PROTOTYPE DESIGN FOR A PHARMACEUTICAL INTERMEDIATE WAREHOUSE

TECHNICAL DESCRIPTION OF REFRIGERATION

CONTENTS

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1 INTRODUCTION

1.1 Framework

For some time now that the Mozambiqueês Ministério da Saúde (MISAU) has identified that was expend considerable monetary values in the lease of infrastructure, at provincial and district levels for storage of medicines and other medical products for distribution to local health facilities at risk of deterioration, since most of these infrastructures do not have the appropriate conditions for storage of such products. Based on this evaluation, in 2013 the MISAU prepared the Strategic Plan for Pharmaceutical Logistics (PELF) covering politics, infrastructure, retail chains and financial needs to achieve a sustainable improvement in the safety of medicines.

According to the PELF, there are three regional warehouses, the South in Maputo, the Center in Beira and the North in the city of Nampula, which will distribute medicines and medical supplies to the intermediate warehouses spread over districts that have been identified, and these in turn will get medicines and other items and medical products to health centers.

According to the PELF, the National Health Service is composed of 1392 health facilities to be served by the Logistics System. The supply chain proposed by PELF will reduce the provincial and district warehouses to a single layer, the intermediate warehouse, which will be responsible for:

- Receiving medicines and other medical items in bulk or pre packed sent from regional/ central warehouses;
- Reception of medicines kits (identified products);
- Storage of medicines received in bulk or pre-packaged;
- Prepare the drugs wholesale distribution plan;
- Analyse orders and the drugs wholesale distribution, requested by the health units;
- Organize/ transportation arrangements of medicines and other items to the health facilities deposits;
- Collect and analyse consumption data and preparing reports to the headquarters of the Centre for Drugs and Medical Supplies (CMAM) and the regional warehouse.

In the context of support provided by USAID (United States Agency for International Development) at the MOH, the Project GHSC-PSM (Global Health Supply Chain - Procurement, Supply & Management) in Mozambique supports the MOH and CMAM in adopting the model of regional distribution/ intermediate of medicines in replacing the current national/ Provincial/ District level. For this new model of distribution is crucial to the design of a project prototype for the warehouse of medicines.

This technical specification is aimed in defining the characteristics and requirements to be followed and observed in the construction of cold/ freezer rooms for the conservation of medicinal products, set out in the project in question. The document also intends to establish recommendations and general and specific requirements and the scope of works for this activity.

These cold rooms are intended for the storage of medicines and vaccines and its construction will include the supply, erection and installation of all components, the regulation and the execution of all operation tests.

The characteristics of this type of installation require special attention with regard to ensuring maintenance of storage temperature recommended for the various pharmaceutical products. Thus, all components and construction processes prescribed in this memory must be strictly adhered to and followed.

The Contractor of this skill should be aware that all supplies and facilities must take into account the particular conditions of each of the sites of project implementation. He undertakes to submit a detailed plan for supply, transportation and delivery in the yard, unloading, lifting equipment, installation, testing and putting into operation of the equipment and materials that proposes to supply and install, leaving the installation in perfect working condition, ensuring an equally good service and maintenance of the entire installation during the period of its operation.

At the same time and before commencing their activities at each site, the contractor must also submit the methodology for the development of their tasks for achieving the proposed objectives, together with an indication of the equipment, brands, materials and all the accessories that will be necessary for a good and safe implementation of the project.

This documentation in conjunction with the drawings of this discipline are the Detailed Design for the Calculation of Cold Rooms for Medicines Storage and should be considered as part of the Detailed Designs from other engineering disciplines involved, as well as complement to other contract documents.

2 THE SCOPE OF WORK AND LIMITS THE SUPPLY

2.1 General Information

This project was developed with the aim of giving storage locations of medicines, better conditions for the conservation of these products, so as to ensure the maintenance of all its characteristics for their use in hospital units attached to each of the warehouses of medicine currently under development.

The chambers proposed in this project should respond to the requirements of the plant health legislation, in terms of:

- Coating with durable material and washable;
- Thermometer to read the temperature at the outer side of the camera;
- Electrical Switchboard which permits the monitoring of refrigeration equipment and lighting inside the house, including pilots of indication of the operation of the same, besides all the necessary set of exterior of the electrical system;

- Airtight doors that allow the internal temperature and with security lock (lifeguard) that allows opening from the inside of the camera;
- Adequate system of compartments of the stored products.

