Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of:
Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection
of the Federal Republic of Germany

Cold Chain Logistics Resource Centre

Confederation of Indian Industry

Technical Specifications for COLD ROOM

Published by Confederation of Indian Industry (CII), The Mantosh Sondhi Centre; 23, Institutional Area, Lodi Road, New Delhi 110003, India, Tel: +91-11-24629994-7, Fax: +91-11-24626149; Email: info@cii.in; Web: www.cii.in

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ABOUT US

COLD CHAIN LOGISTICS RESOURCE CENTER

Cold Chain Logistics Resource Center (CCLRC) has been set up as an industry-led Center towards supporting and catalyzing the development of integrated cold chain networks across the country. The Centre is aligned with the overall objectives of reducing food loss, maximizing energy efficiency, and optimizing time and cost in the cold chain networks. The CCLRC vision is also dovetailed with the National Logistics Policy with key objective of integrated development of the logistics sector, leveraging multimodal transport, digital transformation, sector modernization, logistics excellence and democratization.

The key focus of the Center is aligned towards bringing in investment into the sector, supporting harmonization & convergence of Government's financial outlay for the sector, promoting Environmentally Sustainable Technology Solutions and Innovative Cross-functional Shared Infrastructure and enabling capacity building.

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DEUTSCHE GESELLSCHAFT FÜR INTERNATIONALE ZUSAMMENARBEIT (GIZ) GMBH

As a service provider in the field of international cooperation for sustainable development and international education work, we are dedicated to shaping a future worth living around the world. The 2030 Agenda is the overarching framework that guides our work. For over 60 years, GIZ has been working jointly with partners in India for sustainable economic, ecological, and social development. The Federal Ministry for Economic Cooperation and Development (BMZ), the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU) as well as the Federal Ministry for Economic Affairs and Energy (BMWi) are the main commissioning parties of GIZ in India.

The Government of India has launched numerous important initiatives to address the country's economic, environmental, and social challenges, and GIZ is contributing to some of the most significant ones. For example, it supports key initiatives such as Smart Cities, Clean India and Skill India. GIZ, in close cooperation with Indian partners, devises tailor-made, jointly developed solutions to meet local needs and achieve sustainable and inclusive development.

Confederation of Indian Industry

ABOUT US

The Confederation of Indian Industry (CII) works to create and sustain an environment conducive to the development of India, partnering Industry, Government, and civil society through working closely with Government on policy issues, interfacing with thought leaders, and enhancing efficiency, competitiveness and business opportunities for Industry.

For more than 125 years, CII has been engaged in shaping India's development journey and works proactively on transforming Indian Industry's engagement in national development. The premier business association has over 9000 members, from the private as well as public sectors, and an indirect membership of over 300,000 enterprises from around 294 national and regional sectoral industry bodies.

With 62 offices, including 10 Centres of Excellence in India, and 8 overseas offices in Australia, Egypt, Germany, Indonesia, Singapore, UAE, UK, and USA, as well as institutional partnerships with 394 counterpart organizations in 133 countries, CII serves as a reference point for Indian Industry and the international business community.

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ACKNOWLEDGMENT

The Cold Chain Logistics Resource Centre (CCLRC) works with a vision to support and catalyze the development of integrated cold chain networks across the country. Towards the same, a series of technical reference manuals have been developed for most used cold chain infrastructure— including cold stores, ripening chambers and reefer vehicles, which are available as open source (at WWW.CCLRC.in) to be utilized by new entrants of the industry.

We would like to thank and acknowledge the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH for their support towards developing this document series.

We would also like to acknowledge our international technical experts from United Nations Environment Programme (UNEP) and Alliance for Energy Efficiency (AEEE); and industry experts from Blue Star, Carrier Transicold and Desai AgriFoods, without whose support, efforts and invaluable inputs, this document would not have been possible.

