TECHNICAL SPECIFICATIONS, DESCRIPTION OF MATERIALS AND WORKMANSHIP FOR THE ELECTRICAL WORKS IN Kilo Project- ICU REHAB

The whole of the specifications contained in this section shall be read as incorporated in all subsequent sections of the Bills of Quantities and the contractor shall include in his rates for complying therewith.

It is assumed that the contractor's supervisory and estimating staff is fully conversant with the normal standards of good workmanship and relevant publications of trade and technical organizations.

This document directs the contractor to the relevant information necessary for pricing the Bills. It is therefore essential that the text contained therein be read in conjunction with the measured items which shall be priced accordingly.

Any specified material, product or service may be substituted only with the approval of the Project Manager/ Supervising Officers.

Should it occur that any part or parts of the drawings or specifications should not be clearly intelligible to the contractor, or that the materials or methods of execution to be used in the works be considered insufficiently described or inappropriate, then the Project Manager/ Supervising Officers shall be requested in writing, to make clear, also in writing, his requirements or amendments.

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1. Preliminaries

A. Protection of the works

(i) The Contractor shall provide, erect and maintain all necessary temporary casing, masking, fencing off and screening to partly finished work including work executed by sub-contractors (nominated or otherwise) and shall also provide all necessary temporary roofs, tarpaulins, screens, planking and general protection necessary to protect the works from damage by inclement weather, and provide all temporary gutters, pipes, surface water drains and the like for conveyance of rainwater and clear away when no longer required.

B. Drying the works

(i) The Contractor shall be responsible for the adequate drying out of the works and for maintaining them at a suitable temperature and humidity until handed over.

C. Removing rubbish and cleaning

(i) Remove all rubbish and debris from the site both as it accumulates from time to time and upon completion of the works and shall not bury or otherwise conceal the same upon the site. Clean the works internally and externally upon completion to the satisfaction of the Project Manager/Supervising Officers.

D. Energy for the works

(i) The contractor must provide the energy for the works including the required protections. No claims for lack of energy supply will be entertained.

(ii) The energy setup provided by the contractor must not put in danger the workers. The contractor will be responsible for any incident related to a lack of protection.

(iii) The protection must respect the MSF standards. If MSF notices a lack of protection within the energy setup, the contractor must add the MSF requested protection.

(iv) MSF will not be responsible for any equipment failure used by the contractor.

(v) The transportation of generators and fuel must be organized and managed by the contractor.

(vi) The fuel transportation must not endanger the safety of the workers and the field.

(vii) The contractor must provide energy for the testing of works.

2. Responsibilities by the Contractor

(i) Organization chart showing the names and ranks of the staff to be engaged in the project. The organization chart shall also show the telephone number of the staff to enable the Engineer or his representative to have efficient contact with any member of staff as mentioned in the organization chart during any stage of the project. The Engineer shall be informed immediately if there is any change in such chart.

(ii) The work for opening and closing the trenches must be planned with the consideration of the other teams planning (Construction and Watsan).

(iii) The program of work. The document shall show clearly the commencement and completion dates for different areas. The Contractor shall inform the MSF Energy Manager for approval if there are adjustments of the schedule during the course of the project.

(iv) Sample board containing samples of all compact-sized materials to be used in the project for the MSF Energy Engineer's acceptance. All electrical equipment must be validated prior to installation.

(v) The Contractor shall need to make his own arrangements of the tools and other utility services as deemed necessary for the works area and the execution of works.

(vi) The Contractor shall provide the basic safety apparatus for their workers, e.g. safety glass, gloves, masks etc.

(vii) The contractor must use suitable material to partition the working areas.

(viii) A list of materials with detailed quantities and areas where these materials are installed, prior to the completion of the project.

(ix) All materials to be used should be new and of the approved type, as specified in the Bill of Quantities.

(x) Any modification from designed plan should be reported for approval before implementation. A new electrical layout indicating the changes should be submitted.

