

# **FIRE SAFETY ENGINEERING**

**REHABILITATION OF THE SAUDI MATERNITY HOSPITAL**

**KASSALA HEALTH CITADEL, SUDAN**

**DETAILED DESIGN**

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**LIST OF WRITTEN DOCUMENTS**

## LIST OF WRITTEN DOCUMENTS

<u>REFERENCE / NUMBER</u>	<u>DESCRIPTION</u>
LFS.01.COV.001	Cover
LFS.02.LOW.001	List of Written Documents
LFS.05.MEM.001	Descriptive Memory
LFS.13.LOD.001	List of Drawings

# **FIRE SAFETY ENGINEERING**

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

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

#### **DETAILED DESIGN**

#### **DESCRIPTIVE MEMORY**

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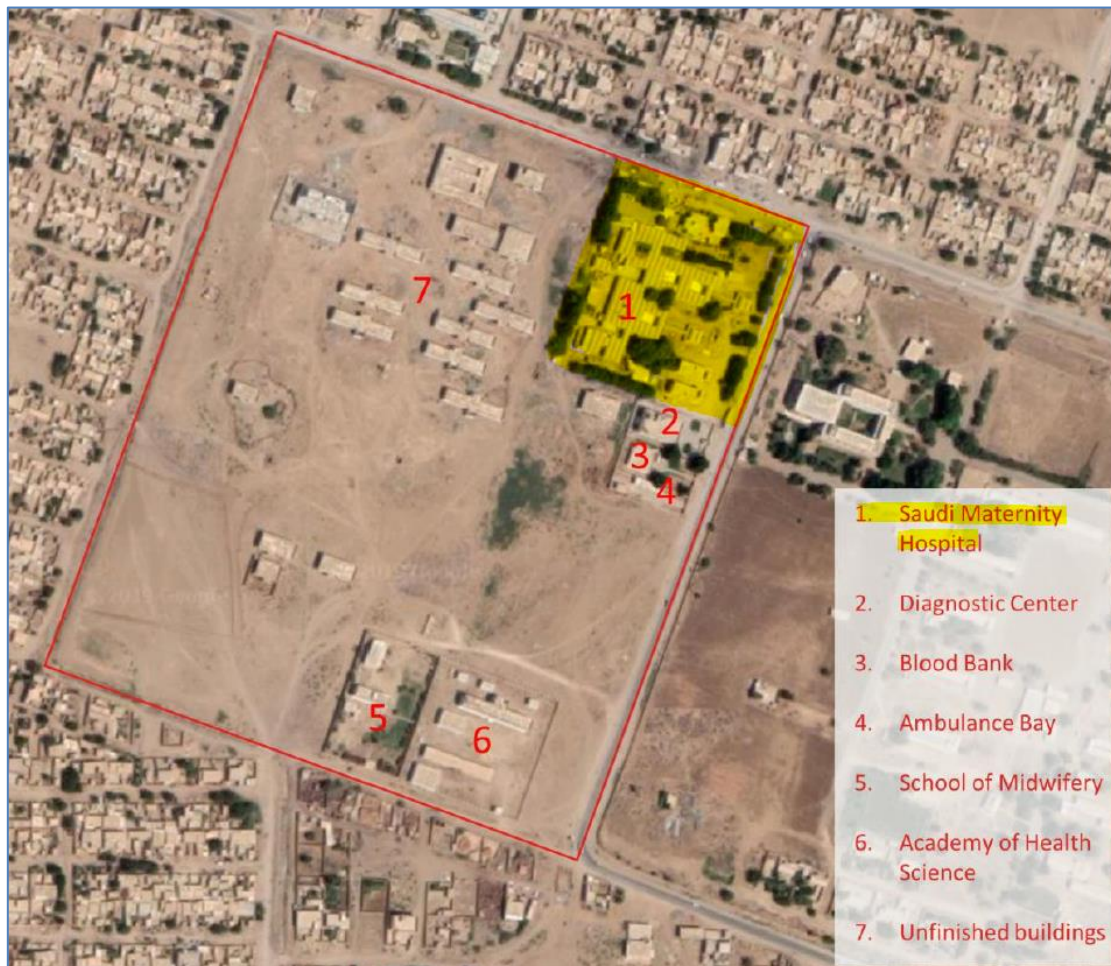
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## 1. INTRODUCTION

