

# **ELECTRICAL ENGINEERING**

## **REHABILITATION OF THE SAUDI MATERNITY HOSPITAL**

### **KASSALA HEALTH CITADEL, SUDAN**

#### **DETAILED DESIGN**

#### **TECHNICAL SPECIFICATIONS (EQUIPMENT AND MATERIALS)**

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## **1. SCOPE OF WORKS AND REQUIREMENTS**

### **1.1. GENERAL**

The technical specifications and drawings are intended for the description and the execution of a completely finished work.

The Contractor shall carry out all the necessary works for successful installation of the electrical services as described and set out in this section of the Technical Specification, Bills of Quantities, other sections of the electrical documents and accompanying Drawings in accordance with the General Electrical Specification herewith.

The Works, the major elements of which are scheduled below, includes the supply of all labour, material, equipment, plant and components necessary for complete installation and setting out work in respect of the entire electrical services requirements within the proposed development and rendering it in complete working condition in respect of but not limited to the following installations:

- Primary & Secondary distribution (MV switchgear);
- Power Transformers;
- Power Generator;
- Energy Distribution;
- Trunking Systems;
- Distribution Electrical Switchboards;
- Earth Network and Foundations / Lightning Protection;
- Sockets for general purpose / Power Supplies;
- General Lighting / Emergency light;
- Fire Protection System;

The following items detail the solutions to be adopted.

### **1.2. SCOPE OF REQUIREMENT**

The word “installation” shall mean not only the major items of plant and apparatus conveyed by this Specification and the Contract, but also all the incidental sundry components necessary for the complete execution of the work and for the proper operation of the installation, with their labour charges, regardless whether these sundry components are mentioned in detail in the tender documents issued in connection with the Contract.

## **2. ISS SUBSTATION & MV/LV TRANSFORMER SUBSTATION**

### **2.1. MV SWITCHGEAR CUBICLES**

The cubicles (cells) will be modular of prefabricated type, metal-enclosed, forming a single-piece assembly and equipped with fixed air-insulated medium voltage switchgear. Air-insulated technology will be used.

The cubicles (cells) will be aligned on the front of the board.

MV cubicle (cell) design must allow easy access to the protection fuse, and the connections that will be made from the front of the equipment.

Operational factors and classifications for the design and construction of the MV cubicle:

- Rated voltage max. 24 kV (11 kV);
- Rated current to 630 A;
- Rated frequency 50 Hz;
- Rated short-time withstand current 16 kA / 1s;
- Protection class IP4X;
- Range of ambient temperature: -5 °C ... +41 °C

The connections will be made from the bottom. The company shall command the civil engineering reservations needed for the direct penetration for the cables into the MV cubicles that will be placed on the ground and in the foundation cubicles.

The cubicles will be fixed to the ground by threaded rods or T-nuts and M8 screws, according to the manufacturer's specifications.

In order to avoid intrusion of rodents into the cubicles, the cubicles shall have a minimum protection rating of IP 4X and the cable passages in the lower part will be done through pass prefabricated cables to maintain this IP 4X.

General Characteristics:

- Modular construction;
- Expandable;
- Small installation area;
- Operational simplicity;
- Exclusively operated from the front;
- Internal arc resistant;

- Equipped with a vacuum circuit breaker with high electric and mechanical life (E3 and M2 classes) or contactor;
- Reliable and requires little maintenance;
- Insertion/extraction of the circuit breaker with the compartment door closed;
- Several optional equipment.

## 2.2. POWER TRANSFORMER

This specification covers design, engineering, manufacture, assembly, stage testing, inspection and testing before supply and delivery at site.

The Power Transformer shall conform in all respects to highest standards of engineering, design, workmanship, this specification and the latest revisions of relevant standards at the time of offer and the employer shall have the power to reject any work or material, which, in his judgment, is not in full accordance therewith. The Transformer(s) offered, shall be complete with all components, necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of supply, irrespective of whether those are specifically brought out in this specification and / or the commercial order or not.

The transformer and accessories shall be designed to facilitate operation, inspection, maintenance and repairs. The design shall incorporate every precaution and provision for the safety of equipment as well as staff engaged in operation and maintenance of equipment

Each transformer shall be capable of uninterrupted operation and shall have the minimum characteristics as follows:

- Cooling methods: Oil type transformers (Oil-Immersed - Hermetically Sealed) ONAN
- Transformer rating (Standard): 500 kVA;
- Cooling medium:
- Primary voltage: 11kV;
- Secondary voltage: 415/240 V;
- Frequency: 50 Hz;
- Coupling: Dyn 11;
- Rated voltage (medium voltage) max. 24 kV
- Rated short-time withstand current (medium voltage) 16 kA / 1s;
- Rated insulation voltage (low voltage) 1,000 V;

- Rated current (low voltage) up to max. 2,500 A;
- Protection class IP2X.
- Type of mounting: On Wheels, Mounted on rails.

The Transformers shall be suitable for satisfactory continuous operation under the local climatic conditions.

## **2.3. ENERGY METER**

The meter should be able to perform satisfactorily in hot climate. The climate conditions are also prone to wide variations in the ambient conditions. The meter shall work satisfactorily even under lightning conditions and also the meter performance and life shall not be affected due to dust present in the atmosphere.

Energy meter along with its accessories shall withstand following extreme operating conditions.

- Voltage: 70% to 120 % of V ref;
- Frequency:  $50 \pm 5\%$  Hz;

The manufacturer can also offer meters, which can withstand higher variations.

The meter should be only factory calibrated and no modification of calibration should be possible at site to ensure none tampering of meter at site.

## **3. DIESEL GENERATOR (DIESEL GENSET)**

### **3.1. DESCRIPTION OF FEATURES**

#### **3.1.1. DESCRIPTION**

The purpose of this document is to describe the generating set installations.

The 450kVA (ESP) generating set will operate as backup generators in place of the main power grid in the event of a mains power failure.

The connection between the power plant and the low voltage central control panel is included in the Mains switchboard.



The installations include:

- Supply, transport and installation of generating set(s), coolant system, exhaust silencer, machine cabinets;
- Installation of generating set(s) on the site;
- Exhaust circuit including chimney;
- Fuel circuit including daily service tank and tank;
- Ventilation circuit including rain screen grilles;
- Electrical connection of generating set to cabinet and generating set auxiliary;
- Site smoke control;
- Installation commissioning;
- Training;
- Studies and documentation.

### 3.1.2. APPLICABLE DIRECTIVES AND STANDARDS

Reference system for the Standards and directives governing generating sets.