The equipment that should be marked renowned will be fully provided by contractor or its responsibility and should be installed in the positions agreed with the designer.

Each camera shall be provided with two sets of refrigeration equipment, fully independent, comprising each condensadora unit unit, evaporator, interior of command and control, refrigerator, electrical supply and all devices necessary for the proper functioning of the systems. Each of these sets should have the ability to respond to the complete heat load.

Although it may possibly be remiss in Bill of Quantities, it is assumed that the supply and installation of equipment, including all accessories of brackets, fastening devices, measurement and power supply equipment, electrical switchboards, tests and other supplies, so that the system is able to be delivered to operate under conditions for which it was designed.

The described above includes all the work of the Contractor, expenses with his staff, materials and equipment, whether temporary or permanent, needed to run safely and efficiently the implementation works, always supervised by skilled technicians.

2.2 Scope of Work

This description aims to establish the specific conditions for the supply, installation and operation of the refrigeration equipment for the Medicines Intermediaries Warehouses.

The project must comply with the following main steps:

- Definition of design conditions;
- Calculation of cold storage capacity by means of the use of spreadsheets or a dedicated computer software;
- The estimated quantity of medicines to keep in the cold rooms in each warehouse location, taking into consideration the recommended temperatures for the purpose for each one of them;
- Selection of all refrigeration equipment and accessories to be installed;
- Preparation of drawings, with the necessary detail, to allow its understanding of the Contractor and of all those involved in the project.

In the implementation of this project, it is recommended that the supply and installation of equipment from renowned, reliable brands and/or with commercial/ technician agent established in the country, or otherwise likely to be assisted technically by duly qualified staff.

The Contractor shall only provide and install new equipment, components, equipment and materials and it is not being authorized the reuse of any material.

The works associated with this discipline to be performed by the Contractor are the following:

- Supply and installation of modular cold/ freezer stores, polyurethane insulated panels, with a strong freestanding metallic structure. The isothermal panels should be coated on both sides with galvanized steel sheet painted in white color (or another that the Architect find convenient) with a minimum thickness of 0.5 mm; the panels should have the kind male-female junction with overlapping sheets as a form of sealing guaranty.
- Supply and installation of refrigeration units including all accessories necessary for the proper performance of the installation, according to the Bill of Quantities that is part of the documents of the contract;
- Supply and installation of all support and connection fittings for refrigeration units, necessary for a good performance of the contract;
- Testing and commissioning of the entire installation. A certificate of completion of the tests should be prepared by the Contractor, certified by the Supervion Team and delivered to the Client;
- Preparation of final as built drawings of the whole installation, with precise indication of the position of all supplied and installed equipment.

3 REFERENCE STANDARDS

The development of this project complies with the standards and requirements of the following international bodies:

ASHRAE - American Society of Heating and Air Conditioning Engineers

ARI - American Refrigeration Institute

WHO - World Health Organization

4 MEMORY OF CALCULATIONS

4.1 Project Data

4.1.1 Cold Rooms for Conservation of Vaccines and Other Pharmaceutical Products

Vaccines are biological substances are very sensitive likely to heat, light, cold, humidity, etc. depending on their nature. If the conditions of conservation than those recommended by its manufacturer, their characteristics can be changed in a very short time and a vaccine that has lost its potential, never recovered, is a vaccine has been lost.

In this sense, the vaccine should not be exposed to temperatures above or below those recommended by manufacturers under the risk of quickly losing their potential. For example, the measles vaccine maintained at 5 o C will maintain its potential for at least 2 years, while when exposed to 40 o C, you will lose power in less than 1 day.

The system of cold for the conservation of vaccine starts with your manufacture and only ends with his administration to airports, warehouses, warehouses intermediaries, Health Centers and finishing with the

medical centers where the immunization of children. The elements common to all systems of cold chain is a series of links to conservation and transport through a network of fridges, freezers and thermal boxes which keep the vaccines at a safe temperature along its route.

However, in the context of this work, what matters is the cooling system in warehouses intermediaries, which should have available spaces designed for the conservation of different pharmaceutical products requiring controlled temperatures, in particular the chambers to be installed in the sectors of vaccines, drugs chilled and Laboratory, in which the temperature ranges vary from 2 to 8 o C, -2 to -8° C and -15 to -25 o C.

