PROTOTYPE DESIGN FOR A PHARMACEUTICAL INTERMEDIATE WAREHOUSE

160kVA SUBSTATION PROJECT DESCRIPTION

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1 SUBSTATION DESIGN PROJECT

1.1 Context

The scope of this descriptive and supporting document refers to the detailed design of establishment of the Power Transformer Substation, housed type 160kVA and the electrical infrastructures within the prototype design project that will be used to build approximately twenty-five (25) Pharmaceutical Intermediate Warehouse are planned to be built throughout the country, located inter-districts or provinces as suitable), in the most sustainable network to support nationwide health services.

1.2 Substation feeding

The supply of electricity to the Pharmaceutical Intermediate Warehouse will be carried out on medium voltage at 33-11-6.6kV by Electricidade de Moçambique EDM, through a direct derivation of the medium voltage line from the existing branch network of medium voltage (MT) closest to the site.

The project provides for the installation a housed in masonry substation with measurement in medium voltage. To ensure a certain redundancy in the power supply to the project, depending on the characteristics of the local network, it may be necessary to include a ring on the power substation.

1.3 Standards and regulations

Ratings, characteristics, tests and test procedures, etc. for electrical equipment encompassed by this specification shall comply with the provisions and requirements of the standards and recommendations of International Electrotechnical Commission (IEC), unless otherwise expressly stated in the Technical Schedules. Where the IEC Recommendations do not fully cover all provisions and requirements for the design, construction, testing, etc. and for equipment and components are not cover by IEC Recommendations, recognized national standards shall be applied. The rules of CEE (International Commission for the approval of electrical equipment) and the standards of CENELEC (Comite Europeen de Normalisation Electrotechnique) may also applied.

The latest version or edition in effect at the time of tender invitation shall apply. Where references are given to numbers in the old numbering from IEC it shall be taken as to be the equivalent number in the new five digit number series

This infrastructure project is drawn up in accordance with the regulations in force in Mozambique; particularly the Regulation of safety of Substations and Transformation Stations and Switching and the Safety Regulation of Electricity Distribution Networks in Low Voltage, regulatory decree No 90/84 of 26 December.

All equipment, materials and equipment must be provided and installed in accordance with:

- The present general technical specifications and specials;
- The facilities scope and works;

The Assembly notes, recommendations of suppliers relating to the installation or maintenance of electrical equipment, which will be considered as part of this specification;

- Generally, all regulations, decrets, decrets and regulations in Moçambique and in theirs absence, IEC standards recommendations;
- Standards and recommendations of the local public energy distributor.

1.4 Installation

Medium Voltage Network

The main feeder from the medium voltage overhead line 33-11-6.6kV from the public electricity company - EDM to the substation shall be carried out by an Underground cable.

The medium voltage supply voltage level will depend on the location of the warehouse to be chosen by the client, since the public electricity company - EDM supply energy in medium voltage at the three levels mentioned above.

The installation of feeder underground cables to the substation, will be provided for an infrastructure consisting of 2 PVC pipes Ø 160 mm, 6 Kgf/cm ² abroad, buried in the soil to a depth of at least 1, 00 m, interspersed by manholes in changes of direction or near buildings, in order to facilitate the work of threading of electric cables.

Electric Network Characteristics

Medium Voltage

- Rated Voltage: 33 kV/11kV/ 6,6kV
- Nominal Frequency: 50 Hz

Symmetrical short circuit power:

- In the absence of of information of the public company of electricity we will calculate the resistance and reactance according to IEC 60909 that recommends as standard impedance (power and short circuit) of 500 MVA (confirm with the EDM).

Low Voltage

- Rated Voltage: 400/231 V
- Nominal Frequency: 50 Hz
- Peoples protection: Regime TT

1.5 MV Switchgear Composition

The medium voltage Station will be indoor installation with MT bus in modular frame with isolation in the air and cutting equipment and SF6 insulation, suitable for indoor installation, composed of metal and electrical switchgear cells built according to international standards-IEC-298, identical to those of manufacture EFACEC, NORMAFIX type.

