete frequencies only. Transmission requirements shall also be met for all intermediate frequencies. Requirements at intermediate frequencies are derived by linear interpolation between frequencies on a semi-logarithmic (NEXT loss, Power Sum NEXT loss, ACR, Power Sum ACR, ELFEXT and Power Sum ELFEXT) or logarithmic (attenuation) scale.

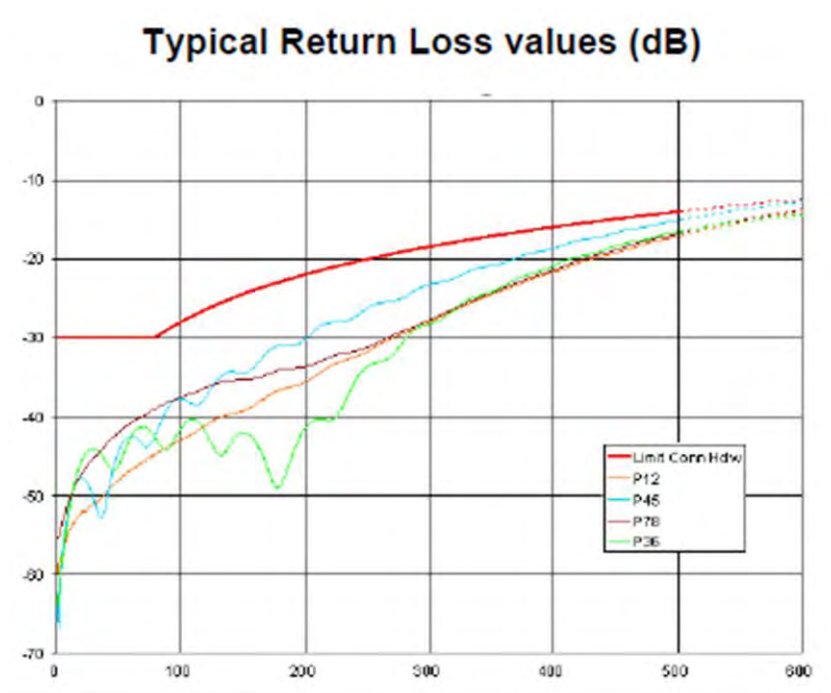
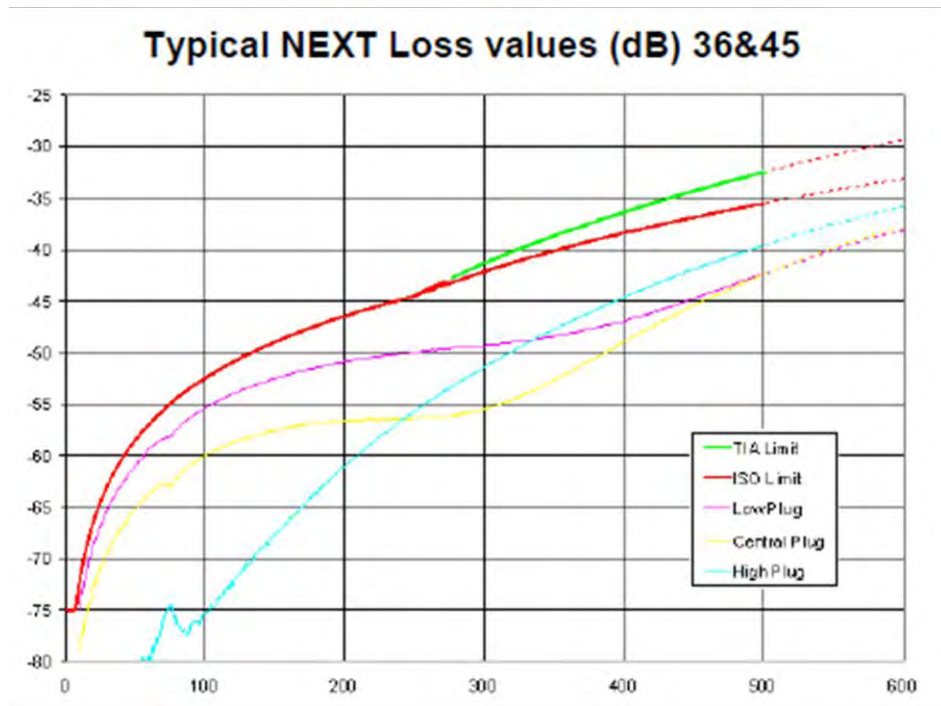
CAT 6 Loss Characteristics

Frequency (MHz)	Return loss (Min dB)	Attenuation Max (dB/100m)	NEXT (Min dB)
1	20.0	2.0	78.3
4	24.2	3.7	69.3
8	26.3	5.2	64.8
10	27.0	5.9	63.3
16	27.0	7.4	60.2
20	27.0	8.3	58.8
25	26.3	9.3	57.3
31.25	25.6	10.4	55.9
62.5	23.5	14.9	51.4
100	22.1	19.0	48.3
155	20.8	24.0	45.4
200	20	27.5	43.8
300	18.8	34.2	41.1
400	17.9	40.0	39.3
500	17.5	45.3	37.8
600	16.9	50.1	36.6

J. CAT6a Connectors

1. All jacks shall be wired to the T568A and T568B wiring pattern. Jacks shall be constructed with a housing of polyphenylene oxide, 94V-0 rated. The connector shall terminate 23 AWG solid conductors with a maximum insulation diameter of 0.050 inches. The jack contacts shall be plated with a minimum of 50 micro-inches of gold in the contact area over a 50 micro-inch minimum nickel under-plate. Jacks shall be compatible with panel thicknesses of 0.058" - 0.063". Jacks shall snap into a 0.790" X 0.582" opening.