Because they are monoblock cooling units and, therefore, with the condensation of the refrigerant gas to come within the internal space of the warehouse, it will be required to include a good mechanical exhaust system from the warm air that results in these compartments.

The temperature in the different areas of the warehouse should be constantly monitored and recorded on a regular basis, depending on the rules established by management, mainly in the fields above named and, in case of deviations, the necessary measures should be taken to the refitting as urgently as possible in the levels laid down by the rules.

All equipment in the cold chain must meet a set of performance standards defined by the World Health Organization (WHO) and by the national policies of the health sector. The dimension, that is to say, the storage capacity of the equipment for cold air will vary depending on the volume and type of products that need to save.

It should be noted that in a warehouse at this level, all the equipment for cold air should be designed with redundancy at 100% and with guarantee of uninterrupted supply of electrical energy (in the draft electricity should be included two groups emergency generators, redundant also in 100%, with automatic start in cases of power failure of the distribution network).

This document intends to define the technical parameters to be achieved in each of the chambers to build, in order to create the best conditions for the conservation of drugs and vaccines - in terms of temperature and other characteristics, in accordance with the recommendations of the standards relating.

This parameter must be controlled by thermostats, which are devices, electro-mechanical or electronic equipment, appropriate, within a range of ± 1,5ºC and measured by thermometers to install on the outside of the cameras for scanning and monitoring the temperature inside the chambers and, possibly, regularly recorded in printed created for the purpose of monitoring the operation of the cold chilled. May be included an audible alarm to be activated in case the temperature area outside of the tracks are recommended for the conservation of pharmaceutical products in question.

There is no dedicated device to control relative humidity.

The data base for the calculation of the refered rooms are, among others, those who are listed below:

1. Dimensions of the rooms;
2. Type of thermal insulation;
3. Outside environment temperature and temperature to be achieved inside the rooms:

4. Type of product the be stored;'
5. Characteristics of using.

4.2 Calculation of Cold Storage Capacity

The thermal capacity will be calculated using a program and a spread sheet devoted, whereas the chambers should have permanent functioning, with redundancy at 100% of the cooling equipment in each of the cameras to install in the scope of this project.

The steps included in the calculation of the thermal capacity were:

1. *Choose the type of insulation:*

   The choice of insulating material for the panels pre-molded parts should consider, among others, the following aspects:

   - Cost;
   - Durability;
   - Fire resistance;
   - Resistance to the retention of smells.

   At present, due to the set of characteristics that presents the material most often used in the manufacture of panels pre-molded parts for the construction of chambers is the expanded polyurethane. And, depending on the temperature you want to keep inside the camera in question, the thickness can vary, approximately according to the table that follows:

Temperature of the Room [°C]	Thickness of Insulation [mm]
8 a 20	60
3 a 8	80
-5 a 3	100 - 120
-15 a -5	150
-20 a -15	180
-30 a -20	200
-40 a -30	240

2. *Determination of the minimum thickness of expanded polyurethane:*

   Despite the recommendation left in the previous paragraph related to the thickness of insulation, is aconselháve l run a check for each particular case. To this end, it is a simple calculation, which relates the insulation material and the difference of temperatures inside and outside:

$$E=k \times \Delta t/q_{max}$$

Where:

- And - Thickness of insulation [mm];
- K - Thermal conductivity of the material (0.020kcal/h.C);
- Q_{max} - maximum flow of heat (8 kcal/h.m^2 is an average value that ensures a satisfactory assessment between the cost of insulation and the operating cost of the installation);
- ΔT - temperature difference within the internal room space

3. *The cold load*

   There are different spread sheets and computer programs for calculating the thermal load required for the cold/ freezer rooms for the conservation of different products.

4.3 Refrigeration System Components

4.3.1 Insulated Panels

The cold/ freezer rooms shall be of the type modular, with walls, floors and ceilings in sandwich type pre-fabricated panels, with rigid polyurethane foam as core heat insulating material, injected between metal sheets of a minimum thickness of 0.5 mm. The inner plate must be made of stainless steel AISI 304 and the external of stucco finish aluminum.

The roof panel with different requirements should be manufactured specifically for this purpose.