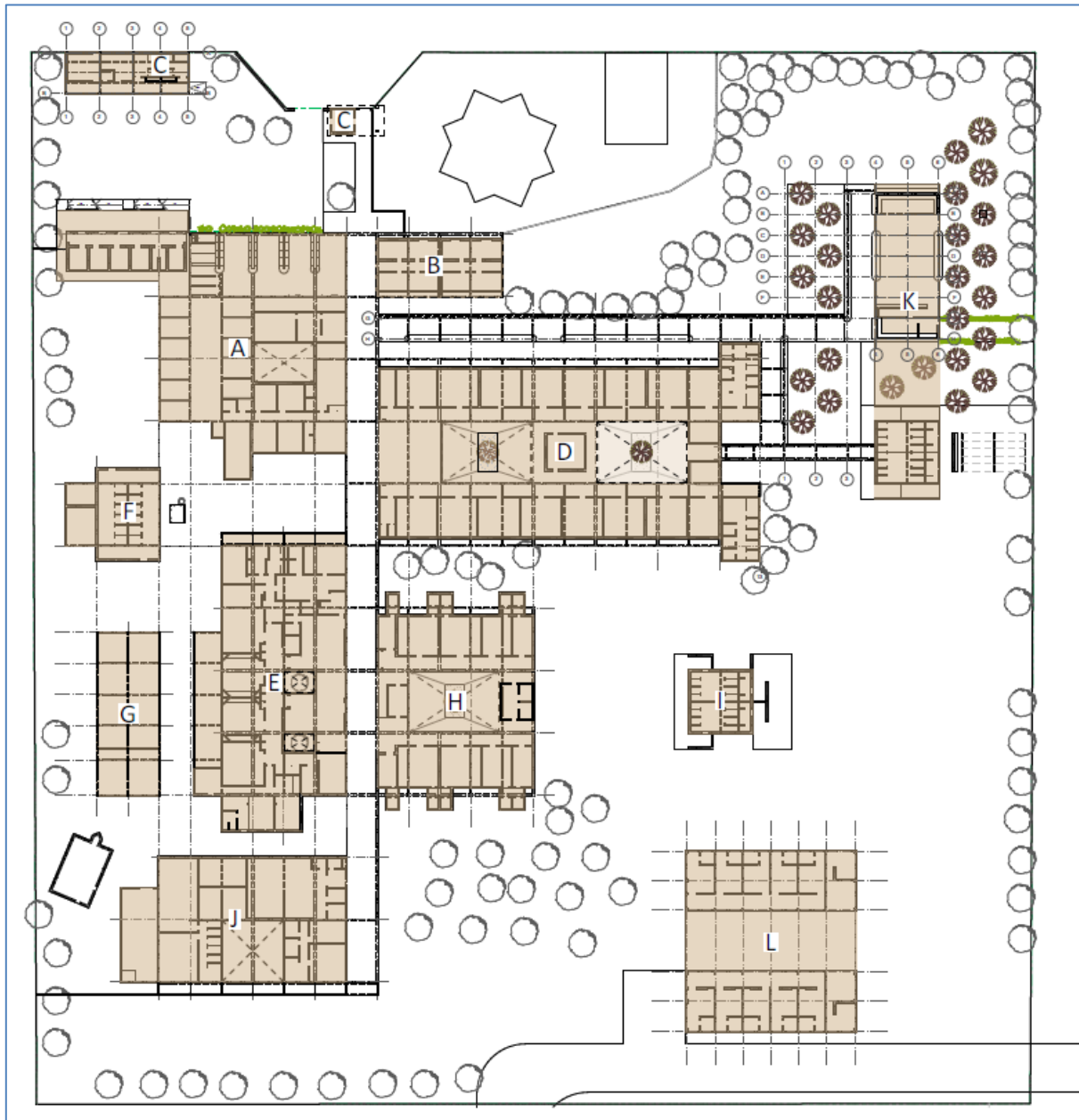
This document refers to the fire safety study for the rehabilitation works at Saudi Maternity Hospital in Kassala Health Citadel in Sudan.

The Saudi Maternity Hospital was built in the 80's and is operative since then. The architecture of the building has a strong character with arched roofs, concrete beams and brick walls. The hospital is concentrated along a central north-south oriented corridor, with departments attached. The interior of the building is characterized by patios. The hospital is enclosed by a fence and has the main entrance on the north side. The building is in need for a rehabilitation, this is part of the Kassala Health citadel development.

