## B. Surge Arresters

Surge arrestors installed on the main feeders to the MDB from EDD will be of type 0 and those installed in SDBs will be of type 1 as detailed here under.

B.1 Type 0

Type 0 surge arrestor is of the lightning current arrestor type with the following caracteristics:

- Peak current: 50 kA (10/350 □s) and up to 100 kA in multipole.
- Response time: less than 100 ns.
- Insulation resistance: > 1000 M□.
- Voltage protection level (1.2/50 □s): less than 4 kV.

The surge arrestor should include also a protection for neutral line as we are working in a TT system that support a lightning impulse current of 100 kA (10/350 □s) and other caractesistics equal to those listed above.

B.2 Type 1

Type 1 surge arrestor is of the over voltage arrestor type with the following caracteristics:

- Nominal discharge current: 15 kA (8/20 □s).
- Maximum discharge current: 40 kA (8/20 □s).
- Response time: less than 25 ns.
- Voltage protection level: less than 1 kV.

## C. Lightning protection

A complete lightning protection system must be installed to allow protection of the building against lightning strikes.

The design shall be based on optimum air terminals like Enhanced Franklin Rods which shall provide a preferred point for lightning discharges, minimize prestrike corona, respond dynamically and develop an upward stable leader released only when the ambient field can sustain its initiation and propagation to ensure a reliable lightning capture. It should be non-radioactive, not externally powered, with no moving parts and a selection of tip radii and variable impedance to adjust for optimum performance at different installation heights like the patented UL Listed ERITECH System 3000 Dynasphere and suitable to use in General purpose applications, high temperature environments and corrosive environments.

The system consists of:

- A pick-up unit (air terminal), copper point with an atmospheric excitation type ionizing system.
- A 25×3 $mm^2$ copper tape down conductor.
- A cut-off strip or control link to check the resistance of the earthing system.
- An earthing system designed to absorb or convey the lightning current.

The air terminal must rise above the highest points of the building; it must be secured by accessories best suited to the case involved.

The down conductor must be of tinned red copper tape 25 mm wide by 3 mm thick, it shall be screened, insulated with semi-conductive outer sheath and which shall allow electrostatic bonding to the structure. The down conductors should be of dielectric material which shall create capacitive balance and ensure insulation integrity under high impulse conditions with low inductance, low characteristic impedance and designed to control internal electric field distribution with provisions for mechanical stress reduction at injection point withstanding voltages up to 250Kv.

Down conductor paths must be as straight as possible, avoiding sharp bends and rises. Bend radius around an obstacle must not be less than 20 cm.

The air terminal is connected to its down conductor by a mobile saddle on the terminal pole. This saddle must be tightly secured. Along elevation rods, the tape is secured by standard metal or Rilsan clips.

The down conductor must be fastened with at least three fasteners per linear meter. Direct contact with easily flammable materials (e.g. wood) must be avoided as much as possible. Galvanized steel spikes and lead plugs are used for fixing.

Down conductor must be fitted with a control link or a cut off strip to allow measurement of the earthing resistance and of the down conductor electrical continuity. The control link is to be located 2 meters above ground and is only accessible for inspection.

The tape is protected between the control link and the ground by a protective tube of flat galvanized metal strip. This tube is 2 meters high and fastened by minimum three clamps.

Down conductor must be connected to an earthing system via CADWELD exothermic welding at connections to provide excellent low impedance and long life electrical connections with excellent corrosion resistance as required by BS6651 standards. Waterproofing mastic tape should be used for waterproofing corrosion vulnerable connections

The earthing resistance must be less than 10 ohms. Earthing termination consists of 25 meters of 25×3 mm2 spread out in three legs buried in three trenches 80 cm deep and fanned out to form a "crow's foot" coupling.
For efficient performance of lightning protection, factors such as soil condition, installation accessibility, site layout, altitude from sea level and specifics decide grounding mechanism in order to lower ground impedance to surges. As per design, sit drawings and installation accessibility, ground conductor footings may be bore and poured with Ground Enhancement Compound such as GEM which shall protect the conductors from corrosion but shall also useful in areas of moisture and temperature variations, sandy soils and rocky ground to maximize dissipation of the surge to the soil by increasing the surface area of electrodes or conductors thereby reducing ground resistance to acceptable levels.

To insulate the grounding system from an area on the surface, it is necessary to isolate the initial injection point of the down conductor from the surface of the ground mass by running through PVC conduit to a required depth from the surface before exposing to the ground mass.

Bonding the Lightning Protection Ground to other services for potential equalization ensures that any potential rise due to the injection of lightning current into the impedance of the grounding network is experienced by all conductive services and thus everything shall rise in potential together. Ground loops and potential differences between separate earths are inevitable and harmful for equipment and personnel safety. Bonding cable must be insulated copper cable 70mm2 (2/0 AWG), minimum run in PVC conduit to the connection point of the intended ground system. It may be necessary to use a Transient Earth Clamp which effectively bonds all grounds to the same potential under Transient conditions.

## WIRING DEVICES (16441)

### A. General Requirements

Supply and install electrical fittings including switches, sockets, etc., together with matching outlet boxes and plates and connect to power supply as shown on the drawings.

All devices are to be standard manufactured items, uniform and modular.

A1 Outlet boxes

Boxes and covers are to be made of heavy gauge pressure moulded plastic and to be manufactured for required application. Boxes to have brass threads for cover screws fixing. Provision for securely terminating conduits are to be provided.

Plastic cover plates are to be of heavy gauge, break resistant, made from pressure moulded plastic.

Surface or recessed boxes are to be suitable for the type of related conduit system. Sizes of boxes are to be suitable for application with switches, sockets, etc,...

A2 Switches

Switches are to be of the quick-make, quick-break type with silver alloy contacts in moulded base. Types are as shown/described on the drawings.

Single pole switches are to switch the phase wire. Switches are to be mounted with long dimensions vertical and operating handle up when in the "OFF" position.

Switches in blind areas, shall be equipped with indicating lamp.

A3 Socket outlets

Each single-phase socket-outlet and plug shall have 2 terminals and one earthing contact. They shall be rated for 10/16 Amp. and 20 Amp. - 250 V. Safety shutters shall cover pin holes to prevent accidental contact.

Fixing the socket and cover plate to the box shall be done with stainless steel or chromium plated screws. Hook fixings are forbidden.

Socket outlets shall be flush or surface mounted according to the type of the installation. Flush mounted socket outlets shall be installed in their boxes with screws.

Floor sockets shall be fixed in flush outlet boxes or concealed screws not chrome plates.

Socket-outlets and plugs intended for the same duty in different locations shall be installed at the same heights.

Socket outlets fed from UPS shall be standard Red colored.

The exact locations of socket-outlets and plugs shall be determined according to the construction details of the building. These locations shall be submitted for the Engineer's approval.

A4 Isolating switches

Used to interrupt loads, rated as shown on drawings, 250 V AC with tumbler operating handle to give positive indication of "On/Off" position of contacts.

The contractor shall provide circuit and motor disconnect switches in types, sizes, duties, features ratings as indicated, and where required by the Regulations/Code applicable. For motor and motor starter disconnects, the contractor shall provide units with horsepower ratings suitable to the loads.

Isolating switches should be two or four poles as indicated on drawings rated to the nominal current of the circuit, as indicated on the drawings, with rapid make and break movements to allow on load circuit breaking in accordance with IEC 408, with external operating handle mechanically interlocked to prevent opening door unless switch is in open position. Switch disconnector is to have provision for by- passing interlock. Position of handle is to be positive and clearly indicated on cover. Utilization category 22 for heating and lighting loads and category 23 for motor circuits. The isolating switch should be installed close to the equipment in an IP65 built-in enclosure.

The isolating switch shall be non-fusible, air-break switch disconnector, single throw, safety type, housed in separate metallic enclosure with arc quenching devices on each pole.

The enclosure shall be sheet steel for indoor use IP 41, and weather-proof type cast-metal or sheet steel for outdoor installations IP 65, unless otherwise required or shown on the Drawings. Locking of operating handle is to be possible in open and closed positions

A5 Fireman's emergency Switches

Switches are to be 16A, weatherproof IP55, 250V-AC1, installed in a fire resistant enclosure.

Double pole, Automatic locking device in "OFF" position to present accidental switching on.

Switches are used to activate: fire fighting pumps, suppression fans and to shut-down Boilers.

A6 Trunking unit

The trunking unit suitable for fixing directly to the wall is made of extruded anodised aluminium painted in polyurethane powder and resistant to cleaning agents.

The trunking shall be a twintrunk system in wich the upper unit used for electrical installations is divided in two compartments with partition to separate high and low current systems and the lower unit used for medical gases is screened off by an integral partition. Both upper and lower units have separate flush front covers.

The trunking unit can be fitted with bedhead unit, power and telephone sockets, all modular wiring devices, medical gases sockets and up to 3 tubes of medical gases 10/12mm.

The trunking unit should be factory assembled and prewired with two prewired terminal blocks at the end of the trunking unit easily accessible from the front (for high and low current).

The trunking unit should be factory fitted according to the position of the bed and the lenght of the room.

It shall be supplied with all necessary accessories like end caps, different types of angles, cable clips, mounting boxes, earthing clamps and terminals, earthing terminal and wire for bonding the front cover.

A7 Bedhead unit

The bedhead unit suitable for rapid mounting on the trunking unit is made of extruded anodised aluminum painted in polyurethane powder and resistant to cleaning agents.

The bedhead unit shall be factory fitted, assembled and prewired according to the position of the bed and the length of the room.

It shall be fitted for each bed with :

- Indirect compensated fluorescent lighting 2x36w on aluminum reflecting support with polycarbonate diffuser.with two way switch controlled from BHU and room entrance door.
- Direct compensated fluorescent lighting for reading 1x18w on aluminum reflecting support with polycarbonate diffuser, controlled only from the BHU.
- Two power socket outlets 2P+E, 16A, one from each side of the bed.
- 12 additional UPS red color power socket outlets, 6 from each side , for ICU Bed head units.
- One 24V multipin socket for hand-held remote control unit with transformer and relays.
- One hand-held 24V remote control unit supplied with 2 meters lead and plug, equipped with one push-button for reading lighting and one push-button for patient call..Emergency nurse call point shall be also provided
- One telephone/DATA socket shall be installed in the bedhead unit, in each patient bedroom.
- Medical gas outlet , as required and shown in the mechanical medical gases drawings.

## B. Installation and Tests

Locations shown on drawings are approximate. Exact locations are to be shown on shop drawings. Switches are to be located at strike sides of doors and mounted at 120cm from finished floor levels. Socket outlets are to be mounted at 30cm from finished floor level.

All fittings are to be visually inspected for fixing, workmanship and operation to the satisfaction of the Engineer.

## C. Submittals

The following data (but not limited to) are to be provided :

- Manufacturer's catalogue cut with complete detailed literature specifications, overall dimensions, etc...
- Shop and construction drawings showing exact location of each outlet box, installation details, wiring diagrams, etc...
- Samples along with material approval requests.

## INTERIOR L.E.D. AND EXIT LIGHTING (16512)

## PART 1 - GENERAL

### A. Requirements

The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

### B. Scope

The work covered under this Section shall include furnishing and installing light-emitting diode (L.E.D.) luminaires (lighting fixtures) complete as shown on the Drawings, as described in the "Luminaire (Lighting Fixture) Schedule", and as herein specified

### C. Quality Assurance

This contractor shall provide luminaires that are of a manufacturer engaged in the production of luminaires that are equal in material, design and workmanship. The manufacturer's luminaire shall have been in satisfactory commercial or industrial use for a minimum of three (3) years. The manufacturer's luminaire shall have been available on the commercial market during the three (3) year period.

L.E.D. luminaires shall conform to the requirements of the National Electrical Code (NEC), state and local codes, and these Specifications.

The luminaires shall be listed by Underwriters Laboratories, Inc. (UL) or listed by a nationally recognized testing laboratory acceptable to Fairfax County DPWES.

Submittals are required in accordance with SECTION 16010 of these Specifications.

### D. Description

This Contractor shall furnish, assemble, and install L.E.D. luminaires complete with sockets, louvers, lenses, internal wiring, leads, trims, rings, frames, hangers, straps, reflectors, light engine, and power supply unit (driver) as applicable and required for a complete installation.

Luminaires that require remote mounting of any components needed for its operation, such as drivers, or light engine electronics are not permitted. All components needed to make the luminaire operational shall be integral to the luminaire housing.

### E. Warranty

This Contractor shall deliver the work described herein in a first class operating condition in every respect. This Contractor shall also warrant that the material and workmanship shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractors own expense. Refer to SECTION 01740 for the start of the warranty period. The contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details

## PART 2 - PRODUCTS

### A. MATERIALS AND COMPONENTS

The L.E.D. luminaires supplied shall have the proper trim, frames, mounting devices, configuration, and accessories necessary to be properly installed in the building construction. Catalog numbers of luminaires in the "Luminaire Schedule" or "Lighting Fixture Schedule" on the Drawings are to establish a type of luminaire and not to determine a method of mounting.

1. Catalog numbers scheduled on the Drawings may indicate luminaire compatibility with certain types of ceiling construction. The Contractor shall determine exact type of ceilings actually to be furnished in each area and shall obtain luminaires to suit, deviating from specified catalog numbers or descriptions only where necessary, and only to the extent necessary to insure luminaire-ceiling compatibility. The Contractor shall notify the Architect/Engineer and Owner in writing where such changes are to be made.

Where L.E.D. luminaires are specified on the Drawings to be complete with a flat diffusing lens, the lens shall be virgin acrylic Type 19 pattern with a minimum thickness of 0.156 inches unless otherwise shown on the Drawings.

When L.E.D. luminaires are specified on the Drawings to be complete with a curved or rounded lens refractor/diffuser, the lens shall be impact resistant 100% virgin acrylic type with diffusing optical film.

Double lock nuts shall be used at the load bearing ends of threaded pipe used as part of a stem mounting assembly

### B. POWER SUPPLY UNIT (DRIVERS)

Luminaires shall be equipped with an L.E.D. driver(s) that accepts the voltage as indicated on the "Luminaire (Lighting Fixture) Schedule". Individual driver(s) shall be replaceable

A. Driver(s) shall be UL8750 class 2 compliant for their intended purpose.

B. Total harmonic distortion (THD) for current: ≤ 20%

C. Driver(s) shall be rated to operate between -30°C to 50°C minimum.

D. Individual driver(s) shall be equipped with surge protection (2kV minimum) in accordance with IEEE/ANSI C62.4.1. Driver shall be protected against damage due to either an open circuit or short circuit fault condition on the driver output.

E. Driver(s) shall have a minimum efficiency of 85%.

F. Drivers shall deliver dimming to 1% light output from 0-10V control signal.

### C. L.E.D. LIGHT SOURCE (LIGHT ENGINE)

A. Individual light engine(s) shall be replaceable.

B. L.E.D. light engine(s) shall have a minimum lifetime of 50,000+ hours at 40° C and shall have a minimum efficiency of 80 lumens per watt.

C. L.E.D. dies shall be tested in accordance with I.E.S.N.A. LM-80-08 standards.

Thermal management shall be passive by design and shall consist of heat sinks with no fans, pumps, or liquids.

## D. SPARE PARTS

A. The Contractor shall furnish to the Owner at the completion of the project, a minimum of 5% spare L.E.D. driver assemblies. LED drivers shall be turned over to the Owner representative in their manufacturer's protective packaging. LED drivers not in their protective packaging will not be acceptable.

B. The Contractor shall furnish to the Owner at the completion of the project, a minimum of 5% spare L.E.D. light engine assemblies. LED light engines shall be turned over to the Owner representative in their manufacturer's protective packaging. L.E.D. light engines not in their protective packaging will not be acceptable.

## E. EXIT LIGHTS

A. Exit lights (signs) shall be universal mount and complete with factory installed light-emitting diodes (L.E.D.'s) mounted behind a red diffusing panel and with direction arrows as shown on the Drawings.

B. Exit lights shall have wire guards were shown on the Drawings.

# PART 3 - EXECUTION

## A. INSTALLATION

A. L.E.D. luminaires (lighting fixtures) shall be installed as shown on the Drawings and in accordance with the manufacturer's recommendations.

B. Wall washer type L.E.D. luminaires for illumination of white (marker) boards shall be located at a distance away from the wall and at a mounting height (pendant type fixtures) to achieve the best illumination for the marker board. This Contractor shall refer to the luminaire manufacturer's published product literature to determine the optimum distances from the wall and mounting height. Various ceiling heights may vary the distances. Pendant type L.E.D. luminaires shall be mounted no lower than 80 inches above finished floor per ADA.

C. Recessed lay-in type linear L.E.D. luminaires shall be supported from the building structure independently of the ceiling grids with a minimum of four (4) steel tie wires per luminaire or as detailed on the Drawings.

D. Recessed lay-in type linear L.E.D. luminaires installed in lay-in type ceiling tile shall be securely fastened from the building structure and be installed in the lay-in type ceiling in such a manner that the louver/lens housing may be easily opened and so that the luminaires may be removed and relocated without forcing the luminaires or changing the grid system tie wires. This Contractor shall coordinate with the ceiling installer before the ceiling grid is installed to assure a mutually satisfactory installation of ceiling and luminaires.

E. Recessed L.E.D. luminaires installed in "hard" ceiling systems (i.e. drywall, metal pan, etc.) shall be securely fastened from the building structure and be installed in such a manner that the louver/lens housing may be easily opened and so that the luminaires may be removed and relocated without forcing the luminaires or changing the ceiling support system. This Contractor shall coordinate with the ceiling installer before the ceiling is installed to assure a mutually satisfactory installation of ceiling and luminaires.

F. Surface mounted linear L.E.D. luminaires shall be supported from the building structure with a minimum of two (2) 1/4 inch threaded rods per each one (1) foot wide by four (4) foot long and a minimum of four (4) 1/4 inch threaded rods per each two (2) foot wide by four (4) foot long luminaire as detailed on the Drawings.

G. Pendant/suspended luminaires shall be supported from the building structure with 1/4 inch threaded rods at each of the luminaires suspension points. Hardware connections to the threaded rods shall be listed components from the luminaire manufacturer and be specifically designed for the type of suspension called for on the Drawings. Installation shall be in accordance with the manufacturer's instructions.

H. Recessed non-linear L.E.D. luminaires (i.e. downlights) located in lay-in type ceiling tile shall be mounted in the center of the tile or as shown on the Drawings and shall be supported by means of bar hangers extended across the main ceiling support members and also supported from the building structure with no less than one (1) 1/4 inch threaded rod per luminaire. Where luminaires are installed in slopped ceilings the luminaires shall be complete with appropriate slopped ceiling adapters.

I. Surface mounted non-linear L.E.D. luminaires and exit lights shall be supported from the building structure with a minimum of two (2) 1/4 inch threaded rods per luminaire or exit light.

J. 1-1/2 inch x 1-1/2 inch steel framing channel shall be used where required to span bar joists and otherwise facilitate structural support for luminaires and exit lights.

K. Ceiling grid layouts when indicated on the electrical Drawings are for convenience only. This Contractor shall coordinate the luminaires layout with the Architect/Engineer and all other trades before the ceiling grid, air outlets, and luminaires are installed.

L. L.E.D. luminaires installed in mechanical room and other similar equipment rooms shall be located in the field to clear all obstructions such as ducts, piping, bracing, and supports. Where the location of luminaires shown on the Drawings must be radically changed, approval from the Architect/Engineer shall be obtained before the luminaire is placed.

M. Pendant mounted luminaires and exit lights shall be located to avoid mechanical systems, ductwork, piping, structural members, and the like.

N. Supports shall not terminate or be fastened directly to the roof decking.

## B. GENERAL CONFORMANCE

A. Surface mounted luminaires shall not have gaps between the luminaire and attaching surface, except where required by code regulations or manufacturer's instructions.

B. Recessed luminaires shall not have gaps between the luminaire trim and the adjacent surface. Where light leaks occur, suitable gaskets shall be furnished and installed.

C. Install luminaires level, plumb and true. Align rows accurately in three (3) dimensions.

D. Where luminaires are to be installed in areas without ceilings, this Contractor shall furnish supports consisting of threaded rods and steel channels as required to have a finished mounting height of 8'-0" to bottom of the luminaire (or other mounting height as shown on the Drawings), unless pendant or chain mounting is indicated on the Drawings or Luminaire Schedule.

E. Recessed luminaires shall be connected with flexible metal conduit or MC Cable (maximum 6'-0" length) from outlet boxes mounted above or alongside of luminaire. Luminaires shall be wired in such a way that removal of one shall not disrupt the continuity of power to the others.

F. All luminaires designated for wet locations shall have sealed conduit entries. Any luminaire leaking water before or during the warranty period shall be repaired or replaced by this Contractor at no additional expense to the Owner.

G. Prior to final inspection, this Contractor shall check all L.E.D. luminaires for damages during construction and replace the damaged luminaires where necessary at no additional expense to the Owner. All luminaires shall be cleaned at the time of final acceptance of the building

## EXTERIOR/SECURITY LED LIGHTING (16542)

## PART 1 - GENERAL

### A. REQUIREMENTS

A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

### B. SCOPE

A. The work covered under this Section shall include furnishing and installing exterior/security light-emitting diode (LED) luminaires complete as shown on Drawings, as described in the "Luminaires (Lighting Fixture) Schedule", and as herein specified.

### C. QUALITY ASSURANCE

A. This contractor shall provide luminaires that are of a manufacturer engaged in the production of luminaires that are equal in material, design and workmanship. The manufacturer's luminaire shall have been in satisfactory commercial or industrial use for a minimum of three (3) years. The manufacturer's luminaire shall have been available on the commercial market during the three (3) year period.

B. Exterior/security LED luminaires shall meet requirements of the National Electrical Code (NEC), state and local codes including Fairfax County's Outdoor Lighting Standards and these Specifications.

C. The luminaires shall be listed by Underwriters Laboratories, Inc. (UL) or listed by a nationally recognized testing laboratory acceptable to Fairfax County DPWES.

D. Submittals are required in accordance with SECTION 16010 of these specifications.

E. In addition to the submittal requirements of Section 16010, submittals shall include but not be limited to the following:

1. Complete point-by-point photometric footcandle calculations of the parking lots on a scaled plan(s) (scaled to match the electrical site plan). The scaled plan must include points thirty (30) feet beyond the property lines. The calculations must include contributions from the building mounted luminaires and the pole mounted site luminaires.

2. Calculations must be based on "one (1) footcandle minimum maintained" with no more than 0.5 footcandles at the property line with a maximum of 0.01 footcandles ten (10) feet beyond the property line and a "light loss factor" (LLF) of 0.85. Luminaire photometry shall be designed using the I.E.S.N.A. LM-79-08 absolute photometric principles for LED lighting. The 0.5 footcandles maximum at the property line(s) and 0.01

footcandles ten (10) feet beyond the property line(s) must not be compromised

3. The exact quantities, locations, and I.E.S.N.A. photometric distribution types of pole mounted luminaries, may differ from the original basis of design layout, but the required footcandle levels must be maintained. Should the luminaire manufacturer require additional luminaires to achieve the stated footcandle levels and/or require additional branch circuit wiring, supports, poles, etc., in conjunction with these additional luminaires, shall not cause additional expense to the Owner.

4. The Architect/Engineer may require changes to the submitted point-by-point photometric plans, if in their opinion the plans do not meet the requirements of this project or do to conflicts with other site issues not addressed in the submittal.