In the floor of the rooms will also be used modular panels coated on the inner surface with aluminum plate mat with a minimum thickness of 0.95 mm and the external face (face in contact with the slab support) in aluminum with stucco finish.

All the edges of the cold/ freezer rooms should be coated with aluminium angle frames.

To access the inside of the rooms, due to the thickness of the floor panel, ramps with enough strength should be provided.

For the connection between the poliuretane insulated panels should be equipped with attachments based on non-oxidable, embebed and anchored in the polyurethane core, with spacing not exceeding 1.5 meters between themselves.

The joining strips should be devoid of the stainless steel sheet coatings in order to ensure perfect contact between the thermal insulation cores of two joined panels, in order to prevent the formation of cold bridges.

In the joints of the panel walls, wall and ceiling or wall and floor it may be used locally injected polyurethane, on the spot, with the same consistency of main insulating material, instead of hooks.

The modular panels should always be mounted on levelled surface, with waterproofing and adequate resistance and coated with ceramics of good mechanical strength and durability.

The fitting of panels has to be very carefully in terms of both vertical and horizontal, to avoid gaps greater than 2 mm.

In the event of more prominent gaps, it is recommended their disassembly and new assembly in order to eliminate them.

After assembly, as per recommended conditions and manufacturers specifications, should be made the sealing of all the joints using adequate rubber paste or silicone.

1.1.1.1 Specifications of the Insulation Core of Insulated Panels

The main physical properties of polyurethane used as core insulation of the panels should be:

- Minimum density: 35 kg/m ^{3}
- Coefficient of Thermal Global Conductivity: 0.020 kcal/h.C
- Thickness: the thickness of the insulation core is dependent on the temperature that is required to keep inside the rooms.

4.3.2 Insulated doors

The insulated doors to use in cold/ freezer rooms should be constructed of structure of profiles of reinforced plastic or aluminum filled with insulating material made of expanded polyurethane foam, coated internally and externally with stainless steel AISI 304, 1 mm thick sheet.

They can be swing or sliding type. The sliding doors are supported by guides secured to the outer surface of the room, in which they slide to open and close. The swing doors are equipped with 2 or 3 adjustable hinges manufactured of molded stainless steel. This type of doors should, on the other hand, present characteristics of appropriate tightness, so they should have a perimetral seal, usually made of alveoli rubber with PVC support. All doors should count on resistance of heating to facilitate its opening.

All doors to be installed in the cold/ freezer rooms shall content devices for closure and opening from the inside, even when locked with an external padlock.

To avoid prominent cold losses to outside at the door openings, it can be included low temperatures resistant, transparent and flexible PVC curtains.

4.3.3 Equipment and Accessories

The mechanical cooling equipment for the cold/ freezer rooms to be deployed in the Medicines and Medical Articles Intermediaries Warehouses will be single monoblock and compact type, that is to say, all components mounted on a same basis and should include incorporated all the required command and control of operation accessories and devices. In this type of equipment it is only required the electrical connection, starting from a partial electrical distribution board.

1.1.1.2 The Cooling Unit

The single monoblock and compact type cooling unit will integrate the condenser, evaporator, compressor, the refrigerating circuit and the entire unit contolling system as a whole, mounted in one body with only a mounting base.

This type of units can be used in various areas of activity - hotels, catering, agriculture, chemical industry, conservation of medicinal and other areas where it is required to use refrigerated storage - in rooms of various temperature levels, since 5 at -20^{o}C.

The compact cooling units are composed of base, condenser coil, compressor, condensation moto-fan, evaporator coil, evaporation moto-fan, refrigerating circuit and a set of monitoring, control and command devices.

There is, as specified above, a wide range of refrigeration units, since the more small and simple to the most sophisticated, intended to be used in special cases. The cooling unit for each case should be sized by taking into account the particularities of each project.

The installation of the this type of cooling unit is very simple, safe and does not require technicians with great expertise, but meanwhile it should be carried out using suitable holders and anchoring system, as per indications of the respective manufacturer.

a) Unit Baseframe

The base of the cooling unit should consist of a galvanized steel frame and panels with a suitable gauge for good stiffness of the whole, protected against corrosion, with electrostatic painting in enamel paint on rust inhibiting primer. In the case of a closed unit, the panels should be removable to allow easier access to the interior of the machine and built with steel sheet. It should receive appropriate treatment to be resistant to the action of time and external environment.

b) Unit Cabinel

In general, the unit cabine is made of aluminum structure with smooth and shining finish to facilitate cleaning, but it can also have epoxy paint finished, in white or stainless steel.

c) Condenser Coil

The coil of the condenser coil unit should be made with copper pipes of appropriate diameter and fins made of aluminum with coating to prevent direct contact with the copper tubes, attached to these by mechanical expansion. The coil should be tested against leaks at a pressure of 350 psi.