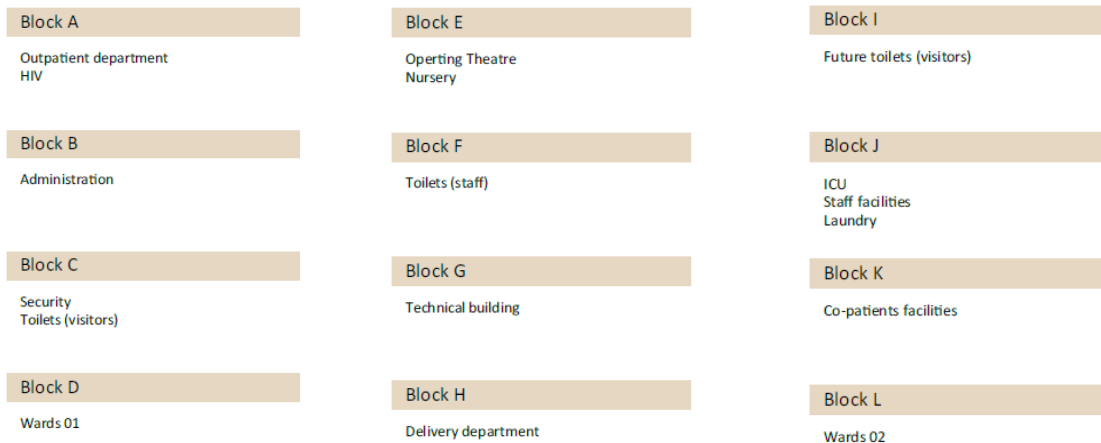


Picture 1 - Kassala Health Citadel in Sudan

The Saudi Maternity Hospital is divided into the following main blocks:







Picture 2 - Saudi Maternity Hospital Main Blocks

## 1.1. LEGISLATION

The fire safety project was developed with strict respect for the following regulations:

- Legal Regulation on Fire Safety (Decree-Law No. 220/2008 of 12 November), with the wording introduced by Decree-Law No. 224/2015, of 9 October;
- Technical Regulation on Fire Safety (Ordinance 1532/2008 of 29 December);
- Order No. 2074/2009 of the Ministry of Internal Administration, of 15 January - Technical criteria for determining the modified fire load density unit.

## 1.2. TYPE OF USE

The several blocks, intended for a maternity, will be classified as type V use:

- **Type-Use V «hospital»**, corresponds to buildings or parts of buildings receiving public, intended for the execution of diagnostic actions or the provision of health care, with or without internment.

## 1.3. RISK CATEGORY

For the purpose of classifying the type-use V use according to its category, we have:

Risk category of type use V			
Category	Height of TU V	Effective	Effective in wards
1 <sup>a</sup>	≤ 9 m	≤ 100	≤ 25
2 <sup>a</sup>	≤ 9 m	≤ 500	≤ 100
3 <sup>a</sup>	≤ 28 m	≤ 1 500	≤ 400
4 <sup>a</sup>	> 28 m	> 1 500	> 400

Table 1 - Risk category of type-use V

Thus, based on the referred parameters, and how we treat each building as independent buildings, we place each building in the **2nd risk category**.

## **2. ACCESSIBILITY**

### **2.1. ACCESSIBILITY TO THE LOCAL**

The accessibility to maternity will be ensured by internal ways of the complex, in order to allow access to large emergency vehicles to all blocks that make up the maternity. At any point the access road has a width less than 3.50 meters.

### **2.2. ACCESSIBILITY TO THE BUILDING**

Inside the maternity, the access to the buildings will be provided through private roads with more than 3.50 meters width and designed with a minimum bend radius not less than 13 meters.

The penetration points in the buildings will be like doors and windows existing in all facades, giving bombers access to all maternity blocks, allowing a better attack on fire.

## **3. STRUCTURAL FIRE RESISTANCE**

The structural elements have a fire resistance that guarantees the function of load-support, thermal insulation and tightness during all phases of firefighting operating (including the aftermath), for an established period of time.

The structural elements for each block will have a minimum period resistance to fire of 60 minutes.