#### Directives

- |  |            |
|--|------------|
| - Machines directive (1)               | 98/37/CE   |
| - Low voltage directive                | 206/95/CE  |
| - EMC directive (2)                    | 89/336/CEE |
| - Outdoor directive                    | 2000/14/CE |
| - (3) Directive 2006/42/CE (29/12/94)  |            |
| - (4) Directive 2004/108/CE (01/07/07) |            |

#### General Information

- |   |                  |
|---|------------------|
| - Engine output   | ISO 3046-1       |
| - Performance, generating set application classes, methods of application , and others. | ISO 8528-1 to 10 |
| - Generating set safety   | EN 12601         |
| - General safety principles   | ISO 12100        |

#### Engine

- |                                   |          |
|-----------------------------------|----------|
| - Measuring exhaust gas emissions | ISO 8178 |
|-----------------------------------|----------|

- Engine safety EN 1679-1

#### Alternator

- Rotating electrical machines IEC 60034

#### Electrical equipment

- Electrical safety IEC 60364-4-41
- Control gear and switchgear ISO 8528-4
- Low voltage equipment IEC 60947-1 à 13
- Low voltage equipment assemblies IEC 60439-1
- Degrees of protection (IP) provided by enclosures for electrical equipment IEC 60529

This list is not exhaustive. It summarizes the main standards and directives which apply.

### **3.1.3. QUALITY**

The entire project (studies, construction and installation) shall be managed using a business management process according to ISO 9001 certification guidelines (2000 version).

The company shall include in its tender a summary of its Quality Management Procedure.

### **3.1.4. DEFINITION OF SERVICE**

The emergency standby power is the standby power available for emergency use under variable loads in accordance with ISO 8528-1. No overload is available for this service.

Emergency standby power applies to installations served by a reliable utility source. Standby power is applicable to varying loads for the duration of the utility power interruption.

## **3.2. DESCRIPTION OF FEATURES**

It is considered the supply and installation of a power generator Unit, 900kVA output in Standby Power (ESP) and 405kVA in prime service, (PRP "Prime Power" according to norm ISO 8528-1), FP=0,8, 50 Hz and 1.500 rpm, including a Fuel tank with a capacity of 540 liters, filled, for a range of 11 hr at 100% of the Prime Power.

### **3.2.1. FACTORY TESTS**

The purpose of the tests, attended by the customer or his representative, is to validate the technical performance of the generating sets.

Tests on the complete generating sets assembled in the factory, in the presence of the Client, the Project Manager and the control office. The costs of transport and accommodation are borne by the contractor for this lot.

Visual inspection of the station before starting:

Static examination enabling the conformity of the assembled elements to be inspected:

- General appearance (paints, finish, welding, mountings, etc.)
- Dimensional (overall dimensions, etc...)
- Indications of the manufacturer's plates
- Protection against direct contact (busbars, etc....)
- Dimensioning of the connection points (electrical or mechanical)
- Inspection of the circuit breaker (number of poles, starting value, etc.)

Functional tests:

- Tests on safety devices;
- Checking of information on the command and control desk or cabinet;
- Visual inspection of the circuit sealing: cooling circuit, oil circuit and fuel circuit;
- Checks on absence of vibrations and abnormal noises;
- Examination of the starting and stopping cycle;
- Operating tests of the automatic control units.

Load tests:

The load tests will be carried out in steps of 25 %, 50 %, 75 %, 100 % and 110% on cos phi 1 liquid resistances.

At each of these steps the following must be recorded, indicating the electrical parameters:

- Voltage;
- Frequency;
- Intensity;
- Power.

At 100 % and 110 %, additional oil pressure and water temperature recordings must also be noted.

### Load impacts:

The load impact measurements must be carried out at different steps of the power assigned with a flat table tracer.

A graphic recording of the frequency and voltage transients must be performed at each of the following impacts:

- > 0 -25 % / 25 - 0%
- > 0 -50 % / 50 - 0%
- a test at maximum power meeting the acceptance criteria for the voltage and frequency drops
- a test at the maximum power applied to the set outside the acceptance criteria
- The results must be entered on a sheet of tests listed in the quality system.

### Validation:

After the tests a factory acceptance test report must be signed.

## **3.2.2. TECHNICAL DOCUMENTATION**

### User and maintenance manual for generating sets

This reference material provides users with information concerning the equipment, operating instructions, and guidelines on daily maintenance.

- Documentation for alternators General information -Safety instructions -Installation -Special maintenance instructions.
- Descriptive documentation and user manuals for control units: this documentation provides users with information concerning the equipment and operating instructions.
- Technical documentation for engines
- Technical

### Engine parts catalogue

This documentation enables users to identify a part for the purposes of ordering a replacement.

- Repair and workshop manual
- This documentation enables expert users to carry out equipment repairs.
- Wiring diagrams of the command and control system
- Factory test procedures for the assembled sets

- Summary of the Quality Management manual

### **3.3. MONITORING AND CONTROL SWITCHBOARD**

The power generator set is equipped with a reliable monitoring and control switchboard. This equipment is mounted on the power generator.

#### **3.3.1. AUTOMATIC SWITCHBOARD**

The equipment must be based on a programmable module with three microprocessors, specialized in their respective tasks of electrical measurements, the generator logic and communications group, which gives the equipment a good performance process.

Should be prepared to work under extreme ambient temperatures from -30°C to + 70°C; and a great protection against electrical disturbances such as lightning discharges.

The screen must be at least a TFT Color 5.7 "display. The front panel keys must allow access to different screens.

## **4. TERTIARY POWER SUPPLY (UPS)**

For priority loads (medical IT services) and ICT equipment, will be considered a decentralized UPS's Systems, restricted to supporting critical care and essential services rather than being a main (whole site) SPS.

- Medical (UPS system) – for medical and healthcare applications;
- ICT (UPS system) – for ICT equipment. The source will consist of a rack mount UPS.

Observation: For Priority loads (critical care) central UPS systems have risks to be consider, like location and segregation of UPS distribution cabling and switchboard configuration, to avoid a single fire or fault affecting the whole system.

The Topology of the UPS Systems must be VFI (Voltage and Frequency Independent accordingly with classification mentioned in the IEC62040-3Standard), in order to guarantee filtered and stable output voltage to the load, independently from the input voltage. This means that the output is obtained by two converters in cascade. The first converter rectifies the AC input voltage, the second converter (Inverter) transforms the DC voltage, coming from the rectifier, in AC voltage to supply the load. This double conversion allows to completely clean eventual disturbs from the mains. In case of anomalies in the input voltage, the DC voltage, which supply the Inverter, can be obtained, thought a booster circuit, from batteries. In this way the output is always guaranteed with continuity. In case of overloads or faults, the automatic static by-pass guarantees the load supply.