2. Category 6a jacks shall be 4-pair and shall meet the performance requirements listed in the table below. Jacks shall fit in a 0.790" X 0.582" opening. Each jack shall be wired to T568B. Jacks shall be UL Listed.
3. The Jack shall meet the following performance characteristics:



K. CAT6a Patch Cords

1. Cat.6a copper patch cords are to be used to connect the Copper patch panel with the workstations to RJ45 outlets, and allow for patching in the enclosures between patch panels and active devices. They shall meet the following criteria:
 - a. Factory made. (hand crimping of cable is not acceptable)
 - b. Minimum length of 3 ft or 0.97 m, and maximum length of 5m.
 - c. Third party component verified to the standard for Category 6a ANSI/TIA/EIA 568 B 2.1.
 - d. Compliant to channel ISO 11801 Class EA and Channel TIA 568B.2-10 Category 6A performances.
 - e. Center tuned to cat.6 test specifications. (Perfectly centered in relation to the limit values set by standard ANSI/TIA/EIA-568-B.2.1.
 - f. Manufactured from stranded wire cable.
 - g. Have a "Snag-Less" design to protect plug tabs from damage during moves and installs.
 - h. Be available in various colors and allow the use of color icons.
 - i. Rated for at least 750 plug insertions.
 - j. Fire resistance IEC 60332-1
 - k. Toxicity/Corrosion IEC 60754-1.
 - l. Modular contacts must be plated with 50 micro inches of gold.

L. CAT6a Patch Panels

1. The Contractor shall provide a 24/48 ports modular patch panel which shall be equipped with the same CAT6a connector as specified in the previous section. Patch panel shall also have 19" equipment practice dimensions to permit mounting in standard cabinets, racks or bays and shall be available to take a minimum of 24 copper jacks per 1U. The patch panel shall be Category 6a RJ45, third party component verified to cat.6a ANSI/TIA/EIA 568 B . .1 of 20 June 2002.
2. The presentation of the patch panel shall provide a built-in labeling using clear plastic holders and laser printable paper. If blains, circuit cross over or impedance matchers are used, these shall be external to the patch panel. The connector shall provide T568B color code identification
3. The panels shall be designed for keystone fitting of jacks/ sockets and shall have cable management and tie down points for copper cable. The Connection of the cable shall be done through rear IDC contacts with use of a standard 110 impact tool.
4. If angled panels are to be used, they must be recessed from the 19" rails, and meet all requirements above.

M. Cable Marking and Identification

1. Cable shall be UL/cUL listed under file number E138034 and the contractor shall submit a compliancy statement of third party verification.
2. The cable jacket shall be legibly marked at least every 24 in. by surface printing. The following information shall be provided:
 - a. Manufacturer's Identification
 - b. Type of Cable Construction
 - c. UL/cUL or ETL Verification
 - d. Jacket type Identification Code
 - e. Cable Footage Marker

2.3 WORK AREA

- A. The Work Area shall also include the wall plate itself, connectors, even the adapters that link cabling to wall outlet. It shall be designed to tolerate frequent moves but with careful management.
- B. Work Area Outlet
 - 1. Outlets are used to connect user equipment to the network through a patch cord. The Contractor shall provide a compatible outlet that facilitates the termination of multiple horizontal cables in a common location. Work area cables originating from the Outlet shall be routed through work area pathways and shall be connected directly to work station equipment without the use of any additional intermediate connections.
 - 2. Outlets shall be located in fully accessible, permanent locations such as building columns, permanent walls, and floor and shall not be located in ceiling spaces, or any obstructed area. Moreover, Outlets shall not be installed in furniture unless that unit of furniture is permanently secured to the building structure.
 - 3. The presentation of faceplate shall support a built-in labeling using a clear plastic holders and laser printable paper.
 - 4. The RJ45 modules shall meet the following criteria:
 - a. Category 6a RJ45, third party component verified to Cat.6 ANSI/TIA/EIA. 568 B 2.1. A new certificate shall be provide.
 - b. Center tuned to Cat.6 test specifications. (Perfectly centered in relation to the limit values set by standard ANSI/TIA/EIA-568-B.2.1. of 20 June 2002.)
 - c. Compliant to FCC part 68, subpart F and UL1863, dealing with the interface's physical dimensions, including the 1.27mm gilding on the contacts, the traction force that has to be borne by the RJ45 socket, the plug (100 grams) and the maximum force authorized for connecting the plug in the jack (2.2 kg).
 - d. Support T568A and T568B wiring.
 - e. Available in various colors, and be icon compatible.
 - f. Enable maximum untwisting of 1/4 inch (1,2cm) of the pairs.
 - g. Connection the cable will be done through rear IDC contacts with use of a standard 110 impact tool. (Tool less connectors is not acceptable).
 - h. Modular contacts must be plated with minimum 50 micro inches of gold.
- C. Modules that cannot be re-connected in case of error are not acceptable.

2.4 ANALOG CONNECTIVITY

- A. As the whole network infrastructure is an IP based Network, The Contractor shall provide analog connectivity for different applications, such as Emergency telephone lines, faxes and K-Net through CAT6a cable which shall run through the backbone shaft to connect the MOC/ISP gateway in MCCR with the media gateway located at each SDR.
- B. A bundle of CAT6a multi-pairs shall be pulled from the MCCR copper patch panel to each SDR copper patch panel and connected to the A/D converter to support the number of analog connectivity required for that floor where each pair shall support single analog connectivity.
- C. The Multi-pairs Cat6a cable shall be terminated in a patch panel in a floor to support the analog connectivity for the floor and the floor above.
 - 1. Other cable markings shall include:
 - a. Standards Verification
 - b. Number of pairs
 - c. Part number
 - d. Manufacturer's Identification
 - e. Type of Cable Construction
 - f. Cable Footage Marker

2. The cables shall withstand a bend radius of 30 mm at a temperature of $-20^{\circ}\text{C} \pm 1^{\circ}\text{C}$, without jacket or insulation cracking, when tested in accordance with ASTM D4565, Wire and Cable Bending Test. For certain applications, the use of cables with a lower temperature bending performance of $-30^{\circ}\text{C} \pm 1^{\circ}\text{C}$ shall be considered. The minimum breaking strength of the cable, measured in accordance with ASTM D4565, shall be 400 N (90 lbf) minimum.
3. The Flame Spread Index of CAT6a cable provided shall not be greater than 25 derived from the spread of flame versus time in accordance with NFPA 255 "Standard Method of Surface Burning Characteristics of Building Materials" while the Smoke Developed Index shall not be greater than 50 derived from measurements of smoke obstruction versus time in accordance with NFPA 255 "Standard Method of Surface Burning Characteristics of Building Materials" and shall be indexed to red oak. As for Potential heat, it shall not be greater than 3500 BTU/lb (8141kJ/kg) which is measured in accordance with NFPA 259, Standard Test Method for Potential Heat of Building Materials".