The condenser is the component of the refrigeration cycle responsible for transferring the heat from the system to the air or water or a combination of the two, known as evaporative condenser.

The gas that has high pressure and temperature, passing through the condenser is cooled, liquefying, transferring sensible heat and latent heat of condensation.

d) Compressor

The compressor is one of the key components of the refrigeration systems; it is the heart, of the cooling systems. Its function is to increase the pressure of the refrigerant and promote its circulation through the system.

The main types of compressors are: alternatives, rotating, screw, vane and scroll.

And, in terms of construction, the compressors can be classified according to their accessibility, in hermetic, semi-hermetic and open.

In the hermetic compressors, both the compressor and motor are housed in the same housing, offering only access to input and output of the electrical connections of the motor. This type of compressor operates exclusively with halogened gases and the the cooling fluid steam comes into contact with the motor winding, cooling it. They are generally used in domestic refrigeration and air conditioning equipment, with powers up to 30 kW.

The semi-hermetic compressors are similar to previous type, but allow the removal of the head of the housing, allowing access to the pistons and valves.

In the open type compressors, the drive shaft of the compressor passes through the housing, allowing the drive through an outboard motor. They are large compressors operating mainly with ammonia.

The choice of the type of compressor depends mainly on the power of the installation.

The cooling unit can be equipped with one, two or three compressors depending on the required refrigerating power. Generally, the compressors used in these units are alternative hermetic, rotating or bolt, mounted on vibration absorbers, depending on the manufacturerg, required refrigeration power and other technical-commercial factors.

As mentioned above, the compressors are driven by electric motors, internally protected against overloads and suitable for tolerating the voltage variation of up to 10% of nominal value. These electric motors are cooled by the flow of suction of refrigerant and can be equipped with carter heaters. For additional protection, in the electrical switchboards should be installed components to avoid the reversal of phases (in the case of three-phase units) or other according to the requirements of each project.

e) Condensation Moto-Fan

The fan from the condenser unit, in general, are axial with blades facing forwards, constructed of any plastic material, aluminum or stamped sheet of galvanized steel, statically and dynamically balanced, driven by motor directly coupled to the shaft.

The condenser fan should be of low noise type.

The electric drive motor can be single or three phase, depending on the power of the cooling unit.

f) Evaporator Coil

The evaporator coil of the unit should be made with copper pipes of appropriate diameter and fins made of aluminum with coating to prevent direct contact with the copper tubes, attached to these by mechanical expansion. The coil should be tested against leaks at a pressure of 350 psi.

This is a type of evaporator that has thin metal plates fixed between its tubes. The fins improve the efficiency of the heat transfer, due to increase the global area of heat exchange.

Due to this greater area, these evaporators can be more compact than the smooth pipe without harming the ability to absorb heat.

The evaporator can possess gas distributors and collectors at the entry and exit for optimization in its distribution.

In its lower part they must have water collector trays with the same finishing and material of the cabinet.

The internal tray that prevents air leaks and concentrated flow of water heated to the drain, avoiding undesirable formation of ice on the tray and heating of the room during defrosting. And the external tray rocker and removable type, with rounded corners, improves access to the de-icing system and its sanitation.

g) Evaporation Moto-Fan

The evaporator fans are, in general, axial with blades facing forwards, constructed of plastic material, aluminum or galvanized and stamped steel sheet, statically and dynamically balanced and driven by a motor directly coupled to the shaft.

The evaporator fan should be of low noise type, if required.

The electric motor drive can be single or three phase, depending on the power of cooling unit.

h) Refrigerating Circuit

The refrigerating circuit interconnecting all the cooling unit components is executed in the factory in piping from the appropriate class and dimension and should incorporate all devices to control the refrigerant gas flow. This copper pipeline should be with the smallest number of amendments and supported by appropriate clips so as to avoid its contact with the existing moving parts.

i) Refrigerant gas

The units of all refrigeration systems must operate with the refrigerant gas R404A or other alternative, also free of CFCs and, therefore, with ODP (Ozone Depletion Potential) equal to zero.