## 4.1. STANDARDS

- EN 62040-1-1 (Security);
- EN 62040-2 (EMC);
- EN 62040-3 (Performance and Topology);
- CE Certification;
- IP 20 (according to IEC 60529).

## 4.2. FUNCTION PRINCIPLE

The UPS should be of the On-line double conversion and work in the following ways:

- Normal operation - When the network is present;
- Under Batteries - When the network is not present or is outside the tolerances;
- Normal Operation with Battery Recharging - When the network returns;
- Operation in static bypass - When the overload occurs;
- Operation in Bypass Manual - For maintenance operations.

## 5. LOW VOLTAGE SWITCHGEAR

### 5.1. MAIN & SUB-MAIN DISTRIBUTION BOARDS

The Main & Sub-Main Distribution Board/s (MDB/s & SMDB/s) shall be of floor-standing, totally enclosed type, built up from enclosed units housing the Air Circuit Breakers (ACB), Moulded Case Circuit Breakers (MCCB), Fuses, Contactors, Relays, Bus Bars and other ancillary equipment as shown on the drawings.

MLVS shall fully comply with BS EN 60439 – 1 and the segregation amongst the Switchgear components shall be of Form 3b.

The Bus Bar system of the MDB shall be capable to withstand the electrical and mechanical stresses and temperature rise produced by a fault with a magnitude of 25kA for 3 seconds.

The construction of the indoor type MDB shall be designed to have the degree of protection of IP42 or higher in accordance with the standard requirement of IEC 60529.

The construction of the MDB shall be modular construction metal enclosure by electro galvanized steel sheets not less than 2mm thick and Epoxy powder coated to BS 4800 to provide resistance to corrosion.

The panel shall be built up on substantial framing with all necessary stiffeners and supports with no cross struts. The entire panel shall be vermin proof.

Front access doors shall be provided and with hinges and lockable handles to facilitate inspection and maintenance. Removable gland plates shall be provided at the top and at the bottom of the switchboard with knockouts or blanked off openings for incoming and outgoing circuit cables.

All doors shall have concealed hinges and where necessary, shall be interlocked with the switch mechanism. All doors shall be provided with gaskets made of Neoprene or other equal and approved material to prevent ingress of dust.

## **5.2. SUB & FINAL DISTRIBUTION BOARDS**

The distribution Board/s (DB/s) installed for connection of the final Circuits within the electrical installations shall be factory built complying with BS EN 61439/IEC 61439. An integral isolator shall be provided for isolation of the incoming supply. The circuit breaker accessories, etc. shall generally comply with the international standards. Re-wirable type fuses shall not be permitted in any type of wiring installation.

## **5.3. EQUIPMENT REQUIREMENTS**

For each equipment, required IP rating and short circuit rating capacity will be specified.

All the equipment's will be factory fabricated in an approved factory having modern fabrication and testing process. It shall have seven tank pre-treatment process comprising of degreasing, rinsing, de-rusting, rinsing, phosphatising, rinsing and passivation followed by powder coat painting having a paint thickness of 60 microns or as specified. The powder paint will be subjected to oven-heated process. All panels will be provided with suitable gasket to make it dust/ vermin proof.

As a general practice only prewired MCB/HRC type DBs shall be used, on account of their superior technical features, compared to conventional DBs, which don't allow for proper wiring space and wiring termination. Rewirable fuse type DBs shall not be used.

## 5.4. SWITCHBOARDS CHARACTERISTICS

### a) WALL MOUNT

The body frame and door should be metal with interior self-extinguishing polyester. Should be versatile and flexible composition and easy installation. The chassis should be removable for bench electrification. Should allow modular devices assembling simply and rapidly, with the following main features:

– Rated current	630A
– Degree of Protection	IP 31
– Isolation	I
– Standard	IEC 61439
– Mechanical impacts	IK 10
– rated insulation voltage for the main busbars	1000 V
– peak withstand current	Ipk 53 kA
– short time withstand current	Icw 25 kA ef/ 1 s
– Frequency:	50/60 Hz
– Color	White RAL 9001
– Frame height	450 a 1750mm
– Widths	600 mm
– Depths	260 mm + door
– Reversible door	Transparent

Reference equipment: Schneider / Prisma G, or equivalent.

### b) General Characteristics of the devices/mechanisms

The low voltage switchgear shall comply with EN 60 947.

#### Switches General:

Four-pole load break, compact type, with the rated current indicated on the drawings.

#### Residual current device or ground-fault circuit equipment (RCD or GFPE):

Bipolar or four poles set for the rated current and rated differential triggering currents indicated on the drawings.



Switches:

Unipolar or bipolar, modular type, with the rated current indicated on the drawings.

Breakers:

With the number of poles indicated on the drawings and ultimate breaking capacity appropriated for the switchboard in which they are installed.

Shall be modular type or in molded case, depending on the sizes and the frames where they will be installed.

Residual-current circuit breaker with overload protection (RCBO):

Bipolar or four pole set for the intensities and shooting nominal differential currents indicated on the drawings.

Contactors:

Shall be provided for the operating rated current AC3.

Voltage flags:

Shall be modular with optical indicator.

Disconnectors fuses:

Shall be equipped with fuses with high rupturing capacity, withdrawable type via knob tipper, equipped with cylindrical fuses 10,3 x38, and size indicated in drawings.

Rail:

In ladder and fitted with rail plastic transparent protection, insulating and self-extinguishing.

Rulers Terminals:

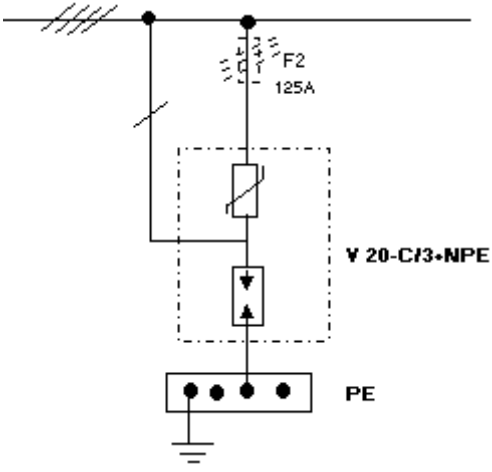
Terminals with insulating body, nonflammable, insensitive to climate and thermal variations.

All terminals shall be marked to allow simple referencing. The terminal blocks shall be withdrawable type.

Reference equipment: SCHNEIDER / Multi9 and Compact, or equivalent.

Surge Arresters:

Overvoltage, embedded within a closed box, with the following features:

<p>Switchboard:</p> <p>Surge arrester on monoblock base with pluggable protection modules, electrified in 3 +1 scheme, equipped with varistors between phases and neutral with 20kA nominal discharge capacity (8/20) and module NPE between neutral and earth of 50kA (8/20).</p> <p>With local signaling of the operating status of the varistor:</p> <p>- Model: V20-C / 3 + NPE</p> <p>125A Fuses Necessary when the overall protection exceeds 125A</p>	
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Reference equipment: Obo Bettermann / V20-C/3+NPE, or equivalent.