F. Precast concrete pole base foundations may be used in lieu of the cast-in-place concrete foundations shown on the Drawings. If precast bases are used, submittals shall be provided and shall include but not be limited to the following

1. Provide pole base foundation design drawings signed and sealed by a Professional Engineer registered in the Commonwealth of Virginia. Foundation drawings shall indicate the design criteria, assumptions, codes, standards, and all foundation reaction forces and moments. Foundation drawings shall indicate the design criteria allowable soils bearing pressures, codes, standards, all foundation reaction forces and moments, construction specifications, materials, and specific installation requirements such as shoring or de-watering. For the purpose of this bid, the Contractor shall assume the following type of sub-grade material specified in the current adopted edition of the International Building Code, Section 1804, Table 1804-2 – Allowable Foundation and Lateral Pressure:
   a. Soils – Class 5 (clay and sandy clay)

## D. DESCRIPTION

A. This Contractor shall furnish and install LED luminaires complete with proper reflectors, diffusers, louvers, glassware, concrete bases, gaskets, shims, wiring, control, conduit, hardware, photocontrols, and other appropriate devices and parts for a complete exterior weatherproof lighting installation. Adjustable luminaires shall be aimed as directed by the Architect/Engineer. Each luminaire shall be complete with prewired integral drivers and optical (LED) assemblies. Luminaires that require remote mounting of any components needed for its operation, such as drivers, or light engine electronics are not permitted. All components needed to make the luminaire operational shall be integral to the fixture housing.

B. Luminaires shall have a minimum IP rating of IP65 or IP66.

## E. WARRANTY

A. This Contractor shall deliver the work described herein in a first-class

operating condition in every respect. This Contractor shall also warrant that the material and workmanship shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractors own expense. Refer to SECTION 01740 for the start of the warranty period. The contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.

B. All luminaires shall have a minimum five (5) year factory warranty for defective or non-starting power supply units (driver), and LED source assemblies, which includes, but not limited to: LED package, LED arrays, LED modules, LED die, encapsulate, and phosphor.

## PART 2 - PRODUCTS

### A. MATERIALS AND COMPONENTS

A. Exterior/security LED luminaires supplied shall be complete with the proper reflectors, diffusers, house side shields, louvers, glassware, gaskets, pole arms, collars, shims, wiring, control, conduit, hardware, drivers, photocontrols, and other appropriate devices, parts and accessories to be properly installed for an exterior weatherproof lighting installation.

### B. POLES AND STANDARDS

A. Poles for LED luminaires shall be aluminum or as indicated on the Drawings with factory finish as shown in the "Luminaire (Lighting Fixture) Schedule". Aluminum poles shall be factory wrapped with heavy weatherproof paper for protection during handling and shipping.

B. This Contractor shall furnish hot-dipped galvanized anchor bolts, templates, ground rods, conduit elbows, and base information, etc., for the installation of concrete bases as detailed on the Drawings.

C. Poles shall be of the height and with brackets, etc. as indicated in the "Luminaire (Lighting Fixture) Schedule".

A. All aluminum poles shall be seamless with all edges and parts factory polished and ground to a smooth congruous finish.

B. Poles greater than twenty (20) feet in length shall be complete with vibration dampers installed.

### C. POWER SUPPLY UNIT (DRIVERS)

A. Luminaires shall be equipped with an LED driver(s) that accepts the voltage as indicated on the "Luminaire (Lighting Fixture) Schedule". Individual driver(s) shall be replaceable.

B. Driver(s) shall be UL8750 class 2 listed for their intended purpose.

C. Individual driver(s) shall be equipped with surge protection (6kV minimum for building mounted units and 10kV minimum for pole mounted units) in accordance with IEEE/ANSI C62.4.1 and shall be rated for a category "C" environment.

D. Driver(s) shall have a minimum efficiency of 85%.

E. Driver(s) shall reliably start at minimum ambient temperatures from -40 deg. C to 40 deg. C with THD of <=20%.

F. Drivers shall deliver dimming to 10% light output from 0-10V control signal.

## D. LED LIGHT SOURCE (LIGHT ENGINE)

A. All LED light engine(s) shall be set to achieve IES, Type III, Type IV or Type V distribution as shown on the "Luminaire (Lighting Fixture) Schedule". Individual light engine(s) shall be replaceable

B. LED light engine(s) shall have a minimum lifetime of 50,000+ hours at 40deg.C and shall have a minimum efficacy of 80 lumens per watt.

C. All LED's shall be installed with 0 lumens above 90° up from nadir (full cut-off) performance.

D. LED dies shall be tested in accordance with I.E.S.N.A. LM-80-08 standards.

E. Thermal management shall be passive by design and shall consist of heat sinks with no fans, pumps, or liquids.

## E. DIMMING CONTROLS

Provide, in addition to the lighting control system, after hours dimming controls which reduces light levels to approximately 30% of full lumen output at a predetermined time. Controls shall be designed to fail to the "OFF" position. Dimming controls shall be compatible with the lighting control system. Refer to specification section 16505 or 16505A and details for lighting control system information

## F. SPARE PARTS

A. The Contractor shall furnish to the Owner at the completion of the project, a minimum of 20% (minimum of 4) spare LED driver assemblies. LED drivers shall be turned over to the Owner representative in their manufacturer's protective packaging. LED drivers not in their protective packaging will not be acceptable.

B. The Contractor shall furnish to the Owner at the completion of the project, a minimum of 20% (minimum of 4) spare LED light engine assemblies. LED light engines shall be turned over to the Owner representative in their manufacturer's protective packaging. LED light engines not in their protective packaging will not be acceptable.

## G. FOUNDATIONS

A. Pole base foundations shall be cast-in-place as detailed on the Drawings and as specified herein.

B. Contractor may at his option use precast concrete base foundations in lieu of the cast-in-place foundations.

1. Precast concrete foundations shall be designed and fabricated by an experienced and acceptable precast concrete manufacturer. The manufacturer shall have been regularly and continuously engaged in the manufacture of precast concrete units for at least 10 years. In addition, the manufacturer shall employ a Professional Engineer registered in the Commonwealth of Virginia.

2. The precast concrete units shall be designed to withstand design load conditions in accordance with the applicable industry design standards. Design must also consider stress induced during handling, shipping, and installation in order to avoid product cracking or other handling damage. Design loads for precast concrete units shall be indicated on the shop drawings, and designed by a licensed Professional Engineer registered in the Commonwealth of Virginia.

# PART 3 – EXECUTION

## A. INSTALLATION

A. The exterior/security LED luminaires shall be installed as shown on the Drawings and in accordance with the manufacturer's recommendations.

## B. POLE LAYOUT

A. This Contractor shall layout all equipment and review locations with the Architect/Engineer and/or Owner prior to construction. Pole locations shall be set by using a metal tape to the exact locations shown on the Drawings.

## C. POLE HANDLING AND ERECTION

A. Transportation, site handling and erection shall be performed by qualified personnel with equipment and methods that are in accordance with standard industry practices.

B. Prior to unloading the pole, shop drawings shall be reviewed to identify proper pick-up points for unloading, storage and erection procedures. A thru-hole shall be provided at the proper pick-up point for the purpose of inserting a steel bar to act as a stop to the cable choker when erecting the pole.

C. Web fabric slings (not chain or cable) shall be used to raise and set structural members. Protect equipment during installation to prevent corrosion.

D. Install poles and other structural units level, plumb and square. Orientation of the cast-in-place foundation anchor bolts in relation to the direction of the lighting must be checked carefully using the manufacturer's drawings, contract drawings and specifications.

E. Pole steel base plates shall not be installed until concrete has reached the specified 28 days strength.

F. After installation is complete, the Contractor shall plug with suitable semi-permanent material any alignment or installation aid or other unused holes or cavities in the poles to prevent them serving as harboring for insects and to prevent tampering. Material used shall be the same color as the pole.

## D. SITE PROTECTION AND RESTORATION

A. Protect existing site, plantings, trees, pavements, facilities, structures, grounds, playing fields, and all other site amenities designated or intended to remain, temporarily or permanently, from damage during demolition or construction activities, including delivery of poles and equipment. Repair items damaged during demolition or construction activities to their original condition, or replace with new, by qualified personnel and technicians, at no additional cost to the Owner. Repairs, reinforcement or structural replacement shall be approved by the Architect and/or Owner

## E. STORAGE

A. Poles and precast bases may be stored on-site (for a short time period) if they do not impact the day-to-day operations of the facility. Poles and bases shall be placed on suitable supports.

B. Luminaires, wiring, control equipment, etc. shall be stored off-site until they are ready for assembly and erection. On-site storage is permitted provided all items are stored in secure and DRY locations.

C. This Contractor is responsible for any damage or theft to any materials left on-site.

## F. FOUNDATIONS – CAST-IN-PLACE CONCRETE

A. Foundations shall be poured in place concrete. Concrete foundations shall be constructed of not less than 3,000 psi.

1. The steel reinforcement within the concrete shall be protected from slippage and exposure to oxidation through voids in the concrete or exposure of the steel through porous concrete material. Provide cover as specified in ACI-318.

B. All exposed areas of concrete bases shall be trowel finished smooth and

level with beveled edges. Top surface shall not vary by more than 1/8 inch in depth as measured across the widest surface. Concrete base forms leaving any imperfections shall be ground down to have a smooth finish. Concrete bases shall be finished to remove all concrete form imperfections. Refer to Specification Section 16010.

C. All concrete shall be fully vibrated.

D. Reinforcing steel shall meet ASTM A615 and Grade 60.

E. Cast-in-place foundations anchor bolt projections must allow for the thickness of the base plate, nuts (including leveling nuts), and raking if required. Adjust leveling nuts before installing the pole. They should be in a horizontal plane.

F. Reinforcing steel in cast-in-place foundations must not be welded to the anchor bolts. Care must be taken not to disturb the position of the anchor bolts while pouring concrete.

G. Orientation of the foundation anchor bolts in relation to the direction of the lighting must be checked carefully using the manufacturer's drawings, contract drawings and specifications.

## G. FOUNDATIONS – PRECAST CONCRETE

A. The installation Contractor shall be responsible for ensuring that the subgrade is compacted to 95% of ASTM D558 density. The subgrade shall be a minimum of six (6) inches in depth.

B. Precast concrete units shall be: installed in accordance with the precast concrete producers installation instructions for direct embedment; installed to the lines and grades shown on the Drawings; be lifted by suitable lifting devices at points provided by the precast concrete producer; in accordance with applicable industry standards.

1. The precast concrete producer shall provide installation instructions.

2. Backfilling shall be done as soon as possible after the unit has been set in place.

C. Orientation of the foundation anchor bolts in relation to the direction of the lighting must be checked carefully using the manufacturer's drawings, contract drawings and specifications before placement of precast foundations into the ground.

## H. POLE/FOUNDATION EXCAVATION

A. The Contractor may excavate by any means he prefers, insofar as these methods conform to these specifications. Holes shall be excavated with diameters not less than 8 inches greater than the largest dimension of the pole foundations being installed. Depth of pole holes shall be as detailed on the Drawings for cast-in-place foundations or as required for precast direct embedment units.

B. The bottom of the pole holes shall be on undisturbed earth. If a pole hole is excavated to a depth greater than required, it shall be backfilled with specified crushed stone, placed in 6 inch layers, and thoroughly machine tamped to an approximate compaction of 95%.

C. Backfill

3. The backfill for poles and foundations shall be Virginia Department of Transportation (VDOT) specification 21-A bluestone placed from thebottom of the pole hole to a distance of 18 inches below the top of the hole and topped with excavated soil. All backfill shall be placed in 6 inch layers and each layer shall be thoroughly tamped to an approximate compaction of 95%.

4. Subject to the Owner's approval, surplus material shall be uniformly spread at the site or removed and disposed of at this Contractor's expense. Care shall be taken that the spreading of surplus material does not result in the channeling of run-off water past pole locations.

5. Follow up inspections for settlements are required. Should settlement occur, the Contractor shall be responsible for all necessary repairs.

## I. LIGHTING CONTROL

A. The contractor shall install photo control sensor(s) for the lighting fixtures circuit(s) so that the exterior/security LED luminaires operate dusk till dawn. At no time shall the exterior/security LED luminaires operate 24 hours a day.

## J. FIELD QUALITY CONTROL

A. Prior to final inspection, this Contractor shall check all exterior/security LED luminaires, poles and concrete bases for damages during construction and replace the damaged luminaires or poles and repair or replace the concrete bases where necessary at no additional expense to the Owner. All exterior/security LED luminaires shall be cleaned and complete with all light engines and drivers at the time of final acceptance of the building.

B. Luminaires shall be checked for proper orientation on pole, proper reflector orientation and proper IES distribution type.

## UNINTERRUPTIBLE POWER SUPPLY SYSTEM (UPS) (16610)

### A. Summary

Provide labor, materials, equipment, and services, and perform operations required for installation of uninterruptible power supply systems and related work as indicated on the drawings and as specified herein.

The UPS system shall be capable to operate continuously providing uninterrupted and regulated power in the event of a power interruption to the connected load up to the specified battery autonomy.

The work shall include, but not be limited to, the following:

- Solid state rectifiers/chargers.
- Static inverters.
- Static transfer switches.
- Maintenance bypass switches.
- Batteries and their racks.
- Accessories.
- Furnishing load banks and test instruments during field testing.

The UPS system shall be suitable for parallel network configuration. It shall consist of a number of units as indicated on the drawings.

### B. System Description

During normal operation, utility power will supply the rectifier(s) that converts the incoming AC to DC. This DC is supplied to the inverter(s) that converts it to AC to feed the critical load. A battery is "floated" on the DC bus to maintain the DC bus voltage and supplies power to the inverter(s) in the event of a loss of utility power. The battery will supply sufficient power to the inverter(s) to maintain inverter output for the specified time. When the battery discharges to the minimum inverter design voltage, the inverter will shut down in an orderly manner. Upon restoration of utility power, the rectifier(s) will resume feeding power to the inverter section and will simultaneously recharge the battery.

The system shall be provided with a bypass section such that utility company power may be connected to the load either manually by automatic control in case of failure of the UPS equipment by synchronizing and paralleling the two sources before the transfer is made without an interruption. Retransfer shall be made in the same manner.

Each set shall have at least 20 minutes autonomy.

### C. Quality Assurance

Materials and equipment shall conform to the latest edition of reference specifications specified herein and to applicable codes and requirements of local authorities having jurisdiction.

### D. Submittals

The contractor shall submit the following:

- Product Data: Submit manufacturer's data on uninterruptible power supply systems and components.

- Shop Drawings: Submit dimensioned layout drawings and descriptive data of UPS systems and accessories including, but not limited to, weights, rectifiers/chargers, inverters, static transfer switches, maintenance switches, batteries and instruments indicating accurately scaled UPS system equipment locations and their spatial relationship to associated equipment; show connections to normal and standby power supplies, elementary diagrams of protection, control and instrumentation systems, wiring and single line diagrams, time current curves of protective devices. Submit calculations to indicate compliance with battery requirements of schedule standby use with no more than specified drop in battery voltage.
- Maintenance Data: Submit maintenance data, parts and recommended spare parts list for each uninterruptible power supply and accessory; including "troubleshooting" maintenance guide. Include this data, product data, and shop drawings in maintenance manual;
- Field Test Procedure: Submit a detailed site acceptance test procedure.
- Submit a failure mode and effects analysis and a reliability prediction based on the final design.
- Submit a detailed factory acceptance test procedure.
- Submit certified factory and site test data and reports, for the UPS equipment and the batteries.
- Submit battery manufacturer name, container type, the total number of containers required per UPS module, battery and rack dimensions and weights.

## E. Delivery, Storage and Handling

UPS equipment and batteries shall be delivered undamaged to the site by an experienced direct carrier using appropriate air ride suspension equipment. In no case shall the UPS equipment and batteries be shipped without prior written approval of the Engineer. Premature shipment will be automatic cause for rejection.

Handle uninterruptible power supply equipment carefully to prevent damage, breaking and scoring. Do not install any damaged units or components; replace with new.

Store units in clean dry places. Protect from weather, dirt, fumes, water, construction debris and physical damage.

## F. Warranty and Guaranty

The UPS system warranty shall be no less than one year after initial startup, and must include costs including repair, parts, labor, travel and living for the manufacturer's service personnel. The manufacturer shall respond to requests for and provide warranty service within 8 hours.

The battery provided herein shall be guaranteed by the UPS manufacturer on a pro rated basis for five years (unless otherwise specified herein. Batteries shall deliver a minimum of 100% of rated capacity initially and a minimum of 80% of rated capacity at the end of the battery guarantee period in accordance with IEE standard 485.

The manufacturer shall guaranty, in writing, the stated system efficiency. If the stated efficiency is less than that stated, the manufacturer shall refund to the user an amount based on additional power costs incurred by loss of efficiency over a three-year operating period.

## G. Equipment

The materials and equipment of the UPS system shall comply with the following features:

- The UPS system shall have provisions for necessary interface connections and accessory items to ensure it can be easily and economically expanded at a future time for increased capacity as specified.
- UPS module shall include a rectifier/charger, three phase inverter, associated transformers, synchronizing equipment, protective devices and accessories as required.
- Each UPS module shall have a properly rated circuit breaker to isolate it from the battery voltage present in the UPS module enclosure. The UPS module shall automatically be disconnected from the battery by opening the disconnect when the battery reaches the minimum discharge voltage level or when signaled by other control functions. The UPS module shall be provided with a pushbutton to trip the module battery disconnect from the module control panel.
- The overall efficiency, input to output, shall be in accordance with the specified systems requirements measured with the battery fully charged and the inverter supplying full rated load. The manufacturer shall guarantee the efficiency of the system in his proposal.
- The UPS shall be constructed of replaceable subassemblies. Printed circuit assemblies shall be of the plug-in type. All like subassemblies and components shall be interchangeable.
- Noise generated by the UPS under any condition of normal operation shall not exceed 65 dBA measured 2 meters from the surface of the UPS.
- Rectifier and inverter power semiconductor switching circuits shall be fused to prevent cascading or sequential semiconductor failure. Fuses shall be provided with blown fuse indicators. Provide alarm indication on the control panel.
- Active electronic devices shall be solid-state. Relays shall be provided with dust covers.
- Electromagnetic interference (EMI) shall be minimized to ensure that computer systems, or other sensitive electronic systems, shall not be adversely affected by the UPS.
- The UPS shall have built-in protection against undervoltage, overcurrent and overvoltage conditions including low-energy lighting surges, introduced on the primary AC source. UPS operations and the critical AC load bus shall not be affected by impressed transient voltage and current levels as per IEC standard 146.

- Energized terminals shall be shielded to ensure that maintenance personnel do not inadvertently come in contact with energized parts or terminals. A means to de-energize the static switch shall be provided when the UPS is the maintenance bypass mode and operation.
- With the load powered from the maintenance bypass circuit, it shall be possible to check out the operation of the rectifier/charger, inverter and static transfer switch. It shall also be possible to check battery operation.
- Plug-in printed circuit board shall have mechanical interlocks to prohibit a board from being plugged into the wrong place and electrical interlocks to prohibit system operation if boards are not properly installed.
- Components and protective devices shall have adequate interrupting capacities for the duties imposed either from the normal power or the UPS systems.
- Prior to shipment, the manufacturer shall fully test the system to ensure compliance with the specifications. These tests shall include operational discharge and recharge tests on at least a one minute battery plant to assure guaranteed rated performance. Test certificates for all components shall be submitted by contractor and manufacturer to indicate compliance and test success.
- The UPS system shall be capable of handling up to 100% non-linear loads with output distortion less than 5% THD.
- Input filters shall be provided to reduce input harmonic distortion caused by the UPS system to less than 5% THD.
- The contractor shall supply with each UPS with an additional, separate, monitoring panel approved by the supplier for monitoring status of UPS from a remote location. This location shall be assigned in control room on ground floor.
- The Contractor shall submit designs and specifications of those panels to Engineer for approval with suggestions of installation location.
- Full description of panel shall be provided on location with material. Each panel shall be supplied with main power from same supply as the corresponding UPS.
- The UPS's shall be equipped with teleservice, continuous, 24hrs, remote monitoring of operation by a regional supplier-dealer electrical service center.

## H. Enclosures

The enclosures shall be IP21 with the required sizes capable of resisting external vibrations and electromagnetic stimulus, including but not limited to battery chargers, inverters, automatic solid-state transfer switches with manual bypass, and all association equipment.

## I. Rectifiers/Chargers

The UPS shall include rectifier/ charger, of ratings and electrical characteristics required, consisting of primary input circuit breakers, isolation transformers, solid-state rectifier, DC filters, battery circuit breakers, with associated control circuitry.

Rectifier/charger shall be capable of simultaneously supplying DC power to float-charge battery banks and to inverters which are providing power permanently to essential AC loads.

Current outputs shall be limited to present fully discharged batteries from overloading battery charges.

The UPS shall be equipped with automatic electronic shutdown to prevent possible damage by over discharge where batteries are completely discharged, UPS systems shall return automatically to standby status to prevent cell reversal in batteries and damage to UPS system.

The output DC filter shall/be adequate to ensure that the DC output of the rectifier/charger will meet the input requirements of the inverter. The inverter shall be able to operate from the rectifier/charger with the battery disconnected. Maximum ripple current into the battery shall not exceed 2% RMS.

DC overvoltage protection shall be provided so that if the DC voltage rises to the preset limit, the UPS is to shutdown automatically and the load transferred to the static bypass line uninterrupted.

## J. Static Inverter

To prevent battery damage from over discharging at light load, the UPS control logic shall automatically raise the shutdown voltage set point as the load is reduced.

The inverter shall use a manual control to adjust the output voltage from plus/minus 5% of the nominal value.

The system shall comprise:

- Three phase solid-state inverters, comprised of inverters, filters, output power transformers, and regulators for supplying regulated alternating-current outputs.
- Components with recovery time and maximum harmonic content, under full-load conditions, as required and specified.
- DC input and AC output circuit breakers for protecting inverters against overloads and short-circuit conditions.
- Control circuitry capable of starting and stopping inverters electronically.

The inverter shall be capable of supplying an overload current of 150% for one minute and 125% for 10 minutes. A status indicator and audible alarm shall indicate overload operation. The UPS shall transfer the load to bypass when overload capacity is exceeded, without interrupting the load..

For currents above 150% for longer-time duration, the inverter shall have electronic current-limiting protection to prevent damage to components. The inverter shall be self-protecting against any magnitude of connected output overload. Inverter control logic shall sense and disconnect the inverter from the critical AC load without the requirement to clear protective fuses.

For rapid removal of the inverter from the critical load, the inverter control electronics shall instantaneously turn off the inverter transistors. Simultaneously, the static transfer switch shall be turned on to maintain continuous power to the critical load.

The inverter shall be protected by the following disconnect levels, which shall be independently adjustable for UPS application flexibility.

- DC Overvoltage Disconnect.
- DC Undervoltage Warning (Low Battery Reserve).
- DC Undervoltage Disconnect (End of Discharge).

To prevent battery damage from over charging at small load, the UPS control logic shall automatically raise the shutdown voltage set from plus/minus 5% of the nominal value.

The output frequency of the inverters shall be controlled by an oscillator. The oscillator shall be temperature compensated and hold the inverter output frequency to plus/minus 0.1% for steady state and transient conditions. Drift shall not exceed 0.1% during 24-hour period. Total frequency deviation, including short time fluctuations and drift, shall not exceed 0.1% from the rated frequency.

Electronic controls shall be provided to regulate each phase so that an unbalance loading will not cause the output voltage to go outside the specified voltage unbalance or phase displacement.

## K. Synchronizing Controls

The system shall be equipped with master synchronizing oscillators and associated circuitry which automatically synchronizes and phase-locks power converter with incoming AC bypass line; having frequency range of 50 Hz, plus/minus 0.5% and with field programmable frequency synchronizing limits in steps of 0.5% to 1.5% of nominal. Equipment shall include indicating matching of UPS output and bypass voltage and that UPS is synchronized and phase-locked.

## L. Static Transfer Switch

The UPS system shall include solid state static switches, of types and ratings as required with automatic transfer circuit which senses alarm conditions and causes automatic uninterrupted transfer of load without exceeding specified transient limits. Switches shall have capacity to supply full-load current continuously.

