1 PRELIMINARIES

During project planning, specification of materials and equipment, testing equipment and installation, it shall be considered the latest versions of the applicable documentation and international standards specific to this type of systems.

This technical specification aims at the definition of technical parameters of construction and installation to be observed in systems of conservation and freezing fresh food, medicines and other products designed to meet the specific storage conditions for each case.

For the correct selection of equipment to provide and install it must be elaborated a design, as detailed as possible, by skilled technician, in which shall state at least the following data:

a) Estimation of the Cold Load required, through an appropriate calculation method and the most reliable possible, taking into account:

- Weather conditions of the place of implementation of the project;
- Required room dimensions: walls, floors, ceilings and doors;
- Constructive elements: dimensions and materials the walls, floors, ceilings, thermal insulation and others;
- Sources of heat dissipation: people, lighting equipment, electrical/electronic equipment diverse and others;
- Air Infiltration through the door openings;
- Other criteria that can influence this thermal load.

b) Selection of the cooling equipment to be supplied and installed, according to the previously assessed thermal load and the customer requirements and expectations.

c) Brand selection of refrigeration equipment to provide and install, taking into account the most reputable brands such as *DANFOSS, EMBRACO, ELGIN, RECAM, TECHUMSEH* and others.

2 GENERAL FEATURES

The features described below are intended to introduce the basic conditions for a perfect equipment supply. The supervision should do evaluation, adaptation to the specific and complementary equipment to

ensure compliance with standards, the requirements of safety and operational efficiency of the installation and the elaborated calculations.

2.1 Units System:

All quantities should be indicated in units of measurement belonging to the Metric System. However, exceptions may be accepted for items usually manufactured according to other standards, as is the case of copper tubing, insulating sleeve, screws, nuts and others, which often are specified in English Standards.

In the event of a conflict between the Metric System and another system, the first shall prevail.

2.2 Drawings, Written Documents and Others:

All drawings and catalogs should indicate, where applicable, the materials used, dimensions, types of finishings, fixtures and other information that is considered necessary for a better understanding and demonstration of compliance with the requirements of these technical specifications.

2.3 Instructions Manual:

The instructions manual of the proposed refrigeration units should contain at least the following information:

- Å General Index;
- Å Procedures of the different modes of operation of the equipment;
- Å Complete Manual of the manufacturer of each device, containing installation details, operation and maintenance, as well as the quick rotation parts list for subsequent reinstatement;
- Å Instructions for preventive and corrective maintenance;
- Å If possible, it should also contain a list of agents and/or local representatives of the proposed brands.

2.4 Warranty:

The supplier shall ensure that the equipment, whether of its own manufacturing or come in full or in part from other suppliers, comply with the requirements of these specifications, free from manufacturing, raw materials or workmanship defects.

It should also be indicated the respective warranty period and its scope of application.

3 TECHNICAL SPECIFICATIONS

3.1 Insulated Panels:

The cold/ freezer storage room insulated panels have as main function, to maintain and control the internal room temperature.

Currently, the refrigeration contractors have used isothermal panel for cold, freezer rooms, freezing tunnels, in warehouse dividers and other commercial and industrial spaces.

For its ease assembly execution and mobility through a practical junction system and fittings, the isothermal panel for the cold/ freezer rooms have been the choice of large builders on covers for industrial and commercial buildings.

They can be mounted in practically any environment and they ensure an efficient thermal insulation, and today the internal temperature of the environments has been a big opponent to some users or processes.

The mobility of the insulated panels for the freezer allows the inside environment to be enlarged or reduced as needed, which is one of its great points, thus enabling an ideal investment without waste of space or material.

Insulated panels for cold/ freezer rooms can be manufactured with a thickness of up to 200 mm and length and width the most varied possible to meet the requirements of each client and each project in particular. Enabling, thereby reducing the number of joints between them for better thermal insulation, regardless of the dimensions of the room.

There are used various methods to perform the junction of the isothermal panels among themselves, and the more widespread and more effective is the system of male-female (or double male-female) and the system for embedded hook, giving the junction a very good air-tightness and stiffness as required for a robust installation.

The fixing system with built-in hook means greater speed and ease assembly and disassembly compared to other systems used, since it is sufficient that the key turns 3/4 so that the fit between the panels is perfect.

3.1.1 Constitution:

Insulated panels are made up of:

- Coating ï The external and internal coating of insulated panels can be of various sheeted materials, usually with 0.5 mm thickness: Lacquered steel, galvanized steel, natural or lacquered

aluminum, stainless steel, hard plastic and other materials. The base color is white, but they can be provided in the color of preference of the Designer or Owner of the work.