## 5.5. MANUAL MUSHROOM HEAD BUTTON

Emergency pushbutton with breakable glass suitable for surface mounting, red body and mushroom button head, unlocking by key, equipped with two signalling LEDs (red / green - 230V - 20mA).

Features:

- In accordance with standard NFC 15-100
- IP44 - IK07
- Class II insulation
- Equipped with contacts 1NO +1 NC
- Dimensions: 125x125x71mm

Reference equipment: LEGRAND /Model 380 09, or equivalent.

## 6. EARTH CONNECTION

### 6.1. EARTHING SYSTEM – FOUNDATION EARTH ELECTRODE

Foundation earth electrodes are conductive metal parts embedded in the concrete of the building foundation. Concrete embedded directly in the ground has natural moisture content and can be considered as conductive matter, with conductivity similar to that of the earth. Because of the large area of this type of electrode, low resistance can be achieved.

Furthermore, the concrete protects the metal parts against corrosion and steel electrode elements embedded in the concrete do not need any additional corrosive protection. Foundation earth electrodes are nowadays recommended as a very practical solution to building earthing.

#### 6.1.1. MATERIALS

The earth electrode is made from:

Inside the concrete

- Flat conductor with a rectangular cross-section 30x3,5mm, galvanized steel according ISO 1461
- Spacer 250mm long, galvanized steel,
- Cross-connector for flat conductors, galvanized steel,
- Cross-connector for flat conductors and round conductors, galvanized steel,
- Connection terminal for reinforcing steels, galvanized steel,

Outside of the concrete – In the ground

- Flat conductor with a rectangular cross-section 30x3,5mm, made of stainless steel
- Earthing rod Ø 20mm x 1500mm, made of stainless steel
- Connection clip for earthing rod, stainless steel

### 6.2. EQUIPOTENTIAL BONDING

The equipotential bonding system is the link between external lightning protection, surge protection and earthing. In order to avoid damage inside the building, a lightning protection equipotential bonding is necessary.

### 6.2.1. SYSTEM COMPONENTS TO BE CONNECTED

The following system components must be connected to the equipotential bonding:

- Metal carcass of the structure
- Metal installations
- External conductive components
- Electrical energy and information
- Technology systems

### 6.2.2. INSTALLING THE EQUIPOTENTIAL BONDING

The equipotential bonding should be installed at the basement or at ground level. The electrical energy and information technology lines must be connected to the equipotential bonding via Type 1 lightning current arresters. The arresters must be connected to the equipotential bonding as close as possible to where the lines enter the building. The surge arrester connection must comply with DIN VDE 0100-534.

### 6.2.3. MATERIALS

The following cross-sections apply as minimum dimensions for connections in the lightning protection equipotential bonding

- Copper: 16 mm<sup>2</sup>
- Aluminum: 25 mm<sup>2</sup>
- Steel: 50 mm<sup>2</sup>

Main equipotential bonding rail – copper 40x5 mm with 10 lock bolts M10, type 1802/10 Cu,

Local equipotential bonding rail – brass with cover, type 1801/VDE

Reference equipment: Obo Bettermann or equivalent.

### 6.3. MAIN EARTHING TERMINAL

A solid copper main earthing terminal of ample size shall be provided for every electrical installation at a position near the main incoming switch or switchboard for the connection of:

- the circuit protective conductors,
- the main equipotential bonding conductors,
- the functional earthing conductors,
- the earthing conductors and
- the lightning protective system bonding conductors.

To create the equipotential zone. The main earthing terminal shall be connected to Earth via an earthing conductor to an earth electrode or a group of electrodes.

Where an installation distributes to a number of buildings or units, a separate main earthing terminal shall be provided for each individual building or unit at the point of intake thereby creating a separate equipotential zone in each building or unit.

## 7. LIGHTNING PROTECTION SYSTEM

Lightning protection systems shall be installed in accordance with the Particular Specification and Drawings, and as directed by the Architect.

The installation shall conform to the requirements and recommendations set out in the British Standard BS 6651 “Code of Practice for Protection of Structures against Lightning”

### 7.1. DOWN-CONDUCTORS (ARRESTOR SYSTEM)

The arrestor system routes the lightning current from interception system to earthing system. The number of arrestors is derived from the scope of the building to be protected. Care must be taken to ensure that the current paths are short and installed without loops. The number of down conductors is showing in the drawings

The use of reinforcements as conductors optimizes shielding against external electromagnetic interferences.

### 7.1.1. NATURAL COMPONENTS

The interconnected steel framework of the structure is to be used as natural down-conductors.

Accessories:

- Construction clamp to 20mm, type 5010/20FT for connection, on bottom of steel pillar with earth conductor and on the top with interception system.

### 7.1.2. CONDUCTORS INSIDE CONCRETE PILLARS

In building structures that feature steel reinforced concrete pillars and walls, the conductors can be routed in the reinforcements.

The down-conductors are established inside the steel reinforced concrete pillars.

The conductors also have to be clamped to the steel reinforcements.

Earthing fixed points should be used as connection points for conductors and equipotential bonding.

### 7.1.3. MATERIALS

- Round conductor cross-section 50mm<sup>2</sup>, Ø 8mm, galvanized steel according ISO 1461;
- Cross-connector for round conductors, galvanized steel;
- Connection terminal for reinforcing steels, galvanized steel;
- Earthing fixing point, made of stainless steel, contact plate Ø 79 mm, thread M10;
- Construction clamp to 20mm, galvanized steel.

## 7.2. DOWN-CONDUCTORS (ARRESTOR SYSTEM)

The external LPS is intended to intercept direct lightning flashes to the structure, including flashes to the side of the structure, and conduct the lightning current from the point of strike to ground. The external LPS is also intended to disperse this current into the earth without causing thermal or mechanical damage, or dangerous sparking which may trigger fire or explosions.

The interception system is composed by the combination of the following elements:

- Meshed conductors;
- Rods.

### 7.2.1. INTERCEPTION SYSTEM FOR BUILDINGS WITH ROOF STRUCTURES

All metallic parts of a building and electrically powered equipment and their supply cables must be integrated into the lightning protection system. This measure is required to avoid dangerous sparking between both interception system and arrestor and also the metallic building parts and electrical equipment.

The insulation by separation distance is necessary for air-conditioning systems, photovoltaic systems, electrical sensors/actuators or metallic vent pipes with conductive lead into the building.