INTRODUCTION TO THE COLD ROOM

Cold rooms can be termed as large size walk- in coolers for short term storage of perishables like fruits, vegetables, flowers, meat, fish, dairy products or specialized products like medicines, chemicals, etc.

COLD STORAGE & COLD ROOM

Cold storages are run as independent industrial units & sizes range from 500 Ton storage capacity to 15000 ton or even more in multi – room / multi temperature / multi commodity configuration with individual room sizes as large as 70' X 45' X 55'. Products are stored in multilevel racking arrangement & for loading / unloading, mechanical devices like forklifts are generally used. Frozen or chilled products can be stored in different rooms. The grading, packing, pre-cooling & other operations are also carried out in processing halls within the same facility.

As against this, the walk-in cold rooms are generally single rooms or units comprising of many small rooms of sizes having maximum height of 10 – 12 feet. The intention is that the person operating this facility should be able to load / unload the products without using forklifts or any other mechanical / electrical equipment. Products needing similar storage conditions are generally stored together in the cold room.

WALK-IN COOLER & FREEZER APPLICATION

The walk-in coolers are walk-in freezers are used in a variety of temperature ranges.

- High temperature walk-in cooler: used for holding fruits, vegetables, eggs, medicine and wood.
- Medium temperature walk-in freezer: used for holding meats, seafood and stuff that needs the same temperature environment.
- Low temperature walk-in freezer: used for holding ice cream, already frozen food.
- Ultra-low temperature walk-in: used for freezing food, and in industry and pharmacy field.

NOTE: Walk-in coolers and freezers of different temperature classifications are equipped with different insulations and compressor types, therefore high temperature walk-in cold room cannot be used as lower temperature walk-in cold room. Besides, low temperature walk-in freezer room is not recommended to be used as higher temperature walk-in cooler room, because walk-in cold storage operates most efficiently at designed conditions. Walk-in cooler / freezer and walk-in warehouse refrigeration system are constructed with different materials. As a result, they should not replace each other in application.

DESIGN OF COLD ROOM

Performing A Job Survey & Determining Refrigeration Load

JOB SURVEY

SITE CONDITIONS

The calculation of the transmission, product, internal and air change load segments will be discussed in detail. Before the load can be estimated, however, a comprehensive analysis of site conditions must be made to assure an accurate evaluation of the total refrigeration load.

This job survey should determine all pertinent job site information including:

- Design ambient temperatures
- Storage area temperature and humidity requirements
- Storage area dimensions and type of construction, insulation, exposure, etc.
- Type and amount of stored product
- Electrical service requirements
- Any miscellaneous loads including people, lights, appliances, etc.

Based on this data, the total heat load of the refrigerated space can be calculated by adding the totals of the four load segments: transmission, product, internal and air change. It is common practice, and recommended, to add a 10% safety factor to the calculated refrigeration load.

REFRIGERATION LOAD CALCULATIONS

Refrigeration Load Segments

The primary function of refrigeration is to maintain conditions of temperature and humidity that are required by a product or process within a given space. To perform this function, equipment of the proper capacity must be installed and controlled on a 24-hour basis. The equipment capacity is determined by the actual instantaneous peak load requirements. Generally, it is impossible to measure the actual peak load within a refrigerated space. These loads must be estimated. The total refrigeration load is the total of the following “load segments”:

- **Transmission Load** - heat gain through walls, floors and ceilings.
- **Air Change Load** - heat gain associated with air entering the refrigerated space, either by infiltration or ventilation.
- **Product Load** - heat removed from and produced by products brought into and stored in the refrigerated space.
- **Internal Load** - heat produced by internal sources such as lights, electric motors, and people working in the space.

EQUIPMENT SELECTION CONSIDERATIONS

Now that the refrigeration load for a particular job site is calculated, it is time to select the most suitable equipment for the application. Section Two offers information that will help make equipment selection decisions. This information, used together with product data and specifications from manufacturers' literature, will result in an informed selection decision.