2.5 PATHWAY AND ROUTES:

The cable run from the SDR to each point shall be through a direct connection using under floor trunk and ceiling cable tray divided into compartments to separate different type of cables (Fiber Optic, Copper, Spare) with minimum of 30 cm from the electrical cable. The trunk shall be grounded to get rid of the current that is produced from electromagnetic wave even from copper or electrical cables to avoid the effect on data running in the copper cable.

2.6 NETWORK CABINET (STEEL CABINET)

- A. The Contractor shall provide a closet that houses Active equipments, backbone and horizontal cabling equipment, and associated pathways for the cable in addition to the most auxiliary equipment including but not limited to security systems, key-entry systems, file servers, etc. Specific closet sizes shall be based on service-area size which shall ensure a sufficient space for all connecting hardware, as well as enough room for service personnel to function without causing undue system disruptions.
- B. The cabinet's installation shall comply with ANSI/EIA-310-D-Specifications for Equipment and Racks, ETSI and DIN 41494. The cabinets shall be free- standing types for the Main Central Room and Sub Distribution Rooms.
- C. Cabinets shall meet the requirements of accommodating high volume of cabling 19" 24/48-port patch panels and the Active components equipment. It shall be steel and powder coated cabinets, Ventilated top cover, with removable side panels and Castors heavy duty broke.
- D. The Cabinets shall be made of rust-free aluminum, with a black powder coat finish to minimize fingerprints and resist scratching. In case racks are assembled together, they must be separated by 10" wide cable management cages. (instead of the 6" wide)
- E. The standard 42U cabinet size is 800 mm x 800 mm and 1200 mm X 800 mm shall have the following features:
 1. 19"format, front and back. The rack's spaces (units) must be stamped every unit.
 2. Supports both passive and active equipment
 3. Have 10" wide vertical management cages, with individual plastic 1-rack unit fingers, include spools and bend limiting clips. The cages will be covered by double hinged aluminum doors. Clip-on panels are not acceptable

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4. Have a top trough with built-in waterfall providing bend radius control and efficient patch cable routing.
 5. Provides cable entry from top, sides, back and bottom
 6. Permits a minimum load of 250kg
 7. Consist of a right/left handed door
 8. The front and back doors shall be perforated for better cooling
 9. Accommodates both 19" and ETSI equipment
 10. Contains lockable side panels
 11. Allocates Castor-Leveler combination
 12. Contains cable management rings and panels
 13. Fully assembled and configured from the factory
 14. Allows for future growth
 15. Comply with the following standards:
 - a. DIN 41494, Part 7
 - b. DIN 41491, Part 1
 - c. EN 60950
 - d. IEC 297-2
 - e. VDE 0100
 16. On the other hand, each rack shall supply 13 power strips; these power strips shall have the following features:
 - a. Illuminated Power Switch
 - b. 45 Degree Angled Socket
 - c. Modular construction using polycarbonate sockets
 - d. CE Marked
 - e. Fully earthed construction with an external earth facility
 - f. Clips to prevent accidental switching
 - g. Conform to BS 5733/VDE 620

CHAPTER 11
UNINTERRUPTIBLE POWER SUPPLY

CHAPTER 11

UNINTERRUPTIBLE POWER SUPPLY

Part 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Design, engineering, procurement and installation of a compact and silent uninterruptible power supply (UPS) system suitably designed for office environments for power conditioning, voltage, frequency regulation, harmonic suppression, and full power back-up which comprise of batteries, charger, inverter, remote management of the entire set using SNMP and on Ethernet network and all other necessary accessories as shown on drawings and as specified herein. It shall be new and of current manufacture, high grade.

1.2 SYSTEM DESCRIPTION

- A. The following specification describes requirements for an uninterruptible power system (UPS). It shall automatically maintain AC power within tolerance specified to critical load without interruption during failure or deterioration of normal power source.
- B. All materials and equipment designed and furnished shall be fully compatible with electrical, environmental and space conditions at site duly interfaced with AC power source and loads served.
- C. Provide the services of the manufacturer or his authorized agent to advise upon the provision, engineering, installation, testing and commissioning of UPS.
- D. Coordinate and provide to the system integrator section for all signals to be monitored remotely for the management of the entire setup.

1.3 SUBMITTALS

- A. Detailed shop drawings and installation instructions shall be submitted for the UPS.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: The UPS and all associated equipment and components shall be manufactured in accordance with standard IEC 146 - Part 4 for UPS performance and test methods. Quality assurance procedure shall satisfy ISO 9001.

Part 2 - **PRODUCTS**

2.1 MANUFACTURER

A. The products shall be from one of the manufacturers listed below and shall comply the requirements specified herein. The decision of acceptability rest with the Engineer.

1. APC by Schneider Electric
2. Emerson / Libert (England)
3. EATON (Germany)
4. Socomec (France)
5. Legrand
6. Approved Equal

2.2 GENERAL

A. The UPS system shall provide precise continuous A.C. power to critical electrical, electronic loads in a highly reliable manner irrespective of transients or disruptions to the mains A.C. power including total failures.