### 7.2.2. MATERIALS

- Round cable, galvanized steel according ISO 1461;
- Vario Quick connector, steel galvanized, for T, cross and parallel connections;
- Roof cable holder for flat roofs, stone from concrete with plastic bottom;
- Interception rod, aluminum, with concrete stand;

Reference equipment: Obo Bettermann or equivalent.

## 8. LIGHTING

In this chapter we consider the following types of lighting:

- Normal Ambient lighting;
- Emergency lighting.

### 8.1. NORMAL AMBIENT LIGHTING

#### 8.1.1. GENERAL

All luminaires must be an approved type and manufacture, and be manufactured in accordance with the appropriate Design and Installation Standards and Requirements.

LED lighting only shall be used. The installer / manufacturer shall warrant the equipment, control gear, drivers, and luminaire for 5 years or 50,000 hours from the formal completion of the works.

All luminaires shall properly electrified with lamps and accessories for a voltage of 240 V, 50 Hz.

All luminaires are fixed to the ceiling or walls in order to ensure a strong fixation.

All lighting appliances shall follow the directive to electromagnetic compatibility relating.

The lighting appliances shall conform to IEC 598, regarding the implementation and security.

### **8.1.2. INDOOR LUMINAIRES DESCRIPTION**

See the legend of the lighting drawings and the attached technical report.

## **8.2. EMERGENCY LIGHTNING**

In the situation of normal network failure, will enter service security lighting will ensure the minimum illumination for safe evacuation and easy public abroad and execution of maneuvers concerning the safety of aid and intervention.

The emergency lighting shall consist of two types of lighting:

- Lighting Circulation (evacuation)
- Lighting Environment (anti-panic)

The emergency lighting to be implemented consists of autonomous blocks equipped with led lamps.

### **8.2.1. CIRCULATION LIGHTING**

In all corridors and escape routes will be installed autonomous blocks fitted with a led lamp 3W, for continuous operation, powered from batteries incorporated in the unit, which will ensure the safe evacuation and easy public (in fault situations network).

The autonomous blocks possess autonomy of at least one (1) hour.

All autonomous blocks will be endowed with pictographic symbols, clearly indicating access to outside according to Ordinance 1456A/95.

The light path of movement of each evacuation length exceeding 15m is made by at least two independent blocks.

### **8.2.2. ANTI-PANIC LIGHTING**

The emergency and safety lighting will be guaranteed by the normal ambient lighting, supplied by the backup power system of the hospital

## **8.3. EXTERNAL LIGHTING**

Where specified in the project, complete external lighting systems must be provided, including supply and assembly of all posts, columns and supports.

Includes free standing columns, and luminaires fix to structures and buildings.



The luminaires mounted on buildings, must have the wiring routed within the building.

All columns must be of the flange base type, suitable for fixing to concrete foundations.

## **8.4. INSTALLATION**

### **8.4.1. PENDANT**

Tube pendant shall comprise a dome cover and a biscuit ring and a piece of screwed steel conduit of suitable length to give the required mounting height of the luminaire.

Plain pendant shall comprise a ceiling rose and a cord-grip lampholder connected by a flexible cord having a suitable length to give the required mounting height of the lamp shade.

### **8.4.2. LUMINAIRE MOUNTED ON PATTRESS**

When a luminaire is not provided with facility for a surface cable entry, the luminaire shall be mounted on pattress. The cable shall then enter the luminaire from the rear through a slot and a hole formed in the pattress.

### **8.4.3. CEILING ROSE**

Ceiling rose shall not be used for the attachment of more than one outgoing flexible cord or cable unless it is specially designed for multiple pendants.

### **8.4.4. CABLE IN ENCLOSED LUMINAIRE**

Cables within an enclosed type luminaire shall be of heat resistant type. Cables entering the luminaire shall be protected by heat resistant insulating sleeves. The sleeves within the luminaire shall be extended to a distance of 150mm outside the luminaire.

Heat resisting cables shall be selected in accordance with the appropriate tables given in IEC 60364.

### **8.4.5. SPECIAL REQUIREMENTS FOR OUTDOOR LUMINAIRES**

Outdoor luminaires shall be able to withstand the weather. Metal work should be protected against corrosion, and parts which have to be removed for access to the interior shall be provided with proper gaskets to restrict the entrance of moisture and dirt. Mounting brackets shall be heavily galvanized and stainless steel or galvanized bolts and nuts shall be used.

The adjustment bolts and nuts of a luminaire which is mounted on high level shall be captive to prevent accidental loss during servicing. Safety chains shall be provided to hold the luminaire from falling. A luminaire installed in a location within hand reach shall be of robust construct, fitted with an impact-resistant transparent or diffusing front panel, and shall have secret key fixings for the panel to the body of the luminaire.

Where necessary, wire guards shall be fitted over the front panel to give extra protection.

## **8.5. DEVICES**

All devices/mechanisms will be for the rated current 10, 250 V, 50 Hz

### **8.5.1. FLUSH MOUNT**

The devices/mechanisms for flush mounting is fixed to switchgear boxes fit through appropriate supports. The various appliances when installed in groups always take individual frames.

Reference equipment: Berker (British Standard) / model K1, or equivalent.

### **8.5.2. SURFACE MOUNT**

The surface mount devices/mechanisms will be waterproof type IP55 - IK07.

Reference equipment: Berker (British Standard) / model Aquatec, or equivalent.

### **8.5.3. INSTALLATION OF DOMESTIC SWITCHES**

Switch for domestic and similar purposes shall be mounted at a height of 1350mm above finished floor level unless otherwise specified.

When lighting switches are mounted adjacent to one another, they shall be grouped in a single enclosure (multi-gang box) and shall share a common switch plate, subject to a maximum of three lighting switches per single-gang plate.

Lighting switches installed adjacent to a door shall be located on the handle side of the door, and shall be as near to the door as practicable.