The initial charge of the cooling unit is carried out by the manufacturer in their premises.

The cooling units must be all tested and commissioned at the factory under the operation regimes for which they were designed and built.

1.1.1.3 Command and Control Accessories

All the cold/ freezer rooms shall, as already mentioned, include mechanisms and devices for the control of the operation, of which the most important are:

a) Thermostat

Thermostat is a device designed to maintain a constant temperature of a certain system, through automatic adjustment. Its function is to prevent the temperature of the system varies beyond certain planned limits. Such a mechanism is composed mainly of two components: one indicates the thermal variation experienced by the system and is called sensor element and the other controls such variation and corrects the temperature deviations, keeping them within a given adjusted range.

b) Pressure Switch

Pressure switch is a device for measuring pressure used as a component of the system for equipment and various industrial processes protection. Its basic function is to protect the integrity of equipment against overpressure or underpressure applied to them during their operation. It consists in general of a sensor, a mechanism for adjusting the setting point (set-point) and a two-position (open or closed) switch. As a mechanism for adjusting the set-point it is used, in most applications, a spring with a selected adjustment range according to the working pressure and in opposition to the applied pressure.

c) The Partial Electrical Panels

It should be provided partial electrical panels for control and electric command of the installed refrigeration equipment, preferably installed near the respective cold/ freezer rooms and must contain the following components:

- Cabinets manufactured from steel sheet thickness not less than 1.2 mm with pivoting door and painted with paint epoxy based on electrostatic process, after manufacturing, with appropriate dimensions. They should be provided with adequate locks and should be equipped with:
    - Contactors and relays;
    - Power and command terminals;
    - Phase indicators;
    - Manual starting and stopping push buttom of the equipment;
    - Device for shutting down the thermostats, through the use of knob;
    - Automatic defrost system with programmer;
    - Tagging and complete legend of all installed electrical equipment.

On the other hand, the switchboards should also be fitted with pilots of indication of operation (green for normal operation, red for door open or some failure in equipment).

4.3.4 Piping from the condensate drainage and resistance of Drainage

Drainage of condensates that form derived from the process of de-icing (programmed de-icing of the cold/ freezer rooms) in evaporators trays should be made by gravity, through PVC pipe of adequate dimensions (in general, it is used the 4 kg/cm2 of 32 mm nominal diameter PVC pipe), including bends, fittings and supporting devices, being referred to the drainage system of the infrastructure, taking care to install a system of curve and curve that will act as a siphon to prevent the entry of any bad odours inside the compartments where they are installed the refrigeration units.

Due to the fact that the initial phase of pipes of drainage is inside the cold/ freezer rooms and, therefore, subject to very low temperatures, it is recommended that in that extension it should be installed an adequate resistance element to prevent water solidification.

The entire length of the condensate drainage pipe should be well supported through appropriate clips along its whole extension. It should be also used a elastic and flexible connection between the pipe and the refrigerartion unit to absorb any vibrations caused by its own operation.

Whenever it is require to make crossings of walls it should be required to provide the installation of an appropriate wall sleeve with adequate size for moisture protection of the civil construction structures.

5 ELECTRICAL INSTALLATIONS

The Contractor of electricity is responsible for adequately feeding with electrical power all the electrical boards dedicated to cold/ freezer rooms, from the Main Distribution Board.

All materials, equipment and services provided for this area of activity should follow the norms inherent in force.

To responde to the refrigeration equipment, the refrigeration Contractor is responsible for the supply and installation of two independent circuits, being a principal and another of back-up, equipped with its own circuit breakers in the Main Distribution Board. Each one of these circuits must include a device for protection against variations in the electrical supply quality.

All conduit for the drawing of the electrical wiring that has contact with the inside of the cold/ freezer rooms should be sealed with suitable products; during the inspection for provisional delivery of the work it should be verified if the electrical conduit sealing was correctely executed ant thatfact should be included in the report of the inspections to be carried out by the Supervision team.

Lighting of the Cameras

For better operation in the cold/ freezer rooms interior, there should be provided a system of artificial lighting. The lighting fixtures to install should be moisture and vapor proof. The switches to switc on and off should be located on the outside wall of the rooms and should be equipped with adequate flags for indication of light on inside the rooms.