## **4. FIRE COMPARTMENTATION**

### **4.1. FIRE PROTECTION OF COMPARTMENTS**

The fire-resistant compartments of this buildings are based on the risk of fire in each compartment, and the closeness between buildings. Each building will be treated as an independent building and an independent compartment with a maximum area of 800m<sup>2</sup>.

In general, all fire compartments will be surrounded by 1-hour fire rated walls (EI 60). The doors installed in this fire enclosure shall guarantee at least half of the fire rated time indicated for walls, meaning 1/2-hour rated doors and provided with a properly dimensioned closing device (E 30 - C).

The Operating Theatres, Intensive Care Unit and Nursery are an exception to the fire rated concept indicated before. These locals will be surrounded by 1-1/2-hour fire rated walls (EI 90). The doors installed in the surrounding of these compartments will be with at least 3/4-hour fire protection rating and provided with a properly dimensioned closing device (E 45-C).

In the technical spaces, the fire compartmentation concept was defined according to the fire-load and the importance of equipment installed in each room.

Therefore, considering the high importance of the installed equipment on the technical spaces for the proper functioning of the maternity, the separation walls of each technical room will guarantee a 1-hour fire rated walls (EI 60), and the space of generator with 1-1/2-hour fire rated walls (EI 90).

#### **4.2. FIRE PROTECTION OF EVACUATION STAIR**

The staircase in block L that connects the different floors of that block will be surrounded by 1-hour fire rated walls (EI 60). The access doors will guarantee at least 1/2-hour fire rate and will be provided with a properly dimensioned closing device (E 30-C).

#### **4.3. FIRE PROTECTION OF PIPEWORK AND DUCTS**

The pipework, duct, and cable trays related to hydraulic and electricity infrastructure that cross the fire resistance walls shall be provided by fire sealing.

It is planned to place fire dampers and valves for the ducts related to HVAC and gas installations that cross the fire resistance walls, which ensure the automatic closure in case of fire. The fire resistance of the dampers and closure valves shall be at least equal to the fire rated time indicated for the crossed fire resistance walls. In case of being installed inside fire resistant ducts, they shall guarantee at least half of the fire rated time indicated for the crossed fire resistance walls.

In general, the reset of these fire dampers will be operated manually.

### **5. TECHNICAL INSTALLATIONS**

The electrical power supply to the building will be carried out in medium voltage with conversion to low voltage in a private electrical substation.

The place where the electrical substation is installed will be surrounded by 1-1/2-hour fire rated walls (REI 90/ EI 90) and all interior finishing materials applied inside this local will guarantee a reaction to fire classified as A1 in accordance with the Euroclasses.

The ventilation of this local will be guaranteed by installing grids in the exterior walls, placed in such way that allows the natural flow of air. The lower level allows new air entrance and upper level allows the escape of hot air.

The healthcare facility will be supplied by a generator sets to guarantee the backup in case of failure of electrical public network supply.

The place where the generator is installed will be surrounded by 1-1/2-hour fire rated walls (REI 90/ EI 90) and all interior finishing materials applied inside this local will guarantee a reaction to fire classified as A1.

Moreover, there will be equipment in the building that by their importance, will be supplied by Uninterruptible Power Supply devices (UPS).

The locals where the UPS are installed will be surrounded by 1-1/2-hour fire rated walls (REI 90/ EI 90) and the doors will guarantee at least 3/4-hour fire protection rating and will be provided with a properly dimensioned closing device (E 45-C).

All interior finishing materials applied inside this local will guarantee a reaction to fire classified as A1.

## **5.1. CENTRALISED EMERGENCY POWER SUPPLY**

The maternity will be supplied by generator sets as a centralized backup emergency source. This equipment will be located in an exterior area.

In case of failure of electrical public network supply the generator will automatically start functioning with a maximum time-delay of fifteen seconds.

The generator will supply the following installations:

- Emergency light;
- Water pressurization systems for firefighting;
- Fire detection system, combustible gas detection systems or other independent devices with the same purpose.

The generator will function for at least the time requested for structure elements fire resistance, which is 1-hour (60 minutes). The exhaustion gas escape will be made directly to the exterior by ducts.

These ducts will be constructed with materials that guarantee a reaction to fire classified as A1 and respecting the installation conditions applicable for ducts and openings intended for escape of combustion effluents.

The combustion engine of the generator will be powered by a fixed diesel tank located in an adjacent compartment.

An emergency cut-off switch will be placed in the reception of the maternity that will interrupt the function of this system in case of need. This switch will be properly identified by a signage.