## **8.6. PRESENCE DETECTORS AND LUMINOSITY**

### **8.6.1. WALL MOUNTED**

- Wall motion detector with the sensing field 180 ° relay model
- With acoustic sensor for use in embedded spaces injured or obstacles
- Programmable distance remote control, p. former., permanent light
- ON / OFF and automatic read function of the current brightness value
- Compatible with tag switches, substituting therefore any conventional switch
- Model IP 44 suitable for damp rooms, garages and access to caves
- Vandal resistant cover with stainless steel screws (accessory)

- Double-socket terminals for through-wiring allow for quick and simple assembly
- Manual switching of the switch ON / OFF / AUTO integrated
- Prevents inadvertent switching, for example, small animals to hide part of the sensing field with vertical adjustable cap included
- Mounting box IP 54 with three tabs membrane cable.
- Function integrated impulses to trigger PLC ladder or signaling devices/mechanisms and application in intelligent buildings

#### Technical characteristics:

- System voltage 240 V CA, 50 Hz
- Approximate power consumption. 0,9 W
- Detection field 180° horizontal, 60° vertical
- Reach 8 m, with mounting height of 1.1 m - 2,2 m
- Adjustment options: level through mechanical potentiometers; the electronic level with infrared remote control; Mobil-PDi/MDi (included)
- Power Switching 240 V CA 50 Hz: 2300 W/10 A ( $\cos \phi = 1$ ), 1150 VA/5 A ( $\cos \phi = 0,5$ )

#### Timing:

- Pulse of about 15 s - 30 min.
- Brightness value about 5 - 2000 Lux
- Input device "slave" Yes
- Allowable temperature -25 °C...+55 °C
- Protection Level IP 44
- Protection Class II
- Certification TUV Sud
- Mounting Type Wall Mount
- Casing UV-resistant polycarbonate

Reference equipment: BEG, model 180i/R+Panel IP44 or equivalent.

### 8.6.2. CEILING INSTALLATION

#### a) ON/ OFF CONTROL

Presence detector with field detection 360, 10m range, ceiling mount, recessed.

Recommended mounting height of 2.5 m in height

Channel 1 for lighting control based on the presence, with constant measuring the amount of light, making the drive lighting when natural light level drops below the programmed through software calculation inserted into the detector.

Model IP 20 for mounting recessed.

Control and programming via remote control, ability to turn on / off the light permanently.

Possibility of expanding the field of detection of the detector by coupling master Slave detectors

Reference equipment: BEG, model PD9-M-FC-White or equivalent.

#### b) ON/ OFF CONTROL IP65

Presence detector with field detection 360, 10m range, ceiling mount, recessed. Recommended mounting height of 2.5 m in height

Channel 1 potential free control for lighting because of the presence with constant measuring the amount of light, making the drive lighting when natural light level drops below the programmed through software calculation inserted into the detector.

Model IP 65 for mounting recessed.

Control and programming via remote control, ability to turn on / off the light permanently.

Possibility of expanding the field of detection of the detector by coupling master 1 slave detector, which can be installed up to 3m detector master

For use in bathrooms, shower cabins, among other.

Reference equipment: BEG, model PD9-M-SDB-FC-white or equivalent.

## 9. SOCKETS-OUTLETS AND DRIVING FORCE

All sockets used will be always provided with earthing contact, British Standard model, in versions for surface mounting, mounting pad and installation in trough footer.

### 9.1. SOCKETS

#### 9.1.1. SINGLE-PHASE SOCKET

The single-phase sockets with earth terminal, will be British Standard type with rated current 16 A, 240 V, 50 Hz, designed without active parts accessible to the user.

The sockets installed on technical areas shall be suitable for surface mounting. Elsewhere shall be suitable for flush mounting.

##### a) Flush Mounting

The sockets for flushed mounting are housed inside the devices recessed-mounting boxes, to which they are fixed by screws.

All sockets when installed together, always inherit individual mirrors.

Reference equipment: Berker (British Standard) / model K1 or equivalent

##### b) Cable Tray Mounting

The single-phase sockets for mounting on underfloor boxes shall be British Standard type.

Reference equipment: Berker (British Standard) / model K1 or equivalent.

### 9.2. INSTALLATION OF SOCKET OUTLETS

Socket outlet intended for supplying a fixed or stationary appliance shall be located as near as possible to the appliance.

Socket outlet shall be mounted at a height of 1350mm above finished floor level in kitchens, sculleries, ironing rooms and the like. In other locations, they shall be mounted at 300mm from finished floor level, 75mm from surface top measured from bottom of socket outlet or as specified.

The installation of socket outlets in hazardous areas should be avoided as far as possible. Where it is absolutely essential to install a socket outlet in such area, the socket outlet shall be type 'e' - increased safety conforming to IEC 60309-3 and shall be controlled by a sparkles switch. The socket outlet shall be interlocked with the plug so that removal or insertion shall not be possible unless the controlling switch is

in the OFF position. The plug shall have shrouded pins and the design of the pin contacts shall be such as to guard against development of hot spots or sparking.

## **10. CABLE TRAY**

In sections common to several electrical cables shall be proposed cable trays (shelves) for laying the cables horizontally or vertically.

The cable trays are fixed to walls or ceilings by suitable fixing devices which ensure a good attachment, and when they are metallic shall be treated against corrosion.

The cable trays that are installed together, may be placed at various levels, where deemed appropriate.

Electrical cables are tied or simply supported so as to ensure a good stability and parallelism between them.

Along with cable routes shall be provided the necessary accessories whenever there is change of section or direction.

In addition to the proposed cable tray more can be installed in other false ceiling areas in alternative to cables fixed by clamps mounted at sight.

In the floor transitions shall be considered cable trays with dimensions identical to those used in the horizontal pathways.

### **10.1. FIXING**

Cable trays shall be fixed securely to the walls, ceiling or other structure by means of mild steel hangers or brackets of adequate mechanical strength. The hangers or brackets shall be painted with anti-rust epoxy paint unless otherwise specified. Fixings for cable trays shall be disposed at regular intervals not exceeding 1.2m for straight run and at a distance not exceeding 225mm on both sides from a bend or intersection.

A minimum clear space of 20mm shall be left behind all cable trays.

### **10.2. FIXING OF CABLE ON TRAY**

Saddles for securing multi-core cables to the cable tray shall be made from PVC covered metal strip, and shall be shaped to the form of the cables to be secured. The saddles shall be fixed to the cable tray by means of corrosion resistant cheese-headed screws and nuts. The shanks of the screws shall not protrude beyond the nuts by more than three threads. Where saddles exceed 150mm in length, intermediate fixings shall be provided such that the maximum spacing between screws shall not exceed 150mm.

Single-core cables shall be secured to the cable tray by clamps made of wood or other non-ferrous materials specially designed to suit the dimension of the cables. The clamp shall be secured to the cable tray by means of bolts, washers and nuts.

Cable saddles or cable clamps shall be provided along the entire cable route with their spacings in accordance with the manufacturer's recommendation.

### **10.3. CABLE TRAY IN STEEL PLATE**

The cable trays in steel plate perforated galvanized by Sendzimir method.

Shall be installed where indicated on plans and will support the various wiring.

Reference equipment: Obo Bettermann, model RKS-Magic FS or equivalent.

### **10.4. SERVICE OUTLET**

Service outlet for twelve accessories module 45 in three GB3 mounting boxes for use in raised floors systems. Universal fixing bracket, adjustable to raised floor thicknesses to 65 mm. Carpet protection frame, hinged cover and cord outlet made of polyamide. Allow 5 mm floor covering recess in the hinged cover, if necessary, adjustable to 3, 8 or 10 mm.