1.6 Electric Loads

For the determination of load installed, was considered the plant of architecture and the consumption of each buildings of the project, which resulted in the following table:

EDIFÍCIOS	TIPO DE CARGAS			
	NORMAL	EMERGÊNCIA	SOLAR	REDE DE UPS
Pharmaceutical Warehouse	33.238W	49.300W		7.400W
Toxic and Flammable Products Warehouse	4.300W	5.160W		
Workshop and Maintenance	2.663W	2.160W		
Power Substation		1.330W		
Guard House		2.275W		
Waste Disposal	1.500			
Outdoor lighting		5.000W		
Water pump		30.000W		

Installed Power Ÿ 144826,00W

Taking into account the simultaneity Factor normally used in these case according to the safety regulations of collective installations of buildings and entrances ï 63%, as mentioned above, we obtain:

Consumed Simultâneos Power Ÿ 86.895,60W

Aparent power for cosű = 0.8 Ÿ 108.619,50VA

Considering the necessary reserve in this type of installations and the standardized powers, for the apparent power of 96.66kVA, we will apply a nominal power transformer of **160kVA**, which will guarantee a reserve of 32

%.

1.7 HV/LV Short-circuit Calculations

Impedance Method

1.7.1 *– HV feeding line:*

□□ □ □□ □□□□□ / □□ m Ÿ factor without charge adopted as being 1.05

Wedl as above referred, adopt the IEC recommendations where have as default 500MVA.

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Z_Q = 0,353mÝ, consequently X_Q = 0,995 x Z_Q it means XQ = 0,351mÝ e R_Q = 0,1x X_Q = 0,035

1.7.2 *– Transformer*

Z_{tr} = (mxU_n)^2 / S_{tr} x U_{cc} / 100 Ztr □ □□ □□□□ □ / □□□ □ □□□ / □□□

Z_{tr} = (1,05x400)^2 / 160 x 5/100

Z_{tr} = 22,05mÝ consequently Rtr = 0.31xZ_{tr} ou seja R_{tr} = 6,846mÝ e X_{tr}=0,95xZ_{tr} = 20,794mÝ

Resistances and reactancesŝ Sum will be:

×R = 0,035+6,846 = 6,881mÝ Ь ×X = 0,351+17,76 = 21,15mÝ

1.7.3 *– Short-circuit Current I_{cc}*

I_{cc} = m x c x U_f / ã× R^2 + ×X^2Ÿ □□□ □ □ □□□□□ / □∑□□ ∑□□ where c is the voltage factor gave as being 1,05

I_{cc} = 1,05 x 1,05 x 231 / ã $6,881^2$ + $21,15^2$

I_{cc} = 11,45kA

So the short-circuit current on the busbar of the LV general switchboard should be 15kA

1.8 Power factor Compensation

The equipment will be equipped with automatic power Factor adjustment through capacitor batteries to be placed on the medium voltage side of the substation.

S = 160 kVA

P = 128 kW

From the table come:

Cos ű$_1$ = 0.80 in load results Ÿ tg ű$_1$= 0.75

tg ű$_2$ = 0.40

Q = P (tg ű$_{1\,ï}$ tg ű$_2$)

Q = 128 (0.75 ï 0.40)

Q = 44,8 kVAr

44,8 kVAr capacitors are required to produce the necessary compensation in power to prevent additional payments from reactive power to the respective supplier

Note:

The compensation is not required to purchase, only in case of energy provider recommendation.

1.9 Extensin of the contract

Considered to be included in this contract all the works and supplies needed for the execution of the following facilities:

- MV Network, incluinding:
    - 160kVA power transformer, inner mounting.
    - Sectioning portico and shunt transition in overhead line for underground cable.
    - Tubes and manholes to connect the monobloc to the public network of MT of EDM.
- Power distribution network, for connecting the QGBT, embedded in substation and distribution cabinets of the hospital complex, including:
    - Ducts and Drawpits
    - Cabling Networks
- Earthing network
- Tests and verifications

The premises behind indicated will be delivered fully equipped, properly tested, ready to work and conveniently connected to the distribution network.

2 ASSEMBLY RULES

2.1 Recticulations

HIGH VOLTAGE CONNECTIONS (HV):

The primary side connection will be made by three type LXHIOV-sheathed cables 33-11-6,6 kV, 1 x 120 mm2 and their connection through heat ends of 36-22-12 kV and bimetallic terminal of 120 mm 2 to the power transformer (AT side) and the CIS cell.