## **5.2. LOCAL SOURCES OF EMERGENCY POWER SUPPLY**

The central of fire alarm and detection system and the central of gas detection system will have a battery that will guarantee a minimum working autonomy of 72 hours.

### **5.3. UNINTERRUPTIBLE POWER SUPPLY DEVICES (UPS)**

All sensitive devices mainly the medical ones that are necessary to keep working in case of failure of the public network supply, will be supplied by Uninterruptible Power Supply devices (UPS).

It will be installed a warning signage in the entrance of the locals where the UPS are installed, indicating the electrical risk, regardless of the power of the installed device.

An emergency cut-off switch will be placed in the reception of the maternity that will interrupt the function of the UPS supplied systems.

### **5.4. GENERAL AND PARCIAL ELETRICAL SWITCH OFF**

The electrical panels will be installed in properly sized cabinets, specific for this use, placed with free access of any obstacles for a proper manoeuvre and provided with an appropriate identification signage.

The main electrical panel of the maternity is located as indicated in the drawings.

Moreover, the power supply circuits for firefighting water pressurization systems shall be dimensioned for the largest overloads that the motors can withstand and will be protected against electrical short-circuits.

The circuits used to provide a signal for fire safety systems/devices and the electrical circuits, (including conductors, cables, conduits, accessories and connecting devices) shall be protected by elements that assure their integrity in case of fire.

This protection shall be conceived to preserve the security and functionality of circuits at least for the time that the systems and devices that these circuits serve, are required to function.

In the maternity reception it will be installed the following energy shutdown buttons:

- Main electricity cut off point
- UPS cut off point
- Generator set cut off point

These cut off points will be located as well in the security poste, in the reception of the maternity.

### **5.5. HOT WATER PRODUCTION SYSTEM**

The production of hot-water in the building will be made by several electrical water heaters with maximum power of 3 kw.

This equipment will be installed in according of water supply project.

## **5.6. VENTILATION AND AIR CONDITIONING SYSTEM**

In the building, it will be installed a ventilation, and Air Conditioning System (HVAC).

The material of the air distribution ducts, as well as any other materials applied inside shall have a fire reaction classification as A1. Moreover, the thermal isolation materials applied on the external face of these ducts shall have a fire reaction classification as BL-s2d0.

According to the fire safety strategy, the main corridors, and the stairs will be permanently open, so they have a natural smoke control.

## **5.7. COMBUSTIBLE GASES AND LIQUIDS**

The combustion engine of the generator will be powered by a fixed diesel tank located in the technical space, near the generator area.

This tank will have a capacity of 3000 L diesel. Also, it will be surrounded by 1-1/2-hour fire rated walls (REI 90/ EI 90) and be provided by a retention basin to prevent any spills when storing and dispensing fuel.

## **6. SECURITY EQUIPMENT AND SYSTEMS**

### **6.1. FIRE SAFETY SIGNAGE**

In the buildings, it will be installed fire safety signage to identify:

- Evacuation routes;
- Fire extinguishers and fire hose reel;
- Alarm and alert systems;
- Passive and active systems with manual operation device.

The characteristics of the fire safety signage are as following:

- Made of rigid high density PVC photo luminescent with 2 mm of thickness;
- Have an anti-static surface to inhibit the accumulation of dust, and be vitrified;
- Guarantee 10 years without changes of printed colours;
- The photo luminescent properties have to respect minimum values in accordance with the applicable standards.

#### **6.1.1. DISTRIBUTION AND VISIBILITY OF THE SIGNAGE**

The signage shall have a minimum pictogram affected area (A), depending on the visibility distance (d), based on this equation:

$$A \geq d^2/2000$$

The minimum value of (A) should be 180 cm<sup>2</sup>, for a visibility distance of 6 m. The previous equation is not applicable for a visibility distance more than 50 m.

The signage that protrude the construction elements which support them, shall be fixed at a height of not less than 2.1 m and not more than 3 m. This is not applicable for the signage placed on the doors.

### **6.1.2. LOCATION OF SIGNAGE**

All signage that is placed to indicate evacuation routes and location of fire extinguishers, fire hose reel, fire alarm and alert devices, shall be placed in the escapes routes perpendicular to the possible direction of escape.