Reference equipment: OBO Ackermann, model GES9DBK1 or equivalent.

## **11. WIRING**

Cables for lighting and bell circuits shall have CSA of not less than 1.5mm<sup>2</sup>, and those for power circuits shall have CSA of not less than 2.5mm<sup>2</sup>. Internal wiring in factory made panel or equipment may comprise cables of different suitable CSA determined by the manufacturer.

The CSA of any cable shall not be reduced at its point of termination, junction, joints, etc.

Where signal cables of less 1.0mm<sup>2</sup> are to be terminated, approximately 15mm long of cable insulation shall be removed and half the length of the bare conductor shall be bent into the other half to form a solid part prior to the insertion into the termination.

In areas with ceiling void, between the cable tray and the terminal equipment, it shall be provided cable mechanical protection, consisting on tubes fixed on clamps.

In general, and as an alternative to cables fixed directly on clamps, they can be threaded into tubes of appropriate diameter, as long as the distances to overcome are appreciable.

The conduits to apply the salient premises must be formed by halogen-free material not flame spreader, and may be of thermoplastic material, VD type, when in masonry elements.

The tubes when installed in a building void (ceiling void), shall be mounted on plastic brackets:

- 1 conduit .....simple band
- 2 conduits .....double band
- more of 2 conduits .....band in perforated trays

The maximum distance between brackets will be:

- 0,50 m for conduit  $\varnothing$  16 and  $\varnothing$  20
- 1,00 m for conduits of diameter equal or greater than  $\varnothing$  25

The diameters of the conduits for cables provided are as follows

All screws of clamps should be galvanized iron or brass

The tubes when in masonry should be embed 3 cm from the surface of the walls and involved in cement grout of the same composition as the wall.

The connection between the tubes themselves shall be made by appropriate unions, properly bonded by cellulosic type glue.

For wire threading ease, the conduits should intercalate terminal boxes with appropriate dimensions for the number and diameter of conduits, in each 10 meters of the straight sections and all points considered focal (changes in direction and curves).

In embed premises all conduits should intercept the mechanism recessed-mounting boxes vertically (from below or above), not being allowed oblique routes.

## 12. BOXES

- a) Junction boxes and passage for surface mounting

The boxes are made of halogen-free material should be of good quality.

Shall have the following minimum dimensions:

- 80 x 80 x 42 mm – for pipes  $\varnothing$  16 and  $\varnothing$  20 up to a maximum of 5 entries.
- 103 x 103 x 45 mm – for pipes  $\varnothing$  25 up to a maximum of 5 entries.



- 160 x 102 x 55 mm – for pipes Ø 32.

In the bonds boxes to use pipes shall be of the same material nozzles rigid boxes with nut.

In the cable connections to the boxes using cable glands will be based with the proper dimensions to the diameters of the cables.

The covers are fixed by means of screws cadmium-plated or chrome plated brass.

In junction boxes, the connections of the conductors shall be made by means of end plates in nickel plated brass with porcelain base.

Reference equipment: Obo Bettermann, or equivalent.

b) Junction boxes flush mounting

These boxes shall have minimum dimensions for the boxes indicated earlier, are suitable for mounting pad, made of rigid PVC, and should be of good quality and reputed brand in the market. In connection with these cases the RV, will be used with mouthpieces rigid anvil, properly bonded.

Reference equipment: Obo Bettermann, or equivalent.

c) Mechanism recessed-mounting boxes

For mounting the devices/mechanisms, flushed, shall be used PVC rigid boxes of good quality and from a reputed brand in the market.

In case of circuit shunt may be used slings recessed-mounting boxes (only in socket circuits) as long as it is in the same compartment.

The mechanisms must be fixed to the boxes via screw, nickel plated brass, or galvanized.

A color code shall be used for marking the junction boxes to identify the circuits to which they belong: security lighting, outlets and telecommunication. This code must appear on a list to be displayed in a plastic bag, near the electrical panel.

Reference equipment: Obo Bettermann, or equivalent.

d) Terminal boxes

Thermoplastic box, halogen-free, for flush mounting, self-extinguishing, with minimum dimensions of 100x100x45mm including cover and all wiring accessories.

Reference equipment: Obo Bettermann, or equivalent.

### 13. FIXING SCREW AND BOLT

Machine screws and nuts shall be to ISO/R885. Hexagon bolts, screws and nuts shall be to BS EN 24016, BS EN 24018 and BS EN 24034. Wood screws shall be to BS 1210 with countersunk head unless otherwise specified. Bolts, nuts and washers shall be manufactured from non-ferrous materials. Holes for bolts, screws and other fixings shall be drilled or stamped, and no larger than required for clearance of the bolt, screw, etc.

### 14. TRUNKING SYSTEM

Bi-compartmentalized PVC trunking shall be considered in some places.

Sizes and types of trunking shall be as called for in the various sections of the Specification or on the drawings, or shall in any case be of sufficient size to accommodate the wiring required whilst still ensuring the appropriate space factor.

Plastic trunking shall be rigid PVC heavy gauge, white, high impact complete with lid, full length back tray and manufactured fittings.

Plastic trunking shall be installed in accordance with manufacturer's recommendations.

Plastic trunkings shall be secured rigidly to building fabrics using round headed steel wood screws in manufactured plugs with oversize washers to prevent screw heads pulling through holes in trunking

All plastic trunkings shall incorporate protective conductors.

All changes in direction of plastic trunking shall be carried out via purpose made accessories.

Plastic trunking shall be cut to length and access holes for conduit entry etc. shall be cut using only the manufacturer's special tools.

Surface fixed plastic trunking shall be routed as unobtrusively as possible following the architectural features of the room even if this entails longer runs of trunking. Trunking shall be run along full wall lengths and must not terminate part way along a wall, unless specified to the contrary.

Plastic trunking shall not be routed through areas suffering high or low temperatures.

PVC trunking and fittings shall comply with IEC 61084-1. The nominal dimensions of PVC cable trunking shall be selected from any of the following numbers in mm:

12.5, 16.0, 20.0, 25.0, 32.0, 37.5, 40.0, 50.0, 75.0, 100.0 and 150.0

Trunking shall have covers secured by purpose-made rivets. Covers of the clip-on type will be acceptable for trunking sizes up to 100 x 100 mm.

Reference equipment: Obo Bettermann, or equivalent.

## 15. HEAD WALL UNITS

The bed head unit is placed on the wall above the patient bed. It includes all the elements that are required for patient treatment and from nursing personnel and provides lighting (general and local), electrical energy (sockets), data (telephone, nurse call, etc.), medical gases and vacuum.