EVAPORATOR COIL SELECTION - SYSTEM TEMPERATURE DIFFERENCE AND RELATIVE HUMIDITY

When selecting an evaporator coil, the temperature difference, or TD, between the room and the saturated suction temperature dictates the relative humidity in the space (assuming the room is properly sealed). The closer the temperature difference between room and suction temperatures in selecting the evaporator, the larger the evaporator and the higher the relative humidity in the room. Conversely, a large system TD reduces the size of the evaporator and causes it to do more drying and therefore lowers the relative humidity.

Too low relative humidity will result in excessive weight loss in the product as well as surface deterioration. Too high relative humidity speeds the growth of bacteria and surface slime.

There is a slightly different problem associated with freezers. In order to avoid excessive frost accumulation on the coil, and to prevent product dehydration during long term storage, most evaporators are selected for 10°F TD.

Run Time and Defrost Operations

When the design suction temperature is over 30°F, a defrost cycle is not normally required, and it is common practice to select equipment on a 20- to 22-hour compressor operation. For suction temperatures below 30°F and room temperatures over 35°F, off-cycle (air defrost) can generally be used. This involves cycling the compressor off with a time clock while the evaporator fans remain in operation and room air melts the ice on the coil. For every two hours of compressor operation, one hour of air defrost time is needed. Therefore, compressor selection is based on 16 hours per day.

For suction temperatures below 30°F and rooms below 35°F, electric defrost, hot gas defrost or water defrost is required. With these positive methods of defrost, equipment selection can be based on longer compressor operation, with 18 to 20 hours most common. However, this depends on the type of equipment used and the latent load in the storage. A modern unit cooler or product cooler in a tight room with average latent load, can be selected on 20-hour operation.

The type of defrost used is generally a matter of either contractor or owner preference. Different geographic regions tend to use one particular type of defrost more frequently.

As a rule, electric defrost is more common than hot gas, and hot gas more common than water defrost.

Electric Defrost

Electric defrost is the most common method in use today. Equipment cost is about the same as with hot gas, but installed cost can be lower. Operating cost is about 15% higher with electric defrost than with hot gas and a fair amount of heat and moisture is released in the room during defrost.

Hot Gas Defrost

Hot gas defrost is still the most efficient method of defrosting regardless of storage temperature. Defrost is very quick with minimum room temperature rise. Hot gas defrost, however, requires care to ensure that the compressor is protected against liquid slugging.

Water Defrost

While not very common, water defrost can be used on both medium and low temperature storages. Water must be at least 50°F and is sprayed on the coil at a rate of about 3 gpm / square foot of coil for five to 15 minutes, depending on severity of frosting. Water defrost is fast and efficient, but some moisture is re-released into the room. These systems also require more maintenance than electric or hot gas systems.

GENERAL DEFROST CONSIDERATIONS

Because of high suction pressure (and high load) after defrost, compressor selection must be checked to see that it can operate in a higher range than the actual design point. If

not, a crankcase pressure regulator may be required to keep suction pressure down to acceptable values. If this is the case, an accumulator should also be used. This is very important for a blast freezer. On large air defrost systems (gravity coil, for example) it is a good idea to have solenoids in the liquid and suction lines so refrigerant will not migrate during defrost. In addition, large fin coil installations are often split into sections with a thermostat for each section to compensate for uneven room loading.

It is also recommended that a pump down system be used for both off-cycle and all defrost periods.

COMPRESSOR/CONDENSING UNIT SELECTION

The four main types of compressors used in commercial refrigeration today are:

- Open - belt driven (low speed, 500-1750 rpm)
- Open - direct driven (medium speed, 1160 or 1750 rpm)
- Semi-hermetic (1750 rpm)
- Hermetic (welded, 3500 rpm)

The compressor type used is often a matter of personal preference, but it is important to be aware that compressor life decreases with increased speed and increased condensing temperature.