LOW VOLTAGE CONNECTION (LV):

The connection on the secondary side, is made by four mono-conductor cables per phase type XV 3 x 95 mm2 and four to the neutral XV3x95mm2 and tied through the bimetal terminals to power transformer (BT) and the general DB for low voltage.

2.2 Recticulations inside of the Power Transformer

LIGHTING AND SOCKET OUTLET

Inside the power substation will be installed fluorescent luminaires 2x36W, in order to provide a enough level of illumination in accordance with the requirements some outlet sockets for general use.

VENTILATION

The ventilation of the power substation will be made of natural mode, in which the building itself acts as a sink, and can be reinforced with ventilation grilles on doors and Windows if needed.

Developed a special ventilation system, inserted in the roof side, walls and doors that ensures a safe dissipation of the heat generated in the transformer. This system also prevents the accumulation of moisture.

Protective panels in the side walls prevent excessive accumulation of heat inside the compartment in the hours of sunshine.

2.3 Substation output piping

The underground cables for outdoor lighting circuits and distributors who constitute the distribution network will be of type XLPE (aka VAV). The cables must be laid down directly on the ground in plumbing of 0.80 meters deep. Along the pipes will be laid underground crossing boxes 400 x 400 x 600 mm with removable cover concrete.

Vehicle crossing zones, as well as on the route between the manholes and output of each building, the cables should be protected with shackles, concrete, asbestos-cement or thermoplastic material tube of appropriate section to avoid being damaged by the pressure or land settlement.

In the case of vehicles crossing areas the depth of burial should be 1.00 meter. In the ditches the cables should first be covered with a pad consisting of a layer of fine sand on which you put a warning sign for the presence of cables, a network, or plastic tape concrete plates. On this layer there is, finally, the rubble from the excavation.

2.4 Security

PROTECTION ON THE FLUOFIX CELLS

FLUOFIX type cells feature a series of functional jams that respond to recommendations IEC 298 describing as follows:

- It is only possible to close the switch if the earthing switch is in open position and the access panel is in place;

-The earthing disconnector is only possible if the switch is open;

-The opening of the access panel to the cable compartment is only possible if the grounding isolator is closed;

-With the front panel removed, you can open the earthing disconnector to perform the testing of cables, but cannot close the switch.

The functional jams is also predicted that some of the different functions if encravarão between them by means of lock.

Fluofix cells have structural reinforcements want panels or on the access door to the cable compartment that allows them to resist in case of internal arc. Apart from this, these cells have pressure relief devices to protect the operators of smoke and hot gases.

EARTHING AND ISOLATION

Will be connected to the protective earth metallic elements of the installation that are not usually in tension, but that may be due to damage or external circumstances (insulation defect).

The cells will have a copper bar that will link the Earth collector.

The protective earth circuit will consist of a copper bar to which all metallic elements are to be connected.

SERVICE EARTH

Connect to Earth neutral service processor, as described in the chapter ' designed ' Parts of this project.

INDOOR EARTHING

The Earth inside the Post will put electrical continuity mission all the elements which are connected to the ground outside.

Near the exit of the building and within this there is a removable connection that allows the measurement of the resistance of the Earth electrode.

PEOPLE AND FACILITIES PROTECTION

All metal parts, lamps, armor and bolts of power equipment and general purpose that can accidentally come into contact with conductive surfaces must be properly earthed (grounded) power.

The electrodes must be of galvanized steel, copper or copper in the form of steel plates, bars or tubes. Metallic elements simply dipped in water cannot be used with Earth electrodes. The metallic elements that serve as ground electrodes shall be buried in seats as wet as possible, preferably in soil outside the concourses and a considerable distance of deposits of corrosive substances that may infiltrate into the soil.

The electrodes should be placed vertically so that there is a difference of 0.80 m from the top of the electrode on the surface of the ground. The surface of electrode contact with the ground, whatever the manufacturing metal should not be less than 2 metres, so:

If they are used in the form of plates, should be copper or galvanized steel of 2 or 3 mm.

If they are in the form of bar should be 15 mm outside diameter r 1 meter in length.