In rooms with architectural difficulties, where wall mounted installation is not possible, special types of BHU are suggested:

- Suspended (single / double);
- Vertical / pendant.

The following needs were identified:

- ICU Room J.12 (Block J);
- Recovery Room E.39 and Preparation Room E.40 (Block E);
- Operating Room (Block E - E48 to E52);
- NICU E,20 (Block E).

The bed head unit must be manufactured from a special profile of aluminium and coated with electrostatic paint. The characteristics of various types of the bed head units are presented in Table Annexe.

Standards:

- EN ISO 9001 and EN ISO 13485: Quality management systems;
- CE Medical Devices Marking according to 93/42/EEC Directive;
- EN ISO 11197: Medical supply units;
- EN ISO 7396-1: Medical gas pipeline systems - Part 1;
- EN 60601-1: Medical electrical equipment - Part 1.

Special care:

For Operation Theatre / ICU Resuscitation:

Reference equipment: TLV, model Fluidys (Special care) or equivalent.

Normal care rooms:

For NICU and Recovery/Preparation rooms.

Reference equipment: TLV, model Fluidys (Normal care) or equivalent.



Image 1 - Head Wall Units images

## 16. CABLE BURIED DIRECT IN GROUND

### 16.1. PROTECTION TO CABLE

Power cables buried direct in ground shall be armoured. They shall be buried at a depth of not less than 450mm and shall be protected by means of approved cable cover tiles. The bottom of the cable trench shall be covered, to a depth not less than the diameter of the largest cable, with a bedding layer of sand or fine soil. On top of the cables, an after layer of sand or fine soil, to a depth of 100mm, shall again be provided. The sand or fine soil shall not be larger than 13mm sieve.

Particular care shall be taken to ensure that there shall be no pebbles or small stones in the bedding layer or after layer of the fine sand or soil.

The cables shall then be covered, throughout the entire route, by approved type cable cover tiles which shall be laid on top of the after layer.

### 16.2. CABLE MARKER

The route of all power cables buried direct in ground shall be clearly indicated by cable markers laid on the ground. The cable markers shall be engraved with the following wording: "DANGER - BSB ELECTRIC CABLES"

Cable markers shall be placed at regular intervals not exceeding 60m apart and also at positions where the cable route changes direction.

At the position of each underground junction box, a cable marker shall also be installed. Such markers shall be engraved, in addition to the wordings mentioned above, the appropriate information, such as "3 way Joint Box".

## 17. POWER CABLES

Power cables are mainly for electricity supply and distribution. They shall be manufactured under British Approvals Service for Cables (BASEC) licence or an equivalent quality surveillance scheme (e.g. European Committee for Electrotechnical Standardization (CENELEC) Harmonization Scheme) and bear BASEC marking or the appropriate marking of the equivalent quality surveillance scheme (e.g. CENELEC HAR).

Power cables shall have grading as specified in Sub-section C2.2 below.

Cabling facilities will include cable ducts, cable trays and cable ladder.

### 17.1. TYPES OF POWER CABLES

Power cables for supply and distribution shall be one or a combination of the following types as specified in the Particular Specification or on the Drawings:

- 600/1000V cross-linked polyethylene (XLPE) insulated, PVC sheathed copper cables with armour, single-core, two-core, three-core or four-core, suitable for conductor operating temperature not exceeding 90oC – IEC 60502-1,
- 600/1000V low emission of smoke and corrosive gases cross-linked polyethylene (XLPE) insulated and sheathed copper cable with armour, single-core, two-core, three-core or four-core, suitable for conductor operating temperature not exceeding 90oC – BS 6724,
- 600/1000V fire resistant, low emission of smoke and corrosive gases cross-linked polyethylene (XLPE) insulated and sheathed copper cable with armour, two-core, three-core or four-core, suitable for conductor operating temperature not exceeding 90oC - Category F2 of BS 7846,
- 600/1000V PVC insulated, PVC sheathed copper cables with armour, single-core, two-core, three-core or four-core, suitable for conductor operating temperature not exceeding 70oC – IEC 60502-1,
- 600/1000V paper insulated, lead sheathed copper cables with armour, single-core, two-core, three-core or four-core, suitable for conductor operating temperature not exceeding 80oC – IEC 60055-1 and IEC 60055-2.

## 18. PLASTIC OR PVC CONDUIT

Rigid plain PVC conduits shall comply with IEC 60614-2-2 and rigid plain PVC conduit fittings shall comply with IEC 61035. Conduits shall have classification as below:

- According to mechanical properties - for heavy mechanical stress;
- According to temperature - with a permanent application temperature range of -5°C to +60°C.

## **19. OPERATION AND MAINTENANCE MANUALS**

Upon completion of the installation, the Contractor shall submit copies of operations and maintenance (O&M) manual to the Architect incorporating all amendments made during the course of the Contract, all as specified in the contract documents.

## **20. TESTING AND COMMISSIONING PROCEDURE**

Upon completion of the installation but prior to acceptance, the Contractor shall submit to the Architect in good time a schedule showing the appropriate testing and commissioning procedures to be carried out. The schedule shall be agreed by the Architect before any testing and commissioning work is carried out.

21. ANNEXES

Proposed Bed Head Unfits configuration:

				Medical Gases							Electrical Installation											
Service	Compartment	Quantities	Type	O2	N2O	CO2	ACR (4,5 bars)	ACR (8 bars)	VIDE	SEGA	Socket Outlet 2P+E	Socket Outlet 2P+E (Up5)	Connection equipotential	Indirect lighting controlled by a switch	Direct lighting controlled by switch	Simple switch to control general lighting	Double switch for controlling general lighting	Dimmer to control general lighting	Single plug type RJ45 Cat.6	Double plug type RJ45 Cat.6	Nurse call module (buttons and patient handler) *	Nurse call module (buttons, voice and patient manipulator) *
ICU	ICU Room J.12 (Block J)	8	Horizontal Head Wall Unit (HW - 1)	2	-	-	1	-	-	-	3	2	1	1	1	1	-	-	-	-	1	-
Recovery/Preparation	Recovery Room E.39 and E.40 (Block E)	10	Horizontal Head Wall Unit (HW - 2)	1	-	-	1	-	-	-	3	2	1	1	1	-	-	-	-	-	-	-
Operating Theater	Operating Room (Block E - E48 to E52)	4	Horizontal Head Wall Unit (HW - 3)	3	-	-	2	2	-	-	-	2	1	-	1	-	-	-	-	-	-	-
NICU	NICU E.20 (Block E)	4	Horizontal Head Wall Unit (HW - 4)	1	-	-	1	-	-	-	4	-	1	-	-	-	-	-	-	-	-	-
Note: All equipment must be Antimicrobial.																						

Image 2 - Head Wall Units configuration