3. Work Progress Report and Meetings

(i) The MSF Electricity Manager shall call project progress meetings in his office or at the site, as he deems necessary for the control of the Contract. Normally these meetings will be conducted daily. In the meeting, the Contractor is required to describe the progress of the project, scheduling for any anticipated delay or other relevant information against each activity. The Contractor shall arrange his approved site representative or other responsible person to attend such meetings.

(ii) The Contractor shall send daily progress reports with pictures and work performed via email to the MSF Electricity Manager. A template of the daily progress report will be provided.

(iii) Weekly meetings must be held to report the progress of work. The minutes of the meeting will be sent to the Contractor for acknowledgement and necessary action.

4. Workmanship

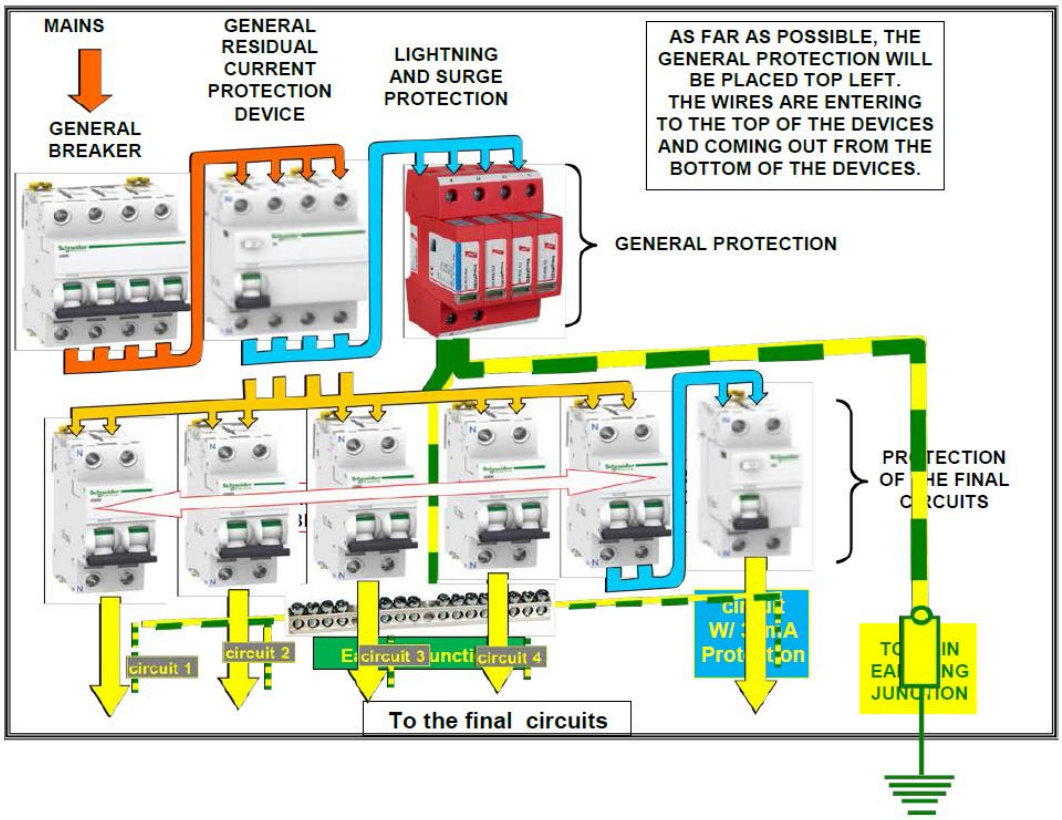
4.1 Panel Boards

(i) Panel Boards must conform to existing standards for both MSF and Yemen, and other international standards (IEC, NEC, ICRC, NEMA, etc.). It will be the responsibility of the sub-contractors to provide the panel boards and install them. Panel Boards must not be installed without prior validation of the MSF Electricity Manager.

(ii) All circuits should be identified or numbered. Printed copies of the position and electrical diagrams should be included inside the board, or in a sealed file close to the board. These diagrams must of course be up to date.