B. The UPS shall be capable of supplying 125% of its rated current for 10 minutes and 150% for 30 sec. If the critical load demands more than 170% of the full rated load, the UPS shall instantaneously transfer to static by-pass switch and after a short period shall transfer automatically to the inverter and if the 170% overload still exists, the UPS shall transfer to static by-pass and protection circuit breaker shall clear the fault.

C. The input power characteristics are as follows:

1. Voltage: 220/380V, A.C., 3 phase, 4 wire $\pm 10\%$ - 15%.
2. Frequency: 50 Hz. $\pm 5\%$.
3. Power factor: 0.90 - 0.95 lagging at full load with nominal input voltage enhanced providing input harmonic filter.
4. Input current limit: Maximum of 115% normal full load input current.
5. 2 Level battery charge current limit: Mains input - 2.25%, Generator input - 90% of set input current limit.
6. Current distortion: Less than 10% of total harmonic distortion with input filter.
7. Maximum short circuit current: Refer system schematic and calculate the system fault level to be protected.

D. The UPS output power characteristics shall be as follows:

1. Voltage: 220/380V, A.C. 3 phase, 4 wire ($\pm 0.5\%$ for balanced loads) and less than 3% for unbalanced load.
2. Frequency: 50 Hz. $\pm 0.1\%$ normally synchronized to input/ by-pass supply.
3. Voltage adjustment: range up to 5%.
4. Module efficiency - Not less than 95%.
5. Harmonic voltage: In general less than 4% RMS maximum on a full load.
The harmonic distortion shall be given for the following:
 - a. Non-linear load.
 - b. Unbalanced load.
 - c. Less than 50% load.
6. RMS current into fault: 150% of rated full load mini-mum.
7. Sustained short circuit time: 1 second minimum.
8. Voltage transients:
 - a. 20% load step 4%
 - b. 30% load step 5%
 - c. 50% load step 8%
 - d. Loss or return of AC input power $\pm 5\%$

- e. Manual transfer 100% load $\pm$ 8%
- 9. Transient voltage recovery time - 95% in 50 millisecond or less.
- E. The UPS output neutral and input neutral shall be insulated under normal operating circumstances.
- F. The UPS shall provide for an equipment grounding terminal of high safety design.
- G. The UPS unit shall be suitable for continuous operation at 10-40°C ambient temperature and maximum 95% relative humidity non-condensing.
- H. The UPS system shall be guaranteed against faulty and improper materials and workmanship for a period of two years from date of final acceptance except that the batteries shall be guaranteed for ten years to deliver minimum 80% of its rated capacity.
- I. The UPS system shall be inspected and tested to demonstrate achievement of system objectives.
- J. The UPS shall have built-in self protection against:
 - 1. Over-voltage and under-voltage input power surges.
 - 2. Load switching.
 - 3. Sudden changes in total output load.
 - 4. Internal UPS element failures, including rectifier and inverter solid state devices.
 - 5. Fast acting current limiters to protect against cascading failures of solid state devices. The status of protective device shall be indicated on graphic display screen.

2.3 MAIN UPS CUBICLE

The UPS system cubicle shall consist of but not be limited to the following major components:

- A. Rectifier/Battery Charger: The rectifier/charger shall be totally solid state, complete with rectifier bridge and D.C. filter to deliver regulated and filtered D.C. power to a static frequency inverter, and to the batteries. Control logic shall be provided to effect the necessary control of the firing angles of the rectifier's thyristors. The rectifier/battery charger shall be capable to carry out the charging according to the following stages:
 - 1. At constant current till the charging voltage level of battery cell is reached.
 - 2. At constant voltage (charging level) and then charging current decreases to very low value.
 - 3. When batteries retain their 100% capacity, the rectifier/charger goes back to its floating state.
 - 4. Battery charging current.
- B. Static Inverter: The silicon solid state static inverter shall be capable of accepting the output of the rectifier/ charger or emergency battery and providing an A.C. output which shall be passed through a phase filter before being supplied to the critical load. The inverter shall contain its own frequency determining oscillator. The design of the oscillator circuit shall be such that failure of any associated component, connector pin or terminal lead wire or D.C. power source shall isolate the module from the system.
- C. Input harmonic filter to reduce input current. Total harmonic distortion on full load to less than 10%.

- D. AC Input Current Limiter: The rectifier/charger shall include a circuit to limit AC input current to an adjustable level of 100% to 115% of full input current rating.
- E. Input current walk-in feature to limit total initial power requirement at input to 20% of rated load and gradually increase to 100% over 5 seconds time.
- F. Static by-pass switch.
- G. The maximum noise level inside the UPS room shall not be more than 40 decibels.
- H. Maintenance by-pass system, to permit direct connection of the critical load to the incoming power line, by passing and isolating the entire UPS and its static by-pass transfer system. The maintenance by-pass and isolation breakers shall be both electrically and mechanically interlocked to prevent interruption of service to the critical load due to improper operation.
- I. Module shall have a suitably rated circuit breaker for over current and short circuit protection as per system requirements. Refer main electrical schematic diagram to ascertain the available fault level in the system.
- J. Instruments: The following switchboard type instruments shall be provided, including current transformers as required:
 - 1. Full scale D.C. voltmeter and ammeter for measuring D.C. bus volts and battery charge/discharge current.
 - 2. Full scale A.C. voltmeter and ammeter with switch for measuring input and output phase voltages, line to line, line to neutral and current in each of the input and output phases.
 - 3. Frequency meter to measure UPS input and output frequency.
- K. Alarm Indicators: An external visual and audible alarm indicator shall be provided for various type of faults at remote location over and above module indicators.
- L. Wiring practices and materials shall be in accordance with IEC requirements. All copper bus bars shall be tin plated. Cable entries shall be for top and bottom. UPS shall be built for floor mounting (free standing).
- M. Adequate ventilation shall be provided to ensure all components are operated within temperature ratings. All fans are to be equipped with fan failure sensors connected to local and remote alarm. Temperature to be internally monitored and excess to be alarmed.
- N. All required accessories, softwares, hardwares shall be furnished with the UPS. Coordinate with building system integrator and furnish all items for proper operation of the system.