Signage shall be placed at a distance of less than 2 meters in horizontal projection, but not glued on the devices, except for the signage placed directly on the light blocks located on the escape routes.

In the compartments where the UPS are installed there will be special signage placed at their access. There will be placed emergency cut off signage for the electricity cut off button.

## **6.2. EMERGENCY AND SAFETY LIGHTING**

### **6.2.1. EMERGENCY AND SAFETY LIGHTING IN THE CIRCULATIONS**

Emergency and Safety lighting will be provided by using emergency light blocks maintained and non-maintained, equipped with local batteries, consisting of nickel-cadmium batteries, guaranteeing an operation autonomy of at least 1 hour after the power failure.

The emergency and safety lighting will be supplied by the backup power system of the hospital.

The emergency and safety lighting devices shall ensure 5 lux, measured 1 m from the ground or an obstacle, and shall be placed at least 2 m in horizontal projection.

For the lighting devices that shall be placed at least 2 m in horizontal projection:

- The intersection of corridors;
- The changes in the directions of the exploration pathways;
- The access levels and intermediate vertical pathways;
- The fire buttons;
- The commands of safety equipment;
- The 1st intervention means;
- The exits.

## **6.3. DETECTION, ALARM AND ALERT SYSTEMS**

### **6.3.1. SYSTEM DESIGN AND PROTECTED ZONES**

The buildings will be provided with automatic fire detection systems, which, in case of emergency, allow the alarm transmission to the occupants, alert the firefighters and trigger the safety systems and equipment.

- Manual alarm activation devices (Fire Button);
- Automatic detection devices (Fire Detectors);
- Control-command and signalling centres;
- Signalling of the restricted alarm;
- Automatic alert (Signal or notifications) transmission equipment;
- Telephones for manual alert transmission;
- Command devices of safety systems and equipment;
- Emergency power supply source.

### **6.3.2. SYSTEM CONCEPTION**

The system is planned to use equipment of analogue addressable type, composed of the following devices:

- Centre of Fire Alarm;
- Control interface;
- Point detectors (optical smoke detectors and thermos-velocity detectors)
- Alarm siren;
- Manual alarm triggers (Fire button);
- Piping and cable network;
- Telephones.

The system relies on the use of highly sensitive smoke and thermos-velocity detectors, which ensure the rapid detection of a fire. The optical smoke detectors are planned to be installed in locals with no special characteristics. The thermos-velocity detectors are planned to be installed in locals where can exist during normal exploration smokes, vapours, dust, or a sudden increase in temperature in a fire event.

In addition to the automatic detection devices, manual alarm triggers will be installed. On the assumption that a fire was detected, this pushbuttons can be operated by any user. They will be located in the escape routes, next to the exits of each floor and main exits of the buildings.

The alarm diffusion will be realised by sound warning and coded voice notification, complemented with internal communications via telephone between the security station and the reception. This alarm system is intended exclusively for employees, workers and security officers who remain, monitor or have to intervene in those places.



All these procedures should be considered and implemented in the development of the internal security plan.

#### **6.3.2.1. CENTRAL OF FIRE ALARM**

The central of fire alarm is responsible for all decision-making regarding the information coming from the various devices of the system, triggering warning and command actions including alert building occupants; alert rescue teams; activation of the fire resistance door and fire dampers; and activation of the smoke control system and fire extinguishing systems; etc..

Control-command and signalling centre will be installed in the maternity reception that ensure:

- The power supply to the alarm trigger devices;
- The power supply to general alarm diffusers;
- The signalling of the presence of energy in the network and the failure of the autonomous power supply ;
- The visual and audible signalling of the restricted alarm, general alarm, and alerts;
- The signalling of the standby mode of the installations;
- The signalling of the malfunction, test or deactivation of circuits of the alarm trigger devices;
- The command of activation and deactivation of the general alarm;
- The command of the safety systems and equipment of the building;
- The command of activation the alert;

#### **6.3.2.2. CONTROL INTERFACE**

This will be used to activate the decentralised commands for the technical installations including ventilation system; pressurizing; VAC; etc...

They shall be Analogue Addressable type, with internal microprocessor, bidirectional electronic.

#### **6.3.2.3. EMERGENCY POWER SUPPLY SOURCE**

The plant will have an emergency power supply source that guarantees:

- The operation of the system in standby mode for a minimum period of 72 hours, followed by a period of 30 minutes in general alarm mode.