The static transfer switch shall have an overload rating of 200% rated load for the five minutes and 2000% rated load for two cycles. The static transfer switch control logic shall contain an automatic transfer control circuit that senses the control circuit shall provide an uninterrupted transfer of the load to an alternate bypass source, when an overload or malfunction occurs within the UPS, or for bypassing the UPS for maintenance.

The transfer control logic shall automatically turn on the transfer switch, transferring load to the bypass source, after sensing one of the following conditions:

- Load on battery
- Inverter overload capacity exceeded.
- Critical AC load overvoltage or undervoltage.
- Battery protection period expired.
- UPS fault condition.

The transfer control logic shall inhibit a transfer (manual or automatic) of the load to the bypass source if one of the following conditions exists:

- Inverter/bypass voltage difference exceeding preset limits.
- Bypass frequency out of limits.

- Bypass out-of-synchronization range with inverter output.

Retransfer of the load from the bypass source to the inverter output shall be automatically initiated unless by manual control. The transfer control logic shall inhibit a transfer (manual or automatic) of the critical load to the inverter if one of the following conditions exist:

- Bypass out of synchronization range with inverter output.
- Inverter/bypass voltage difference exceeding present limits.
- Overload conditions exists in excess of inverter full load rating.
- UPS fault condition present.

## M. Maintenance By-Pass Switches

The UPS system shall include circuit-breaker type maintenance bypass switches, of types and ratings as required, mechanically operated, key interlocked with system output breaker with switchable modes; normal and test, to isolate and bypass the rectifier/charger, inverter and static transfer switch.

## VIDEO SURVEILLANCE CCTV SYSTEM (16626)

## PART 1 - GENERAL

### A. General requirements

This Performance Criteria (PC) specifies the installation and quality of voice communication terminal equipment.

### B. References

- MOI and Green Riyadh guidelines for surveillance cameras
- National Fire Protection Association (NFPA)

## PART 2

### A. System Requirements

System and materials used must be UL listed and labeled; must be suitable for the environment in which they are installed.

Provide cabling and other balance of system components in accordance with the manufacturer's recommendations and MOI Building Telecommunications Cabling System.

All products that have interoperability capable hardware (i.e. internal storage, data transmission via wireless, ethernet, of USB to PC or server connectivity) must meet MOI and/or Cybersecurity requirements.

System must be non-proprietary.

Video-signal format must comply with NTSC standard, composite interlaced video. Composite video-signal termination must be 75 ohms.

Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.

- Minimum Protection for Power Connections 220 V and Greater.
- Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements as recommended by manufacturer for type of line being protected.

Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components must initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display must identify tamper alarms and indicate locations.

## B. Performance Requirements

The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.

Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

Comply with NECA 1.

Comply with NFPA 70.

Electronic data exchange between video surveillance system with an access-control system must comply with SIA TVAC.

## C. Standard Cameras

A. ANPR:
- Resolution: 8MP UHD/4K (3840 x 2160)
- Power source: PoE, PoE+ or PoE++
- IR Viewable Length +30m
- compression Support: H.264, H.265 and H.265+
- Brand/Model/Color Recognition and search Black/White list access.
- Minimum Framerate: 25 FPS
- Minimum Illumination: Color: 0.005Lux, B/W: 0Lux
- IP Rating: IP66
- Support all protocols: onvif, rtsp ...etc.

B. Dome/Bullet
- Tamper proofing.
- Power source: PoE, PoE+ or PoE++
- IP 66 protection resolution: 8MP/4k
- Minimum Illumination: Color night 0.15 Lux, B/W: 0 Lux
- optical zoom: support optical zoom depends on the location it will be fixed in.

C. Face Recognition
- Face Detection Maximum detects 20 face targets simultaneously.
- Power source: PoE, PoE+ or PoE++ Database Support Face Database, with categorization
- Comparison Allow manual input of photos to be compared with the face database.
- Recognize Face Distance between pupils ≥ 60 pixels; face ≥ 150 pixels.
- Attitude angle Capture angle: ≤25° of pitch | ≤60° angle from left to right.
- Accuracy Capture Face : ≥98% | Recognize Face : ≥95%
- Speed Recognize speed: ≤200ms.
- Face Filter Support duplicate Face filter and detection quality filter.
- Detection Area Adjustable, defined by the user.
- Occlusion Glasses, hair banging, and slight backlight have no effect.

D. PTZ

- Material Aluminum
- IP rating IP66
- Pan max angle 0-360° with endstops (360° continuous optional)
- Tilt max angle Tilt -45/+45° (Custom angle -/+° option)
- Variable Pan speed 0,01 – 12°/sec (64 step)
- Variable Tilt speed 0,01 – 8°/sec (64 step
- Absolute positioning Yes
- Presets 100 presets
- Preset accuracy less than 0-1 degree
- Position repeatability less than 0-1 degree
- Motor type motorized.

E. Color Camera:
- Comply with UL 6
- Sensitivity: Camera must provide usable images in low-light conditions.
- Shall be WDR wide dynamic range.
- White Balance: Auto-tracing white balance, with manually settable fixed balance option.
- Motion Detector: Built-in digital.

**D. Lenses**

A. Description: Optical-quality coated lens, designed specifically for video-surveillance applications and matched to specified camera. Provide color-corrected lenses with color cameras.
- Auto-Iris Lens: Electrically controlled iris with circuit set to maintain a constant video level in varying lighting conditions.
- Fixed Lens: With calibrated focus ring.
- Zoom Lens: Motorized, remote-controlled unit, rated as "quiet operating." Features include the following:
  a. Electrical Leads: Filtered to minimize video signal interference.
  b. Motor Speed: Variable.
  c. Lens must be available with preset positioning capability to recall the position of specific scenes.

**E. Power supplies**

A. Low-voltage power supplies matched for voltage and current requirements of cameras and accessories, and of type as recommended by manufacturer of camera, infrared illuminator and lens.
- Enclosure: IP66.

**F. Infrared illuminators**

A. Description: Lighting fixtures that emit light only in the infrared spectrum, suitable for use with cameras indicated, for nighttime surveillance, without emitting visible light.
- Field-Selectable Beam Patterns: Narrow, medium, and wide.
- Rated Lamp Life: More than 8000 hours.
- Power Supply: 12-V ac/dc or 230-V ac.

B. Area Coverage: Illumination to 50 m in a narrow beam pattern.

C. Exterior housings must be suitable for same environmental conditions as the associated camera.

## G. Camera supporting equipment

A. Minimum Load Rating: Rated for load in excess of the total weight supported times a minimum safety factor of two.

B. Pan Units: Motorized automatic-scanning units arranged to provide remote-controlled manual and automatic camera panning action and equipped with matching mounting brackets.
   1. Scanning Operation: Silent, smooth, and positive.
   2. Stops: Adjustable without disassembly, to limit the scanning arc.

C. Pan-and-Tilt Units: Motorized units arranged to provide remote-controlled aiming of cameras with smooth and silent operation and equipped with matching mounting brackets.
   1. Panning Rotation: 0 to 355 degrees, with adjustable stops.
   2. Tilt Movement: 90 degrees, plus or minus 5 degrees, with adjustable stops.
   3. Speed: 12 degrees per second in both horizontal and vertical planes.
   4. Wiring: Factory prewired for camera and zoom lens functions and pan-and-tilt power and control.
   5. Built-in encoders or potentiometers for position feedback and thermostat-controlled heater.
   6. Pan-and-tilt unit must be available with preset positioning capability to recall the position of a specific scene.

D. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions. Include manual pan-and-tilt adjustment.

E. Protective Housings for Fixed and Movable Cameras: Steel enclosures with internal camera mounting and connecting provisions that are matched to camera/lens combination and mounting and installing arrangement of camera to be housed.
   1. Tamper switch on access cover sounds an alarm signal when unit is opened or partially disassembled. Central-control unit must identify tamper alarms and indicate location in alarm display.
   2. Camera Viewing Window: Polycarbonate window, aligned with camera lens.
   3. Duplex Receptacle: Internally mounted.
   4. Alignment Provisions: Camera mounting must provide for field aiming of camera and permit removal and reinstallation of camera lens without disturbing camera alignment.
   5. Built-in, thermostat-activated heater and blower units. Units must be automatically controlled so the environmental limits of the camera equipment are not exceeded.
   6. Sun shield must not interfere with normal airflow around the housing.
   7. Mounting bracket and hardware for wall or ceiling mounting of the housing. Bracket must be of same material as the housing; mounting hardware must be stainless steel.
   8. Finish: Housing and mounting bracket must be factory finished using manufacturer's standard finishing process suitable for the environment.

## H. Network video recorders

A. Video and audio recording over TCP/IP network.
B. Video recording of MPEG-2 and MPEG-4 streams.
C. Video recording up to 48 Mbps for internal storage and up to 100 Mbps for external storage.
D. Duplex Operation: Simultaneous recording and playback.
E. Continuous and alarm-based recording.
F. Full-Featured Search Capabilities: Search based on camera, time, or date.
G. Automatic data replenishment to ensure recording even if network is down.
H. Digital certification by watermarking.
I. Internal RAID storage or non-RAID storage of up to 1500 GB.
J. Capable of adding external RAID storage up to 7000 GB for models with no internal storage.
K. Full integration with LAN, Intranet, or Internet through standard Web browser or video management software.
L. Integrated Web server FTP server functionality.
M. Supports up to 150 devices.
N. Recording resolution Full HD 1080p minimum.
O. Storage for not less than 90 days.
P. Event-based monitoring
Q. Video export for evidence
R. Ready to integrate with all CCTV brands and systems (i.e scada).
S. Support compression: H264, H265 and H265+, and all Audio Compression e.g. G.711/AAC/G.722/G.726 support AI and video analytics
T. Should handle all the bandwidth traffic coming from all cameras that are connected to.
U. The NVR shall support monitors and control monitors as per the manufacturer's recommendations.

## I. IP video systems

A. Description:
   a. System must provide high-quality delivery and processing of IP-based video, audio, and control data using standard Ethernet-based networks.
   b. System must have seamless integration of all video surveillance and control functions.
   c. Graphical user interface software must manage all IP-based video matrix switching and camera control functions, two-way audio communication, alarm monitoring and control, and recording and archive/retrieval management. IP system must also be capable of integrating into larger system environments.
   d. System design must include all necessary compression software for high-performance, dual-stream, MPEG-2/MPEG-4 video. Unit must provide connections for all video cameras, camera PTZ control data, bidirectional audio, discreet sensor inputs, and control system outputs.
   e. All camera signals must be compressed, encoded, and delivered onto the network for processing and control by the IP video-management software.
   f. Camera system units must be ruggedly built and designed for extreme adverse environments, complying with NEMA Type environmental standards.
   g. Encoder/decoder combinations must place video, audio, and data network stream that can be managed from multiple workstations on the user's LAN or WAN.

h. All system interconnect cables, workstation PCs, PTZ joysticks, and network intermediate devices must be provided for full performance of specified system.

## J. Control Stations

A. Description: Heavy-duty, freestanding, modular, metal furniture units arranged to house electronic equipment. Coordinate component arrangement and wiring with components and wiring of other systems.

B. Equipment Mounting: Standard 19-inch (483-mm) rack complying with CEA 310-E.

## PART 3

## A. Examination

A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.

B. Examine roughing-in for LAN, WAN, and IP network before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

## B. Wiring

A. Wiring Method: Install cables in raceways unless otherwise indicated.
1. Except raceways are not required in accessible indoor ceiling spaces and attics.
2. Except raceways are not required in hollow gypsum board partitions.
3. Conceal raceways and wiring except in unfinished spaces.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

C. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

## C. Video surveillance system installation

A. Install cameras and infrared illuminators level and plumb.

B. Install cameras with 2134-mm minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.

C. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms and adjust.

D. Install power supplies and other auxiliary components at control stations unless otherwise indicated.

E. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system-component enclosures and mounted in self-protected, inconspicuous positions.

F. Avoid ground loops by making ground connections only at the control station.

## D. Field quality control

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:
   1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
   2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:
      a. Prepare equipment list described in "Informational Submittals" Article.
      b. Verify operation of auto-iris lenses.
      c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
      d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet (17 to 23 m) away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
      e. Set and name all preset positions; consult Owner's personnel.
      f. Set sensitivity of motion detection.
      g. Connect and verify responses to alarms.
      h. Verify operation of control-station equipment.
   3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
   4. Operational Tests: Perform operational system tests to verify that system complies with criterion. Include all modes of system operation. Test equipment for proper operation in all functional modes.

E. Video surveillance system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

## E. Adjusting

A. Occupancy Adjustments: Within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Tasks must include, but are not limited to, the following:
   1. Check cable connections.
   2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
   3. Adjust all preset positions; consult Owner's personnel.
   4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
   5. Provide a written report of adjustments and recommendations.

## F. Cleaning

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

## G. Demonstration

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.

## H. Submittals

A. Submittals required for government review

- Product Information must include manufacturer's installation instructions, sizing (including required clearance for access and maintenance), utility requirements, isometric drawings, tagged floorplans showing placement for count accountability and accessories/options/consumables list.

- All submittals require MOI approval prior to procurement. Submit all listed items herein, with information sufficient to show full compliance with the criteria. Submit all product selections for review and approval, including but not limited to materials, finishes, colors, options, accessories, and complimentary products. Provide for review all warranties and service contracts and any available extended warranty or service options.

- Samples: Furnish material samples and full range of color selection options for all items that offer material and color selections.

- Submit and highlight all applicable options for Government review for all items which optional accessories are provided.

## I. Quality Assurance

A. Materials and Equipment:
Materials and equipment must be standard products of a manufacturer regularly engaged in the manufacture of products which are of a similar material, design, and workmanship and are offered for sale on the commercial market through advertisements, manufacturer's catalogs, or sales brochures. The products must have been in commercial or industrial use under similar circumstances and of similar size for 2 years prior to selection for approval/procurement. Products must be supportable for at least three years after government acceptance.

B. Alternative Service Record
Products having less than a 2-year field service record will be acceptable if a certified record of the manufacturer's factory or laboratory tests demonstrating performance compliance is provided to the Contracting Officer.

C. Service Support
Equipment items must be supported by service organizations located near the equipment installation, able to service the equipment on a regular basis and respond to emergency calls throughout the warranty period.

D. Manufacturer's Nameplate
Each item of equipment must have an attached nameplate that is securely affixed in a conspicuous space. A nameplate listing only the name of the distributing agent is not acceptable. The nameplate must contain the following fields in English:

- Manufacturer's name and address
- Model and Serial Number
- Item's utility ranges and/or capacities
- Voltage, amperage, and applicable Underwriters Laboratory (UL) or Conformitè Europëenne (CE) rating if electrically powered
- Date of manufacture

E. Factory Inspection
Arrange and perform all quality control and quality assurance inspections required by the technical sections of the criteria, unless otherwise specified. Report these inspections in the daily report to the Government inspector.

F. Product Qualifications
The products specified in the technical sections of this criteria establish standards for each item.

G. Design Parameters
It is not the intention of this Criteria to limit consideration to products of specific manufacturers. The product standards establish the characteristics for which submitted items of equipment will be reviewed and approved by the Government. Equipment furnished must meet each of the following parameters specified in the technical sections:

- Size of equipment
- Function of equipment
- Standard and listed accessories and options
- Equipment controls and performance of equipment

- Construction of equipment
- Finish

## J. Standards Deviations

A. Reporting and Submission for Approval
Submit for approval a record of deviations from the standards listed in section established for each specified product, before ordering equipment.

## K. Delivery, Storage and Protection

A. Packaging and Transporting
Each unit of equipment must be placed in a substantial shipping container or crate for safe transportation to final destination. The shipping container or crate for heavy equipment must be on skid construction to facilitate handling by lift equipment.

B. Packing List
Clearly and legibly indicate on exterior of each container or crate the shipping address and a brief description of contents. Fasten to outside of container a packing list and complete instructions for uncrating equipment and setting it in place. Protect such information in a weatherproof envelope.

C. Protection
Properly protect all materials and equipment from injury and damage during storage, installation, and acceptance.

## L. Installation, Verification and Acceptance Testing

A. Installation, Operation, Testing and Certification

Products must be delivered in manufacturer's original packaging with manufacturer's installation instructions. Include clearly marked project reference. Prior to installation, thoroughly examine the equipment, materials, and components for both visual defects and conformance with criteria.
Install all equipment in compliance with manufacturer's written instructions and installation procedures.

After installation, the equipment must be inspected and tested under operating conditions. If the equipment fails an inspection or test, such defects/failures must be corrected. Upon correction of defects/failures, inspect and retest all affected functions related directly and indirectly to the defect or failure. Corrections, replacement, and retesting must be made at no additional expense to the Government.

Provide all items necessary to make equipment fully functional.
Provide appropriately trained personnel to energize, commission, inspect, electrical safety check, calibrate, certify, and provide all required technical testing for equipment and systems. Contractor must provide documentation, test reports and certification documentation attesting that the equipment is properly installed, functional, safe, calibrated, and ready for its intended use.

Provide two sets of special tools, software, and any other item/s for each equipment item type for maintenance and/or future reconfiguration of the item.

Contractor to supply all start-up supplies for medical equipment for a fully operational installation. Contractor must supply to the Government a listing of all needed supplies for ongoing equipment operation for each item of equipment requiring additional supplies for operation.

Engage a factory-authorized service representative to train Client's staff and maintenance personnel to adjust, operate, and maintain medical equipment. Confirm functionality of required interfaces to other systems and networks.

## M. Warranty

A. Minimum Requirements

Provide manufacturer's written warranty for all items listed. Provide warranty for a minimum of (1) year against defects in materials and workmanship. Warranty must provide for material, labor and all associated replacement and/or repair costs required to provide for a fully operational equipment replacement or repair. Submit manufacturers and installers standard service contract beyond the warranty period for Government review. Warranty must be transferrable to the final owner without risk of being voided. All warranty certification and documentation must be provided to the final owner after date of acceptance.

Provide routine warranty service in accordance with manufacturer's warranty requirements, for a period of 12 months (minimum) after the open for business date. Perform work during regular working hours. Perform service only by factory trained personnel. Maintain a maintenance log of all service orders performed during the warranty period.

## N. Operations And Maintenance (O & M)

A. Provide the following to the final owner

Provide O & M data manual to the Client.

Upon completion of equipment installation, furnish two copies of operators/service/maintenance manuals for each type of equipment which will require service or maintenance.

Each manual must contain operating instructions and information required for performing periodic maintenance on the equipment. Each service manual must include an illustrated parts breakdown which identifies each part of the unit with manufacturer's part number, wiring diagrams, and a list of necessary service parts, tools, and equipment needed to support maintenance requirements.

Accessory Catalogs: Upon completion of the Project, furnish two copies of the manufacturer's catalogs containing optional accessory items available for all equipment relative to the procured equipment/system delivered herein.
Provide instruction video for cleaning and maintenance, when available.

Provide cleaning requirements for all items to prevent void of warranty.

Provide contact information for Repair Technician or Emergency Repair Company.

Train designated staff in the operation and maintenance of the provided equipment/system. Provide two training sessions for equipment/system users and

two training sessions for maintenance personnel scheduled to accommodate shift work. Provide DVD copy of the training with the O & M data.

## CLOCK DISTRIBUTION SYSTEM (16731)

### A. General requirements

A1 Work included

Work comprises supply and installation a complete clock distribution system.

Work is deemed to include at least :

- Master and receiver clocks for displaying of time throughout the building especially in the entry, the operating theatres, the administration and the nurse posts.
- Starting and stopping lighting, heating, ventilation, etc.
- Cables, conduits, outlets, boxes, raceways, interface modules and all other items needed for the complete installation and function of the system.

A2 Master clock

Master clock shall be entirely electronic, modular and have 19" rack presentation.

Power supply will be at 230VAC with standby lithium battery (24h hours autonomie duration at least).

Signalisation :

- Mains presence
- Power failure

The master clock shall indicate time and date with a precision of +0.1 second for 24hours. Summer / Winter changeover will be automatic.

The master clock shall be equipped with 4 relays with dry contacts and a breaking capacity of 10A / 250 volts.

A3 Receiver clock

Receiver clocks shall be of the electronic type. Different colors of display shall be used for different locations.

Clocks shall display day, month, hour and minute 230VAC supply, with Ni-Mh battery reserve power supply.

Clocks will have square or rectangular aluminum case, with wall mounting and with protective glass.

A4 Submittals

The following documents (but not limited to) are to be provided :

- Manufacturer's catalogue cuts (for master clock, receiver clocks, characteristics, ...)
- Shop drawings showing exact location of equipment and the routing of cables and conduits.

## DATA AND TELEPHONE SYSTEM

### A. General

The data and telephone system shall consist of complete installation of all conduits, conduit fittings, main distribution frame, network cabinets, terminal boxes, junction boxes, pull boxes, outlet boxes, data and telephone cables, data socket outlets, circuit wiring, wiring connectors and all work relating to the data and telephone installation in accordance with the drawings and as directed by the Engineer.

Outlet faceplates shall be integral with other types of outlet faceplates.

Suitable distributing data and telephone terminal and junction boxes with suitable connectors shall be provided as required on the drawings.

Numbered tags corresponding to the respective branches shall identify terminals.

### B. Execution

A clearance of at least 20 cm must be respected between the low current cables and the power cables in all the installation.
Each data cable should be one piece from each outlet to the corresponding network cabinet as shown on drawings.

All 4 pairs of each TP cable shall be terminated on a single port. The splitting of cable pairs between different jacks is not permitted. Terminating resistors required in certain applications shall be placed externally to the outlets.

Terminating cable pairs (Category 6) shall have a maximum of 13 mm (1/2 inch) of cable untwisted before termination.

One telephone cable, per network cabinet, with number of pairs as indicated on drawings will be used for the connection of the network cabinet to the MDF. Main telephone feeder will run inside PVC duct and on cable trays as shown on drawings.

All telephone and data cables will be installed on the same side inside the shaft and will be clearly labeled to indicate the type and destination on each floor level.

During the actual installation, bend radius on 4-pair cable shall not exceed eight times the outside diameter of the cable and ten times for multi-pair cable. This shall be done unless this violates manufacturer specifications.

In the telecommunications room/closet where cable trays or cable racking are used, the contractor shall provide appropriate means of cable management such as reusable color-coded hook and loop cable managers (ties) to create a neat appearance and practical installation.

In telecommunications room/closets a minimum of 3 m of slack should be left for all cable types. This slack must be neatly managed on trays or other support types.

Tie wraps shall be used at appropriate intervals to secure cable and to provide strain relief at termination points. These wraps shall not be over tightened to the point of deforming or crimping the cable sheath.

Hook and loop cable managers should be used in the closet where reconfiguration of cables and terminations may be frequent.

## C. Main distribution frame (MDF)

The MDF should be 19" rack mount made of high-quality metal alloy. It is to be floor standing, floor mounted, space saving, on-site assembled, flexible design, of modular sections, cable ways, wire guide rings, numbering plates, labeling strips for all terminal blocks, and frame earthing.

The MDF is to be large enough to accommodate the ultimate internal and external capacities as shown on the drawings and to wire the full capacities of all cables plus 30% spare space.

The MDF will accommodate various data telecommunications equipment, controllers, multiplexes, bridges, routers, LAN hubs, etc., in addition to the cross-connecting hardware. The MDF may also house Telephone Company equipment. The contractor responsibility is to install the MDF with patch panels and IDC connectors only. Switches, bridges, ... are not included in the contract.

Each cable arriving to the MDF should be terminated. UTP cables should be terminated into patch panels Cat6. Fiber optic cables should be terminated into fiber optic patch panel with SC termination. Telephone cables should be terminated into cross connect IDC connectors.

For telephone cable connection, each terminal block is to be composed of a set of horizontal connection modules. Connections are to be performed by quick-clip IDC (Insulation Displacement Contact) connectors, no soldering shall be allowed. It is to be possible to directly access front points for inserting test probes, and provisions is to be available for the insertion of over voltage and over current protection devices as necessary. There shall be as many connection modules as needed to wire at least the full capacities of all existing cables, including every spare wire.