- Insulation ï The insulated panels used in cold/ freezer storage room are produced with rigid polyurethane foam insulation with average density of 40 kg/m³, which gives them a heat transmission coefficient (U) as indicated in the table below.

Thickness (mm)	U (kcal/h.m^2.°C)
50	0,042
80	0,026
100	0,021
120	0,017
150	0,014
175	0,012
200	0,010
250	0,008

- Junction system ï the junction system between the insulated panels, as mentioned elsewhere in this document, will be the setting with embedded hook; in this case, the panels junction are made by turning the square key on a metal shaft.

3.1.2 Dimensions:

Length ï Cold rooms insulated panels, as mentioned elsewhere in this document, may have the length that each project requires up to a maximum of 12 meters; due to manufacturing restritions.

Width ï The width of insulated panels for cold rooms is normally of 1,180 mm;

Thickness ï The thickness of the insulated panels for cold/ freezer rooms can be of 60, 75, 120, 150, 180 and 200 mm according to the required temperature inside of the room.

3.1.3 Accessories:

For a good installation of insulated panels for cold rooms, manufacturers offer a range of mounting accessories, manufactured from the material and coat color, from Interior and exterior angles of equal or unequal tabs, U-shaped profiles, rods, rivets and others.

In addition, there are also sealing materials, silicone based, suitable for use in cold storage rooms and negative temperatures environment.

3.2 Cold/ Freezer Rooms Door

The cold/ freezer room door is the element responsible for the opening of its access to inside; it must, on the one hand, allow access to the inside of the room and, at the same time, give similar thermal insulation quality or higher than the insulated panels of the room.

The door is a special type of insulated panel and it is the same way, consisting of:

- Internal and external coating in lacquered steel, stainless steel, galvanized steel, aluminum or other suitable material sheet plate;
- Rigid polyurethane foam insulation, with average density of 40-43 kg/m³;
- Internal substructure built of anodized aluminium profile.

The cold/ freezer room door shall, on the other hand, present appropriate air-tightness characteristics and therefore it must have a perimeter seal and usually made of double alveolus rubber on PVC support.

It can be of different types to meet the needs of each particular project:

a. Hinged doors for spans up to 1,200 x 2,200 mm, in locations that require good looks and high performance and are manufactured with a small thickness to the outside and the rest to the interior; the value of these partial thickness depends on the temperature inside the concerned room:

   i. Refrigeration (0° C) ï thickness 40 mm outer and interior of 20 mm;

   ii. Freezing (-20° C) ï thickness 40 mm outer and interior of 60 mm;

   iii. Super freezing (-40° C) ï thickness 40 mm outer and interior of 100 mm.

b. Pivot superimposed doors ï for spans greater than those used in previous door type and up to 1,500 x 2,500 mm, with the locking device superimposed to the panel. The total thickness, in this case, is:

i. Refrigeration (0° C) ï thickness of 75 mm;

ii. Freezing (-20° C) ï thickness of 100 mm;

iii. Super freezing (-40° C) ï 140 mm thickness.

c. Sliding doors - This type of doors is intended for applications where there are limitations in terms of space. For this type of door the sliding rails are made of structural carbon steel with anticorrosive treatment or stainless steel. The locking devices are manufactured by injection and painted with epoxy paint and the adjustable hinges are manufactured in stainless steel and composite.

The refrigerating door to use in each case should be always very well specified, in particular, in accordance with the following characteristics:

- Dimensions;
- Room service: refrigeration, freezing or super freezing;
- Coating Material;
- Insulated panel or in masonry mounting;
- With or without shoulders;
- With or without threshold;
- Opening to the left or to the right;
- Material of inner and outer surfaces finishing.

3.3 Equipment and Accessories

3.3.1 Refrigeration Unit

The monoblock refrigeration unit type will integrate compact condenser, evaporator, compressor and control system of the unit as a whole, in a body with only a mounting base plate.

This type of units can be used in various areas of activity ï hotels, restaurants, agriculture, chemical industry, medicine and conservation in other areas where it is required to use cold storage of various temperature levels, from 5 to -20^{o}C.

The compact refrigeration units are made up of base, condenser coil, compressor, condensing fan motor, evaporator coil, evaporation fan motor, refrigeration circuit evaporator and a complete set of control, adjustment and control devices.

There is, as specified above, a wide range of refrigeration units, since the most small and simple to the more sophisticated, for special aplications. The cooling unit must be sized for each case 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 great technical expertise and, in the meantime carried out using appropriate brackets that come with the unit and expansive metal anchor bolts of suitable diameter considering the unit weight and ensuring compliance with the manufacturer's indications.