Technical Requirements:

- A minimum distance of 1 meter must be kept between a panel board and a window. Boards cannot be placed in front of doors or windows.
- Boards must be installed in dry places. When boards are installed outdoors, they must be at least IP65, the floor must be a dry slab or any other dry floor above the outdoor ground surface. They must be protected from the rain with appropriate roof and walls at least 2 meters around. If required the area around the shelter must be drained. The access to an electrical shelter must remain clear.
- The top third of an electrical board should ideally be placed at a height of between 150 and 200 cm.
- Example of Panel Board set up:



4.2 Grounding

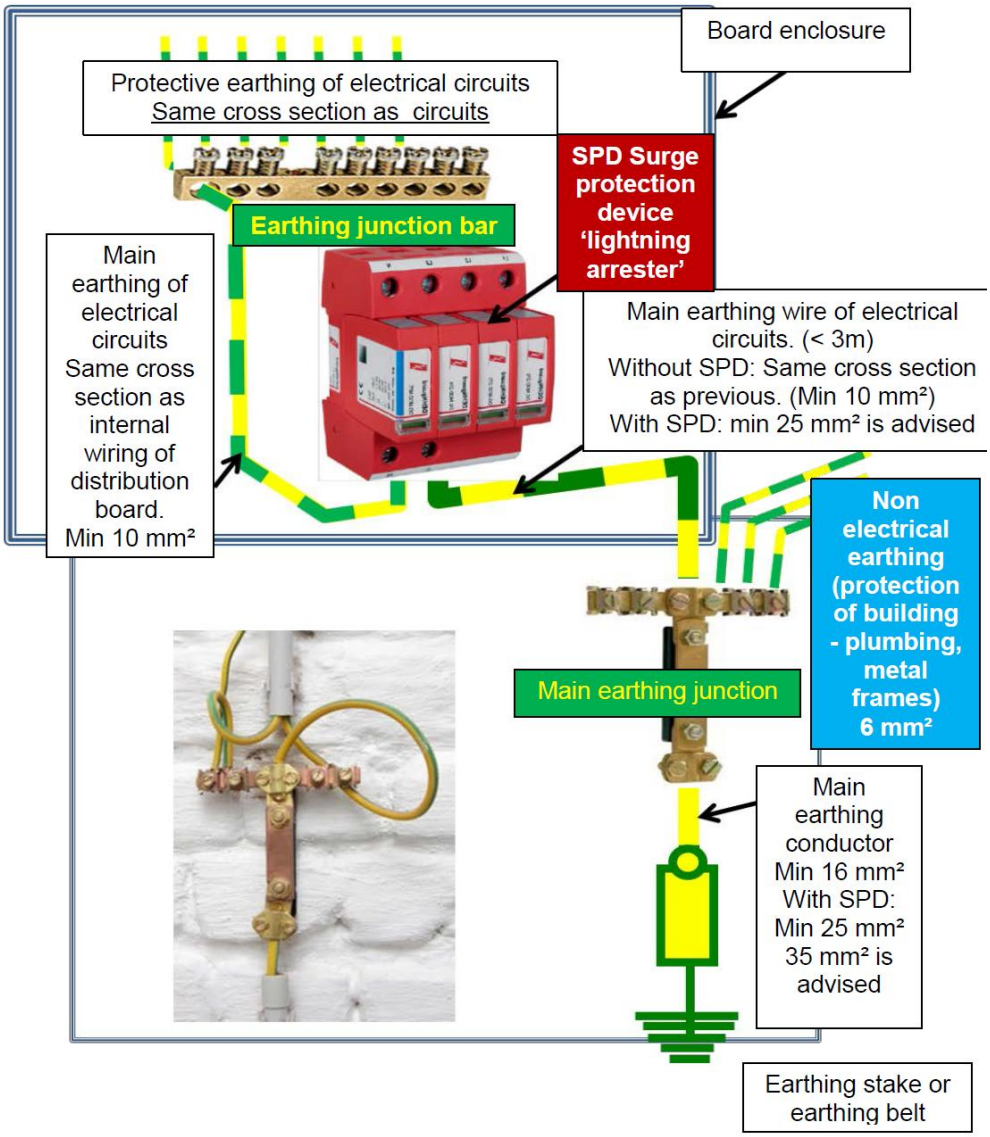
(i) All metal works associated with the electrical installation shall be bonded together and shall be effectively earthed. The containers and the metallic stairs must be grounded.