If using copper tubing or galvanized steel, must have 25 mm outside diameter, 3 mm wall thickness and 3 meters long.

For further informations see Tecnical Specifications ï Earthing System

2.5 Type of mini-substation

The transformation to be used will be of type low masonry construction Cabin ï CBU/CBL should be similar to the type III PUCBET manufactured by EFACEC or equivalent.

2.6 Constitution

This kind of mini-subestação consists of three compartments which allows a great flexibility of use of interior space, defining their use as appropriate. It is recommended, in this case, the section of cells, the measuring cell and the switch of the transformer. There will be room for placing the general framework of low voltage low voltage (QGBT), from which the feeders will be connected.

Cellôs Areas (sections)

- 1 Incoming distributor Cell (Ring);
- 1 General cut Isolater Cell;
- 1 Measurement Cell;
- 1 General Isolater Cell;
- 1 MV output Cell;
- 1 Transformerôs isolator Cell;
- 1 Transformerôs protection Cell;

Cells Descriptions

Cells general Characterístics

The boxes should consist of standard cells with the following features:

Rated insulation Voltage:	36 KV
Test Voltage:	
– Short duration power-frequency withstand voltage:	70 KV
– Lihtining impulse withstand voltage 1,2/50 εs:	170 KV peak
– Short-time Current 1 segundo:	16 KA
– Busbar rated Current:	350 A
– Protection degree:	IP 305

The cell have to be construted by steel plate with 1.5mm of thickness and are charaterizated by:

- Apparatus and equipment assembled in boxes to isolate equipment different function such as:
  - Medium voltage busbar;
  - Cut Devices;
  - Protection Devices and measurements and control cables.
- This partitioning of the equipment will have the advantage of, among others, in case of malfunction or failure, do not affect contiguous cells or cell equipment in question.

2.7 Operation

There will be mechanical locks to prevent any access to the medium voltage compartment, when the appliances are in charge and the earth connections have not been carried out. The operation of the equipment will be held from outside the cells and by means of levers.

External immobilization by padlock to manage the maneuvers.

Existence of a synoptic scheme.

Incomer cells characteristics:

- 350 A Busbar, isolator switch, auto- pneumatic double cut in SF6
  - Insulation rated voltage: 36-22-12 kV
  - Short duration current 1 segundo: 16 KA
  - Close power : 25 KA

Equipped with:

- Manual Comand
- Earthing Knives with locking switch
- 3 Insulations Protections for capacitors e 3 neon flags for the presence of voltage in the cable.

Protections cells Characteristics

- 1 350 A triple Busbar
- 1 SF6 circuit breaker
- Nominal voltage 33kV/11kV/6,6kV
- Nominal current 160(1900) A
- Closing power 40KA

The cell is also equipped with motorized command with Earth knives, coils and voltage indicators.

- Envisaged output for dry cable
- Lock Solenóide by Romis with access to the cell panel of the power transformer.
- Interconnection Busbar Cable between the dry protection celland and the power transformer.

2.8 Power Transformer to be supplied

160 KVA - 33.000-11000-6600/400-231 V Power Transformer (Depenciong of the local level of EDM Medium Voltage) with following characteristics:

- Cooling System; Natural
- Phase Número; 3
- Assembling type; interior
- Output Power; 160kVA/400 kW

- Frequência; 50Hz
- Primáry voltage ; 33-11-6,6 KV
- Clearance; ±2.5% ±2.5%
- Secundary voltage without load; 400/231 V
- Connection group; DYn11 / DYn5
- Reduced looses

2.9 Metering

The energy measurement system will be located in a suitable cell, on the side of the medium voltage. The equipment must be suitable for measurement of reactive power and reactive.

2.10 Earthing

2.10.1 Introdution

There will be two distinct types, namely: Land and Land protection service, which must be separated from each other by at least 20 meters.

The connection of each circuit of Earth to the respective electrodes must be carried out by sufficiently robust clamps to ensure a solid grip of their drivers. There should be removable, links (links) to allow the measurement of Earth resistance.

2.10.2 Service Earth

The electrodes which must be of steel rod Ø 20 mm copper-plated thickness (0.7 mm), should be buried vertically in the soil to a depth of at least 0.8 meters between the top and the surface of the ground.