On commercial refrigeration applications, compressors are most commonly used with air-cooled condensers. They are also used with water-cooled condensers and occasionally with evaporative condensers. Water restrictions in recent years and simpler maintenance are the reasons for the popularity of air-cooled systems.

The air-cooled condenser may be an integral part of the compressor unit (air-cooled condensing unit) or it may be remotely located (on the roof, for example).

Compressor/condensing units are generally classified as high, medium or low temperature. Approximate evaporating temperatures are:

- High +30°F to +50°F
- Medium -10°F to +30°F
- Low 40°F to -10°F

A choice of refrigerant, R-22, R-404A and R-134A is available, depending on the application.

Knowing the room load, room temperature and desired suction temperature (room temperature - TD = suction temperature), a condensing unit can be selected. As the range of models (capacities) is far more limited in condensing units than in evaporators, it is common practice to select the closest condensing unit size that will do the job, then select the evaporators to balance with the condensing unit selected at the correct TD.

When it is possible that the compressor may occasionally be the coldest spot in the system, crankcase heaters should be used. Unloading is seldom (if ever) used on commercial refrigeration systems.

Refrigerant receivers are generally used and are sized to hold from 80% to the complete system operating charge.

In any critical application, use two completely independent systems. In all cases, every room should be on a separate and independent system.

EVAPORATOR SELECTION

The spacing of the fins on the evaporator coil must be considered for a particular application. While high fin density (12 fins/inch) gives increased coil capacity, it also increases the problem of dirt and frost collection. In the majority of commercial refrigeration applications, the fin spacings used are 8, 6 and 4 fins/inch. Generally, 8 fins/inch is used down to +32°F coil temperature while spacings of 4 and 6 fins/inch are used whenever frost will be present. The closer the fins are together, the more rapidly the coil capacity will fall off as thefrost builds up.

On most low temperature applications, 6 fins/inch can be used as long as the evaporator capacity is reduced by 15% (x 0.85), when making the selection. This 15% frost reduction is a more accurate representation of the unit capacity averaged over the four to six hours between defrost cycles. For minimum downtime, base selection on a 4 fin/inch coil and its normal capacity reduced by 5% (x 0.95). In most cases, holding freezers are selected with 6 fin/inch coils while blast freezers use 4 fins/inch.

Once the space and product loads have been established, select the evaporator type most suitable for the application.

This selection will depend on:

- Storage temperature
- Relative humidity
- Air velocity
- Room size and shape

As most rooms handle more than one product, compromise may be necessary. Next, establish what form (if any) of defrost will be required.

When selecting hot gas or electric defrost units, allow for coil frosting and for the capacity rating of the unit to be reduced accordingly. With electric defrost units, where the heaters are internally located in blank tubes, compared to a standard coil, the capacity must be reduced to allow for the loss of surface.

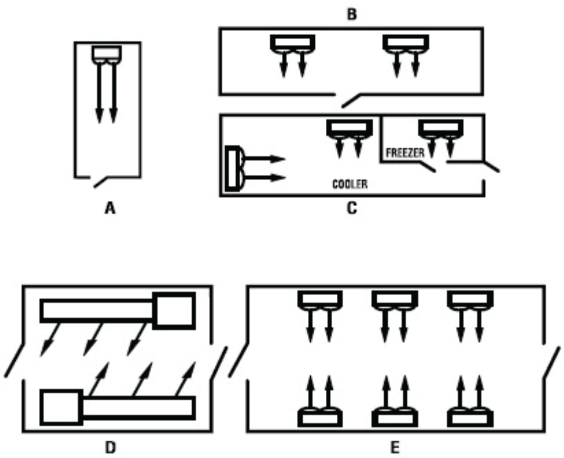
Manufacturers usually recommend a rating correction factor for electric defrost coils. It is always good practice with any storage (and particularly with freezers) to have two completely independent systems. In the event of a breakdown of one system, the other unit will slow down the temperature rise in the room until the other system is repaired and placed back into service.