(ii) Earth rods shall be installed in locations as shown on the drawings as far as practicable. Suitable earth cable clamp and earth cable shall be used to connect the grounding system to the electrical panels.

(iii) The contractor must construct an earth pit 40x40 cm for each grounding rod so that the rods and its cable clamp must be visible.

(iv) All ground wires of the cable shall be properly terminated in the electrical panels.

(v) Example of grounding set up:



4.3 Cable installations

(i) Junction boxes shall be installed for connecting cables and rubber grommets shall be used for all cable entries.

(ii) Cable entries into a building shall be sealed by approved means to prevent the ingress of moisture.

(iii) Each cable shall be clearly labeled in accordance with the drawings. All wiring terminations shall be finished in a neat and approved manner and shall each be separately identified by a wiring code number.

(iv) When cables pass through walls, a piece of PVC sleeve of adequate size shall be inserted into the wall and the cables shall be drawn therein. Holes so created around the sleeves shall be fitted up with cement.

(v) Rubber grommets shall be used to protect the cables passing through metal covers of panel boxes.

(vi) Straight joints in cables should be avoided and Tee-joints in protective conductors with suitable connectors are acceptable.

(vii) Power cabling shouldn't share with data/telephone cabling in the same trunking. It also follows the power cabling shouldn't run in parallel with data/telephone cabling.

(viii) Power cables that carry high current shouldn't share trunking as this causes induction, in effect a reduced current carrying cable.

(ix) Cable termination with breakers is accomplished with appropriate cable lugs.

4.4 Cable color standard

(i) The following color code for electric cable must be followed:

Three Phase Line (L1)	
Three Phase Line (L2)	
Three Phase Line (L3)	
Three Phase Neutral (N)	
Three Phase Protective Earth or Ground (PE)	

4.5 Wiring Installation Using Cable Trunking

(i) Individual pieces of trunking shall be independently supported by means of at least two fixed points per piece. On straight runs, supports for trunking shall be fixed at regular intervals of around 0.5m. For runs with bends, supports should be fixed as near to the bend as practicable.

(ii) The trunking shall be fixed by screws and washers should be used under the head of screw.

(iii) Holes in trunking should be drilled, punched or cut by appropriate tools. After cutting, burrs and sharp edges on the trunking should be removed to prevent abrasion of cables.

(iv) All trunking and appliance (socket, switch, and light) should be fixed on the wall with plastic anchor.

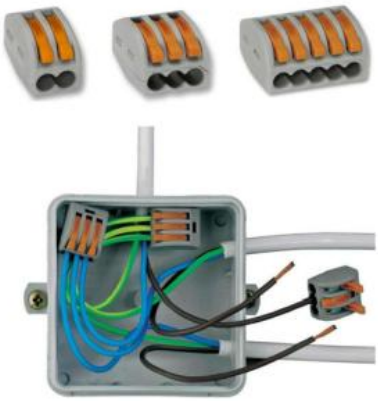
(v) Each piece of trunking shall be properly cut and the gap between each piece shall be kept to a minimum. White adhesive silicon rubber shall be used to fill the gaps after the installation.

(vi) If several circuits made with single conductor wires are to be installed in one cable trunking, this trunking must have separation system to segregate circuits from each other.

(vii) It is recommended to follow the conduit fill of 40%.

4.6 Cable connection in junction box

(i) Cable connection inside the junction box must be made with "WAGO" clamps (see picture) not with tape.



4.7 Lighting

(i) Fixed lightings: All ungrounded lighting fixtures should be class II equipment – in particular all external parts of bulb holders should be made from nonconductive material.