2.4 BATTERIES

- A. The built-in batteries shall be provided with the cubicle to provide power to UPS. The battery cells shall be of lead acid maintenance free and sealed type, high impact resistant polycarbonate plastic encased.
- B. The ampere hour rating shall be sufficient to supply the D.C. to the inverter for an emergency period of 30 minutes with the inverter operating at full rated output. The cells shall have explosion proof vents, clear container.
- C. Circuit breaker shall be installed near battery cabinet for isolation.

Part 3 - EXECUTION

3.1 INSTALLATION

- A. The UPS and all other accessories shall be installed as indicated on the drawings and strictly in accordance with the manufacturer's printed instructions and recommendations.

3.2 SYSTEM OPERATION AND PERFORMANCE

- A. The normal mode of system operation shall provide un-attendant, uninterrupted power supply to the critical loads as shown on the drawings for a period as specified herein.

3.3 COMMISSIONING

- A. The completed installation shall be tested for compliance with the specifications following completion of all installation works. Testing shall be conducted by a representative of the manufacturer and in the presence of the Engineer. The Engineer shall be notified in advance. Certified copies of test procedures and results shall be forwarded to the Engineer.

CHAPTER 12
CCTV

CHAPTER 12

CCTV

Part 1 - GENERAL

1.1 OVERVIEW

- A. Security System provided shall be a Distributed Intelligent Supervisory Control and Data Acquisition System which shall be used primary to handle the Security of the building. Moreover, the system shall be fully Integrated Computer based Security Monitoring System with high-level intelligent interfaces to other External Systems. It shall be a Multi-tier Distributed Intelligent System using the state of the art Microprocessor Technology incorporated at every level that is capable of functioning in Stand Alone Mode or in Local Area Network (LAN).
- B. Benefits:
 - 1. Surveillance – Identification – Prevention.
 - 2. Detection and location of intruders.
 - 3. Forced entry prevention.
- C. The objective of the Security System (SS) is to improve the operation efficiency and security in the new project. The system shall consist of the following components:
 - 1. CCTV surveillance System
 - 2. Interface with BMS

Part 2 - PART 2 – PRODUCTS

2.1 Components

- A. The Security System architecture shall consist of the following components which are described in the following sections:
 - 1. System Database Servers.
 - 2. System Storage Server
 - 3. PC based Supervisory Control (SC) Workstation.
 - 4. Single lens Cameras
 - 5. Dual Lens Camera
 - 6. PTZ Camera
 - 7. Hemispheric / Fisheye / 360degrees cameras

2.2 INTERFACE WITH BMS

- A. The System shall integrate with designated Security Facility that is monitored via the BMS System. The System shall accept signal or data from the BMS via Interface Device or Converter and translate the data into Camera status using an Open Interface Protocol that meets the level of connectivity. The Open Industrial Protocol that must comply with International Standards shall be used. The mode of communications shall be based on an Open Communication Protocol or OPC Standard at the Network Protocol Level

2.3 SYSTEM ARCHITECTURE

- A. The Digital Video Recording & Management System shall meet the following Standard:
 - 1. ISO 9001 (2000).
 - 2. ISO/IEC 15504 Level 3 or Higher.
 - 3. (SPICE 2.0 Software Process Improvements and Capability Determination).
 - 4. SEI CMM Level 3 or higher.
 - 5. (American Software Engineering Institute - Capability Maturity Model)
- B. The Digital Video Recording & Management System shall include:

1. Major and Redundant Database Servers.
2. Camera Servers.
3. Security or Control Systems.
4. Operator Stations.

C. Database Servers

1. The Database Server which is located in the MDC contains a database of all network-connected cameras and their configuration.
2. The Database Server shall manage the system database with details including:
 - a. System Configuration.
 - b. Camera Configuration and Settings.
 - c. Recording Configuration and Settings.
 - d. Configuration of Quad Views and Sequences.
 - e. Details of Recordings.
 - f. Schedules.
 - g. Operator Security Details.
 - h. Configuration of Surveillance and Alarm Monitors.
 - i. Configuration of Video Motion Detection.
 - j. Manage communication between the Operator Stations and the Camera Servers
 - k. Allow Alarms/ Events in the Security System or Control System to initiate recordings.
 - l. Report any camera failures or recording failures to the Integrated Control system or Security System.
 - m. Provide a full audit log of all System Status (Camera and Server availability) and operator actions.

D. Redundant Database Server

1. The DVRMS shall be capable of running a pair of similarly configured computers in a hot backup configuration where at any point in time, one is acting as Primary and the other is acting as the Hot Backup. An on-line database duplication mechanism shall be supported.
2. Simply having each Database Server scanning each Camera Server, or requiring the Camera Servers send all updates to both Database Servers is not acceptable. The database duplication shall be performed on a per- transaction basis for two reasons:
 - a. To ensure that the duplicated Backup Database is consistent at all times with the Primary Database.
 - b. To avoid unnecessary loading of Camera Servers caused by duplicate polling.
3. Moreover, the Redundant DB Server shall be possible to remove one of the Redundant Systems for maintenance without interrupting operation, and upon its reinstall, re-synchronize the databases, again without interruption to system operation.

E. Camera Servers

1. The Camera Servers shall handle all cameras. Each server shall handle (128) cameras requiring storage space of 1 TB. Furthermore, the Camera Server(s) shall be capable of supporting a large amount of disk space for online video storage and access to high capacity archiving mechanisms for the removal of stored video to off-line media. The Camera Servers shall rely on the Database Server for all camera database information. The Camera Server shall perform the following functions:
 - a. Manage Live Video from camera streamers.
 - b. Transmit Live Video to Operator Stations.
 - c. Receive camera control commands from Operator Stations and then send the commands to cameras.
 - d. Store Live Video to hard disk.
 - e. Transmit previously stored video to Operator Stations.