#### **6.3.2.4. ALARM REPEATER PANEL**

At each nurse station there should be a repeater panel that replicates the signalling of all events triggered at the centre of fire alarm. Thus, the procedures provided for in the internal security plan could be initiated simultaneously. This equipment is also located at the entrance of the facilities in the security control building.

## **6.4. INTERVENTION MEANS**

### **6.4.1. PORTABLE EXTINGUISHING MEANS**

The location of portable fire extinguishers has been studied to meet the following criteria:

- The traveling distance from any local door to a fire extinguisher in the evacuation corridor shall not exceed 15m;
- Preferably located in the horizontal circulation nearby their exits;
- In the aggravated risk locations.

In the exterior cooking area, fire blankets are provided.

Fire extinguishers shall be clearly marked in a visible manner and placed on their own stand in such way that their handle is not more than 1.20 m height from the floor.

The number and quantity of extinguishing agent must comply with the following rules:

- One per 200 m<sup>2</sup> of floor surface or its fraction, with a minimum of two per floor.

Due to the nature of existing combustible materials, class A fire could occur. Therefore, it's planned to install ABC Chemical Powder type fire extinguishers.

CO2 extinguishers shall also be installed in the following compartments:

- Technical areas;
- Electrical switchboards.

### **6.4.2. FIRE HOSE REEL**

The installation of the fire hose reels must comply with the following:

- The control knob shall be located at a height not exceeding 1.50 m of the ground;
- Built-in fire hose reels, with or without cabinet, shall be pivot or rotate type;
- The cabinet's type should always be approved together with the fire hose reel and the respective door, installed in front of the wall or projecting from the wall, so that it can rotate 170° when opened.

On the axle with the fire hose reel, there shall be a clear zone, free of any elements that could affect their access or manoeuvre, with a minimum radius of 1 m to 2 m.

### **6.4.3. FIREFIGHTING WATER SUPPLY FOR FIRE HOSE REEL**

The firefighting water supply system shall ensure a minimum dynamic pressure of 250 kPa and instantaneous flow rate of 1.5 l/s for a maximum operating four working fire hose.

The pressure of the water in the firefighting networks shall be indicated by manometers installed at their lowest points.

### **6.4.4. CHARACTERISTICS OF THE FIREFIGHTING WATER TANK AND THE PUMPING UNITS**

A private firefighting water tank is provided in order to guarantee the following parameters:

- The water supply for a maximum flow rate of 6 l/s during 1 hour of continuous operation;
- The adequate flowrate and pressure to the system considering the number of devices and systems to be supplied.

The devices and systems served by the firefighting water tank are as follows:

- Fire Hoses Reel.

The pumping unit indicated for firefighting will be composed of:

- One main pump; reserve pump; one jockey pump; electrical switchboards; valves; pressure relief valve; pressure gauges; pressure switch; collectors; manometers; and flowmeters.
- The main and reserve pumps will be electrically operated, which will be connected to the building main transformer substation and its backup supply system.

The main pumps must be dimensioned to meet the flow and pressure conditions resulting from the simultaneity of the systems to be supplied. The respective design will be carried out by the engineering specialty of hydraulic installations.

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**KASSALA HEALTH CITADEL, SUDAN**

**DETAILED DESIGN**

**LIST OF DRAWINGS**

## LIST OF DRAWINGS

<u>REFERENCE / NUMBER</u>	<u>DESCRIPTION</u>	<u>SCALE:</u>
LFS.01.PLT.001	Plan of Ground Floor / Block A, F and G	1:100
LFS.01.PLT.002	Plan of Ground Floor / Block B and D	1:100
LFS.01.PLT.003	Plan of Ground Floor / Block C, J, K and L	1:100
LFS.01.PLT.004	Plan of Ground Floor / Block E, H and I	1:100
LFS.01.PLT.005	Plan of First Floor / Block L	1:100
LFS.01.PLT.006	Plan of Ground Floor / Block A, F and G Signs Plant	1:100
LFS.01.PLT.007	Plan of Ground Floor / Block B and D Signs Plant	1:100
LFS.01.PLT.008	Plan of Ground Floor / Block C, J, K and L Signs Plant	1:100
LFS.01.PLT.009	Plan of Ground Floor / Block E, H and I Signs Plant	1:100
LFS.01.PLT.010	Plan of First Floor / Block L Signs Plant	1:100