The rack shall:

- have 76 mm (3 in) by 152 mm (6 in) vertical cable channels as side rails in both .9 m (3 ft) and 2.1 m (7 ft) heights.
- have channels capable of utilizing and re-locating ten high capacity, reusable hook and loop cable managers provided with rack, and have additional managers available in bags of ten.
- have ten high capacity cable managers provided for the front, side or back of the rack which can be used for horizontal or vertical cable management and easily twist and lock into place without the use of screws or tools, and have additional managers available in bags of ten.
- have standard ANSI/EIA-310-C mounting holes having a full 45 RMS on front and back of rails. Cable routing openings shall be available in the front and rear of the channels.
- have ladder channel which acts as a top bracket to easily nest a standard 304.8 mm (12 in) ladder tray. The channel must have carriage bolt holes for attaching to the ladder system.
- have available an optional rack top cable tray which manages cable bundles routed above the rack, and eliminates the need for installing a ladder rack for routing cables. The tray is mounted without the need of tools or hardware and includes up to three (3) separate cable paths featuring removable quarter-turn hook and loop cable managers.
- be available in two versions, either aluminum or steel with a black finish and utilize black grommets for unused cable openings.

- have two optional vertical cable management channels 152 mm (6 in) x 2.1 m (7 ft) and 76 mm (3 in) x 2.1 m (7 ft) which can be located between racks. The channel shall come with cable retainers which can be hinged left or right and be located in any position along the channel.
- have optional 10 outlet (4 ft) power strip for mounting onto the rack.
- be made by an ISO 9001 and 14001 Certified Manufacturer.

## D. Patch panel

Category 6 patch panel shall:

- be made of black anodized aluminum, in 16-, 24-, 48-, 64- and 96-port configurations.
- accommodate at least 24 ports for each rack mount space
- have circuit boards tested in both directions as required by ANSI/TIA/EIA-568-A and ISO/IEC 11801.
- utilizes tri-balance technology with optimized pair balance design and linear crosstalk response to address applications up to 250 MHz.
- have termination accomplished with a single conductor impact tool.
- be backwards compatible to allow lower performing categories of cables or connecting hardware to operate to their full capacity.
- have rear protective strain relief caps with side or rear entry, which can be installed onto cable before or after termination.
- support industry standards for T568A or T568B wiring options on each individual outlet.
- allow for a minimum of 200 re-terminations without signal degradation below standards compliance limit.
- have modular ports compliant with FCC CFR 47 part 68 subpart F and IEC 60603-7 with 50 microinches of gold plating over nickel contacts.
- be fully enclosed front and rear for physical protection of printed circuit board.
- have a rear cable management bar for strain relief.
- have port identification numbers on both the front and rear of the panel.
- have an optional adhesive circuit identification and color coding designation strips provided with the panel.
- provide self adhesive, clear label holders and white designation labels with the panel, with optional color labels available.
- be made by an ISO 9001 and 14001 Certified Manufacturer.

## E. Connection modules

IDC module is to comprise the terminal blocks in the MDF and distribution cabinets. They are to be of high reliability, and are to have the following minimum specifications:

- Module size: 10 pairs.
- Range of conductor diameter: 0.4 to 0.8 mm
- Range of insulation diameter: 0.7 to 1.5 mm
- Number of insertions: 1000 times
- Maximum contact resistance: 0.02 ohm
- Dielectric strength (50 Hz): 2000 V (r.m.s.)
- Minimum insulation resistance: 10000 M□ at 500 V DC.

## F. Telephone cables

Telephone cables shall be multi-pair cables with high conductivity standard annealed copper of 0.6 mm, insulated with one layer fully colored solid polyethylene. The cable core interstices are filled with suitable compound to avoid longitudinal water penetration inside the cable. The cable core should be protected with one or more tapes helically or longitudinally laid with an overlap. The outer sheath will be polyethylene or PVC.

Conductors should be twisted by pairs and grouped by sub-units of 10 pairs. Spare pairs should be located within the sub-unit. The outer shield will be marked to show the manufacturer's identification, the number of pairs, conductor diameter and a sequentially numbered length marking at each meter interval.

Telephone cable sizes are to be selected to fulfill all the wiring relevant to existing telephone lines plus the spare requirements.

Telephone cable running between the MDF and network cabinets should be connected to IDC connectors at the MDF side and to patch panels on cabinets side with 1 RJ45 per telephone pair.

The main telephone cable connected to the MDF shall be protected from lightning at both sides (from the PABX and MDF sides).

Telephone cables are to comply, at least, with the following specifications:

- Maximum conductance DC resistance: 130 □/Km (at 20°C)
- Maximum attenuation: 1.2 dB/Km (at 800 Hz)
- Maximum mutual capacitance: 70 nF/Km
- Voltage rating: 150 V
- Minimum insulation resistance: 5000 M□.Km at 200 V DC

## G. Data cables

Computer network conduits will be twisted unshielded 4 pairs category 6 (UTP 4P), linking each point individually to the patch panel as shown on drawings. These cables shall conform to ANSI/TIA/EIA-568-A Commercial Building Telecommunications Cabling Standard and ISO/IEC 11801 (International) Generic Cabling for Customer Premises standard (latest amendment and including all applicable addenda).

Pairs within a cable shall not be split and all pairs must be terminated

## H. Outlets

The outlets should be manufactured by Alcatel, Siemon, Krone or approved equal. The selected type should provide maximum flexibility in supporting TP, fiber, and coax while maintaining performance in order to meet the changing requirements that are likely to occur throughout the life of the system. All these outlets should fit within the same faceplates used for all sockets, switches...

Manufacturer shall warrant all modular outlets used. Terminated conductor ends shall be properly trimmed to assure a minimum clearance of 0.25 in. between the conductors of adjacent modules. The outlets shall not be responsible for creating "resonance" on short cable runs as described in the Field Testing TSB 67. This problem is related to return loss and/or the balance of the link and can cause transmission errors. Outlets shall be available in several colors.

## I. Telephone exchange (PABX)

The PABX is to be fully electronic, digital stored program, microprocessor controlled with LSI switching circuits. Reed relays, mini-switches, cross-point switching and crossbar techniques are not acceptable. PABX is to be designed for use as a universal telephone exchange system for all applications. It is to be possible to connect any combination of DTMF and dial telephones to the PABX, with the provision of manufacturer-made interface modules as necessary within the PABX and without the need to modify the assembly.

The number of inputs and outputs are indicated on the drawings.

The mechanisms will be accessed on the front panel, the rear panel will basically contain the fixed wiring and remain accessible.

The power supply will be via buffer batteries with chargers or via a UPS included in the offer to avoid microbreaks on assisted current.

The design of the PABX is to permit station numbers to be assigned to lines at time of installation, in accordance with customer-desired numbering plan, and reassignment while in service to allow personnel moves without requiring number changes.

It is to be possible to assign to each extension, restriction for outward calls as follows:
- Non-restricted: having unrestricted access to external lines for outward calls either by direct dialing or through operator
- Semi-restricted: having access to external lines only for local calls by direct dialing or through operator
- Restricted: having no access to external lines neither through direct dialing nor through operator.

It is to be possible to segregate external trunk lines as follows:
- Lines for outgoing calls accessible only by operators
- Lines for outgoing calls accessible by operators and by all remaining non-restricted and semi-restricted extensions.

The telephone exchange should ensure on each operator post, without being limited to:
- Takeover of an incoming call.
- Parking of an outside line or inside line with message and waiting music easy to modify.
- Automatic transfer of an outside line to a busy set with waiting music, modifiable message, and possible retrieval of the outside correspondent without suppression of the routing maneuver.
- Conference system.
- Offer on a busy set. Intervening as third party must be signaled.
- Night service - transfer to reception.
- Interoffice voice communication, or intercom

## J. Grounding

Proper grounding and bonding is essential and reference shall be made to proper codes and standards. Grounding of metal shield shall be made with
16 mm2 copper wire. Backbone systems must comply with all applicable National, Regional, or Local building and electrical codes.

Each distribution rack shall be connected to the ground bus in accordance with the applicable code requirements as per EIA/TIA 607.

Backbone cabling utilizing a shield shall be bonded at each sheath opening.

## K. Fixing, Labeling and marking accessories

Fixing accessories shall include cable ties, clamp ties, push mounted ties, marker ties. All outlets, patch panels, cross-connects, cabinets... shall be labeled using a mechanically imprinted label similar to Brady or a system as proposed by the contractor and agreed by the Engineer. Regardless of the numbering scheme, every cable has the same permanent identifier at both ends. Each label shall indicate, according to an approved labeling designations, the number of the cable concerned, where it is coming from and where it is going to.

Horizontal cables shall be labeled at each end. The cable or its label shall be marked with its identifier. A unique identifier shall be marked on each faceplate to identify it as connecting hardware. Each port in the faceplate shall be labeled with its identifier.

## L. Cable laying

Data and telephone cables shall run in dedicated raceways apart from those where power cables are laid as shown on drawings.

Before the start of cable works, the site shall be properly checked in order to ensure that the raceways, whatsoever, are clean and dry. Cables shall be carefully unreeled from drums, and pulled-in/laid on raceways according to the approved shop drawings and work procedure. Specialized rolls and tools shall be used for main cable works so as the cables shall not be dragged on ground or surfaces. Cables are to run concealed above cable trays, and through embedded pipes. After the network is satisfactorily completed and tested, cables shall be tied to cable trays and labeled as necessary. For any cable, the maximum distance between two successive ties shall not exceed five meters except for vertical riser cables where the maximum distance shall be two meters. Cables shall be labeled at every terminal location, every bent, before every distribution unit and at every fan-out. Moreover, vertical main cables along the riser, shall be labeled twice at each floor.
Cables shall be terminated at the distribution units where they shall be held, fanned out properly, and wired to the terminal blocks or patch panels. Wires shall be tied into groups, in accordance with the order of pairs as per color code, and corresponding to the relevant connection modules (or strips). Wiring to the terminal blocks in MDF and network cabinets shall be performed by standard IDC connection tools.

## PUBLIC ADDRESS SYSTEM

The voice alarm system shall be the integrated solution for BGM(Back ground Music) and EVAC(Emergency Voice Alarm). The voice alarm system shall be designed for public address andemergency evacuation. All the essential EVAC functionality – such as system supervision, spare amplifierswitching, loudspeaker line surveillance, digital message management and a fireman's panel interface –shall be combined.

A 24Vdc output shall be available to supply power to external relays, so no external power supply shall berequired for that purpose. A LED VU-meter shall allow for monitoring of the master output.

The maximum/rated output power of the internal booster shall be 150 W / 300 W. max mains inrushcurrent shall be 8A @ 230 VAC / 16A @ 115 VAC

The frequency response shall be 60 Hz – 18 kHz (+1/-3 dB, @ -10 dB ref. rated output. The distortionshall not exceed 1% at the rated output, 1 kHz. The controller shall have tone controls to allowfor adjustment of the BGM sound. It shall have separate bass and treble controls. The controller shallhave two BGM source inputs and a mic/line input with configurable priority, speech filter, phantom powerand selectable VOX activation.

The operating temperature range shall be -10°C to +55°C. The storage temperature range shall be -40°Cto +70°C.

The system shall comply to the following standards:

- EVAC compliance acc. to IEC 60849
- EMC emission acc. to EN 55103-1
- EMC immunity acc. to EN 55103-2
- Safety acc. to EN 60065

### A. General Requirement

The design, supply, delivery, installation, testing, commissioning and maintenance of the Public Address System shall include, but not limited to the following:

- Recessed mount (ceiling), surface mount, column and / or horn speakers, sound projectors, box and bi-directional box speakers c/w line matching transformers and volume controls, where applicable;
- Termination of all cables to speakers, power amplifiers, etc.;
- Equipment rack complete with forced air ventilation fan(s), mounting brackets blank panels, terminal boards, etc.
- Main equipment and all associated auxiliary equipment;
- Distribution cabling, including fire rated cables, where applicable, cable ladders, racks and Cable supporting systems (cable trunking and concealed metal conduits)
- All other works and materials necessary for the efficient operation of the whole audio system Complete with power supply requirements and surge arrestors and filters.

The primary objective of the system is to provide clear announcements during public addressingand one-way voice communication during an emergency; the secondary function shall be to providebackground music where required.

The system shall be capable of fulfilling the following requirements:

- Clear, un-distorted announcements to selected areas during public addressing;
- Clear, un-distorted paging to all zones; either individually or collectively. Selection of groups ofzones shall be programmable from time to time; and□ Background music to selected areas when the other functions are not selected.

The loudspeakers shall be wired up in zones and with supervision; localized volume controls as specified shall be provided so that the desired volume adjustments may be made. Locations of localized volume controls are as indicated in the Schedules and /or drawings.

The zones shall further be grouped according to function so that it shall be possible to make an announcement by depressing just one switch on the call station.

To allow flexibility in the system, it shall be designed to be expandable with easy installation withoutchanges in controller.

When the zones are selected for public addressing, a chime shall first be heard, followed by the announcement. The system shall have a range of tones such that it shall be possible to programme different tones for call stations.

It shall be possible for the system to function with different call stations in operation, provided there is no conflict in the zones being called by the call stations. An emergency call station shall be provided for emergency.

The controller shall have a system of priorities such that, should a conflict situation arise, the station or user key with the top priority will override the others. This sequence of priorities shall be determined and programmed during the commissioning stage; it shall be possible to change the sequence by on-site as well as off-site re-programming, as and when the need arises.

The system shall comply with country Public Address Evacuation Code of practice or IEC 60849 for the one-way emergency voice communication system in all aspects.

All control and switching equipment shall be centralized and decentralized as specified and located in equipment racks in the FCC and equipment rooms. No other equipment except the volume controls and cable patch panel shall be located outside the equipment rack.

All equipment supplied shall be from the same manufacturer. Equipment supplied shall strictly be Standard Products from Public Address Product Manufacturer. No tailor- made product shall be acceptable. The tendered shall submit catalogues of all equipment offered and upon delivery; certificate of country of origin, Certificate of Conformity and Certificate of Evacuation for the proposed PA Equipment shall be submitted.

Zoning for the passenger lifts shall be provided as provision and shall complete with the necessary wiring to be terminated in a termination box near the control panel in each lift motor room.Group zoning for the lifts shall be allowed for evacuation announcement.

## B. System Requirement

For general office and public areas, the system shall be capable of delivering a sound pressure level of 85 dB at the listening level. For M & E areas such as plant rooms, etc where the noise level is higher (assumed to be ≤80 dB), the system shall be able to deliver 95 dB at the listening level.

The listening level shall be taken to be 1.5 m above floor level.

The reinforced sound shall be distributed evenly throughout the listening area; the total variation in each area shall not exceed ±4 dB.

An articulation loss of consonants of less than 15% shall be maintained. (Generally, the reverberation time of the various locations shall be assumed to be not more than 1.9 seconds).

Paging announcements shall be possible from any of the microphone call stations, or from the microphone paging station to any zones within the network systems.

Call station shall be using CAT 5 cable with RJ 45 connector to transmit calls.

The microphone paging station shall have the flexibility of selecting any number of user keys (selection buttons) at any one time. It shall be able to program each user key for function.

The central controller shall have a means of monitoring, to continuously monitor the system from the microphone of the call station onwards; any faults shall be displayed on the central unit.

High quality signals shall be maintained at the output of the power amplifiers to compensate for losses in the audio distribution lines.

Each power amplifier with 30% spare capacity shall be provided to drive all loudspeakers during an emergency without overloading.

Each power amplifier shall have a built-in self-restoring protection circuit to guard against hazards of operation such as mis-loading at its input, short-circuiting of its output and connection mistakes.

The power amplifiers shall also have built-in line transformers for 100V loudspeaker matching, DC input of emergency operation. It shall have amplifier monitoring and auto-changeover over circuits & automatic volume control features built-in.

The power amplifiers shall have control inputs and audio inputs for interfacing for fire alarm signals. This control inputs shall be supervised, freely programmable for any system actions and with priorities setting.

A built-in amplifier monitoring circuits shall continuously monitor the functioning of the power amplifiers and shall automatically switch in a spare power amplifier in case of failure of any of the amplifiers. Upon detection, the status of the fault shall be indicated in the Central or local Monitoring. The number of spare power amplifiers to be provided shall be ten percent of the total quantity of each range of power amplifiers.

All speaker lines shall be supervised for open circuit fault, short circuit fault, and short to ground fault.

Upon detection, the status of the fault shall be indicated in the Central Monitoring. The loudspeakers shall be located such that they meet the necessary requirements. Rooms with on / off volume control units as required are indicated in the schedule of tables. Facilities shall be incorporated to override these volume control units, including those in the "off" position to enable emergency announcements to be broadcast. In general, one ceiling speaker shall be provided for every 25 square meters in each room such as offices and corridors, while a minimum of one ceiling speaker shall be provided for areas less than 25 square meters such as booths, pantry and toilets. Horn speakers shall be provided for all plant rooms, generator rooms and outdoor areas with high ambient noise.

The system shall also have the means to cut-off the music sources during emergency paging and shall enable the emergency announcement to be heard in these areas. All volume controls as specified shall be overridden during emergency announcements.

There shall be background music to selected areas. It shall be possible to pre-program any of the output music to any of these zones. Sources provided shall be a continuous cassette player, MP3, an integrated compact disc player with digital tuner.

All equipment such as the central network controller and power amplifiers shall be housed in 19-inch equipment racks.

**C. Power amplifiers:**

It shall meet the following minimum requirements:

- The main function of the power amplifier is the amplification of audio signals for the loudspeakers. It shall be possible to select the output voltage between 100V, 70V or 50V by changing output. The power amplifiers are provided with compact 19", 2U & 3U high housing for tabletop use and rack mounting, while the maximum amplifier wattages varies from 120w to maximums 960w.

- The amplifiers are protected against overload and short circuits. A temperature-controlled fan ensures high reliability at high output power and low acoustic noise at lower power output. Additionally, all booster amplifiers have an overheat protection circuit that switches off the power stage if the internal temperature reaches a critical limit due to poor ventilation or overload.

- Balanced input and a loop-through connector shall be available for easy connection of multiple booster amplifiers to increase the available output power. The power amplifier shall obtain two balanced inputs with priority control, each with a loop-through facility.This allows for easy and automatic switching between e.g. a local music source and a priority announcement from a remote system.
- An additional 100V line input is provided to connect the booster amplifiers to a 100V loudspeaker line, for additional output power e.g. on remote locations. Sensitivity or level control is located on the rear of the unit to avoid accidental setting change. A VU-meter with LED-bar shows the output level.
- The amplifiers not only provide 70V and 100V outputs for constant voltage loudspeaker systems, a low impedance output for 8 Ohm loudspeaker loads is available for different usage.

- The booster amplifiers operate both on mains power and on a 24V battery power supply for emergency back up, with automatic switchover. Amplifier front panel with LED shall shown as an indicator when it operates on the battery or AC supply.

- The power amplifier shall be with the following approval: -
  • EMC emission acc. to EN 55103-1
  • EMC immunity acc. to EN 55103-2

  PERFORMANCE
  • Frequency response 50 Hz – 20 kHz (+1/-3 dB, @ -10 dB ref. rated output)
  • Distortion <1% @ rated output power, 1 kHz

  INPUTS
  • Line input (3-pin XLR, 6.3mm phone jack, balanced)
  • Sensitivity 1 V
  • Impedance 20 kOhm
  • CMRR >25 dB (50 Hz-20 kHz)
  • Line input 1, 2 (3-pin XLR, balanced)
  • CMRR >25 dB (50 Hz-20 kHz)
  • 100V input (Screw, unbalanced)
  • Sensitivity 100 V
  • Impedance 330 kOhm

  OUTPUTS
  • Line loop through output t (3-pin XLR, 6.3mm phone jack, balanced)
  • Nominal level 1 V
  • Impedance direct connection to line input
  • Line loop through output 1,2 (3-pin XLR, balanced)
  • Impedance direct connection to line input
  • Loudspeaker outputs (Screw, floating)
  • Output power @ 24 V
  • Battery operation -1 dB ref. rated power

  ENVIRONMENTAL CONDITIONS
  • Operating temperature range -10 to +550C
  • Storage temperature range -40 to +700C
  • Relative humidity <95%

## D. Power Supply

The contractor shall make provision for all necessary power supply units, voltage regulators, etc, to ensure that the equipment will perform satisfactorily c/w necessary surge arrestors and filters.

All necessary power supply (s/s/o's etc) required for the operation of the sound equipment shall be designed supplied and installed by the contractor.

## E. Emergency Override Unit

The emergency override unit when activated from the Fire Command Center, it will override all incoming signals to allow emergency messages to pass through.

## F. System Testing

The contractor shall test the system in the presence of the Superintending Officer to show that its performance satisfies the requirement of this specification. All test equipments shall be professional and supplied by the contractor. A sound pressure meter will be required. No claim is allowed for this test. The cost shall be deemed to be included in the schedule of rates for the equipment.

## NURSE CALL SYSTEM (16750)

### A. General requirements

A1 Work included

Work comprises supply and installation of a complete microprocessor controlled Nurse call system as described herein and shown on the drawings.

The system shall include :

- Main console units with all additional boards, DC regulated power supply and accessories necessary for the good operation of the system.
- All room interfaces and system interfaces needed and DC regulated power supply.
- All system devices needed like call units, Door units, Corridor bulkhead lights, etc, ...

Works are to include supply and installation of mounting Boxes, Cables, Conduits, Pull and junction boxes, Connectors, Raceways and all other accessories necessary for a complete function of the system.

The contractor shall coordinate the electrical installations of the nurse call system with other trades where necessary.

The system shall be completely tested to assure that all components, stations and other accessories are connected and operational.

All items of Nurse call system shall be manufactured by a single reputable manufacturer.

A2 Submittals

Provide three (3) copies of submittals within 30 days from contract award.

Layout of equipment, Typical wiring diagrams.

- Bill Of Materials
- Samples: Provide one sample of all field devices.
- Installation details: Provide one copy of installation instruction sheet for all system components.
- Specifications: Provide one copy of specification sheet for all system component.
- Certificates: Provide one copy of all required certificates and approvals as per local civil defense regulations.

### B. Products

B1 System description

The nurse call system shall provide efficient and reliable signaling between patients and staff. The system shall be display based.

The system shall include a main console unit in the nurse post room, nurse door unit at the entrance of each patient room, a patient call unit at each one or two beds and at bathrooms and a corridor bulkhead light over the door of each patient room.

The system shall use the necessary interfaces in order to minimize wiring to a single cable carrying all necessary information.

The system shall provide interfacing to radio paging.

B2 System operation

The patient calls by pressing the push button at the hand-hold remote control unit of the bedhead or trunking unit.

The red indicator room of the door unit and the red bulkhead light above the door of the room flashes slowly and the audible signal sounds.

The Nurse acknowledges receipt of the call by pressing the mute button, the red indicator stops flashing and becomes steady and the audible signal stops.

In the room the red room indicator stops flashing and become steady and the red bulkhead light above the door goes to steady.

The nurse cancel the call by pressing the push button on the door unit as she comes in, the indicators go out in the room, in the corridor and on the console. If the patient calls by pulling the cord operated push button in the bathroom then the red bathroom indicator, the red and white indicator room of the door unit and the read bulkhead light above the door of the room flash rapidly. On the main console unit the room numbers appears, the red indicator flashes rapidly and the audible signal emits a rapid intermittend sound. The nurse goes to the room and cancels the emergency call by pressing the door unit push-Button.

B3 System units

Main console unit

The main console unit shall be of desk-top type, resistant to cleaning agents used in hospitals.

It includes:

- Numeric display for showing room numbers in order of receiving calls and priority.
- Indicator lights, call mute and attendance indicator call signal buzzer
- Alarms triggered in the event of a power cut, data saved in memory.