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Image compression:	M-JPEG, JPG
Image processing:	Backlight compensation, automatic white balance, image distortion correction, video sensor (motion detection)
Interfaces:	Ethernet 10/100
Security:	User-/Group management, HTTPS/SSL, IP address filter, IEEE 802.1x, Intrusion Detection, digital image signature
Power:	POE

PTZ camera

The camera features a 20x optical zoom with up to 12x digital zoom, and provides continuous 360° degree rotation, in addition to 10 preset guard tours.

Image Sensor:	WDR 1/2.8" progressive scan CMOS
Active Pixels:	1920 (H) x 1080 (V)
Imaging Area:	4.8 mm (H) x 2.7 mm (V) (0.189" (H) x 0.106" (V))
Minimum Illumination:	0.4 lux (F1.6) in color mode; 0.04 lux (F1.6) in monochrome mode
Lens:	4.7-94 mm, 20x zoom, F1.6 and automatic focus
Angle of View:	2.9° - 55.2°
Image Compression:	H.264 (MPEG-4 Part 10/AVC), Motion JPEG
Image Rate:	30
Streaming:	Motion JPEG
Resolution:	Scaling Down to 352 x 240
Motion Detection:	Selectable sensitivity and threshold
Electronic Shutter:	Automatic, Manual (1/6 to 1/8000 sec) Iris
Control:	Automatic, Manual
Day/Night Control:	Automatic, Manual
Flicker Control:	50 Hz, 60 Hz
White Balance:	Automatic, Manual
Privacy Zones:	Up to 4 zones, 3D privacy mask supported
Presets:	100 named presets
Tours:	10 named guard tours
Cabling Type:	CAT5 / CAT6a
API ONVIF:	version 1.02, 2.00, Profile .
Security:	User-/Group management, HTTPS/SSL, IP address filter, IEEE 802.1x, Intrusion Detection, digital image signature
Protocol:	IPv4, HTTP, HTTPS, SOAP, DNS, NTP, RTSP, RTCP, RTP, TCP, UDP, IGMP, ICMP, DHCP, Zeroconf, ARP, LLDP
Streaming Protocols:	RTP/UDP, RTP/UDP multicast, RTP/RTSP/TCP, RTP/RTSP/HTTP/TCP, RTP/RTSP/HTTPS/TCP, HTTP
Power:	POE

Hemispheric/360 degrees camera

Lens:	(180° x 160°)
Sensitivity:	Color: 0.25 lux (t=1/60 s), 0.013 lux (t=1/1 s) B/W: 0.05 lux (t=1/60 s), 0.0025 lux (t=1/1 s) Lowlight Exposure Optimization
Sensors:	1/2.5" CMOS, 5 Megapixel, progressive scan
Max. image size:	Color + B/W: 2048 x 1536 (QXGA)
Image format:	Free image format selection (from 160 x 120 to 2048 x 1536); PTZ view, Quad view, panorama broad view image, double panoramic view, panorama focus with 3 views
Max. frame rate:	VGA: 30 fps, MEGA/HD: 10 fps Max.
Video stream:	VGA: 30 fps, MEGA/HD: 30 fps Image
compression:	M-JPEG, JPG, H.264 (SIP Video only)
Image processing:	Backlight compensation, automatic white balance, image distortion correction (panoramic image correction included), motion detection.

Virtual PTZ:	Digital Pan/Tilt/Zoom, continuous 8x zoom, full image recording in the background
Interfaces:	Ethernet 10/100, IPv4
Security:	User-/Group management, HTTPS/SSL, IP address filter, IEEE 802.1x, Intrusion Detection, digital image signature
Power:	Power over Ethernet (PoE acc. IEEE 802.3af)

Management Software

- Easy-to-use video management software, ideally designed for the wide range of functions
- of the cameras
- Supports decentralized system concept and works with internal camera recording (Internal DVR)
- Simple, quick setup; user-friendly and intuitive operation
- Transparent layout of operating elements; compatible with touch panels
- Ideally suited for small office and home security environments
- Platform-independent format (Windows, Mac, Linux)



CHAPTER 13
SOLAR SYSTEM

CHAPTER 13 **SOLAR SYSTEM**

1. GENERAL

- 1.1. ELECTRICAL WORK GENERALLY** is to be in accordance with the requirements.
- 1.2. DESCRIPTION OF WORK:** PV Photovoltaic panels, grid inverter, solar batteries, hybrid inverter and accessories.
- 1.3. STANDARDS:** work is to comply with international standards.
- 1.4. TECHNICAL DATA:** submit data for approval including manufacturer's illustrated catalogues with description and specification of component parts.
- 1.5. SHOP AND CONSTRUCTION DRAWINGS:** submit drawings for approval including but not limited to, the followings:
 - A. Exact location and routing of Photovoltaic PV panels, cables and wires with indication of sleeves and types of fixings.
 - B. Exact location of solar batteries, inverters and all accessories.
 - C. Typical details of panel boards.
- 1.6. AS- BUILT DRAWINGS:** provide as- built drawings for the system.
- 1.7. MANUFACTURERS:** obtain equipment, manufactured specifically for electrical solar system from one of the European firms.

2. PRODUCTS AND SYSTEMS COMPONENTS AND ACCESSORIES

2.1. TECHNICAL REQUIREMENTS

A. PV PHOTOVOLTAIC PANELS:

- The panels should be placed at the roof and its exact location shall be determined on site as per the environmental conditions (tilted angle).
- The panels are fabricated from multi crystalline (156 x 156mm), maximum weight of 18.6 kg, white back sheet with silver anodized aluminum alloy and a J box with IP 65 rated.

B. PV MOUNTINGS:

PV mountings should be:

- Corrosion resistant; made of 100% aluminum
- Quick, simple, virtually tool-free installation.
- System design based on the latest wind dynamics research.
- Reduced number of components for shorter mounting type.

C. SOLAR BATTERIES:

- Solar batteries should be located inside a room or cabinet and its exact number shall to be determined on site according to the solar system requirements.