(ii) **Interior lighting** fixtures must be at least **IP 41** (no possibility of ingress of solid objects over 1mm). **External lighting** and lighting fixtures must be at least **IP65.**

(iii) Lights should be **LED lighting technology**.

(iv) The LED lights should have a warm white lighting (4000K).

(v) The wall light must be installed at 120cm high from the ground.

(vi) Photo sensor

a. Light sensor with possible settings from 2 to 2000 lux with fixed delay (60s) adapted to the load (regarding the number and type of lights).

b. If possible, avoid extra relay.

c. To be installed, if possible, directed to North; far from light sources.

d. Example: Schneider Electric IC2000

4.8 Sockets and Switches

(i) All plugs and socket outlets must comply with IEC Standards (IEC 60884-1).

(ii) Ingress protection rate: Sockets must include 'children protection' measures that avoid the introduction of any metallic object inside of the socket when no plug is inserted. At least IP 4x is requested.

(iii) The toilet sockets must be waterproof IP65 and protected by a differential circuit breaker 30mA. The sockets must be installed at 120cm high from the ground.

(iv) Sockets above the room tables must be at 85cm high from the ground.

(v) Switches for household and similar fixed electrical installations must comply with IEC Standards (IEC 60669-1).

(vi) All switches installed on the circuit must be rated 16A, even if the lights downstream to the switch require less than 16A.

4.9 Back-up system in the safe rooms

(i) The charger/inverter and the batteries are provided by MSF. All the rest of the installation must be provided and installed by the contractor.

(ii) The back-up circuit is a separated circuit. It is indicated with a different color in the electrical drawings.

(iii) The output of the charger/inverter must be connected directly in the electrical box with the right cable terminals.

(iv) The back-up equipment must be tagged with "back-up".

(v) The charger/inverter grounding cable must be connected to the equipotential grounding.

5. ELECTRICAL INSPECTION AND TESTING PROCEDURES

During the development of works, three types of inspection shall be conducted:

(1) **Equipment validation inspection**: Prior to installation, equipment shall be sent for inspection of Electricity Manager. The following will be checked:

- Visual inspection;
- Quality check: is the equipment of right brand/quality;
- Rating check: is the equipment the correct rating and according to technical specifications and drawings (nameplate wattage, voltage and current ratings and types, area classification and environment, circuit breaker ratings sizes, etc);

(2) **Equipment installation inspection**: After equipment is installed, it will be checked for compliance with MSF technical specifications, technical drawings, single line diagram and safety guidelines. No testing shall be performed before installation inspection has been conducted and validated.

(3) **Completion of works inspection**: At the completion of the work, the Engineer or his representative will check the installation performed by the Contractor using the following check list. The Contractor shall rectify all the outstanding items discovered before the final acceptance

5.1. Panels, circuit breakers and main switches

(i) No visible damage to impair safety.

(ii) Every circuit breaker, main switch and RCCB is provided with legible **labels** giving their ratings.

(iii) Every panel, circuit breaker and main switch is provided with a legible and durable identification **label.**

(iv) All accessible live parts are screened with insulating plate or earthed metal.

(v) All exposed conductive parts are effectively earthed.

(vi) Cables at the panel are terminated with adequate cable lugs.

(vii) Circuits connected to circuit breakers are in accordance with the schematic diagram.

(viii) Exposed cables are protected by suitable means.

(ix) All surface trunking and conduits are properly supported.

5.2. Main power cables

(i) No visible damage to impair safety

(ii) Cables protected against mechanical damage

(iii) Correct phase identification provided at both ends of the cable.

(iv) Cables and ducting are adequately supported.