Door unit

Door unit shall consists of a red indicator and a white indicator supplied and a call cancel button.

Door unit are to be supplied with a flush mounting box, metal support frame for server mounting and a white plate.

Bathroom call unit

Bathroom call unit consists of a push-button with pull cord mechanism and 24V red indicator lamp supplied with a flush mounting box, metal support frame for server mounting and a white plate.

Corridor bulkhead light above doors corridor bulkhead light consists of two triangular bulkhead light one with red diffuser and the other with white diffuser, 24 Volts lamps and supplied with bulkhead base, metal support frame for screw mounting and a white plate.

Patient call unit

The patient call unit shall be supplied within the bedhead or trunking unit.

B4 Installation

Cables should be selected and installed in accordance with manufacturer's specifications.

Cables are to run through heavy gauge rigid PVC conduits maintaining a minimum of 30 cm separation from any disturbance source as lighting fixtures, power cables HVAC equipments, ...

## FIRE ALARM SYSTEM (16771)

### A. General requirements

Contractor is to provide a complete fire detection and alarm system capable of two main functions :

1. Monitoring, detecting and displaying the activation of each device in the system, initiating output functions such as alarm communication, fan shutdown, etc.
2. To permit one way communication in the form of paging to any floor. The system is to be capable of manual or automatic operation by the fire alarm system.

Work included consists of the following :

- Main fire alarm and control panel which is to be microprocessor based, analogue addressable type, modular expandable, fully electronic, supervised, divided into main compartments for control, annunciation and amplifiers. The system will have batteries capable of monitoring the system for a period exceeding 12 hours followed by a 15 minutes audible full alarm.
- Fire alarm repeater panel
- Automatic and manual detectors
- Alert devices consisting of speakers, audible and visual alarms.
- Interface and control modules
- Isolator modules
- Fire brigade automatic dialing system
- Complete wiring system including conduits, fixing, accessories, etc...

Fire alarm system to be in accordance with the local fire protection Regulations and in compliance with International Standards.

Contractor to submit complete technical data for approval including codes, standards, manufacturer's original catalogue and specifications, circuit description, etc..

Test certificates, at the factory, are to be submitted to the Engineer immediately after obtaining product approval and before placing final order.

Contractor to submit shop and construction drawings for approval including at least the detailed system diagram, the exact composition of cabinets, exact routing

and layout of cables, etc...

### B. System general description

Fire alarm system is to be an independent self-contained, audibly and visually supervised, analogue addressable, pre-signal system.

Components (manual stations, automatic detectors, etc.) to be grouped in loops, each having control module on main fire alarm control panel.

System to provide supervisory monitoring activated from at least one of the following: Removal of an automatic detector from its base, wiring faults, failure of power supply including protective device faults, fire pumps faults, smoke exhaust and pressurization fans faults, etc...

Faults are not to prevent fire alarm panel from sounding and are to automatically indicate fault alarm.

The system will be capable to broadcast pre-recorded messages and have an interface with the fire fighters station at the main panel. The main fire alarm panel will house the amplifiers sized in accordance with the number of speakers and wattage.

Speakers will have different tap settings and will be adjusted on site for optimum performance and maximum coverage. The visual strobes will be located in the corridors, operating theatres and in areas with high ambient noise such as mechanical rooms.

In any case, alarm sound should be heart by patients, in hospitalization room.

Upon actuation of any manual station, automatic detector, or any related device, the following sequence operation is to run:

- An audible signal is to sound at the FAP and at the repeater panel while a red LED to light.
- A message to clearly indicate on the LCD the addressable device or circuit of alarm initiation.
- Operator to acknowledge the alarm by activating a dedicated switch. Audible alarm are to shut-off while visual alarm to continue display on LCD.
- After the alarm is acknowledged, the LED shall be steady ON, until the alarm cause has ceased and the system has been reset.
- System is to automatically shut down all HVAC system, close fire dampers and activate smoke exhaust system (exhaust and supply fans) of the zone on fire.
- System is to automatically close all fire doors of the whole floor level on fire.
- System shall not allow any elevator to stop at the zone on fire.
- At the same time authorized personnel are to evaluate the danger and initiate, if needed, the alarm in the staff and nurse posts.

Sensitivity of all analogue sensors to be set by the system and value displayed.
Smoke sensors shall be smoke density measuring devices having no self contained alarm set point (fixed threshold). The alarm decision for each sensor shall be determined by the fire alarm panel. The fire alarm panel shall determine the condition of each sensor by comparing the sensor value to the stored values.
The fire alarm panel shall maintain a moving average of the sensors' smoke chamber value to automatically compensate (move the threshold) for dust and dirty conditions that could affect detection operations. The system shall automatically maintain a constant smoke obscuration sensitivity for each sensor (via the floating threshold) by compensating for environmental factors.

The system shall automatically indicate when an individual sensor needs cleaning. When a sensor's average value reaches a predetermined level, a "DIRTY SENSOR" trouble condition shall be audibly and visibly indicated at the fire alarm panel for the individual sensor. Additionally, the LED on the sensor base shall glow steady giving a visible indication at the sensor location. If a "DIRTY SENSOR" is left unattended, and its average value increases to a second predetermined value, an "EXCESSIVELY DIRTY SENSOR" trouble condition shall be indicated at the fire alarm panel for the individual sensor. To prevent false alarms, these "DIRTY" conditions shall in no way decrease the amount of smoke obscuration necessary for system activation. For scheduling of maintenance, the fire alarm panel shall be able to generate an "ALMOST DIRTY" indication for any sensor approaching a "DIRTY" trouble condition.

The fire alarm panel shall continuously perform an automatic self-test routine on each sensor which will functionally check sensor electronics and ensure the accuracy of the values being transmitted to the fire alarm panel. Any sensor that fails this test shall indicate a "SELF TEST ABNORMAL" trouble condition with the sensor location at the fire alarm panel.

## C. System components

### C1 Manual Stations

Manual stations shall be installed in correspondence of all escape routings, as shown on the drawings. Stations shall be of rugged die cast construction for surface mounting. For durability, plastic stations will not be acceptable. Stations shall be of the break-glass type, and must be opened to be reset. Closing the box after opening it shall automatically perform the reset function. It shall be possible, for testing purposes, to initiate an alarm without breaking the glass. Stations shall report an individual alarm to the FAP through the addressable loop. Stations shall be of the pre-signal type with a general alarm keyswitch and shall report both individual pre-alarm and alarm signals to the FAP through the addressable loop. Stations shall be equipped with 1 NC + NO contact. All stations shall be furnished with a spare glass rod.

Short circuit fault isolation to be provided.

Mounting to be 1.4m from Finish Floor Level.

### C2 Optical Smoke Detector

The Photoelectric type detector shall be a plug-in unit which mounts to a twist-lock base, two wire operation and shall be UL listed.

The detectors shall be of the solid state photoelectric type and shall contain no radioactive material. They will use a pulsed infrared LED light source and be sealed against rear air flow entry.

Removal of detector head is to cause trouble alarm at the fire alarm panel. Detector is to be set to detect smoke regardless the type of fire combustible material, temperature and velocity of smoke, etc...

Detector is to have automatic supply voltage regulation, reverse voltage protection, etc...

The detector shall fit into a base that is common with both the heat detector and ionization type detector and shall be compatible with other addressable detectors and addressable manual stations, on the same circuit.

The detector is also to have a LED indicator flashing under normal operation and steady lit when detection is actuated. The reset is done from the fire alarm panel. The detector is to have at least the following characteristics :

- Normal operating voltage 24 V DC
- Alarm current 5 mA
- Ambient temperature 0°C to + 60°C
- Relative humidity 10% to 90%

There shall be no limit to the number of detectors which may be activated or "in alarm" simultaneously.

### C3 Fixed Temperature Heat Detector

Detector is to have plug-in, twist-lock base, sealed against dust and moisture, two wire operation, and shall be UL listed.

A sensor monitors the ambient temperature and reacts at a fast rapid increase in temperature.

Removal of detector head is to cause trouble alarm at control panel.

Detector is to operate at 24 V DC. Also it must have an automatic supply voltage regulation, reverse voltage protection, etc.

The detector shall fit into a base that is common with both the heat detector and ionization type detector and shall be compatible with other addressable detectors and addressable manual stations, on the same circuit.

The detector is supplied with a LED indicator flashing under normal operation and steady lit when detector is activated. Reset is done from the fire alarm panel.

C4 Alarm Bell and Buzzer

Bells shall be polarized and shall be operated by 24 VDC. Each bell assembly shall include separate wire leads for in/out wiring for each leg of the associated signal circuit. Tapping of signal device conductors to signal circuit conductors shall NOT be accepted. Bells shall be vibrating type. Bells shall be finished in baked-on red enamel paint and be UL listed for fire alarm use. Bells shall be suitable for surface mounting and be suitable for use within combination audio/visual units.

Sound pressure level shall be selected to diffuse alarm only in the staff and nurse zone.

Strobes are to produce a minimum of 75 candela and operate at 20 to 24V. Unit to be compatible with DC supervision of alarm lines. Unit is to have red fire lettering and flash approximately one or two times per second. Light is to comprise of xenon slashtube and is to be entirely solid-state. Units are to be capable of either ceiling or wall mounting. lens to be lexan of pyramidal shape.

C5 Speakers

Speakers are to be wall mounted in die-cast housing. The construction has to provide protection from moisture, corrosion, vibration, vermin and vandalism.

The speaker is to be high efficiency especially designed for voice clarity and low frequency fire evacuation signals. The speaker is to have four field selectable taps for site sound level adjustment.

C6 Flame detector

The detector shall operate on 24 vdc. The signal processing circuitry shall require the flichering radiation to exceed minimum threshold levels and three second time delay before signalisation an alarm condition. The flame detector shall be capable of responding to a 1 foot by 1 foot gasoline fire at a distance of 25 feet. The detector shall respond to an intense fire signal within 3 seconds. It shall not respond to radiation generated by arc welding, x rays, artificial lighting or distant lightning strikes, but shall be capable of responding to a fire in their presence. The detector shall have a uniform 90° cone of vision.

The device shall have separate cable - for incoming and outgoing field wiring.

The detector shall operate over a humidity range of 0 to 95% RH.

C7 Electro-Magnetic door holder

Door holders to be of the wall type with low power consumption. Upon signal transmission from the control panel, door holders are to release the smoke exhaust trap to an open position. Magnetic door holders shall have an approximate holding force of 16kg. The door portion shall have a stainless steel pivotal mounted armature with shock absorbing nylon bearing. Unit shall be capable of being either surface, flush, semi-flush or floor mounted as required. Doors holders shall be UL listed for their intended purpose.

Power supply to be 24VDC supplied from the fire alarm panel.

C8 Output Devices

The control circuit shall provide a conventional output for a Relay Control Module (RCM).

An open-circuit fault shall be annunciated at the FAP.

The RCM shall comprise the necessary relays (24DC, SPDT or DPDT) and shall provide power and control to command the shutdown of fans (FCU, Ventilation fans), activation of Fire Fighting Pumps, activation of suppression Fans, etc...

C9 Fire Alarm Panel (FAP)

Where shown on the plans, provide and install the Fire Alarm Panel. Construction shall be modular with solid state, microprocessor based electronics. It shall display only those primary controls and displays essential to operation during a fire alarm condition. Although the keypad can be used for control (fire fighter/emergency) of the entire system, it shall only be used for maintenance purposes. Keypads shall not be visible or required to operate the system during fire alarm conditions.

A local audible device shall sound during Alarm, Trouble or Supervisory conditions. This audible device shall sound differently during each condition to distinguish one condition from another without having to view the panel. This audible device shall also sound differently during each keypress to provide an audible feedback to ensure that the key has been pressed properly.

The Fire Alarm Panel's display shall be backlit for enhanced readability. So as to conserve battery standby power, it shall not be lit during an AC power failure unless an alarm condition occurs or there should be keypad activity.

Cabinet to be 19" rack mounted, modular to ease installation and maintenance.

The cabinet(s) shall be equipped with locks and transparent door panel(s) providing freedom from tampering yet allowing full view of the various lights and controls.

Built- in LCD to offer at least 2 lines of 40 characters each. FAP to be of the intelligent response controller. FAP is to provide power supply to all loops and alarm devices. Power supply to form integral part of the FAP and be protected against transients.

There shall be up to 4 independently supervised and independently fused notification appliance circuits for alarm bells. Disarrangement conditions of any circuit shall not affect the operation of other circuits.

The incoming power to the system shall be supervised so that any power failure must be audibly and visibly indicated at the fire alarm panel and the repeater panel. A green "power on" LED shall be displayed continuously while incoming power is present.

Battery back-up power to exceed 12 hours normal load followed by a 15 minutes audible full alarm.

The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visibly indicated at the fire alarm panel.

Batteries to be of the no maintenance type, float charged. Metering instruments are to be provided.

C10 Repeater Panel (RP)

Where shown on the plans, provide and install a LED annunciator. The annunciator(s) shall have a stainless steel finish and shall provide one alarm lamp and one trouble lamp per initiation device circuit. The annunciator shall communicate to the Fire Alarm Panel over one twisted shielded pair of wire and operating power shall be 24VDC and be fused at the Fire Alarm Panel.

The annunciator shall provide an alphanumeric, 80 Character Liquid Crystal Display (LCD) that provides clear language information, type of alarm (smoke detector, pull station, etc.), number of alarms on the system, and a custom location label. Status information of each device may be individually displayed to investigate specific point detail. Four programmable control switches with associated LEDs are available for custom control functions.

C11 Isolator Module

One Isolator module shall be provided at least by floor. If a short circuit occurs, the isolator module shall automatically disonnect the loop, limiting the number of inoperative detectors. When the fault condition is corrected, the isolator module shall automatically reconnect the isolated section.

C12 Wiring

Initiated devices cables are to be shielded twisted pair cables, halogen free with a flame retardant sheet.

Conductors are to be tinned annealed copper of minimum diameter size 0,6mm.

Bells and controlled circuits are to be 0,6/1KV fire resistant conductor wires to IEC331, halogen free. Conductors are to be tinned annealed copper of minimum 1.5mm2.

## D. Submittals

Provide six (6) copies of submittals within 30 days from contract award.

- Drawings: Riser diagrams, Layout of equipment, Typical wiring diagrams, Talk paths diagram, Annunciation diagram, Sequence of operation diagram.
- Bill Of Materials
- Samples: Provide one sample of all field devices
- Installation details: Provide one copy of installation instruction sheet for all system components
- Specifications: Provide one copy of specification sheet for all system component
- Certificates: Provide one copy of all required certificates and approvals as per local civil defense regulations

## E. Installation

E1 General

The control system contractor shall be responsible for all electrical installation required for a fully functional control system, including all necessary wiring, installation materials, and accessories not shown on the electrical plans or required by the electrical specifications.

E2 Installation

All field devices shall be placed in accordance with the contract drawings, whichever is more demanding.

All system components shall be installed and mounted in accordance to the manufacturer's recommendations per Engineer's approval.

Separate cables shall be installed for the 24Vdc and the 240Vac functions. No common cable employing mixed voltages on different conductors shall be allowed.

E3 Wiring

All wiring shall be properly supported and run in a neat and workmanlike manner. All wiring and tubing exposed and in equipment rooms shall run parallel to or at right angles to the building structure. All piping and wiring within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals.

All wiring for detection circuits shall run through heavy gauge flame retardant rigid PVC conduits. All wiring for alarm circuits shall run through steel conduits.

## F. Validation

The control system contractor shall completely check out, calibrate and test all connected hardware and software to insure that the system performs in accordance with the approved specifications and sequences of operations submitted.

- Witnessed validation demonstration shall consist of :
- Demonstrate alarm sequence.
- Execute manual override commands.
- Display and demonstrate panels man/machine interface functionality.

## G. Manuals

The following manuals will be provided :

- An Operators Manual shall be provided with graphic explanations of keypad use for all operator functions specified under Operator Training.
- Computerized printouts of all panel data file construction including all point processing assignments, physical terminal relationships, command and alarm limits, etc.
- A manual shall be provided including revised as-built documents of all materials required under the paragraph "SUBMITTALS" on this specifications.
- Two sets of manuals shall be provided to the owner.

## COLLECTIVE ANTENNA TV SYSTEM (16780)

### A. Generalities

The Contractor shall supply and install, as specified and shown on drawings, a complete Master Antenna TV System Work is deemed to include; at least:

- Parabolic antennas
- Repeaters
- Receivers
- VHF and UHF antennas
- Amplifier
- Multiswitches
- Cables, Outlets, in addition to any accessory deemed necessary to the system.
- Mounting and installation accessories

### B. Technical Specifications

B.1 Parabolic Antenna

Three fixed parabolic antenna of 180cm diameter is to be installed on the roof. The contractor is to properly install this antenna after a close coordination with other trades.

Each antenna is equipped with 2 low noise blocks (LNB). The reflector is made of aluminium equipped with a galvanized support that could resist a wind speed of 130 Km/h. All metallic parts must be tightened and protected against corrosion using adequate powder coating. The direction adjusting system is to be of an approved one.

The number of channels are four (4) for the antenna. The LNBs are to be connected to the amplifiers using low losses coaxial cables.

B.2 Multiswitches

The multiswitches will have the number of input and output as indicated on drawings. The supply is integrated.

The characteristics are the following (but not limited to):

- Full HD compliant.
- Different level of attenuation for signal balancing.
- Cascadable.
- Return path included.
- Terminal version with 0 dB attenuation.
- Selection of terrestrial active or passive path.
- Bandwidth:950-2150 MHz (SAT) and 5-862 MHz (TV).
- Maximum output level: 100 db µv

B.3 Amplifier

The amplifier gains are at least the following:

| | |
|---|---|
| – Gain | 20-32 db |
| – Reg. gain | 15 db |
| – Max. output level | 112 db µV |

B.4 Cables

Coaxial cables must provide the least attenuation for all channels. The attenuation difference at 100 m between the lowest VHF signal and the highest one must not exceed 13 db. Typical volume attenuations at 50 Mhz is 5 db and 18 db at 800 Mhz. The coaxial cable to be used for the parabolic antenna must not provide an attenuation greater than 28 db for a 100 m distance at 1800 Mhz.

B.5 Outlets

These outlets must be of the standard product. The contractor must ensure a directional attenuation greater than 40 db between two outlets. The signal level at each outlet must be greater than 60 db. The outlets must be of the same range as that of the wiring devices (switches, jacket outlets, etc.)

B.6 Miscellaneous

An earthing connection same as that recommended by the standards and the manufacturer is to be provided for the whole installation. This earthing must be similar to the one described in the "Earthing System".
Coaxial cables connecting the parabolic antenna and the antennas to the modulators and amplifiers must be supplied with overvoltage suppressors and filters. The coaxial cables screen must be connected to the earth.

## C. Submittals

The following data (but not limited to ) are to be provided :

- Manufacturer's catalogue cuts.
- System block diagrams.
- Cabling and wiring diagrams.

## BUILDING MAMAGEMENT SYSTEM (16786)

### A. General Requirements

Provide a fully integrated building management system including labor, materials, tools, equipments and all supplementary or miscellaneous items necessary for a secure and complete installation.

The BMS system shall be capable of integrating multiple building functions including monitoring and control of all mechanical equipments, lighting installations, alarm management, energy management, fire alarm and evacuation management, access control and information management.

The BMS system shall consist of standalone DDC (direct digital control) panels, field devices, high-speed network and bus communication interfaces and portable operators terminals. The personal computers and printers will be provided by BMS supplier but shall be connected by the BMS installer.

The contractor shall install all system components in accordance with the manufacturer's instructions, and shall furnish all necessary interconnections, services, and adjustments required for a complete and operable system as specified and shown. Control signal, communications, and data transmission line grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

All low voltage wiring outside the control console, cabinets, boxes, and similar enclosures shall be plenum rated where required by code. Cable shall not be pulled into conduits or placed in raceways, compartments, outlet boxes, junction boxes, or similar fittings with other building wiring.

All inputs shall be protected against surges induced on device wiring. Outputs shall be protected against surges induced on control and device wiring installed outdoors and as shown. All communications equipment shall be protected against surges induced on any communications circuit. All cables and conductors, except fiber optics, which serve as communications circuits from security console to field equipment, and between field equipment, shall have surge protection circuits installed at each end.

The BMS network shall be interfaced with the Ethernet LAN network at two locations, such that if one interface/gateway or that part of the network is disconnected the other interface/gateway shall provide the necessary connection to the remaining of the network. Remote connection to the DDC network shall also be available through dial-up connection via a digital telephone line modem.

BMS supplier shall furnish the following programs as part of the system:

- Supervisory workstation software as specified for monitoring and control. License for five users (10 users for Johnson) or more and installed on three (six for Johnson) separate workstations.
- One complete set of software programs that has the full feature to program all quoted controllers and the graphic workstation, including program download and upload from controllers. License for two users or more and installed on two different workstations.
- Software program to check the operation of all quoted controllers both via physical connection to a controller and by using simulation software to mimic controller operation. License for two users or more and installed on two different workstations.
- Portable operator terminal software application that allows the use of a laptop as an interface to all types of quoted controllers. License for two users or more and installed on two different workstations.

- All other software designed and provided by the BMS manufacturer and required for modification or implementation of control logics, graphics, and addition/deletion of points for future usage of available spares and system expansion.

All required software programs shall be the manufacturer's latest released versions at the time of system handing over and shall be licensed uniquely to the Lebanese American University. For each required software, two copies of the installation CD's or diskettes shall be provided.

Three Supervisory workstations shall be provided with all necessary interfaces, hardware, and software to interface these stations with the DDC network through the LAN. Also provide one supervisory workstation for remote dial-up connection. All workstations shall be able to be connected to the DDC network simultaneously for monitoring, control, and alarm displaying & printing.

The BMS shall be able to send SMS messages of selected alarms to mobile phones. The BMS shall be able to send SNMP traps to HP openview software or e-mail messages

## B. Quality Assurance

The manufacturers of all hardware and software components employed in the system shall be established vendors to the control/management industry for no less than five (5) years.

The system's sub-contractor shall have been regularly engaged in the installation and maintenance of BMS systems similar in size and scope to that outlined herein for a period of no less than five (5) years and shall supply certification that their firm is an authorised dealer for the system proposed.

The system's sub-contractor shall provide a minimum of three (3) references whose systems are of similar complexity and have been installed and maintained by the system integrator in the last five (5) years.
There shall be a factory authorized local service organization that stocks a complete inventory of spare parts and can provide maintenance for these systems. Local shall be defined as an area within a 75-Km radius of the installed location.

The system shall be installed by competent engineers and technicians regularly employed by the manufacturer with full responsibility for proper operation of the building management system including debugging, calibration and proper commissioning of each component of the system. The BMS supplier shall have an in-place, local support facility with technical staff, spare parts inventory and all necessary test and diagnostic equipment.

## C. Submittals

### C.1 Shop Drawings

The integrator shall provide complete shop drawings, which include the following:

- All system device locations on architectural floor plans. No other system(s) shall be included on these plans.
- Full schematic wiring information for all devices. Wiring information shall include cable type, conductor routings, quantities, and connection details at devices.
- A complete block diagram.
- A statement of the system's operation.

### C.2 Product Data

The supplier shall provide complete product data, which includes the manufacturer's data for all material and equipment.

The supplier shall provide descriptions to show how the equipment will operate to comply with the performance requirements of the system such as the detailed description of equipment and its configuration, porotocol description, operational procedures, expansion capacity, options available and means to add, network configuration ...

The sub-contractor shall provide a description of the operating system and application software.

Contractor shall provide English listing of all analogue points with columnar blanks for high and low warning limits and high and low alarm limits, and a listing of all fan systems with columnar blanks for beginning and end of occupancy periods; and samples of proposed text for points and messages (for at least two systems of at least 15 points total) including sample 480 character alarm message. All text shall be approved prior to data entry.