EVAPORATOR LAYOUT

Evaporator layout is much more important than many designers realize. Follow these general, but important, rules:

1. Air pattern must cover the entire room.
2. Never locate evaporators over doors.
3. Know the location of aisles, racks etc.
4. Locate near compressors for minimum pipe runs.
5. Locate near condensate drains for minimum run.

The size and shape of the storage generally dictates the type and location of the evaporators. The illustrations below show some typical examples.



SELECTING THERMAL EXPANSION VALVES

Selecting and installing thermal expansion valves are of utmost importance for the best coil performance. Valve capacity must be at least equal to the coil load rating but not oversized for the conditions. Any valve which is substantially oversized will tend to be erratic in operation and this will impair both coil performance and rated capacity output.

Always install liquid line strainers ahead of all thermal expansion valves

SELECTING A HEAT EXCHANGER

Although sometimes controversial in high temperature applications, it is generally agreed that in medium and low temperature refrigeration systems, heat exchangers, when properly applied, contribute the following to overall system performance:

1. Sub-cooling the liquid refrigerant entering the thermal expansion valve reduces the flash gas load of the evaporator inlet. It also increases the enthalpy difference of the refrigerant during its evaporating phase which produces more useful work in the evaporator.

2. In the process of heat exchanger sub-cooling, the heat extracted from the liquid refrigerant is transferred to the suction gas, thereby insuring a dry suction return to the compressor at an entering superheat level. This produces the best possible volumetric efficiencies for the refrigerant used.

3. The increase in suction line temperature will also reduce the possibility of sweating.

4. The use of a heat exchanger permits more open adjustment of the thermal expansion valve without risk of serious flood-back of liquid to the compressor under light or variable load conditions. At the same time, this assures

the maximum utilization of evaporator surface.

In all low temperature applications, it is most important to correctly size and properly apply heat exchangers. Selections must be based on accurate performance ratings checked out

against the calculated design loads involved for each evaporator or otherwise for the entire system. Care must also be taken to insure that both liquid and suction connections are properly sized in order to reduce entrance and exit losses to a minimum. Recommended allowable suction line pressure drops due to the heat exchanger vary from 0.50 psi maximum for +20°F evaporator applications to 0.25 psi maximum for -40°F evaporator temperatures.