5.3. Earth

(i) Each building must have its own grounding system with a resistance of less than 100 Ω; it shall be installed as follows:

a. A grounding rod at least 1.5 meters long shall be buried in the ground, with the upper end of the rod at least 50 cm below ground level; a concrete manhole shall be constructed for maintenance or measurement purposes.

b. Charcoal may be used to improve the soil, but no salt or animal manure may be mixed into the soil around the grounding rod.

c. The grounding rod is connected to a bare copper cable with a cross-sectional area of 25 mm^2 and routed to a busbar.

d. The grounding bar

e. must be made of copper-clad steel (at least 100 microns of copper) or galvanized steel.

f. From this bar, a green/yellow insulated copper cable will be routed to the building's distribution panel (see Design for section and details).

g. Equipotential bonding conductors effectively connected to metal pipes, e.g. water pipes and gas pipes, as well as metallic parts of structural framework.

h. The metal water supply piping must be grounded using a green/yellow conductor with a cross-section of at least 6 mm^2.

i. Other metal parts must also be grounded.

j. The grounding systems must be connected to the concrete reinforcement bars of the buildings. There must be a connection at least every 5 meters.

k. The ground conductor must be strictly green/yellow in color.

l. Anti-corrosion measures must be applied to all grounding connection points exposed to outdoor conditions.

m. Appliance ground connections must never be connected in series.

n. All building grounding systems must be interconnected, unless an isolated grounding system has been installed, in which case it must remain a separate system.

5.4. Switches and Sockets

(i) Socket outlets for patient bed shall be installed 1.20m from the floor, the normal sockets at 60 cm and for the corridor at 80 cm from the floor

(ii) Ground wire must be properly connected to the socket earth pin

(iii) No socket outlet is installed closed to water tap, gas tap or cooker.

(iv) Switch and Socket outlets in bathrooms and toilets should be waterproof.

(v) Sockets shall be mechanically held in position during the insertion and the removal of the power plugs.

(vi) Cover of the sockets shall be tightly attached to the body and there shall be no gap for the ingress of water and moisture.

5.5 Installation of protection devices and cabling

According to the drawings, the following devices shall be installed:

DESCRIPTION	SPECIFICATIONS
UPS Installation	Installation of a 6kVA double-conversion UPS, three-phase input and single-phase output, complete with battery cabinet. The equipment shall be supplied by MSF. The UPS shall provide a dedicated power supply for the electrical outlets only. A dedicated feeder cable shall run directly from the technical room to the electrical distribution boards supplying the socket outlets.
As with all electrical devices and installations all UPS must be properly earthed	See Drawing
Protection of the input of the UPS	**The electrical input of a UPS must always be protected by:** - A Residual Current Device (RCD) of 300 mA type Asi. This could be replaced by a 500 mA RCD. But never by an RCD with a higher sensitivity such as 30 mA or 50 mA and this could trip due to the electrical characteristics of UPS. If a 300 or 500 mA RCD is not available it should be ordered and in the meantime the input will not be protected by an RCD, but a 30 mA RCD must not be used as a temporary solution. - A circuit breaker sized according to the maximum power of the UPS - A type 2 Surge Protection Device (SPD). This type 2 SPD could be installed exclusively for the UPS or in the distribution board that feeds the UPS if it is not more than 15 meters away
Protection of the output of the UPS.	**The electrical output of a UPS must always be protected by:** - A Residual Current Device (RCD) of 30 mA type Asi. As with any final electrical circuit it must be protected by a 30 mA RCD to protect the users. - A circuit breaker sized according to the maximum current of the electrical circuit. This will typically be a 10 A circuit breaker for lighting circuits and 16 A for circuits with sockets. - In sensitive circuits such as the supply of oxygen concentrators in ICU each socket connected to the output of a UPS must have an individual RCBO with a sensitivity of 30 mA. The RCBO offers residual as well as overcurrent protection therefore acting as an RCD combined with a circuit breaker in one single device. In sensitive circuits it is recommended that an RCBO be attached to each separate circuit, meaning that a fault in one circuit will not affect the functioning of the others - A type 3 Surge Protection Device (SPD) to protect all the electrical devices connected to the UPS
The estimated load must never exceed 50% of the UPS capacity	This will allow the batteries of the UPS to have a longer life and to avoid any overloading that might put in danger the electrical supply.
A changeover switch must be installed in parallel	to bypass the UPS in case needed • All UPS circuits must be properly identified as such. All sockets and light switches supplied by a UPS must be of red color to identify them.