The contractor shall provide four (4) bound sets of manuals including operations and maintenance requirements, and parts list. The document must include complete as-fitted drawings.

### C.3 Manuals

Final copies of the manuals, (loose-leaf binders) shall be delivered within Forty-five (45) days after completion of the acceptance test. Contents of the manual(s) shall be identified on the cover. The manual shall include names, addresses and telephone numbers of the system integrator installing the system and the nearest service representatives for the system. The final copies delivered after completion of the acceptance test shall include all modifications made during installation, and acceptance.

The Operator manual shall spell out the operational requirements of the system and its theory of operation, design philosophy and specific applications. A description of hardware and software application interfaces and requirements shall be included for all operating modes.

The manual shall describe all equipment furnished including:

- General description and specifications.
- Installation and trouble shooting procedures.
- Hardware and electrical schematics to the component level.
- Installation drawings and schematics.
- Recommended spare parts list indicating sources of supply.
- Procedures for the maintenance system components including, preventive maintenance, fault diagnosis, and repair or replacement of damaged or defective component.

The software sections shall describe the functions of all software and include all other information necessary to enable proper loading, integration and operation. The section(s) shall include, but not be limited to:

- Definition of terms and applications.
- Use of system software.
- Alarm reports.
- Reports generation.
- Data entry procedures.
- Computers and peripherals.
- System commands, and applications software features.
- Graphic Mimic map installation and operation.
- Operator commands.
- Alarm processing and acknowledgement.
- System Log-on requirements.

## D. Training

The contractor shall conduct training courses for personnel designated by the owner. Training shall cover the maintenance and operation of the system. The training shall be oriented to the specific system being installed under this contract, and shall include the server and all peripherals. Training manuals shall be delivered for each trainee with two additional copies delivered for archiving at the project site. The manuals shall include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. Where the trainer presents portions of the course by audio-visual material, copies of the audio-visual material shall be delivered to the owner on the same media as that used during the training session. Up to 40 hours of training shall be provided for in the base contract.

The topics to be covered will be agreed in advance, but will include as a minimum:

- System Overview, Structure and Capacity.
- Hardware components.
- Hardware installation.
- Hardware configuration.
- Software configuration.
- Core Software Applications In Detail.
- System Administration.

Topics will be covered in sufficient detail to enable the customer to utilise all aspects of the system and diagnose faults.

## E. Warranty, maintenance and service

### E.1 Warranty and maintenance

All components, system software, parts and assemblies supplied by the contractor shall be guaranteed against defects in materials and workmanship for one (1) year from acceptance date and not from installation date.

Labor to troubleshoot, repair, reprogram, or replace system components shall be furnished by the contractor at no charge to the owner during the warranty period.

All corrective software modifications made during warranty service periods shall be updated on all user documentation and on user and manufacturer archived software disks.

### E.2 Inspections

The contractor shall perform two inspections at six (6) month intervals or more often if required by the manufacturer. This work shall be performed during regular working hours, Monday through Friday, excluding holidays.

These inspections shall include, but not be limited to,

- Visual checks and operational tests of the server, workstations, monitors, keyboards, system printers, peripheral equipment, system equipment, power supplies, and electrical and mechanical controls.
- Perform diagnostics on all equipment.
- Check and calibrate each control device.
- Run system software and correct diagnosed problems.
- Resolve previous outstanding problems.

### E.3 Emergency Service

The owner will initiate service calls when the system is not functioning properly. Qualified personnel shall be available to provide service to the complete system. The owner shall be furnished with the telephone number where the supplier's service supervisor can be reached at all times. Service personnel shall be at the site within four (4) hours after receiving a request for service. The system shall be restored to proper operating condition after one (1) calendar day.

### E.4 Software

The supplier shall provide free software updates for duration of the warranty period and verify operation in the system as required. These updates shall be accomplished in a timely manner, fully co-ordinated with the operators, and shall be incorporated into the operations and maintenance manuals and software documentation.

## F. General product description

The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, standalone DDC panels, and operator devices.

System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC panel shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

Standalone DDC panels shall be able to access any data from, or send control commands and alarm reports directly to any other DDC panel or combination of panels on the network without dependence upon a central processing device, such as a central file server. Standalone DDC panels shall also be able to send alarm reports to multiple operator workstations, terminals, and printers without dependence upon a central processing device or File Server.

## G. Hardware

### G.1 Central Operator Station

The central BMS Operator Station (OS) shall be IBM compatible provided by the BMS supplier. The minimum requirement for the system shall be sugested by the system provider.

### G.2 Printers

Requirements to be suggested by the system provider. The system shall support as a minimum:

- One printer dedicated to the recording of alarm traffic only.
- One printer dedicated to system reports.

In the event that the alarm or report printer is inoperable, their reports shall automatically be redirected to the other printer.

### G.3 Standalone DDC Panels

Standalone DDC panels shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors. Each standalone DDC panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification and the attached point list.

All DDCs and expansions modules shall be of the PLUG-IN type. No need to disconnect and reconnect the wiring each time you need to replace the mentioned controler.

Each DDC panel shall have sufficient memory to support its own operating system and databases including:

- Control processes.
- Energy Management Applications.
- Alarm Management.
- Historical / Trend Data for all points.
- Maintenance Support Applications.
- Custom Processes.
- Operator I/O.
- Manual Override Monitoring.

Each DDC panel shall support the following types of point inputs and outputs:

- Digital Inputs for status/alarm contacts.
- Digital Outputs for on/off equipment control.
- Analogue Inputs for temperature, pressure, flow, and position measurements.
- Analogue Outputs for valve control, and capacity control of primary equipment.
- Pulse Inputs for pulsed contact monitoring.

The system shall be modular in nature, and shall permit easy expansion through the addition of software applications, workstation hardware, field controllers, sensors, and actuators. The system architecture shall support 20% expansion capacity of all types of DDC panels, and all point types included in the initial installation.

Standalone DDC panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or network terminals.

The DDC panel shall provide local status indication for each binary input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.

Each DDC panel shall continuously perform self-diagnostics, communication diagnostics and diagnosis of subsidiary equipment. The DDC panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each DDC panel, and shall not require the connection of an operator I/O device.

In the event of the loss of normal power, there shall be an orderly shutdown of all standalone DDC panels to prevent the loss of database or operating system software. Non-Volatile memory shall be incorporated for all critical controller configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual intervention.

All system components are to be designed and built to be fault tolerant.

- Provide satisfactory operation without damage at 110% above and 85% below rated voltage and at +3 hertz variation in line frequency.
- Provide static, transient, and short circuit protection on all inputs and outputs. Communication lines shall be protected against incorrect wiring, static transients and induced magnetic interference. Bus connected devices shall be A.C. coupled, or equivalent so that any single device failure will not disrupt or halt bus communication.
- All real time clocks and program and data file RAM shall be battery backed for a minimum of 30 days.

G.4 Data Communication

The Local Network shall conform minimum to the IEEE 802.3 (Ethernet) 100BaseT, providing a data transmission rate of 100 megabit per second. Cables shall be Unshielded Twisted Pair category 5e (UTP cat. 5e) or category 6 (UTP cat. 6) in case supported by the system.

Any failure in any of the systems connected shall not affect the capability of the others to perform their respective functionalities and tasks, with no disruption.

Communication with field processors such as DDC outstations, lighting control panels and fire alarm & evacuation panels shall be by means of bus communication interface boards, allowing direct connection of the field communication buses to the BMS personal computer.

G.5 Portable Operator's Terminal

Portable Operator's Terminals (POT) shall be provided for operator readout of system variables, override control, and adjustment of control parameters at all plant controllers.

The POT software application shall be installed on a laptop provided by yhe client and plugged directly to DDC's. The Portable operator terminal software application shall provide the following functions:

- Back-up and/or restore DDC data bases
- Display all points on a DDC
- Display trending and totalizing information
- Command, change set-point, enable/disable any system point
- Load and/upload DDC logic programs

Connection of a POT to a panel shall not interrupt nor interfere with normal network operation in any way, prevent alarms from being transmitted, or preclude remote initiated commands.

## H. System Software Features

H.1 General

All necessary software to form a complete operating system as decribed in this specification shall be provided.

The software programs specified in this section shall be provided as an integral part of the DDC panel and shall not be dependent upon any higher level computer for execution.

H.2 Control Software Description

The DDC panels shall have the ability to perform the following pre-tested control algorithms:

- Two Position Control
- Proportional Control
- Proportional plus Integral Control
- Proportional, Integral, plus Derivative Control
- Automatic Control Loop Tuning

Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.

The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

Upon the resumption of normal power, the DDC panel shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.

H.3 Energy Management Applications

DDC Panels shall have the ability to perform any or all of the following energy management routines:

- Time of Day Scheduling.
- Calendar Based Scheduling.
- Holiday Scheduling.
- Temporary Schedule Overrides.
- Optimal Start.
- Optimal Stop.
- Night Setback Control.
- Enthalpy Switch Over (Economizer).
- Peak Demand Limiting.
- Temperature Compensated Load Rolling.
- Fan Speed/CFM Control.
- Heating/Cooling Interlock.
- Cold Deck Reset.
- Hot Deck Reset.
- Hot Water Reset.
- Chilled Water Reset.
- Condenser Water Reset.
- Chiller Sequencing.

All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow operator customization.

H.4 Custom Process Programming Capability

DDC panels shall be able to execute custom, job-specific processes defined by the operator, to automatically perform calculations and special control routines.

It shall be possible to use any of the following in a custom process:

- Any system-measured point data or status.
- Any calculated data
- Any results from other processes.
- User Defined Constants.
- Arithmetic functions (+, -, /, square root, exponential, etc.)
- Boolean logic operators (and, or, exclusive or, etc.)
- On-delay/Off-delay/One-shot timers

Custom processes may be triggered based on any combination of the following:

- Time interval.
- Time of day.
- Date

- Other processes.
- Time programming
- Events (e.g., point alarms)

A single process shall be able to incorporate measured or calculated data from any and all other DDC panels on the local area network.
In addition, a single process shall be able to issue commands to points in any and all other DDC panels on the local area network.

Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device, buffer the information in a follow-up file, or cause the execution of a dial-up connection to a remote device such as a printer.

The custom control programming feature shall be self-documenting. All interrelationships defined by this feature shall be documented via graphical flowcharts and English language descriptors.

H.5 Alarm Management

Alarm management shall be provided to monitor, buffer and direct alarm reports to operator devices and memory files. Each DDC panel shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the DDC panel's ability to report alarms be affected by either operator activity at a PC Workstation or local I/O device, or communications with other panels on the network.

All alarm or point change reports shall include the point's English language description, and the time and date of occurrence.

The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three priority levels shall be provided. Each DDC panel shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.

The user shall also be able to define under which conditions point changes need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date.

Alarm reports, messages, and files will be directed to a user-defined list of operator devices or PC disk files used for archiving alarm information. Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.

In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200-character alarm message to more fully describe the alarm condition or direct operator response.

Each standalone DDC panel shall be capable of storing a library of at least 250 Alarm Messages. Each message may be assignable to any number of points in the panel.

Operator commands and system events shall be automatically logged to disk in Personal Computer industry standard database format. Operator commands initiated from Direct-connected workstations, dial-up workstations, and local DDC panel Network Terminal devices shall all be logged to this transaction file. This data shall be available at the Operator Workstation. A utility shall be provided to allow the user to search the transaction file using standard database query techniques, including searching by dates, operator name, data point name, etc. In addition, this transaction file shall be accessible with standard third party database and spreadsheet packages.

H.6 Historical Data and Trend Analysis

A variety of Historical data collection utilities shall be provided to automatically sample, store, and display system data.
Standalone DDC panels shall store Point History Files for all analogue and binary inputs and outputs.

The Point History routine shall continuously and automatically sample the value of all analogue inputs at half hour intervals unless otherwise required by the client system engineer. Samples for all points shall be stored for the past 24 hours to allow the user to immediately analyze equipment performance and all problem-related events for the past day. Point History Files for binary input or output points and analogue points shall include a continuous record of the last ten status changes or commands for each point.

Standalone DDC panels shall also provide high resolution sampling capability in one-second increments for verification of control loop performance.
Measured and calculated analogue and binary data shall be assignable to user-definable trends for the purpose of collecting operator-specified performance data over extended periods of time. Sample intervals of 1 minute to 2 hours shall be provided. Each standalone DDC panel shall have a dedicated buffer for trend data, and shall be capable of storing a minimum of 5000 data samples.

Trend data shall be stored at the Standalone DDC panels, and uploaded to hard disk storage when archival is desired. Uploads shall occur based upon either user-defined interval, manual command, or when the trend buffers become full. All trend data shall be available in disk file format compatible with Third Party personal computer applications.

H.7 Totalization

Standalone DDC panels shall automatically accumulate and store runtime hours for binary input and output points as specified in the Execution portion of this specification.

Standalone DDC panels shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analogue and binary pulse input-type points.

Totalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g. KWH, KBTU, tons. etc.)

Standalone DDC panels shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis.

The Event Totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.

The Totalization routine shall have a sampling resolution of one minute or less. The user shall have the ability to define a warning limit for Runtime Totalization. Unique, user-specified messages shall be generated when the limit is reached.

## I. Workstation Software Features

Operator Station (OS) software shall include as a minimum the Operating System, Database manager, Communications Control, Operator Interface (OI), Trend and History Files, Report Generator, and Support Utilities.

Operator Interface Software shall have its features available whether the workstation is directly connected to the DDC network, or connecting through the Ethernet interface, or through dial-up modems.

Real time operating system shall be true multi-tasking providing concurrent execution of multiple real time programs and custom program development. "Switching" from foreground applications to background applications where the background applications are suspended is not acceptable.

Database manager is to manage all data on an integrated and non redundant basis. It shall allow additions and deletions to the database without any detriment to the existing data.

Operator Interface Software must provide an hierarchical linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. Description for graphics, points, alarms, etc., shall be modified through the operator station under password control. Operator Interface Software shall not restrict the number of graphics to be generated and shall support graphic generation and modifications. The supervisory software shall provide a library of predefined symbols, consisting of industry standard representations of equipment; user defined symbols shall also be supported. All graphics shall be hyperlinked together, such that going from one graphic to another is by clicking on assigned and designated locations on the graphic. Clicking on a curtain point shall open the parameters window of this point where the value, status (manual or automatic), alarm set values, software address, program name, trend file shall be displayed and adjusted.

Required Graphics shall include but not limited to the below list

- Main graphic shall be a digital photograph of the buildings façade from which an Auto-cad elevation drawing of the floor can be selected.
- From the Auto-cad elevation drawings an Auto-cad floor layout can be selected where room occupancies are displayed.
- Selecting a technical room will open the equipment layout graphic of the room with basic readings. The drawn equipment shall resemble the actual equipment. Selecting equipment will open the graphic containing the schematic of the equipment with all related readings.
- Selecting other rooms will open the graphic of the HVAC equipment serving that room, e.g. FCU or AHU, with available readings and with a link to the graphic of the main equipment, e.g. Chiller Plant or Heating Plant Serving that FCU.

Operator access to the system is to be under personal ID and password control. The operators shall be permitted to change their own password without permitting access to

any other password. Sign-off from a station shall be a manual operation via pull-down menu or, if no mouse or keyboard activity takes place within an assignable time period, shall be automatic. Automatic sign-off period shall be adjustable from zero to 100 minutes for each operator or may be disabled on a per operator basis.

Each operator shall be assignable an access level for system use as follows:
- Level 1: View data.
- Level 2: Modify time programs.
- Level 3: Modify intermediate level data such as setpoints and alarm limits.
- Level 4: Modify high-level data such as control parameters.
- Level 5: Define new operators.

All operators shall have privileges at their assigned level and above.
User activity, such as alarm acknowledgment, set point value changes, points placed in manual mode, shall be logged with the name of the user who performed the action.

Data to be displayed within a graphic, shall be assignable regardless of physical hardware address. Graphics are to be on-line programmable and under ID and password control. Points may be assignable to multiple graphics where necessary to facilitate operator understanding of system operation and where specified. Graphics shall also contain calculated or pseudo points. Each physical point and each point assigned to a graphic shall be assigned an English descriptor for use in reports.

Penetration within a graphic hierarchy shall display each graphic name as they are stacked to facilitate operator understanding. The "backtrace" of names shall permit the operator to move upward on the hierarchy by mouse click on the stacked backtrace. The backtrace shall show at least the previous four penetration levels. The operator shall be provided the option of showing each graphic full screen size with the backtrace as a horizontal header or by showing a stack of graphics.
All operator accessed data shall be displayed on the color monitor. The operator shall select further penetration via mouse click on an area, building, floor, fan, etc. Dynamic data shall be assignable to any and all graphics.

The operator shall be provided with a means to directly access any graphic or any point without going through the penetration path.

Direct access to graphics shall be menu selectable wherein the operator may optionally enter the name of the graphic system desired or select the desired graphic via cursor positioning on a scroll bar listing of all graphics.

Graphics shall also be selectable by entering, or selecting via scroll bar of all system points, the user address of any point within the graphic.

Up to 100 frequently addressed system points shall be definable as "quick access" points. This listing shall be selectable from a screen top menu bar drop down menu item. Each points user address, descriptor, and value/status shall be displayed.

By partial data entry, a wild card search utility shall be provided. For example, by entering "Room," all points with the word "Room" in their name shall be listed. The wild card search utility shall be usable by the following functions :
- Graphic access by point name.
- Point selections for the "quick access" group.
- Data access by point name.
- Point access by point attribute.
- Alarm history reports, search by date range or critical alarms only.

- Operator activity report, search by date range.

Points (physical and pseudo) shall be displayed with dynamic data provided by the system with appropriate text descriptors, status or value, and engineering unit. Coloration shall be used to denote status and alarm states. Coloration conventions shall be variable as chosen by the owner. In addition, animation shall be used where specified, to confirm operator commands (e.g., fan rotation, damper position, fluid flow, etc.). All points shall be dynamic and shall continuously update anytime their field status / value changes.

Points shall be commanded directly from the color monitor via mouse selection. For a digital command point such as a valve position, the valve would show its current state (e.g., CLOSED) and the operator could select OPEN via mouse click. Upon selection of analogue commendable points (such as discharge air static pressure) from any graphic, a dialog box shall appear containing the decimal value of the setpoint with the adjacent up-down arrows, the selection of which shall vary the setpoints.

An on-line context-sensitive help utility shall be provided to facilitate operator training and understanding. The document shall contain text and graphics to clarify system operation. At a minimum, help shall be available for every top level menu bar item and dialog box.

Electronic messaging facility shall be provided on the operator station for any operator to enter a message to another operator by selecting a MAIL menu item, selecting the receiving operator's ID from a drop down menu and entering the message (such as "CLEAN PRE-HEAT STRAINER ON AHU-16"). When an operator with a queued message signs onto the OS, the "Mail message" area of the dialog box shall indicate that a message is waiting. Upon selecting a mail display, the operator shall be presented an index of the title or subject of each message from which he may select the order of display. Upon displaying a mail message, the display shall prompt the operator with three message options to execute; delete, print, and save. Messages shall also include the sender's personal ID and be 300 characters minimum length, plus a brief title or subject description.

To enable operators to view graphics in greater detail, a zoom/pan display feature shall be provided. Zooming shall be by dragging the cursor diagonally across the area to be zoomed. Panning shall allow horizontal and vertical scrolling around graphics. To return zoomed/panned graphics to their original view, a "redisplay graphic" feature shall be provided.

Operator assignment capability shall include designation of operator names, passwords, access levels, and auto sign-off.

Peripheral assignment capability shall include assignment of segregation to printers.
System text add/change capability shall include English descriptors for graphic points, action messages for alarms, and run time and trouble condition messages.
Time program change capability shall include time/date set, time/occupancy schedules, holiday schedules, and daylight savings time schedules.
Points shall be definable as to coloration, animation, operator messages (480 characters minimum), critical or non-critical alarm, alarm and warning limits, and engineering units.

Point related change capability shall include lockout, run time, and setting a fixed input value.

Graphic construction is specified under Graphic Creation.

Point alarms shall be user-classifiable as critical or non-critical.

Critical alarms shall be displayed in a dialog box of the color monitor. Display shall include as a minimum:

Time and date of occurrence, indication of alarm condition, i.e., ABNORMAL OF, HI ALARM / LO ALARM), analogue value or status, user address, and alarm message.
A discrete per point detailed alarm-action taking message shall be user definable from the dialog box; i.e., "The fan has shutdown due to an excessively high discharge duct pressure. There is a strong indication of a system malfunction such as an inlet vane drive failure, or major fire damper closure. The switch should not be manually reset until a thorough investigation of the cause is conducted" of up to 480 characters.

Alarms shall be directed to the user selected alarm printer.

Alarm silencing shall be by selecting a "silence" button of the dialog box or by authorized operator's acknowledgment. In all cases, alarm acknowledgment shall only be allowed by operators of access level 2 or better.

Non-critical alarms shall only output to the printer and OS disk in order of occurrence.

An unacknowledged alarm indicator shall be provided on the color monitor display to alert the operator that there are unacknowledged alarms in the system.
Symbols for critical points in a graphic display that are in an alarm state shall have a flashing red border.

Run time limit messages shall be presented and processed as alarm messages except the action message shall be of a maintenance directive nature.

Dynamic trends shall provide for each OS of up to eight user selected points to show real time activity of the associated points. This information shall be printed and/or displayed in numeric, bar chart, curve plot, pie chart, etc., as selected by the operator. Graphic plots shall allow a unique color for each point. As new point values are sampled, they shall be processed, scaled, and dynamically appended to the plot being displayed. Sample interval of points selected for dynamic trend shall be user selectable from five seconds to sixty minutes.

Standard reports shall be provided which shall be output onto the selected report printer. A "terminate report" command shall be available to allow the operator to stop any report in the process of being printed. The following standard pre-formatted reports shall be provided:

The user shall be provided with a command trace feature selectable on a per point basis allowing the archiving of all commands issued to each point. The archived trace shall include the point status, the point ID, and the time and date of the status change. Command trace reports shall be output upon operator demand.

A custom report capability shall be provided to allow the user to format reports of any mix of text, points with status/value and descriptors, and points with status/value only. Custom reports may be scheduled or requested manually. A spreadsheet program similar to Microsoft Excel shall be provided fully integrated with the BMS data base, and available to the user. Spreadsheet packages which require off-line execution or manual translation of date files from one program format to another are not acceptable. A time-and calendar date graphic scheduler shall also be provided to allow simple scheduling of the printout of each custom report.

A screen top menu bar item shall allow selection of the following historical reports from continuously archived data:

- Alarm history: The last 4000 alarm events shall be disk archived. Viewing or printing shall be by entering a date range (from-to). The display printout may be selectively limited to critical alarms only. Alarm history data shall include time and date of occurrence, point name, alarm type, value / status, alarm message, name of operator acknowledging the point alarm, and time and date of acknowledgment.
- Operator activity: All operator activity shall be archived. Viewing or printing shall be by entering a desired date range. Activity displays/printouts shall include the time and date of activity, and nature of activity (log on, attempted log on, data point changed notation with point name).
- Controller alarm history: Alarm event history within a controllers alarm buffer shall be displayable including the pointname, time and date, alarm condition, status / value, and alarm message.
- Controller current alarms: Points within each controller currently in an alarm state shall also be displayable / printable including data noted for controller alarm history.