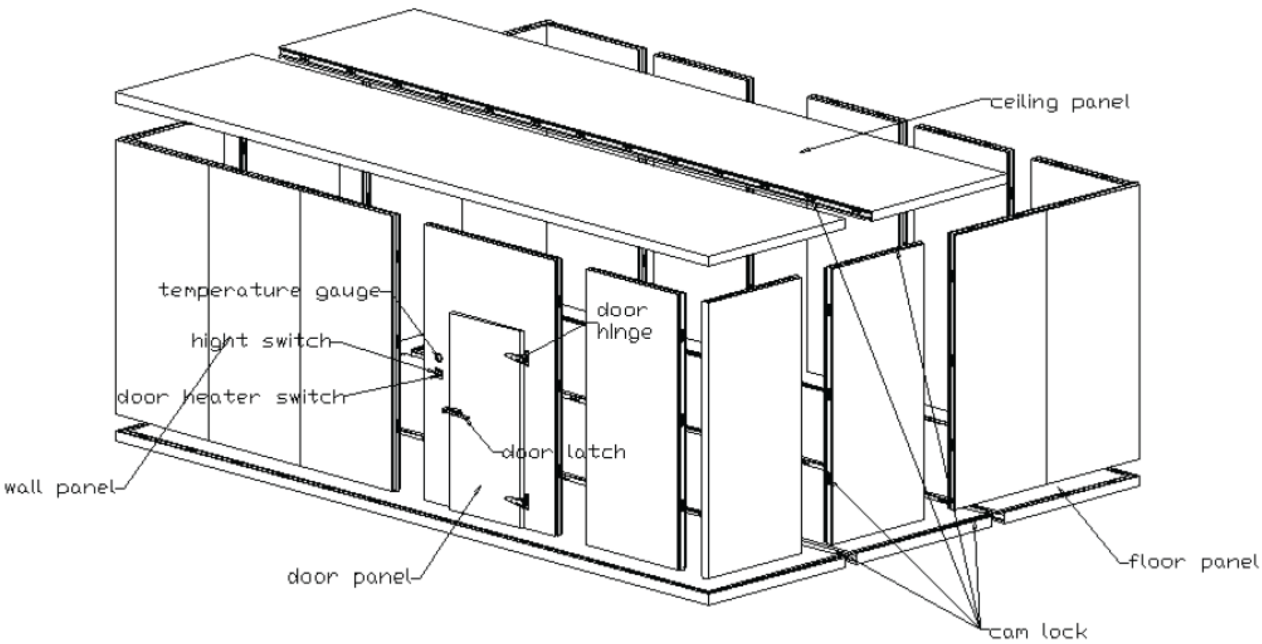
COLD STORAGE ROOM INSTALLATION

PREPARATION

- Job site for both walk-in compartment and refrigeration unit must be dry and even.
- Outside units should be installed membrane roof cap to keep away from heat reflection.
- Job site selection should consider the ventilation, drainage, noise and repair of refrigeration system, especially the assurance of good ventilation around condenser to avoid heat air re-circulation.

PUF PANELS & DOORS

Installation diagram



Panel installation procedure

- Fastening the “L” shape GI positioning
- Sealing with Silicon
- Floor Installation
- Wall Installation
- Door frame Installation
- Ceiling Installation

Fastening the "L" shape GI positioning

Before installing floor panel, please fasten the "L" shape G.I positioning with self-tapping screw on the bottom of the floor, the hole is prepared. And this will be fast, easy for wall panel installation.

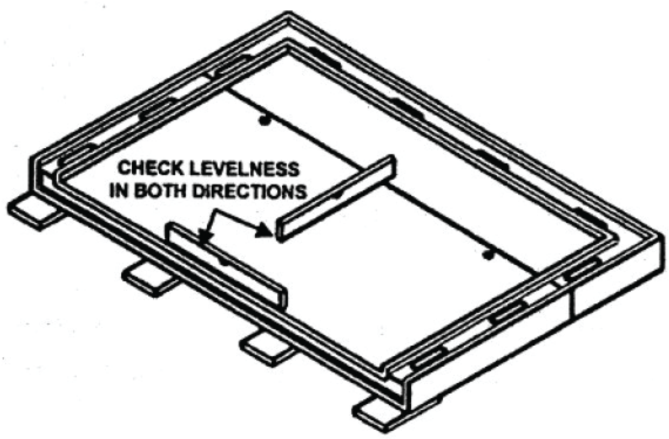
Sealing with Silicon

Before installing wall panels, please seal with silicon on the "L" shape G.I. positioning.

Installing Floor panel

Lay out floor panels based on their serial number as indicated on the floor panel layout drawing of the cold room design. Begin with an edge section corresponding to the blueprint and place it in position in the installation area. Move the next panel into position and check to be sure it is level. Lock the came-lock between the two panels, until the floor is fully installed.

A level walk-in floor is essential. Take care to ensure a level floor. Wall and ceiling panels will not align properly, causing installation and operation problems.

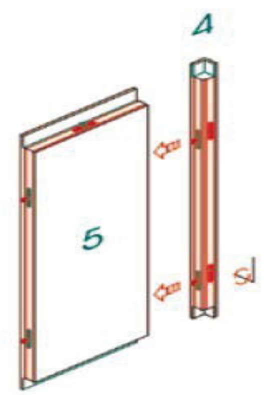


Checking the Levelness of the Floor Section

Wall Installation

Wall panels and ceiling panels are the same in every way. You must take note of the distribution and placement of the panels on the provided layout. Any panel that is longer than the internal height of the cold room can automatically be considered a ceiling panel. Follow the blueprint to select the correct panel. Start installing wall panels with a corner panel. Place the panels in position, but don't lock it to the floor yet.