D. INVERTERS:

- Three phase output voltage 380/220V or single phase output voltage 220V/50 Hz.
- Fixed load steady state: +/- 0.5% from no full load to full load.
- Dynamic output regulations: +10% - 8% with a load variation of 50%.
- Recovery time of the steady state value:
 - < 20 ms for ΔU +/- 1%
 - < 40 ms for ΔU +/- 0.5%
- Output frequency: 50 Hz
- Harmonic content: < 4%

3. FIELD AND INSTALLATION WORK

3.1. INSTALLATION

- A. Actual layout and specifications of components of the system.
- B. Testing and commissioning for the lighting solar system.

CHAPTER 14
BELL SYSTEM FOR CLASSES
(End of Session)

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BELL SYSTEM FOR CLASSES
(End of Session)

A. GENERAL

The Contractor shall supply and install complete Class Bell System with quartz clock, bell, bell pushes, conduits, wires, boxes, accessories etc.

Pressing a bell push shall ring the bells for a predetermined time as an override for the clock.

Cover plates to bell pushes shall be similar to those of other devices used. Conduits, trunkings, boxes and accessories shall comply with the relevant clauses of these specifications. Conduits shall be completely separate from other system conduits.

Bell locations as shown on the drawings are approximate. Final locations shall be approved by the engineer.

The bell shall be of 20cm diameter, vibrating type, dust proof, surface mounted.

CHAPTER 15
ELEVATORS

CHAPTER 15

ELEVATORS

A. GENERALLY

- i) These specifications are intended to cover the complete installation of the elevators described in this Chapter in a first class workmanlike manner.
- ii) The Contractor shall provide all materials, labour and equipment necessary to furnish, deliver, install and maintain the works as described hereunder.
- iii) The work shall be done in accordance with the requirement of any European Elevators Code and any local codes which may govern the requirements of the installation as described herein.
- iv) In all cases where a device or part of the equipment is herein referred to in the singular number, it is intended that such reference shall apply to as many such devices as are required to complete the installation.
- v) The Contractor shall conduct an acceptance test, in order to make sure that the state of the art safety criteria are met and the elevator is safe for use. The acceptance test consists of a design review, a recalculation of the essential component parts as well as an initial acceptance test at the site of installation.

B. SHOP DRAWING AND SAMPLES

- i) The Contractor shall prepare and submit complete shop erection and detail drawings to the Engineer for approval, as described in the General Conditions and he shall not proceed with any work for which such samples are required until they have been approved.
- ii) Samples of the materials proposed for use shall be submitted as the Engineer may require for approval and no work for which such samples are required shall proceed until they have been approved.
- iii) The work included herein shall be executed in strict accordance with approved shop drawings and samples.

C. APPROVED MANUFACTURERS

- i) Obtain elevators from one of the following or other equal and approved:
 - 1. MITSUBISHI – Japan
 - 2. THYSEEN – Germany
 - 3. OTIS – Spain
 - 4. KONE - Finland
- ii) Provide evidence that the proposed equipment manufacturer has a locally established and authorized organization which can be called upon for professional advice and maintenance as may be required, and which can immediately supply parts to support day to day and emergency maintenance requirements. Failure to satisfy the engineer may disqualify a manufacturer.
- iii) Elevator shall be totally imported and shall be obtained from one manufacturer only.

D. PAINTING

All exposed metalwork furnished under these specifications unless otherwise specified shall be properly painted with rust protection paint by the elevator contractor.

E. GUARANTEE

The Contractor shall guarantee that the materials and workmanship of the apparatus installed by him under these specification are first-class in every respect and that he will make good any defects, not due to ordinary wear and tear or improper use, which may develop within one year from date of completion.

F. MAINTENANCE

- i) The elevator Contractor shall furnish maintenance on the entire elevator equipment described herein for a period of one year after completion of his work. This maintenance shall include systematic examination, adjustment, and lubrication of all elevators equipment. The Contractor shall also repair or replace electrical and mechanical parts of the elevator equipment whenever this is required and shall use only genuine standard parts produced by the manufacturer of the equipment concerned. All wire ropes shall be replaced as often as necessary to maintain an adequate factor of safety. Renewals or repairs necessitated by reason of negligence or misuse of the equipment shall not be the responsibility of the Contractor.
- ii) All work under this maintenance provision shall be performed by competent personnel under the supervision and in direct employ of the Contractor. All work shall be done during the regular working hours and days of the Contractor.
- iii) The Contractor shall be able to show that he has had successful experience in the complete maintenance of elevators, employs competent personnel to handle the service, maintain locally an adequate stock of parts for replacement or emergency purposes and has qualified men available at such places to insure the fulfilment of this service without unreasonable loss of time.

G. GUIDES AND FASTENINGS

Guides for car and counterweight shall consist of planed steel tees, erected plumb, and securely fastened to the hoist way framing by heavy steel brackets. The ends of all guides shall be tongued and grooved; forming matched joints and connected with steel splice plates. Contact surface of the splice plates and the back of the guide rail ends shall be accurately machined to form smooth joints.

H. SHEAVES AND SUPPORTING BEAMS

Provide all deflector and overhead sheaves necessary to obtain the proper lead of the ropes to car and counterweight. Sheaves shall be cast iron, accurately machined by steel beams or chains furnished in place by the Contractor.

I. SOUND REDUCING

The Contractor shall provide necessary sound reducing material, to effectively isolate the machine from the machine foundation concrete slab.

J. AUTOMATIC STOPPING DEVICE

The elevators shall be equipped with an automatic stopping device arranged to bring the car to a stop at the terminal landings independent of the regular operating device in the car.

Final limit switches shall be provided in the hoistway, operated by the car, and arranged to stop and prevent normal operation, should it travel beyond the zone of the normal stopping device.