Standard data reports shall include the following :

- Time Programs (per controller).
- Each Time Control Schedule Command.
- Sorted by Time.
- Sorted by Point Name.
- Time Programs overridden (for following 365 days).
- Text descriptors (per controller).
- Parameter files and parameter (per controller).
- Listing of all assigned operators.
- Listing of all customer PC programs and custom reports.
- Listing of "Quick Access" points with status / value.
- Multiple point group display (per HVAC System).
- Point Data Record (each point) listing:
    - Point Name
    - Point Description
    - Analogue Alarm Limits (4)
    - Fixed Value / Status
    - Fixed Mode
    - Trend Status
    - Digital Run Time
    - Alarm Delay Time
    - Related Graphic
    - Enable / Disable
    - Alarm Text
    - Alarm Delay Time
    - Alarm Status
    - Alarm Lockout Status
    - Last Change (Date / Time)

Trend reports shall allow the operator to randomly select point archival. Each system point (hardware and software) shall be assignable to PC archive files for display at user selectable intervals of 10 seconds to 24 hours. Trend data sample resolution shall be a minimum of one degree or one percent of the points range, whichever is smaller. Each point trend file shall have a user assignable selectable archive duration of a day, a week, or a month. For any duration period selected, the file shall retain one full duration period while it collects another (i.e., after collecting data for May, May is retained in total as June data is accumulated).

Trend display points shall be subsequently printed/displayed individually or in logical groups of up to any eight points in any group. Points shall be assignable to multiple trend groups. The system shall have up to 500 trend groups which may be predetermined by the user for a unique set of logical points and display characteristics.

## J. Field Devices

J.1 Air differential pressure switch

Solid-state design, operating on capacitance principle, with non-interactive fine resolution, zero, and span adjustments. End-to-end accuracy +/- 2% of full scale pressure range, including temperature compensation. Shall have integral filters at each air connection port. Pressure range depends on the application.

DPS to be installed for:
- Fans: to read the on/off status.
- Filters: to read the clean/dirty status.

J.2 Control valve (2 way, 2 position)

Bronze or cast iron globe valve construction, with screwed or flanged ends. Materials suitable for chilled water or hot water up to 125 °C 24 VAC. Working pressure, 10 bar. N.C. spring return. Minimum close off pressure rating shall meet requirements of mechanical specifications; if no requirement, minimum close off pressure rating shall be 70 kPa.

J.3 Control valve (2 way modulating, spring return)

Bronze or cast iron globe valve body, with equal percentage flow characteristics. Materials suitable for chilled water or hot water up to 125 °C. Modulating actuator with 0-10 VDC signal range, power to open and power to close. Working pressure 10 bar.

J.4 Fluid level sensor

It consists of pressure transmitors that calibre, and amplify the receiver signals. These signals shall be transmitted as tension or standard current to the BMS station Immerged type, suitable for water and for domestic fuel oil.
For domestic fuel oil application, the level sensor shall be with anti deflagrant protection.

J.5 Pressure sensors for liquid

For the measurement of positive and negative pressure in hydraulic systems using liquids.

| | |
|---|---|
| Pressure ranges | 0 - 16 bars |
| Response time 90% | < 5ms |
| Media | Neutral and mildly corrosive liquids and gases, including freon (R134a) and ammonia |
| Admissible temp. of medium | 0 ... 100 °C |
| Orientation | Any |
| Protection standard | IP65 |

Suitable for BMS.

J.6 Fluid Temperature Sensor

To provide proportional single output for electronic temperature controller. Type having the following features :

- Electronic type
- Insertion or immersion type for mounting on liquid line
- Set point range 0 to + 100 °C
- Accessories including 100 mm immersion element with pressure rating for 16 bar for liquid line mounting.

J.7 Duct Temperature Sensor

Constructed soft copper tubing, incorporating numerous temperature sensors encapsulated at equal distances along the length of the element. The assembly acts as a single sensor, reporting the average temperature from all the individual sensors. Operating range: 0 to 60 °C; end-to-end accuracy
+/-0.3 °C. Assembly complete with wiring housing and mounting flange. Sensitivity to air velocity between 100 to 1000 FPM.

J.8 CO level sensor

CO detection range shall be from 0 – 500 PPM. Detectors to be multi-stages, sensors to be protected by a metallic cover and to be provided with a filter for contamination protection (IP64).

J.9 Outside air temperature sensor

10 K□ thermistor sensor encapsulated in a 6 mm OD probe, complete with weatherproof enclosure, sun shield and mounting bracket.
Operating range: -35 °C to +50 °C. End-to-end accuracy: +/- 0.3 °C over the entire operating range.

J.10Relative Humidity Sensor

Operating range: 10% RH to 99% RH, over a 0 °C to 60 °C temperature range. End-to-end accuracy: +/- 3.0% of operating range, with maximum temperature dependence of 0.2% RH per °C change.

J.11 Flow switch

Water flow switch to be electrical switching device actuated by vane extended inside water pipe so that water flowing in pipe closes circuit.
Flow switch to have range of vane sizes to match the flow range to be properly selected.

## K. Schedule of control points

As per attached schedule or described in the bill of quantities.

## ACCESS CONTROL SYSTEM

### A. The System

The Security Management System should be capable of Controlling and Monitoring Access through the doors, Monitor and control Inputs and Outputs, include an Integrated Video Badging, Integrate Elevator Control and Seamless Integration to Digital Video Recorder and control CCTV functionality. The software should be capable of recording events in such a way that they are recorded whenever an access is granted/denied or access granted during programmed schedules or holidays etc.

Pop up screens should display the video if the Access points or input points are tagged to those points in case of alarm. This should be programmable by the operator. The system should also have video verification capability where the guard could verify the person before granting access through the software and from the video. The guard should have a single screen wherein he can see the Video as well as have the card details of the person accessing the door with his photo from the file. The system should also have a High security mode wherein only privileged card holders can have access to the facility and this should be programmable to be based on events or per a programme time schedule. This should be flexible and should be easily programmed to suit any specific needs.

The system should also provide Time & Attendance information such as Name, In Reader location, Out Reader Location, IN time, OUT Time and the number of hours worked along with other system reports. The data should be exported to any payroll or HR package in various different file formats. Whenever a card holder presents the card at the reader the system should be capable of displaying the Video from the camera focused on the door plus bring in his card details from the database on a single screen for verification. It should also be possible to verify at a later date if the access has been not been misused.

The system should also be capable of recording events automatically on any compatible DVR and should be able to retrieve recordings based on events.

### B. System Overview:

B1 General Overview

Functions of the Integrated Access Security Management System (ISMS) shall include:

- Granting or denying access to secured areas.
- Controlling access point features and modes.
- Alarm input and abnormal access point activity monitoring.

B2 Output control.
System configuration and management functionality to facilitate functions listed above.
Reporting of the events generated by the functions listed above.

B3 System configuration reporting.
Facilities to automate event search on connected Digital Video Recorders (DVR). Integrate seamlessly with any compatible DVR and control CCTV functionality Control Elevator Access to the floors based on Access permissions. Elevator Controller allows control of up to two elevator cabs with 8 floors total. Can be expanded to control up to 32 floors. It should utilize flash firmware for easy upgrades, and employs fully distributed intelligence for off-line operations.

B4 Integrate with third party Alarm panels
The software should be capable of producing ID badges and printing them on any suitable card printer
With optional modules the system should be capable of controlling upto 4 doors per panel or 4 doors with IN/OUT capability

## C. System Architecture

ISMS shall consist of the following:

C1 Server Software package, with following functions:

- User interface for system control and configuration.
- Field hardware communication functionality.
- Live activity and status display.
- System and event history reporting functionality.
- Server for the Client Software packages.

C2 Client Software Packages, with following functions:

- User interface for system control and configuration.
- Live activity and status display.
- System and event history reporting functionality.

C3 Intelligent Field Panels, supporting:

- 2 access points.
- Local means of control trough system and panel links as well as reader and reader/keypad input.
- Field interface to access control readers of various types.
- Field interface to variously configured alarm inputs.
- Control relay and voltage outputs.
- Communicate with the Server Software package, by means of:
  - Direct RS-232 connection
  - Direct or networked RS-485 connection.
  - Direct modem connection (Utilizing external modem)
  - Direct TCP/IP connection (Utilizing TCP/IP gateway).
- Convert RS-232 into RS-485.

## D. Operational Features

D1 Access Points:

➢ Access point shall be configured to:

- Auto-relock, when door is closed. Overriding unlock timer.
- Deduct usages from cardholder's balance.
- Report or not to report door forced open events.
- Unlock based on a schedule.
- Require System Operator's decision to grant or deny access to cardholder requesting access by use of a card.
- Conform to "first person delay" rule of the scheduled unlocking.
- If specified bypass door contact only without activating lock output following request to exit activation.
- If specified deny access to cardholders without High Security privilege.
- If specified operate in site code only mode.

- Report or not to report request to exit activations.
- Report or not to report failure of a cardholder to open the door following a valid card use.
- Report or not to report invalid card format event.
- If specified require both card use and PIN entry based on a schedule.
- Function in timed anti-passback mode with a specified delay if required.
- Function in true panel or global anti-passback mode with either hard or soft enforcement if required.
- Associate with entering and exiting pre-defined areas.
- Initiate display of the cardholder's information and picture on Server and Client software packages, based on Access Granted and/or denied and/or requested.
- Initiate recording on any compatible DVR based on programmed events on the Access points.
- POP up video of the designated camera in case of alarm
- Allow Elevator Access to designated floors.

➢ Access Points shall be granting or denying access to a secured area, based on:
- Access Level permissions, specifying an independent access schedule for each access point.
- Status of the card.
- High security privilege.
- Current usage balance.
- Anti-passback status or privilege.
- Card de-activation date and time.
- Card and PIN match.
- Site code mode.
- Manual command based on access request.
- RTE input activation.

➢ Access point shall lock and unlock:
- Manually, through system command.
- Manually, through double consecutive use of an authorized card.
- Manually or automatically, through panel or system linking.
- Automatically, based on schedule.
- Automatically, based on schedule and first valid card use.

➢ Modes of the access point shall be controlled:
- Manually, through system command.
- Manually, through quadruple consecutive use of an authorized card (See High Security Mode).
- Manually or automatically, through panel or system linking.

➢ Access point shall posses convenience features for handicapped cardholders:
- Extended unlock time for designated cardholders.
- Activation of an additional output for designated cardholders.

- Access point shall provide reporting of the following events:
  - Access granted, requested.
  - Access denied with a specific reason.
  - Door held open warning.
  - Door held open alarm.
  - Door locked and unlocked.
  - Forced entry.
  - Restore.
  - Door not open alarm, following card access granted.

- Access point shall have capability to trigger Recording on any compatible DVR, panel and system links by:
  - Access granted or denied events.
  - Door held open warning.
  - Door held open alarm.
  - Door locked and unlocked events.
  - Forced entry event.
  - Restore event.
  - Door not open event, following card access granted.

- Access Point shall be associated with a specific camera on a specific compatible DVR (addressed by IP address and port) for automated video retrieval and display of live picture from the camera associate with it.

D2 Alarm Inputs.

- Alarm input shall be configured to report various messages to Server software package with abilities to:
  - Specify in which state (never, armed and/or disarmed) a specific alarm input reports.
  - Suppress individual message types of a specific alarm input based on a schedule.
  - Display a pre-defined message for each event type of a specific alarm input.

- Alarm input shall have the ability to be configured with a delay on alarm reporting.

- Alarm inputs shall be armed and disarmed:
  - Manually, through system command.
  - Manually or automatically, through panel or system linking.
  - Automatically, based on schedule.

- Alarm input shall provide event reporting of the following events:
  - Input alarm.
  - Input restore.
  - Input trouble.
  - Input normal.
  - Input abnormal.
  - Force armed.

- Alarm input shall trigger panel and system links by:
  - Input alarm and restore events.
  - Input trouble event.
  - Input normal and abnormal events.

- Alarm input shall be associated with a specific camera on a specific compatible DVR (addressed by IP address and port) for automated video retrieval. POP up video of the designated video in case of alarm

D3 Outputs.

- Outputs shall be configured as:
  - Fail-safe or fail-secure.
  - Reporting or non-reporting to the Server Software package.

- Outputs shall be activated and deactivated:
  - Manually, through system command.
  - Manually or automatically, through panel or system linking.
  - Automatically, based on schedule.

- Output shall provide event reporting of the following events:
  - Output on.
  - Output off.

- Output shall trigger panel and system links by:
  - On and off events.

- Alarm Output shall be associated with a specific camera on a specific compatible DVR (addressed by IP address and port) for automated video retrieval

## E. Hardware Specifications:

E1 Intelligent Field Panel (IFP)

The panels should be UL listed and also comply with FCC and CE regulations

- IFP Architecture:
  - IFP shall utilize a fully distributed intelligence controller architecture whereby access decisions are made locally at the controller.
  - IFP shall utilize flash firmware for easy upgrades.
  - IFP shall support two access points.
  - IFP should be capable of expanding the functionality of the two access points to two access points IN/OUT, making the IFP a 4 reader controller.
  - IFP shall support local means of control through system and panel links as well as reader and reader/keypad input.
  - IFP shall support field interface to access control readers of various types.
  - IFP shall support field interface to eight variously configured alarm inputs.
  - IFP shall control four relay and four voltage outputs.

- The Server software package (host computer) shall download panel specific data, including up to 8,000 cardholders, to the IFP on the network. This data shall be stored within each panel and contain all pertinent information relating to the panel's functionality.
- Host computer shall communicate global links and anti-passback messages between panels.
- Should communication with the Server software package (host computer) be lost, up to 3,000 time-stamped events shall be stored in panel's buffer, until communication is restored. Upon restoration of communications all event data shall be automatically uploaded to the host computer including the actual time of occurrence.
- This functionality shall enable any off-line controller to maintain full access control processing capability. A card user shall not be aware of the off line condition.
- A system that does not buffer event information when communications are lost will not be acceptable.

➢ IFP communications:
- Host computer shall support up to 16 networks with a maximum of 32 panels connected, upgradeable to a maximum of 64.
- Up to 16 Intelligent Field Panels shall be connected on a hard wired network.
- Following means shall be used to connect a hard wired network of panels to the host computer:
  a) Direct RS-232 (three wire)
  b) Direct RS-485, utilizing RS-232 to RS-485 converter.
  c) Dial-up, utilizing external modem connected via RS-232 (4 wire) with modem power reset capability in IFP.

TCP/IP, utilizing a field configurable network gateway.
- The hardwired communication network shall be wired with 18AWG twisted-pair, shielded cable. The hardwired network shall have maximum length of 4,000'. This network shall be wired in a daisy chain configuration.
- System shall be configured to report various panel communications status messages to the Server software package with abilities to:
- Suppress individual message types of a specific alarm input based on a schedule.
- Display a pre-defined message for each event type of a specific alarm input.
- System shall provide event reporting of the following events:
  a) Panel online.
  b) Panel offline.
  c) Panel trouble.

➢ IFP hardware configuration:
- Panel Addressing
  - IFP's address shall be set via four onboard dip-switches.
  - Available addresses shall be 1 through 16.
- Communications speed settings
  - IFP's communications speed shall be set via two onboard dip-switches.
  - Available rates shall be 9.6, 28.8, 38.4 and 56 kbps.
- Modem configuration

- IFP's modem communications shall be enabled via an onboard dip-switch.
- Selection between dial-up and direct network shall be available.

- Host or network setting
  - IFP's location on the network (connected to the host vs. RS485 network connection) shall be enabled via an onboard jumper.
- RS-485 Tuning
  - IFP shall provide means of RS-485 network tuning, specifically:
    - Low bias.
    - High bias.
    - Termination.
  - IFP tuning shall be accomplished by adjusting onboard jumpers.

➢ IFP Reader Interface
- IFP shall provide interface to access control readers utilizing either magnetic stripe or Weigand electrical formats.
- IFP shall support up to 5 different card formats simultaneously.
- IFP shall support all major reader technologies:
  - Proximity
  - Magnetic Stripe
  - Weigand
  - Bar Code
  - Keypad Only
  - Proximity with Integrated Keypad
  - Magnetic Stripe with Integrated Keypad
  - Hand Geometry
  - Fingerprint
- IFP shall provide dedicated control over Red and Green LEDs for each access point.
- IFP shall provide dedicated control over Buzzer for each access point.
- Wire lengths of 500' utilizing 20AWG and 250' utilizing 22AWG 6 or 8 conductor shielded cables shall be required.

➢ IFP Alarm Inputs:
- IFP shall provide eight fully programmable alarm inputs.
- Each alarm input shall support all of the following circuit types:
  - N.O. Non-supervised.
  - N.C. Non-supervised.
  - N.O. Supervised with one resistor.
  - N.C. Supervised with one resistor.
  - N.O. Supervised with two resistors.
  - N.C. Supervised with two resistors.
- Combination N.O. and N.C. Supervised with one resistor.
- Wire lengths of 1,000' utilizing 20 or 22AWG cables shall be required.

➢ IFP Outputs:
- IFP shall provide eight fully configurable outputs (four relay and four voltage ones).
- Each output shall be configured as fail-safe or fail-secure.
- Relay output shall be rated 2A @ 30VDC.
- Voltage outputs shall switch negative 12VDC @ 100mA.

➢ IFP Enclosure:
- Height: 12"

- Width: 14"
- Depth: 3 ½"

➢ IFP Environmental tolerances:
- Operating temperature: 35-150˚F
- Operating humidity: 20-80% RH (non-condensing)

**F. Reports:**

F1. Time and Attendance Reports

The system should also provide Time & Attendance information such as Card Holder Name, In Reader location, Out Reader Location, IN time, OUT Time and the number of hours worked and also calculate the number of hours worked for a certain time period, say a week etc. This should be in addition to a number of other reports being able to be generated from the system. The data should be exported to any payroll or HR package in various different file formats.

Whenever a card holder presents the card at the reader the system should be capable of displaying the Video from the camera focused on the door plus bring in his card details from the database on a single screen for verification. It should also be possible to verify at a later date if the access has been not been misused. All such transactions should be capable of being stored in the database as well as on any compatible DVR.

## GENERATING POWER PLANT

### A. General

This section specifies the furnishing, complete installation, connection and testing of the engine generator system.

The engine generator system shall be fully automatic and shall constitute a unified and coordinated system ready for operation.

The engine generator system must include without being limited to:
- The generator: diesel engine, lubrication oil system, fuel oil system and cooling system.
- Control, regulation and protection panel boards for each generator.
- Auxiliary panel boards.
- Starting systems.
- Fuel supply systems.
- Exhaust system for each generator with mufflers and insulation.
- Silencers and hot air extraction system (fresh and exhaust air) for the generator room ventilation.
- Exhaust pipes and silencers insulation including anti-vibration supports.
- All electrical installations inside the generators room related to the generator and between the generator and the ATS
- All fuel installations inside the generator room and fuel tank room with all safety and isolation valves.
- All other necessary accessories.
- Transportation to site, downloading, erection, installation, commissioning and training on basic maintenance procedures.
- Spare parts.

### B. Quality Assurance

The Contractor shall guarantee that the materials and workmanship of the works installed by him under these specifications are first-class in every respect and that he will make good any defect, not due to ordinary wear and tear or improper use or care, which may develop within two years from date of completion including maintenance and supply of all spare parts over this period.

The supplier of the diesel-engine generator set shall be responsible for satisfactory total operation of the system and its certification. This supplier shall have had experience with three or more installations of systems of comparable size and complexity in regards to coordinating, engineering, testing and supervising. Each of these installations shall have been in successful operation for three or more years. Prior to review of submittals, the Owner Representative and or Engineer reserves the right to:
- Have the manufacturer submit a list of locations of similar installations.
- Inspect any of these installations and operations of engine-generator set, and question the user concerning the installations without the presence of the supplier.

Factory authorized representative shall be capable of providing emergency maintenance and repairs at the project site within two hours maximum of notification.

Engine generator and auxiliary components shall be supplied from a single manufacturer.

Noise level developed by the generator set shall be as herein specified.

The Engineer shall have the option of witnessing at the factory or to ask for Factory Test Reports related to the following tests. Contractor shall notify the Engineer 15 days prior to date of testing. Manufacturer shall furnish load banks, testing instruments and all other equipment as necessary to perform these tests.

- Load Test: Shall include six hours of continuous operation; four hours while the set is delivering 100 percent of the specified KW and two hours while delivering 110 percent of the specified KW. During this test record the following data at 20-minute intervals:

| | | |
|---|---|---|
| Time | Engine RPM | Oil Temperature Out |
| KW | Water Temperature In | Fuel Pressure |
| Voltage | Water Temperature Out | Oil Pressure |
| Amperes | Oil Temperature In | Ambient Temperature |

- Quick Start Test: Record time required for the engine generator set to develop specified voltage, frequency and KW load from a standstill condition.

## C. Submittals

### C.1 Shop Drawings

Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.

Data shall be submitted in the following form:

- Technical Data Sheets (TDS): These include published performance, rating and derating curves, published ratings, catalog cuts, pictures, manufacturer's specifications, material composition, and gauge thickness.
- Description of Operation (DO): Manufacturer's literatures and, if suitable, diagrams.
- Calculations (CALC): Detailed engineering calculations with all equations, graphs, assumptions, and approximations shown, and data sources referenced.
- Certification (CERT): Written confirmation as to the document's accuracy, and genuineness.
- Shop Drawings (SD): Scaled drawings showing plan views, side views, elevations and cross sections.
- Diagrams (DGM): These include control system diagrams, elementary diagrams, control sequence diagrams or table, wiring diagrams, interconnections diagrams (between local control cubicles, remote annunciator panels, remote derangement panels, remote monitoring panels, remote exercising panel and underground fuel storage tanks), wireless connection diagrams, illustrative diagrams, flow diagrams, and other like items.

Prior to fabrication and or installation, submit for approval the following data for each engine-generator set, transfer device and control and supervisory equipment:

Prior to starting the work the Contractor shall submit to the Engineer for approval detailed shop and installation drawings showing to scale dimensions of equipment, pipes, etc. in plan and elevation with clearances and relation of same to the space assigned.

Drawings of equipment and material shall include detailed manufacturer's drawings, cuts of catalogues and descriptive literature, showing specifications, type, performance characteristics, construction, component parts, dimensions, size, arrangement, operating clearances, capacity, etc.

The contractor shall prepare and submit for comment, design, shop drawings and as built drawings as required for the installation. These shall be at a scale that is no smaller than the Engineer's drawings and shall include, but not be limited to:

- Builder's Work drawings: SD
- Generators, Plant and Equipment Layouts: TDS, SD
- Drawings to show the loading imposed on foundation for generators: CALC, SD
- Fully detailed Arrangement and Assembly Drawings of the generator sets: SD
- General Arrangements of Switchboards, Panels and Equipment: SD
- General arrangement and detail drawings of fuel system installation: SD
- General arrangement and detail drawings of drainage installation of generator room: SD
- General arrangement and detail drawings of electrical cabling of power and control of generators room: TDS, CALC, SD
- General arrangement and detail drawings of exhaust installation: CALC, SD
- General arrangements of equipment within the Generator room: SD
- Schematic Diagrams and Wiring Diagrams of equipment and plant: SD
- Diagrams fully detailing interconnecting cabling: SD
- General arrangement drawings of fuel storage facility: SD
- General arrangements and detail drawings of air attenuators and ductwork: TDS, CALC, SD
- Manufacturer's 'As made' drawings: SD
- Isometric drawings for all piping systems: SD
- Batteries, racks and charger: TDS, CALC
- Torsional Vibration: CERT
- Vibration isolators: TDS, CALC.
- Muffler assembly: TDS, SD
- Performance:
  a. Voltage regulating equipment: TDS
  b. Frequency regulating equipment: TDS
  c. Voltage and frequency dips and recovery times due to specified motor loading: CALC
  d. Antifreeze derating: TDS
  e. Ambient derating: TDS
- Detailed calculation notes for:
  a. Sound attenuation installation.
  b. Generators ventilation installation.
  c. Exhaust backpressure.
  d. Cables sizing

C.2 Manuals

Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals of the engine generator set and auxiliaries including technical data sheets, wiring diagrams, and information, such as telephone number, fax number, and web sites, for ordering replacement parts.