They should be submitted catalogs of the proposed equipment, including all associated wiring connections priori to equipment delivery.

For all the electricity works not directly related to the refrigeration systems should be referred to the technical description and details of the electrical energy supply project.

6 CONSTRUCTION WORKS

All construction works, such as bases construction, opening in the masonry for passage of gutters, piping and electrical wiring and respective final finishes and other auxiliary works shall be performed by the Contractor, as and where necessary.

Then, some situations which, at the time of the provisional acceptance of the work, should listed in the presence of the hired Contractor:

- All possibly damages caused to works or services, due to the execution of the work of this contract shall be rectified or best restored to its condition before the implementation of this project;
- Reconstruction of all parts in masonry, floors, roofs, windows, paintings and other works that for whatever reason have been demolished or otherwise damaged to the implementation of this project;

- Implementation of all ancillary services necessary for the installation of the refrigeration equipment - electrical interconnection, social costs, tests and trials of equipment and installation;
- Implementation of general cleaning of the locations covered by this contract and all the installed equipment. This operation does not remove from the contracted company the responsibility for, in the course of their involvement in the work of implementing the installation, perform daily cleaning of the locations covered by its services;
- The finishing of the reconstruction/ repair works of the demolished or damaged parts during the execution of the refrigeration equipment installation services shall be of a similar or higher quality than the rest of the contract.

7 OPERATIONAL TESTS AND COMMISSIONING OF THE INSTALLATION

After completion of room construction and equipment installation, the entire cooling system should be inspected against possible presence of mistakes and wrong fulfilment of the manufacturer recommendations.

Considering that the cooling units are assembled and completely tested at the manufacturer premises, each one of them should be accompanied with a set of Manufacture Test Certificates. Then the inspection and testing actions should dedicate attention to the roomsôerection and equipment installation.

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After the execution of the works and regulated the installation should occur performance tests of the entire set, with a view to the parameters adopted and standards involved. All deviations must be registered and corrected.

Before the provisional delivery of the cold/ freezer rooms, should be carried out, as a minimum, the following tests:

- After three days of routine operation without interruption, it switches off the compressors for each room and measure and record the time it takes for the temperature rise up to 10ºC, taking care to also measure and record the outside temperature.
- Measure and record, several times, the values of the refrigerant gas and oil high and low pressures;
- They should be checked and carefully observed the components of the thermal insulation ï insulated panels and doors, door seals and others;
- Measure and record the readings of the electrical consumption of the various components and compare them with the nominal manufacturerôs specifications.

For the effective implementation of the above tests, the contractor must provide the following measurement instruments:

- Pressure gauges;
- Anemometers;
- Electronic digital thermometer;

- Ammeter;
- And others who deem necessary.

The refrigeration Contractor will be responsible for organizing the survey and all tests in the presence of Supervision Team for the installation verification and register of all detected defects, which should be the subject of correction by the Contractor.

A report containing the results of all tests should be drawn up and signed by the Contractor, certified by Supervision and delivered to the Client, along with the final technical documentation file, at end of the contract.

8 SURVEYS AND LICENSES

The Contractor is responsible for organizing, with the relevant local authorities if required, all the surveys and licensing for the public use and exploitation of the installed equipment.

The Owner of the Works will be responsible for obtaining permission to cContract implementation as a whole.

The Contractor shall also deal with all licenses relating to their activity on the project implementation location.

The surveys of the installation for the purpose of operating license and others, will be borne by the Contractor, which should ensure that the installation is duly approved by the date of provisional delivery of the work in general.

9 OPERATION AND MAINTENANCE MANUALS

They are part of the Contractor deliveries: the as builtl drawings of the entire installation under contract, the Operations and Maintenance Manuals in detail for each piece of equipment and/or component.

It should be delivered to the client a complete collection of these elements for file and later consultation.

The Contractor pointed to this project implementation must submit, prior to starting the work, a proposal for a maintenance contract, to be approved by the Customer or his representative, because it is extremely important to ensure the maintenance and technical assistance after the conclusion of the Contract.

10 GUARANTEES OF EQUIPMENT

The Warranty period of installation is 12 months, but in all that relates to the supplied equipment, these guarantees must be at least 5 years, against manufacture and installation defects, if longer guarantee period is not granted by the manufacturers of the equipment.