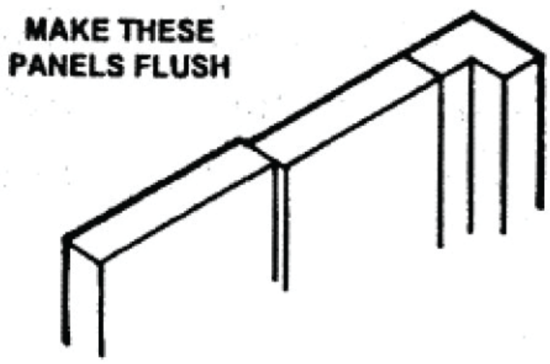
Setting up the walls and corner panels requires 2 people minimum, as does setting up the ceiling, so please have someone ready to assist you from this point onward!



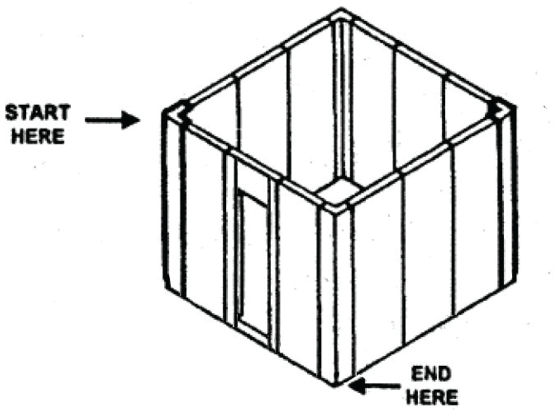
Following the blueprint, select and install the next adjacent wall panel.

Reach the second corner. Keep adjacent top and side surfaces flush, this will make locking the cam-lock easier.

Make sure that the tops of the corner and wall panels are flush. If wall panels have a stair step effect, take wall panels down and level floor panels or concrete pad.



Plan to end at a corner. The final wall panel must mate with two other wall panels at the same time. This only happens at a corner.

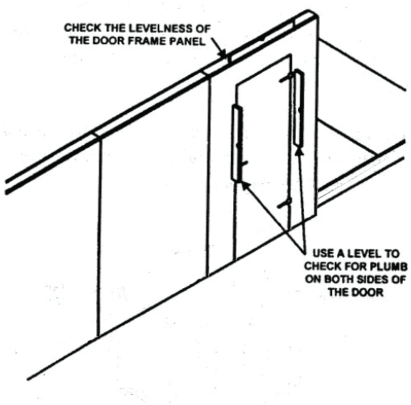


Fitting the Door

The door(s) should be treated as if it were a wall panel and set up in its place accordingly.

NOTE: Doors are shipped in the locked position with the keys taped onto the inside of the door leaf. Please remove the keys from the door before completing the walls! If you have decided to complete all the walls and ceiling and save the door for last, you might end up with a room with no way of getting in!

Check for plumb using a spirit level on the face of the door frame panel. After all of the wall panels are installed, check all panels for flush fit across the tops of the vertical seams and lock the wall panels to the floor panels.



Checking for Plumb

Fastening the foot-treadle and sealing with silicon.