5.6 Installation of HVAC and Air Conditioning units

The NFC 15-100 standard also applies to the installation of air conditioning systems:

(i) Each air conditioner must be powered directly from the distribution panel without any branches (no splices);

(ii) Each power supply line to an air conditioner must be equipped with all associated protections (ground-fault circuit interrupter, earth ground, overload protection) for the dedicated circuit, as specified in the attached plans and diagrams;

(iii) The indoor unit must be positioned so as not to create a draft, with a condensate drainage system leading to the outside and located lower than the outdoor unit;

(iv) The electrical connection between the indoor and outdoor units must be made using a 3-wire cable (1P+N and ground) of sufficient cross-sectional area, as specified by the manufacturer.

(v) The electrical interconnection between the indoor and outdoor units shall be carried out using cables of the type and cross-sectional area recommended by the manufacturer.

(vi) Refrigerant piping shall be installed, insulated, pressure-tested, evacuated, and charged strictly in accordance with the manufacturer's installation instructions. Pipe lengths and elevation differences shall not exceed the manufacturer's allowable limits.

(vii) Outdoor units shall be installed on galvanized steel brackets or concrete plinths fitted with anti-vibration pads. The minimum service and ventilation clearances recommended by the manufacturer shall be always maintained.

(viii) All wall and floor penetrations shall be neatly sealed using suitable weatherproof materials and, where fire-rated walls are penetrated, approved fire-stopping materials shall be provided to maintain the integrity of the building.

(ix) Refrigerant pipe insulation exposed to direct sunlight or outdoor conditions shall be protected with UV-resistant cladding or equivalent weather-resistant protection.

(x) Before energizing the equipment, the Contractor shall verify the supply voltage, polarity/phase sequence (where applicable), earth continuity, insulation resistance, and correct operation of all protective devices.

(xi) **Upon completion of the installation, the Contractor shall carry out complete testing and commissioning, including as a minimum:**

- Verification of electrical connections.
- Refrigerant pressure and leak testing.
- Vacuum evacuation prior to refrigerant charging.
- Functional testing of cooling and heating modes (where applicable).
- Verification of condensate drainage.
- Measurement of operating voltage and current.
- Verification of thermostat and control operation.
- Confirmation that the equipment operates within the manufacturer's specified operating parameters.

Prior to handover, the Contractor shall submit:

- Testing and Commissioning Report.
- Refrigerant pressure and leak test records.
- Equipment commissioning records.
- Manufacturer's Operation and Maintenance Manuals.(when supplied by the contractor)
- Warranty certificates. (when supplied by the contractor)
- As-built drawings reflecting the final installation.

(xiii) All HVAC installations shall comply with the manufacturer's installation manuals, NF C 15-100, and the applicable requirements of recognized international standards and engineering best practices

Low-Tech Negative Pressure ICU Isolation Room

A negative pressure exhaust system for each ICU isolation room is required.

(i) The system shall consist of a compact wall or window-mounted exhaust module including an **EC centrifugal fan**, **G4 pre-filter (ISO Coarse 60%)**, **F7 fine filter (ISO ePM2.5 65%)**, weatherproof external discharge grille, and airtight filter access panel for maintenance.

(ii) The exhaust fan shall be capable of delivering the required **airflow rate of 300 m^3/h**, ensuring continuous operation (24/7) while maintaining a room negative pressure relative to the adjacent ICU.

(iii) Air shall be extracted from a high-level grille located on the external wall, preferably above or adjacent to the patient's bed, to promote airflow from the ICU towards the isolation room and then directly outdoors.

(iv) Replacement air shall be provided passively from the adjacent ICU through a transfer grille (minimum free area approximately **900 cm², therefore, with a minimum size of 30x30cm or, ideally 35x30cm**) installed in or adjacent to the door, supplemented by an undercut where applicable. The window shall remain closed during normal operation and shall only be used as an emergency backup.