Two weeks prior to the final inspection, submit four copies of the updated maintenance and operating manual to the Engineer:

- Brief description of every system and equipment with basic operating features.
- Descriptive literature of all equipment and components with manufacturer's name, model number, capacity rating and operating characteristic.
- Service manual for every major piece of equipment giving operating and maintenance instructions, starting and shutdown instructions, lubrication

instructions and possible breakdown and repairs. The service manual shall be prepared specially by the manufacturer for the particular equipment.
- Detailed and simplified one line, color coded flow diagram of every system with tag number, location and function of each valve and instrument.
- A description of the installation and its method of operation written in non technical English to enable a non technical person to safely operate the plant.
- A detailed schedule of all equipment giving manufacturers reference.
- Detailed maintenance instructions for all items of plant including a planned maintenance scheme in chart format.
- Include complete "As installed" diagrams, which indicate all items of equipment and their interconnecting wiring.
- Include complete diagrams of the internal wiring for each of the items of equipment, including "As installed" revisions of the diagrams.
- The wiring diagrams shall identify the terminals to facilitate installation, maintenance, operation and testing.
- Complete Manufacturer's lists with unit prices of spare parts and special tools recommended for two years of normal operation of the complete system.

All control panels, relay panels, control switches, isolators, junction boxes, distribution boards, feeder pillars, valves, thermostats, etc. and all other items of plant and equipment shall be provided with a suitably engraved laminated plastic label permanently fitted to the plant concerned. The label shall indicate the designation, plant item or equipment number and a brief description of the function of the plant, item or equipment.
In general, labels shall be of adequate size with black filled characters on a white surface. The fixings of all labels shall be by means of machined brass screws Adhesives will not be permitted.

The instruction manual shall be submitted in draft form to the Engineer for his review and approval as to the fulfillment of the specified requirements prior to final issue.

The instruction manual shall be submitted to the Engineer at least four weeks in advance of the complete date of the system to be available for the final inspection prior to acceptance of the respective systems.

C.3 Certifications

Prior to fabrication of the engine-generator set, submit the following for approval, to the Engineer:

a. A certification in writing that a diesel engine of the same model and configuration, with the same bore, stroke, number of cylinders, and equal or higher BMEP and RPM ratings as the proposed diesel engine has been operating satisfactorily, with connected loads of not less than 75 percent of the specified KW/KVA rating, for not less than 2,000 hours without any failure of a crankshaft, camshaft, piston, valve, injector or governor system.
b. A certification in writing that devices and circuits will be incorporated to protect the voltage regulator and other components of the auxiliary electrical power system during operation of the diesel engine-generator set at speeds other than the rated RPM while performing maintenance.

Prior to installation of the engine-generator set at the job site, submit four copies of the following to the Engineer a certified test data, alternator temperature rise test and strip chart recordings, and photographs showing test setup and equipment.

Two weeks prior to the final inspection, submit four copies of the following, to the Resident Engineer:

a. Certified test report by the manufacturer of the engine-generator set that the auxiliary electrical power system conforms to the requirements of the drawings and specifications submitted.
b. Certified report of field tests from the contractor that the engine-generator set and major auxiliaries have been properly installed, adjusted and tested.
d. A certificate by the manufacturer that the engine-generator set, accessories, and components will withstand the seismic forces and that the set will be fully operational after the seismic event at the project site.

Certificates shall include statements of applicability, certifying reports from governing and testing agencies, industry standards and applicable certificates specified in each section of the specification.

C.4 Miscellaneous.

Miscellaneous submittals shall include submittals related directly to the work (non-administrative) including warranties, maintenance agreements, workmanship bonds, reports, physical work records, copies of industry standards, record drawings, field measurement data and similar information applicable to the work and not processed as shop drawings, product data, samples or certificates.

All submissions for approval shall be furnished in five copies.

## D. Product

The system must have 4 operating modes: Automatic, manual, test and out of order mode.

In automatic mode, upon receiving a signal (as a dry contact) from the voltage supervisory system indicating a voltage anomaly on the local network (the dry contact will be provided by others from the ATS system), the generator should start immediately with an adjustable time switch (0-2 minutes).

Voltage anomaly should be one of the following, without being limited to:
- Loss of normal power.
- Loss of one or more phases on normal power.
- Over or under voltage (Values to be set) of normal power.
- Frequency out of range of normal power.

In manual mode, generator can be turned on or off manually in the presence or absence of any load.

In test mode the generator must start without any load while the normal power supply is available.

The out of order mode must forbid the starting of the generator in any case. Switching to this mode stops the set immediately.

The diesel generator set must comply to class G2 to ISO8528-1.

Generator set assembly is to be compact package type, with all equipment mounted on one rigid steel bed frame suitable for skidding.

Radiator and synchronizing panel are to be mounted on the set.

Design is to permit easy operation, maintenance and repair.

The generator should have individual insulated steel enclosure epoxy painted from outside and inside with Access service lockable doors and four lifting points for complete unit mobility.

Vibration reduction is to be achieved by appropriate design and careful balancing at factory.

Compact set is to have approved anti-vibration isolators of steel spring or resilient neoprene between rotating equipment and bed-frame, limiting transmission of vibration to building to a maximum of 0.04 mm amplitude throughout the operating vibration frequency range.

Noise reduction is to be achieved by approved methods at source of noise, with sound level measured at 25 m limited to 78 dB at 20 Hz down to 41 dB at 10 kHz in accordance with ISO standards for residential areas. Sound level shall be less than 65 dBA at 3 m outside the room.

Cold starting engine is to be fully equipped to start and pick up full load immediately at minimum ambient temperature of 5°C.

Cold starting aids, such as engine jacket water heater, lubricating oil heater, intake-air heater and all required temperature controls to reach desirable starting temperature and to limit temperature rise, battery and all devices, accessories, connections, thermostatic switches and off-duty disconnects with pilot lights and necessary protection, are to be supplemented as recommended by the manufacturer and approved.

Equipment ratings are to be as required or the next higher standard ratings provided by the manufacturer. Ratings are to be net stand-by to consumer, excluding fan and any auxiliaries, auxiliary drives and losses, delivered at specified frequency, voltage and power factor and under worst climatic conditions on site.

## E. Diesel Generator Set

Generator set is to basically consist of diesel engine, brushless synchronous generator with direct flexible coupling to engine and single control cubicle.

Governing is to be to ISO 3046/IV, electronic type governor with limits of speed control as specified.

An electronic isochronous and load sharing governor is to be provided. Governor speed drop adjustable between 1% and 5% of the nominal speed.

Maximum transient speed change shall not exceed 5 % with the maximum anticipated step load applied.

Manual adjustment shall be provided for 5% rated speed.

Steady load band shall not exceed 1% of rated speed.

When in the automatic mode, the set is to start and stop automatically by a signal sensed through an auxiliary contact in the load transfer switchgear.

The set is to stop after an adjustable cool-down period (2-30 minutes).

Plant is to reach full speed within 10 seconds from start impulse and accept immediately 100% of net rated output (load being mixed, steady and inductive, with motor starting loads).

Transient voltage variation is not to exceed 10% under any step-load application for which the system is intended, up to full rated load recovering to within ± 2% within a few cycles.

Should engine fail to start following a start impulse, the system is to come to rest for a few seconds.

Two further starting attempts are to be automatically made with intermediate 20 seconds maximum periods of rest.

Should the set fail to start after three attempts, an alarm is to sound and a 'Start failure' signal illuminate and an auxiliary dry contact to be activated.

Hand operation is to be possible for testing or normal operation through a test/manual/off/auto selector switch.

In auto mode, the set is to start regularly and automatically every week and is to operate for 30 minutes before stopping.

E.1 Diesel Engine

Diesel engine is to be designed for type of load and application required. Engine and governor are to be selected to meet operating requirements and response specified.

Engine type will be compression-ignition type with direct solid-injection, turbo-charged after-cooled, water cooled, with air-cooled radiator, 4-stroke cycle, inline or V-type cylinder arrangement, 1500 rpm, operating on ASTM No. 2 diesel oil, suitable for direct coupling to driven machine.

Flywheel is to be suitably sized for type of service and constraints specified, and capable of being rotated at 125% of rated speed without failure.

Torsional vibration dampers are to be provided.

Engine rating is to be such that alternator can deliver net specified rated output as specified earlier, with temperature rise not exceeding rise allowed by the standards.

Provide with each generator crankcase explosion relief valve.
It is to be possible to:

- Remove rocker-box covers without disturbing fuel injection pipes or other components.
- Remove and replace pistons and piston rods, liners, big and small end shells and caps without dismounting engine.

E.2 Measuring Instruments

Engine mounted instruments are to include, at least, water temperature gauge, lubricating oil temperature gauge and pressure gauge, speedometer and running time meter.

It is to be possible to measure, with extra instrumentation, coolant temperature at lower end of radiator, air depression after air filter, air boost and temperature using methods recommended by manufacturer.

Instrument accesses are to be normally sealed by threaded blanking caps.
Speed is to be sensed via a magnetic pickup of the engine flywheel ring gear.

E.3 Cooling System

Engine is to be water cooled with gear-driven water pumps.

System is to be pressurized, with heavy duty tropical radiator cooled by reverse flow fan. Fan coil and hand protection guard are to be fitted.

Coolant temperature is to be controlled by one or more thermostats as determined by design of system.

Radiator is to be air cooled and sized for continuous performance at 110% rated load at worst operating ambient conditions (100 % full load for 1 hour at an ambient temperature of 50 °C) with a 15 °C temperature differential.

Radiator is to be non-ferrous metal, incorporating pressure valve, radiator cap and drain cock and with integral expansion tank.

Direct acting modulating thermostatic diversion valve is to control engine cooling water temperature. Under normal operation, by-pass is not to be fully closed.

Treated or fresh cool in extended life coolant is to be used as recommended by manufacturer for specific conditions of installation. Obstructions in path of cooling air flow (openings, louvers, grilles mesh, ducts, bends, etc.) are not to reduce air flow below that needed at full rated output. Fan and radiator characteristics are to be selected accordingly. Advise if additional booster fans are required and provide necessary control gear for automatic operation.

E.4 Lubricating Oil System

Pressurized circulating type, using two engine-driven, gear type lubricating oil pumps with full flow filters and replaceable elements and lubricating oil heat exchanger.

Filter system is to have spring loaded by-pass valve to permit oil circulating if filters become clogged.

Audible and visual alarms are to cut-in when valve starts opening. Lubricating oil cooler is to be shell and tube heat exchanger with water from engine radiator as the cooling medium.

Direct acting thermostatic diversion valve is to control oil temperature.

Under normal operation by-pass is not to be fully closed.

Lubricating oil is to be of approved brand by the generators manufacturer.

E.5 Fuel System

Fuel system is to have injection pump and injectors that are easily removable and replaceable for servicing.

Engine is to have integral, gear type, engine driven transfer pump to lift fuel against a head of 2.5 m and supply it through filters to injection pump at constant pressure. Fuel filter elements are to be easily replaceable.

Fuel system is to include for each generator primary and secondary fuel filters, fuel/water separator (with an alarm and axiliary dry contact when water is full).

System to include also daily fuel tank supplied with a steel retention tank of bigger capacity or tray equipped with fuel leak detector connected to BMS and to cut off solenoide valve.

E.6 Electric Starting System

System is to consist of heavy duty 25 V DC starter motor, heavy duty battery and battery charger.

Cranking motor and battery are to be rated for cranking the engine when cold and at lowest temperature recorded. Starting pinion is to automatically disengage when engine fires.

Storage battery is to be lead-acid, sealed-in-plastic type, complete with battery rack and intercell connectors.

Battery is to have sufficient capacity to provide minimum four cranking periods.

Battery charger to be 25% over-rated, solid state, full-wave rectifier type, adequate to fully recharge depleted battery in not more than 8 hours and to automatically control rate of charge (providing a high-charge rate to a depleted battery and reducing to a trickle-charge rate when battery is fully charged).

Ammeter is to be provided to indicate charging rate, which is to be adjustable.

Battery charger is to be mounted in control cubicle unless otherwise approved.

Charger should be a part of the system imported with the generator and not custom made. Batteries rack and cable connection should be included with the system.

E.6 Protection System

Protection system is to comprise engine shut-down and generator trip with visual and audible alarm in event of overspeed, low lubricating oil pressure, high cooling water temperature and over cranking.

## F. Alternator

F.1 Generality

The alternator type is synchronous, low reactance, high efficiency, revolving field type, with brushless exciter and flexible coupling, sized to pick up effective load without exceeding transient and steady-state voltage deviation limits specified up to its full nominal rating and designed for the performance stipulated in the specification.

It is to be two bearing construction with bearings of the sleeve or sealed ball type.

Phase leads are to be brought out fully insulated to a terminal cable box of heavy gauge sheet steel, protection IP44.

Control and protection cables are to be brought out to a separate terminal box.

Maximum voltage difference between the three phases at 100% balanced load is not to exceed 1%.

With unbalanced load up to 8% on one phase at unity power factor and zero load on other phases, the line-to-neutral voltages are not to differ by more than 2%.

F.2 Characteristics

| | | | |
|---|---|---|---|
| - | Number of phases | : | 3 |
| - | Rated voltage | : | 400 V |
| - | Frequency | : | 50 Hz |
| - | Rated output | : | as specified previously |
| - | Rated power factor | : | 0.8 |
| - | Winding connection | : | Reconnectable with ends brought out and fully insulated |
| - | Maximum unbalanced load current with none of the phase currents exceeding rated current | : | 8% of the rated current |
| - | Overload | : | 110% nameplate rating for 1 hour every 12 hours |
| - | Rotor | : | Salient pole type, incorporating damping grid |
| - | Excitation | : | Brushless, with rotating armature rectifiers and discharge resistors |
| - | Voltage regulator | : | Digital automatic, with readily accessible controls for voltage level. |
| - | Insulation | : | Class H for stator and class H for rotor & exciter, with class F temperature rise |
| - | Enclosure | : | Drip proof and screen protected (IP 21) |
| - | Cooling | : | Built in centrifugal fans |
| - | Maintained short circuit | : | 250% for 2 seconds |

- Over-speed : 120% (minimum) for 2 minutes

- Telephone harmonic factor (THF) at no load : 3% max.
- Waveform distortion factor at no load : 5% max

F.3 Voltage regulation

Overall voltage deviation within normal speed variations is to be within limits specified from no-load to full-load, from hot to cold and with load power factor from 0.8 lagging to unity.

Regulator is to automatically reduce voltage if load exceeds capacity of generator.

Voltage build-up is to be positive and rapid even when full load is suddenly applied. Line-to-line voltage waveform deviation factor is not to exceed
± 5%.

Total harmonic content is not to exceed 5% and that of one harmonic not to exceed 2%.

Radio interference suppression is to be within the limits set by the standards, grade (N). Voltage regulation must be done at ± 1 % of the nominal voltage. Time response must be less than 5 seconds.

F.4 Exciter

Armature is to be 3-phase, directly mounted to generator shaft and connected to generator field windings through six solid state, hermetically sealed, silicon rectifiers, accessible for maintenance or repair.

Exciter is to have field suppression system to eliminate any source of diode failure resulting from high inductive loads and surges.

Exciter field windings are to be stationary.

Exciter-regulator combination is to maintain output voltage within limits specified for any load up to 110% generator rating and under any sudden load changes specified.

F.5 Voltage regulator

Solid state, volts/Hz type, utilizing silicon semiconductor devices in control and power stages, with built-in electro-magnetic interference suppression and designed for single or parallel operation.

Manual adjustment to ±5 % of regulated voltage level is to be possible by a potentiometer at control panel.

All components are to be sealed, moisture and heat resistant, with a suitable environmentally protected enclosure.

Voltage regulator is to automatically reduce voltage if load exceeds capacity of generator and is to sustain a 3-phase short-circuit current at the generator terminals for the period for which the short-circuit protection operates and at least for 3 seconds.

Voltage regulator power is to be supported by generator voltage and current to maintain excitation field power.

## G. Instrumentation, Protection and Control Equipment

The generator shall be provided with a diagnostics software for alarm reading and troubleshooting.

All necessary software and training should be included with the offer.

Connection to the generators should be done from the control room.

Control relays, sensing equipment, switchgear protective relays and devices and start, stop and shutdown controls are to be provided as necessary for operation specified.

Generating set, instruments, protection and controls are to be mounted in a control cubicle installed in control room next to the generators.

Instrument and control are to include at least the following:

Voltmeter to indicate true RMS output voltage for the 3 phases (Line to Line and Line to Neutral)

Ammeter to indicate true RMS AC amps per phase.

- Frequency meter.
- Off/Test/Manual/Auto duty switch
- Manual start and stop push-buttons
- Emergency Stop
- Output KW (total and per phase)
- Output KVA (total)
- Output KVAR (total)
- Total KWHr.
- Total KVAHr.
- Power factor meter.
- Percent or rated total power.
- Service-hour running counter.
- Voltage level control.
- Speed raise/lower device.
- Cool-down time setting controls
- Illuminated indicator panel with LEDs or LCD display with alarms clearly indicated at least for low oil pressure, high water temperature, over-speed, fail to start, generator overload, reverse-power (controls shall include three phase sensing reverse power equipment, to prevent sustained reverse power flow into the generator set. When the reverse power condition exceeds 10% of the generator set kW for 3 seconds, the paralleling circuit breaker shall be tripped open and the generator shut down), generator on load, battery low charge state lamp test push-button, Generator voltage, frequency and phasing match, low coolant level, over and under voltage, over and under frequency, over current (110% of rated current for more than 60 seconds).
- Indicating gauge and low level fuel alarm battery charger, on/off switch, pilot lights, DC ammeter.
- Alarm sounder and reset controls.
- Anti-condensation heater.

- Protective gear is to ensure orderly engine stop or shutdown with reset relays, as required for safety and operational reliability, and is to include the following:
- Output molded case circuit breaker (MCCB) with solid state trip unit, electrically operated and electrically tripped by shunt release, for over-current and external earth fault protection.
- Over-voltage protection with voltage and time lag adjustment.
- Loss-of-field/under excitation protection
- Phase unbalance via negative phase sequence protection.

## H. FUEL TANK

A fuel tank of welded steel plate, protected inside and outside against rust, shall be provided.

A system of fuel oil piping from the main storage tank to the daily tank and engine, including all connections, transfer pumps, etc. should be also provided.

The set must include a daily tank of heavy duty unified design with all piping pre-connected, enclosed, protected and ready for final connections.

The tank shall include connections for inlet engine suction, engine return, overflow, vent, drain and float switches for automatic operation.

## I. EXHAUST AND SILENCING

Exhaust system to include muffler (made of 5 mm metal sheets) including all mounting accessories & flanged flexible connection (and jacketing for exposed part as for exhaust pipes) as well as suitable support to avoid noise propagation inside the building.

A maximum noise level of 45 dB is permitted measured at a point 10 m in the horizontal direction from the end of the exhaust pipe.

Supply and install for each generator a catalyzed soot filters in adequate sizes and quantities for reducing the emissions to provide EPA requirements for inside city approved level of emissions.

Filters to be complete with exhaust gas pressure monitors with volt free contact for remote indication of replace cartridge alarm.

## J. CONSTRUCTIONAL REQUIREMENTS

The diesel engine and generator must be mounted on a rigid base frame, including an oil sump below the engine.

The necessary anti-vibration elements and fixing screws are to be supplied with the frame.

The generator must be self ventilated and process neither slip rings nor brushes.

## K. SPARE PARTS

Tenderer shall submit with the bid the following:
- Manufacturer's list of general spare parts for every piece of equipment with unit prices.
- Manufacturer's list of recommended spare parts for one year of operation for every piece of equipment with unit prices.

- Indication of the lifetime of Parts with specific guaranteed lifetime according to manufacturer published data, where this lifetime does not exceed 25% of the expected lifetime of the equipment itself, these parts shall be treated as consumable parts.

Prices shall be valid for four years.

Discount on spare parts to be given to the client shall be shown on the price list.

All necessary spare parts specially those that must be changed regularly, should be supplied with the generators, covering a total running of 2000 hours for each generator.

If the contractor missed some parts by mistake, he must be responsible for every damage caused due to this mistake.

As an indication, and not limited to, spare parts to be delivered should be:
- Oil filters
- Fuel filters
- Air filters
- Belts
- Control module
- Set of safety sensors

## L. POWER AND CONTROL CABLING

All power and control cables inside the generators room related to the generators should be done by the contractor.

The contractor should provide all necessary equipment to allow the reading from the BMS for all the required points.

Additional field devices not built-in with the generator control panel should be coordinated with the BMS installer for compatibility.

Termination of all points should be done in a panel with 30% extra space, where the BMS installer will connect its system.

If the built-in readings are not compatible with the BMS system, necessary accessories should be added to assure full compatibility.

Power cables shall be XLPE insulated single wire armored and PVC sheathed rated 600/1000V, multi-core with high conductivity plain annealed stranded copper conductors, XLPE insulated with an extruded layer of PVC bedding having a single layer of galvanized steel wires armored for multi-core cables and aluminum wires or tape for single core cables and final outer extruded PVC sheath.

The insulation and sheath shall be with insulation colored to identify phases and neutral.

Earth conductors shall be taped to the cable at appropriate intervals.

## M. EARTHING

An earthing system should be provided for the generators and shall be independent of the building earth.

All metallic parts of the generators and panels should be bonded to the earth electrode.

Earthing system shall follow the same specification of the earthing system section.

## LIST OF ELECTRICAL APPROVED MATERIALS

| ITEM | MATERIAL |
|---|---|
| 1. PANELBOARDS | |
| 1.1 Main distribution Panelboards | MERLIN GERIN, ABB |
| 1.2 Power and Lighting Panelboards | MERLIN GERIN, ABB, LEGRAND BTICINO |
| 2. WIRES CABLES AND FEEDERS | LIBAN CABLES, BICC, PIRELLI |
| 3. CONDUITS AND WIREWAYS | |
| 3.1 Cables trays | TOLARTOIS, OBO BETTERMANN |
| 3.2 Conduits | UNIVOLT, PM |
| 4. EARTHING SYSTEM | OBO-BETTERMANN, FURSE, ERICO, DEHN, Copperweld. |
| 5. LIGHTING FIXTURES | In addition to those listed in the specifications: PHILIPS, HOFFMEISTER, ERCO, IGUZZINI |
| 6. WIRING DEVICES (PLAYBUS), | LEGRAND (MOSAIC 45), GEWISS |
| | TICINO (LIVING) |
| 7. FIRE DETECTION SYSTEM | SIMPLEX, MENVIER, NOTIFIER. |
| 8. COLLECTIVE ANTENNA TELEVISION | FUBA, KATHREIN, 3B ELETTRONICA, HIRSCHMANN |
| 9. CLOSED CIRCUIT TELEVISION | BURLE, JAVELIN, VISTA |
| 10. TELECOMMUNICATIONS INSTALLATIONS | |
| 10.1 EPABX | ERICSSON, AT&T, SIEMENS, PANASONIC |
| 10.2 Distribution Frames | POUYET, KRONE |
| 10.3 Cables | ACOME, POUYET |
| 11.CONTROL | LANDIS & STAFA, JOHNSON HONEYWELL. |
| 12. GENERATORS | DEUTZ, MAN, CATERPILLAR, VOLVO, CUMMINS |
| 13. LIFTS | MITSUBISHI (JAPAN) THYSSEN (GERMAN), SCHINDLER , OTIS, KONE |

| ITEM | MATERIAL |
|---|---|
| 14. DATA SYSTEM | |
| 14.1 Outlets | LEGRAND – BITICINO, GEWIS |
| 14.2 Passive components | AVAYO - ALCATEL – KRONE – SIEMON-POUYET |
| 14.3 Active components | AVAYO -SISCO – 3COM – NORTEL |
| 14.4 Data Cables | R & M |
| 15. Sound System | TEAC, PHILIPS, DB TECHNOLOGIES |
| 16. UPS | LEGRAND - SOCOMEC |