The electrodes connection cables must be of type H07V-R 1G95 and isolated until a depth of 0.8 m.

2.10.3 Protection Earth

The technical area will have an electrode that will extend throughout their range in order to create an equipotential volume. In foundations with at least 1 metre deep, will be installed a bar with 32 x 3.5 mm Copper or aluminum that will form a closed ring around its perimeter. The parallel sides of this ring will be interconnected, longitudinal and transversely at regular intervals to form a mesh.

The bar should be involved in concrete in order to maintain a minimum distance of 50 mm from the surrounding terrain. If it is not possible to install the bar (or wires) in the rafters of the foundations of the building, it shall be placed in an open ditch along the perimeter of these bases.

In both cases, the installation of equipotential connections between the ring of tape or wire and the armour of the walls should be made, whenever possible, at regular intervals. These links, as well as the interlinkages between sections should be carried out with the appropriate accessories or by welding. Links for equipotential connections must use the same type of wire or bar to ensure full involvement of concrete.

Where it is planned to install frames or other electrical infrastructure that requires grounding shall be provided for direct derivations of the ring of land described above, in accordance with the conditions mentioned, which must end up in a removable link installed at least 0.5 metre high.

2.10.4 Earthing rod

- Made of steel rod construction of rectangular section 32 x 3.5 mm hot dip galvanized or coated with copper or aluminum.
- Interconnection of basic segments of continuous electrode through threaded overlay. The placement of the electrodes in the mass of concrete or beam gives adequate support.
- The same must be spaced of 1.5 to 2 meters. The pickets of Earth must be coated with copper in a minimum thickness of 0.7 mm and shall have minimum dimensions of 15 mm diameter and 2 meters long.

2.10.5 Rod Interconnection

- All sections of the bars should be interconnection by screws galvanized surfaces to warm;
- The bonding surfaces must be thoroughly cleaned immediately before connecting;
- Immediately after run the links, you will need the full involvement and careful of the same plastic and adhesive tape, which consists of a polyethylene coated base, if possible on both sides, with paraffinic hydrocarbons with high melting point.

The main features of this net based on coated polietilen are:

- Durability e
- Resistente to acids and other corrosive agents
- Tickness 0.50 millimetres
- Resistence to adhesive tensile
- Width 30 a 40 N/cm ï 300% elongation at break.

The involvement will be held in spiral shape with exits in at least 10% of the width of the tape. The coating obtained should be covered by a second layer of PVC with thickness of 0.3 mm or more.

2.10.6 Equipotencials connections

This item refers to the connection to the Earth electrodes at various points of the structure of the armature, preferably at the level of the foundations.

Basically consists in welding at the base and on the walls of an iron bar type Fe 22 with 50 mm square cross section, linking the armor with the Earth electrode with all metal pillars.

2.10.7 Earth Link

Galvanized steel, copper or aluminium with 32 x 3.5 mm;

Mounted on the wall at a height of 0.5 meter from the ground.

Fixed by means of metal bearings and nuts of the same type as the bar behind referenced.

2.11 Tests

With a maximum resistance of at least 5 ohms, at any time of the year, aiming to identify the flaws in continuity that, if in the end will be much more expensive, should be checked:

- The electrical continuity of each section, only to get involved with the assembled system, through óhmica resistance measurements between the extremes.

- Resistance of the Earth electrode via measurements at various stages of its implementation and separately on each soil until the sealing ring

.

Given the close coordination that must exist between the set of electrodes with the other works, the same should be planned sufficiently in advance and with the knowledge of the Supervision.

The results of the measurements and their dates are recorded in balance sheets, which once signed for monitoring should be sent to the execution of the works.

2.12 Accessories

On the outside of the substation should be affixed to one or more boards with the inscription "danger of death", with the identification of the same.

It is recommended that one of these plates is indicated, the initials and phone number of the distributor of electricity on site.

Inside the substation should be placed:

- First aid instructions in personal injury due to electric current;
- Book of records of measurements of Earth;
- 1 portable self-powered Lantern; 1 40 KV insulating mat;
- 1 pair of insulating gloves;
- Triangular cards with the warning "danger of death" on all ports.

Maputo, November 24th de 2017

(Alexandre Mutemba, Eng.º)