Base

The base of the condensing unit should consist of a metal frame made of galvanized steel sheet of appropriate gauge to good rigidity, protected against corrosion, with electrostatic painting on enamel paint on anticorrosive primer.

In the case of a closed unit, the panels should be removable to allow easy access to the inside of the machine. By its term the panels should receive proper treatment to be resistant to the action of time and the outside environment.

In monobloc and compact units the base must be able to accommodate all cooling system components, including all the control accessories.

The base should be covered by a cabinet which is a monoblock structure made of aluminium with smooth and shiny finish to make cleaning easier, but it may also have white epoxy paint or stainless steel finish.

Condenser Coil

The condensing unit coil, i.e. refrigerator condenser, should be made with seamless copper tubes of adequate diameter and aluminum fins with coating preventing direct contact with copper tubes, attached to these by mechanical expansion. The coil must be tested against leakage at a pressure of 350 psi at manufacturer premises.

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

The gas that has high values of pressure and temperature, passing through the condenser coil cools down and liquefies, transferring sensitive and latent heat of condensation.

Compressor

The compressor is one of the main elements in a cooling system; it is the heart of it.

Its function is to increase the pressure of the refrigerant and promote its circulation along the system.

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

And, in terms of construction, the compressors can be classed as hermetic, semi-hermetic and open.

In the hermetic compressors, the compressor tself and the electric are housed in the same case, showing the inbound and outbound access only the electrical connections of the electric motor. This type of compressor operates exclusively with halogenated refrigerants and refrigerant vapor comes into contact with the motor winding, cooling it. Those compressors are generally used in domestic refrigeration and air-conditioning appliances with power up to 30kW (8.5 TR).

The semihermetic compressors are similar to previous type, but they allow the removal of the head of casing, providing complete access to valves and pistons.

In open compressors, the compressor drive shaft goes through the casing, allowing its drive by an external electrical motor. They are large compressors operating mainly with ammonia.

The choice of the type of compressor to be used depends essentially on the power of the installation.

The cooling unit can be equipped with one, two or three compressors depending on its required cooling power.

Generally, the compressors used in the cooling units for cold/ freezer rooms of small sizes are hermetic rotary, reciprocating or screw type, installed on vibration insulators, depending on the manufacturing, on cooling power and other technical and commercial factors.

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

Condensation Moto-Fan

The condensation moto-fan units, in general, are axials with the shovels thrust forward, constructed of stamped plastic, aluminium or galvanized steel sheet, statically and dynamically balanced, directly coupled to the motor driven axle.

The evaporator moto-fan should be of low noise.

Depending on the cooling capacity of the evaporator unit, the drive electric motor may be single-phase or three-phase,

Evaporator Coil

The evaporator coil should be made with seamless copper tubes of adequate diameter and aluminum fins with coating preventing direct contact with copper tubes, attached to these by mechanical expansion. The coil must be tested against leakage at a pressure of 350 psi. The fins improve heat transfer efficiency, due to increasing the overall area of heat exchange.

Due to this the largest area, these evaporators can be more compact than plain tube without damaging heat absorption capacity.

They can have their own gas collectors/distributors to the inlet and outlet for an optimisation in refrigeranting gas distribution.

On its bottom they must have condensate collector trays to collect the water resulting from the de-icing process made of the same material as the unit cabinet.

The inner tray to prevent air leaks and concentrated water flow from the defrost process to the drain, avoiding undesirable formation of ice in the tray and heating of the cold/ freezer room during defrost. It eliminates the disadvantages of water condensation on the outside during the defrosting phase.

The external tray, with rounded corners, tipper and removable for better access to the defrost system and cleaning.

Evaporator Moto-Fan

The evaporating moto-fan units, in general, are axials with the shovels thrust forward, constructed of stamped plastic, aluminium or galvanized steel sheet, statically and dynamically balanced, directly coupled to the motor driven axle.

The evaporator moto-fan should be of low noise.

Depending on the cooling capacity of the evaporator unit, the drive electric motor may be single-phase or three-phase,

Refrigeration Circuit

The pipe to be applied in the execution of the refrigeration circuit for this type refrigeration equipment must be type malleable copper up to ¾òdiameter and hard for larger diameters.

In the first case, the curves must be performed with the aid of appropriate tools - pipe bending tools or springs - and should be avoided at all costs amendments over each length. In case of use of rigid pipe connections should be used and the connection should be properly welded and carefully inspected.