(v) Filters shall be installed upstream of the fan within an accessible sealed housing to protect the fan, facilitate maintenance, and reduce particulate emissions. The housing shall allow filter replacement without dismantling the fan assembly.

(vi) All ductwork, casings and accessories shall be airtight and constructed from corrosion-resistant materials suitable for healthcare environments. External air discharge shall be located to avoid recirculation into outdoor air intakes, windows or occupied areas.

(vii) **Continuous-Operation**

The exhaust fan shall be designed for continuous 24-hour operation and shall remain energized at all times while the isolation room is in service. The fan shall be connected to a local control -operated switch.

(viii) **Commissioning**

Upon completion of the installation, the Contractor shall verify the correct operation of the exhaust fan, confirm the direction of airflow from the adjacent ICU into the isolation room using a simple smoke test or equivalent method, and demonstrate proper condensate and weather protection where applicable.

5.7 Tests

(i) **Continuity Test:** Verify the continuity of all conductors to ensure there are no open circuits or broken connections.

(ii) **Insulation Resistance (Megger) Test:** Verify the insulation integrity between conductors and earth to identify leakage, short circuit, or insulation faults

(iii) **Earth Continuity Test:** Verify the continuity of protective earth conductors to ensure all exposed metallic parts are properly grounded.

(iv) **Polarity Test:** Verify the correct connection of phase, neutral, and earth at all socket outlets and switches.

(v) **Phase Sequence Verification:** Verify the correct phase rotation sequence for three-phase circuits before connecting equipment.

(vi) **Load Balancing Test:** Measure and compare current on each phase to ensure balanced loading of three-phase systems.

(vii) **Thermal Inspection:** Check distribution boards, breakers, and cable terminations for abnormal temperature rise or loose connections.

(viii) **Functional Test:** Verify the correct operation of lighting fixtures, socket outlets, switches, alarms, and connected equipment.

(ix) **UPS Functional Test:** Simulate mains power failure to verify automatic UPS operation and continuity of supply to critical circuits.

(x) **RCD/RCBO Test:** Verify correct operation and tripping time of residual current protection devices where installed.

6. Equipment quality, brands and equivalent – Examples

LIGHT, LED, 2x18 W, water proof Pelson IP65



Ceiling Fan KDK M56XG with 5 speed selector





LIGHT, LED PANEL 30x30 cm, 24W, Surface mount (PHILIPS)

PHILIPS



EMERGENCY LIGHT, LED 8 W waterpoof IP65 with Battery Autonomy 3h



EMERGENCY LIGHT, LED 8 W waterpoof IP65 with Battery Autonomy 3h

SMOKE DETECTORS



Features:

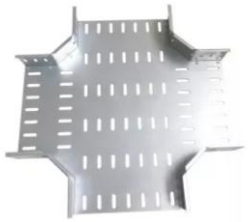
- power supply: sealed lithium battery
- 1 battery
- battery life 10 years
- low battery warning
- sound power: 85 dB at 3 m
  detection area: 20–40 m²
- test button
- mounting plate
- conform to european smoke alarm standard: EN14604:2005

Location of detector:

- do not install heat alarms on walls.
- do not locate near fans or extractors; these can pull smoke and heat away from the alarm
- do not install bathrooms and showers
- do not install in rooms where the normal temperature may exceed 40 °C or fall below 0 °C. These may cause nuisance alarms.
- do not install in the peak of an A frame ceiling, this may delay heat reaching it due to still air (see diagram above for minimum distances from the peak)
- do not install less than 300 mm from walls and beams due to still air
- do not install less than 300 mm from light fittings
- do not install heat alarms in sleeping areas such as bedrooms, nurseries, playrooms or areas where the elderly and disabled may spend long periods of time
- do not install on poorly insulated ceilings where cold air boundary layers may delay heat from reaching the alarm
- do not install near objects that may delay or prevent heat from reaching the alarm
- avoid installing within 1500mm of fluorescent light fittings that could cause nuisance alarms
- do not paint the alarm.

Outdoor Cable tray 50x100 mm hot-dip steel galvanized with all accessories Example :





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