Maputo, November 24th 2017

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(António Dias, Engineer)

11 ANNEXES

11.1 Annex 1 – Installation Completion Qestionnaire

Site Name:		Date:		
Room description:		___ / ___ / ___		
TEST 1 - General Inspection				
All components are undamaged?		Y		N
Comments on status/condition of parts on arrival before installation:				
1. All room enclosures have been installed and are of the correct size (m3).		Y		N
2. Wall, floor and ceiling finishes are as specified in the specifications.		Y		N
3. All enclosure panel joints are tightly butted together.		Y		N
4. There are no gaps around panel cut-outs where refrigeration units and services penetrate the enclosures.		Y		N
5. There are no gaps around room door seals. Catches and locks operate freely.		Y		N
6. Door seal heater elements (where specified) are fitted.	NA	Y		N
7. Freezer room pressure relief vents are fitted and operate correctly.		Y		N
8. Internal tungsten lighting has been fitted, operates correctly and produces the specified minimum lighting level throughout the room.		Y		N
9. Shelving units are of the specified size, material and have been set up with adjustable shelves correctly spaced.		Y		N
10. Enclosures are marked with the correct temperature zone symbol sticker.		Y		N
11. Heater mats (where specified) have been fitted under floor panels and operate correctly	NA	Y		N
Comment on above questionnaire:				

Refrigeration and temperature monitoring equipment:						
12. Automatic/Manual duty-sharing circuits are installed and operate correctly.				Y		N
13. Refrigeration units are marked with the correct refrigerant identification.				Y		N
14. Evaporator cages or deflectors (where required) have been installed.		NA		Y		N
15. Temperature recording units and sensors are correctly located.				Y		N
16. Acoustic and/or visual alarm units are correctly positioned.				Y		N
17. All electrical cables are securely clipped in place and electrical cover plates and accessories are securely fixed.				Y		N
18. All components that require routine servicing or replacement are easily accessible.				Y		N
19. All components are correctly protected against the weather or other environmental conditions.				Y		N
Comments:						
20. Test 1 recommendation: Pass.				Y		N
TEST 2: Cool down						
21. Number of hours for the Room to reach +4^{o}C/-15^{o}C						
22. Test 2 recommendation: Pass.				Y		N
Training course.						
23. Training on Maintenance for technicians recommended.				Y		N
Brief description for the reason to arrive on the above recommendation						
Overall conclusions and recommendations on installation and commissioning						
24. Recommendation: Pass.				Y		N
If **FAIL,** list outstanding work still required:						
A -						
B -						
C -						
D -						
If PASS, the installation can be handed over to the user.						

11.2 Annex 2 – Maintenance Plan

Activities	Date e Signature
Weekly Activities	
Check condensation points on door frames	
Check the evaporator water drain system	
Check thermostat actuation	
Check the performance of the defrost resistors	
Clean power and control boards, both internally and externally	
Inspect the power and control panel components (connectors, cables, wires, clamps)	
Inspect refrigeration system components, including compressor oil level	
Check the occurrence of abnormal heating of power and control panel components and power supply connectors	
Assess external thermometers (mechanical and digital)	

Activities	Date e Signature
Monthly Activities	
Clean the condenser coils with compressed air or fine hair brush	
Cleaning the condensation trays	
Verificar o nível de óleo dos compressores	
Retighten power and control board connectors and terminals	
Check motors voltage and current	
Check refrigerant fluid pressures	
Check the humidity display	

Activities	Date e Signature
Quarterly Activities	
Check the state of preservation of the thermal insulation of the refrigeration circuit	
Check the infiltration points for the outer joints and walls, especially the holes in the walls and ceilings of the rooms, made for the entrance of the refrigeration unit and electrical cables	
Check the corrosion points of the metal parts of isothermal panels, cabinets and supports	
Re-tighten the fan fixing bolts and nuts	
Check tightness of all nuts in the cold/ freezer room assembly	
Check oil pressure in compressors	

Activities	Date e Signature
Semester Activities	
Check operation of control and command systems	
Check operation of safety devices	
Clean evaporator coils	
Check for overheating and undercooling	
Check compressor motor insulation	

11.3 Annex 3 - Technical Specifications