The refrigerant gas lines should be designed and implemented to carry out the following functions:

- To ensure proper liquid supply to the evaporator;
- To allow refrigerant gas flow without excessive load losses;
- To prevent accumulation of oil in low areas;
- To prevent that the oil which leaves the compressor be retained in the piping system;
- To prevent liquid from entering the compressor, both when in operation, as well as when stopped;
- To enable the circuits to remain clean and free of moisture.

Regarding its design, the refrigerant gas lines must be:

- Arranged in such way that it will not affect other componentsôoperation, or hamper the access to other organs or control devices;
- Protected against shocks, particularly small diameter and isolated pipes;

For the design of the refrigerant piping should be aware that:

- Oil circulation must be ensured;
- Should not produce condensation in the pipes and the liquid formed in the condenser should not reverse the direction of the flow;
- In the pipes should not produce abnormal noises or vibrations;
- The dimensions of the pipes should limit the load losses to a minimum.

In the cooling circuit, in addition to the larger components ï condensing, compressor and evaporating coils ï there is still the need to include the filter drier, sight glass and the thermodynamic expansion valve, service valves, as well as all the operation control devices ï low and high pressure switches.

Filer Drier

Filters driers are components installed in the cooling system with the function of retaining the residual moisture, acids and solid particles.

They are constructed in copper or steel tubular bodies.

Internally they have a thick screen at the entrance and a fine screen in the output and between the screens they are placed a moisture absorbing desiccant.

The filter must be installed in vertical position with the output down (when installing the liquid line drier in a vertical position, it is necessary to make sure that the entrance is on top and the output, facing down. In this way, there will always be coolant in the filter, so that the drying capacity is used in the best way possible). When this position is not possible, they can mounted horizontally, but must never be mounted vertically with the way up.

With the emergence of several alternative refrigerants, several dryers filter options have been developed to respond to the particularities of each refrigerant substance.

The drying filter consists of desiccant particles and must be chosen according to the particular application, taking into account refrigerant type, working pressures and mass flow.

Sight Glass

Is a very important component in the refrigeration systems; especially in medium to large machines, it plays an important role showing the passage of liquid fluid by high pressure liquid line, and, in some cases, moisture in the system.

The sight glass serves to indicate lack of liquid at the thermostatic expansion valve. The presence of steam bubbles in the display indicates, for example, lack of load, low under-cooling or partial dryer filter obstruction.

Typically, the display is equipped with a color indicator that changes from green to yellow when the moisture content of the refrigerant exceeds a given value and, in this case, actions should be taken to replace the dryer filter. The color display is reversible, that is, the color goes from yellow to green again when installation is free from moisture, for example, by replacing line dryer filter.

Thermostatic Expansion Valve

Thermostatic expansion valves regulate the injection of refrigerant gas (in liquid) in the evaporating units and consequently the amount of steam being drawn in by the compressor. The injection is controlled by the overheating of refrigerant.

The various thermostatic expansion valves sizes and types cover different valves designed for specific applications. The valves are supplied with threaded, welded or bimetal connections in copper/stainless steel.

In addition, the expansion device ensures the reduction of pressure of the fluid that comes out of the condenser and enters the evaporator and yet, through a sensor bulb is kept constant the overheat at the outlet of the evaporator. This is achieved by leaving spend more or less refrigerant to the evaporator.

Expansion valves can be with external equalisation (the pressure at the top of the diaphragm is the evaporator output) and with internal equalization, that is, the pressure at the bottom of the diaphragm is the inlet pressure of the evaporator.

Refrigerant

O R404A is an azeotropic mixture of hydrofluorocarbonates ï HFC ï consisting of:

R125 ï Pentafluoroetane (CF3CHF2), 44%,

R134a ï Tetrafluoroetane (CF3CH2F), 4%,

R143a ï Trifluoroetane (CF3CH3), 52%.

It presents the following characteristics:

- R404A has a variation in temperature of less than one degree along the isobars processes.
- All components are of HFC group.
- The three components of the mixture have a low pressure reason in isentropic compressions processes.
- R143a is flammable; however, the presence of the R125 in a high percentage makes the mixture non-flammable even if leakage occurs.
- The compressors have to use type Ester synthetic oils to be miscible with the boiling refrigerant vapor in inside the evaporator.
- It is compulsory the replacement of all the fluid of cooling installation if a leak greater than 10% of the total amount of the installation occurs. In the case of an azeotropic mixture, when a leak happens the refrigerant that has more partial pressure will first come out from the refrigeration circuit. The remainder product in the system is no longer R404A and it is not possible to restore the original proportions of the components.
- Critical point:
  - Temperature = 72 ºC
  - Pressure = 37,2 bar