K. CAR FRAME, SAFETY AND GOVERNOR

The car frame shall consist of suitable structural steel shapes securely fastened together and substantially reinforced and braced so as to relieve the car enclosure of all strains. The safety device shall be arranged to bring the car to a gradual stop on the rails in the event of excessive descending speed, and provision made to shut off the power supply to the elevator motor and brake.

L. COUNTER WEIGHTS

The elevator shall be suitably counterbalanced for smooth and economical operation. Counterweights shall consist of cast iron or concrete weights contained in a structural steel frame properly guided with suitable guide shoes. The counterweights shall be equal to the weight of the complete elevator car and about 50% of the specified capacity load.

M. LIGHT OUTLET TOP OF CAR

Light receptacle shall be installed on top of the car for use when servicing the elevator.

N. ROPES

Furnish and install suitable traction steel hoist ropes of size, construction and number to ensure proper operation of the elevator and give satisfactory wearing qualities.

O. ELECTRIC WIRING

- i) Furnish and install complete necessary insulated wiring to connect all parts of the equipment.
- ii) Travelling cables between car and hoistway shall have flame retarding and moisture resisting outer cover. They shall be flexible and shall be suitably suspended to relieve strains in the individual conductors.
- iii) All insulated conductors and conduits or tubing as well as fittings including boxes, troughs, and ducts shall be of first quality.

P. ALARM BELL

The elevator shall be provided with an emergency alarm bell located in center of hoistway, supplied by a self-charging cell.

Q. TOP OF CAR INSPECTION

Top of car inspection operation board and stop switch in elevator pit shall be provided for maintenance service security.

R. CAR POSITION INDICATOR

A digital position indicator of approved design shall be provided in each elevator car.

S. CAR PLATFORM

The car platform shall consist of structural steel frame filled with flooring and linoleum covering. The underside of the car platform shall be covered with steel sheet.

T. HOISTWAY ENTRANCES

For each hoistway opening served, furnish and install one complete elevator hoistway entrance of hollow metal construction. Each entrance to be the opening size after specified and shall include flush doors of hollow metal construction, and unit frame for full wall thickness.

U. WAREHOUSE FACILITIES

An adequate warehouse at the job Site sufficient space to store all elevator equipment since their arrival until the end of the installation will be provided. This warehouse should be near the location of the elevators. All at the Contractor's expense and under his responsibility.

V. CALL REGISTERED LIGHTS

The push button fixture at each intermediate landing shall include "UP" and "DOWN" arrows, and a single arrow at each terminal landing, which shall illuminate when the corresponding button is momentarily pressed to indicate that the call is registered and the direction of the call, and remain illuminated until the call is answered.

ELEVATOR – PASSENGER

Lift No. 1	
Qty	1
Use	Passenger Elevators
Machine room	Refer to Drawings
Door open type	Central Opening 1100 mm
Type Of Drive Control	
Drive	Traction Type- VVVF Geared
Lift Duty	
Rated capacity(kg)	As per the Bill of Quantities
Rated speed(m/s)	1.5 M/S Variable Voltage Variable Frequency (VVVF)
Stops/Floors	Refer to Drawings
Travel	Refer To Drawing
Operation System	
Operation	Simplex
Dimensions	
Door size(W x D)	Maximum Possible
Car inside size(W xD)	Maximum Possible
Car internal height	Min. 2200mm
Hoistway(W xD)	Refer To Drawing
Over head	
Pit depth	
Hall Finishes/Features	
*Landing doors	
Ground floor	Etched Stainless Steel
Typical floors	Stainless Steel Hairline
*Jamb	
Narrow jambs without transom	At All Typical Floors -Stainless Steel
Hall position indicator with hall button	Digital Indicator With Micro Stroke Buttons At All Floors
Hall button face plate	Stainless Steel Hairline
Hall lantern	At All Floors
Hall sill	Extruded Aluminum

Car Finishes/Features	
Car door	Stainless Steel Hairline
Internal car wall	Stainless Steel Hairline
Front wall	Stainless Steel Hairline
Flooring	5mm Thick Vinyl
Entrance column/kick plate/transom	Stainless Steel Hairline
Illumination	Indirect
Emergency lighting	Dc-12 By Self Rechargeable Battery
Car operating panel	Digital Indicator with Micro Stroke Buttons
Ceiling	Suspended
Car operating panel face plate	Stainless Steel Hairline
Car door safety edge	No
Car sill	Extruded Aluminum
Ventilation fan	Electric Fan
Arrival sign	Car Chime
Buffers	
Type	SPRING Type

REQUIRED FEATURES

Fire emergency operation	Operator key switch automatically sends all cars to the emergency shelter floor for standby.
Emergency Landing Device	In case of power failure, the elevator's car automatically moves and stops at the nearest floor using rechargeable battery.
Fire Emergency Return	In case of activation of building fire sensors, all calls are cancelled & all cars will immediately return to specified rescue floor & park with door open.
Attendant operation	Yes
Independent operation	Release car from group control and allows independent operation in simple call response mode.
Automatic Bypass. Full load operation	When a car becomes fully loaded, all the landing calls in the direction of travel shall be ignored.
Micro scan	Multi beams door protection.
Emergency lighting in car	Yes
Intercommunication	Interphone three station
Overload device	Visual and audible
Handrail	Yes
Nuisance call cancellation	Cancels all floor selections when an obvious call is made, such as when the system computer detects multiple calls made all at once by a single passenger.
Door Nudging	When the door is held open for more than a specified amount of time, door nudging attempts to force door closing.
Stopping accuracy	Re-leveling
Up peak operation	Special up peak operation for the morning rush traffic. Home to all-available cars to the main floor and space departures in optimum response to traffic demands.
Door repetitive reversals	When the door does not close properly, it automatically re-attempt closing for a specified number of times.
Nuisance call cancellation (at reversal)	As the car reverses direction after all passengers have deboarded, any remaining floor selections are automatically canceled
Automatic ventilation source off	An energy conserving features that automatically shuts off the ventilation fan when the car is left parked at standby for a specified amount of time.