  - Density = 0,484 kg/dm3

- Liquid phase, at 25 ºC:
  - Density = 1,04 kg/dm3
  - Specific heat = 1,64 kJ/kg ºC
- Gas phase, at 1,013 bar:
  - Boiling temperature = - 46 ºC
  - Boiling point = - 46,4 ºC
  - Specific heat = 0,88kJ/kg ºC
- Satured vapour:
  - Density = 5,41kg/m3
- ODP = 0
- GWP = 0,0555

In general, to be a good refrigerant the substance must have the following properties:

- Liquefy (condensing) under moderate pressure;
- Evaporate at pressures above atmospheric pressure;
- Have low specific volume (small volume relative to its weight);
- Have a high vaporization latent heat;
- Be chemically stable (does not change, even with repeated changes of state in the cycle);
- Do not be corrosive;
- Do not be flammable;
- Do not be toxic;
- Allow easy location of leakage;
- Do not strike the lubricating oil or cause any undesirable effect on other components of the refrigeration cycle;
- Do not strike or decaying foods, if leakage occurs.

Thermostat

Thermostat is a temperature controller device specific for the control of refrigeration rooms with defrosting by resistance or for hot gas monitoring and control the operation of the compressor and the condenser and the evaporator fans motors.

Among its functions can be included start and stop time set of different electro-mechanical components to avoid overloads in the electrical supply line.

It can be electromechanical or electronic.

It is a component whose function is to control the room temperature (internal or external) keeping it as stable as possible. He acts stopping or putting into operation automatically the compressor, fans or other electromechanical equipment.

Usually consists of a bulb, capillary tubing and electrical contacts. Its operation is based on the principle of expansion. The thermostat contains in its capillary a gas which can be Sulphuric Dioxide, Methyl Chloride, and the gas used in the system or other similar. The expansion or contraction of the gas molecules transmits movement to a bellows attached to a mobile part that acts by closing or opening the electrical contacts and, thus, connecting or disconnecting the connected equipment to be controlled.

In cooling systems, the thermostat must also control the starting and stopping of the defrosting process, by electrical resistance or reverse cycle.

Pressure Switch

There would be no mechanical cooling without a fluid (refrigerant) pressure changes along the refrigeration cycle, in a continous process. However, the variation of pressure when exceeds certain limits may damage some refrigeration components. To prevent this from occurring pressure switches are used.

Their basic function is to protect the components of the refrigeration cycle against over pressure (pressure higher than acceptable) or sub pressure (lower than acceptable) during operation of the equipment.

The pressure switches evaluate the high side pressure (high pressure switch) and low side (low pressure switch) and in semihermetic compressors, they also evaluate the oil pressure. The variation of the pressure of the refrigerant level in the cycle does perform the electrical contacts of the pressure switch that can control fans, alarms and even the compressor or others elements of the refrigeration cycle.

Thermometer

The cold room should always have, typically, on the outside on the insulated panel above the door, a thermometer ï analog or digital ï for measurement and indication of the temperature inside the room.

The thermometer can still have high temperature indication sound or light alarm.

The instrument has a probe with about a meter of cable, which allows the local positioning for better convenience inside of the room.

Electrical System

The electrical system of a cold/ freezer storage room carries all devices, cables and electrical equipment installed and that contribute to the smooth operation of the complete equipment set.

In general, the operation of cold/ freezer storage is all controlled from a control panel, which includes partial protection devices to the compressor motors, condenser fan, evaporator fan, defrost element and the lighting circuit for the inside of the room.

This partial electric board is powered electrically via a cable of adequate section to the total electric power of all the installed equipment.

The interior lighting of the cold/ freezer storage room should allow good visibility of the products stored and shall possess the switch drive, next to the room access door.

All the apparatus and electrical wiring installed inside the cold/ freezer storage room must be of suitable class and should be installed in the adequate technical trunking system.

Condensate Drain Pipe

The condensate drain pipe must have a diameter that will allow easy gravity drainage of the condensates that are produced in the process of defrosting the freezer room and collected in the condensate tray.

The disposal of condensate can be done directly to the outside or be referred to a network of condensate collection previously defined, bearing in mind the need for installation of traps to prevent the entry of unpleasant odours from the drainage system.

Whenever there is need for this piping across any wall it should be properly insulated to avoid the action of moisture on that infrastructure.

In cold storage with temperature below zero degrees, it is necessary to provide for the installation of a drain heater element, installed throughout the section of the drainage piping within the room to prevent re-icing of the condensate.