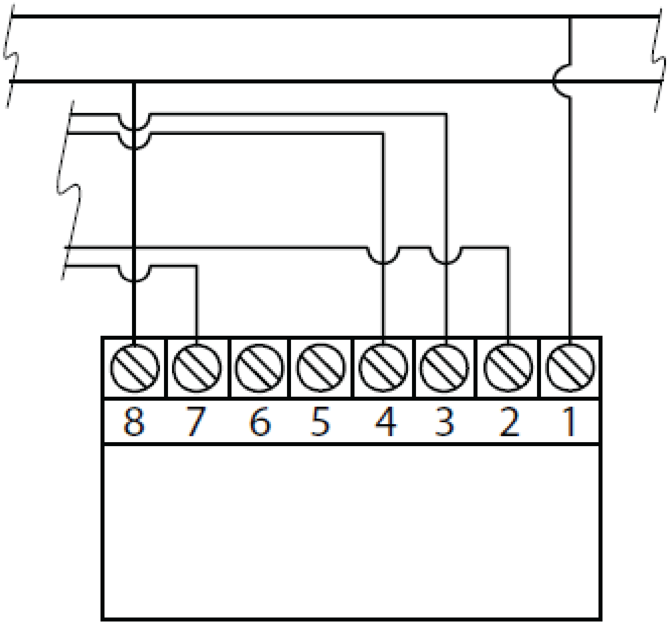
Doors and Freezer rooms

All doors (intended to be used on freezers at < 0 °C) contain a heating cord that heats the portion of the frame that comes into contact with the rubber from the door leaf so that it will not freeze into place and damage the rubber.

NOTE: For Freezer rooms the door heater chord will need to be hooked up to your standard line current by a qualified electrician.

The door heater wires are located in the door panel around the door opening, and can be accessed by prying off the edge of the door opening

The door heater must be connected up to a separate circuit. Refer to the diagram below for door heater wiring details.



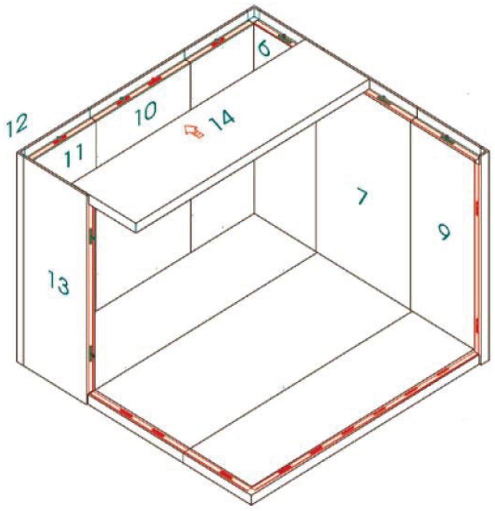
Legend

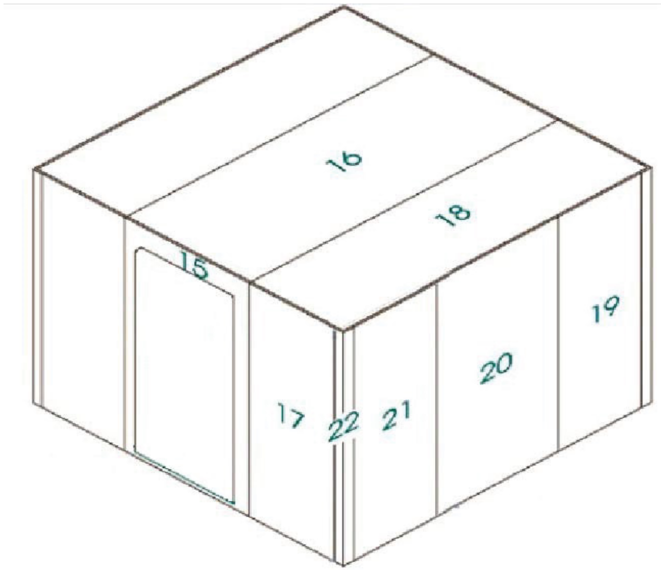
No.	Description
1 & 8	Power supply - 24 V.a.c. on separate circuit
3 & 4	Heater valve - Expansion valve
5 & 6	Remote contact - Do NOT connect up
2 & 7	Door heater - Heater element that runs around the door frame

Ceiling Installation

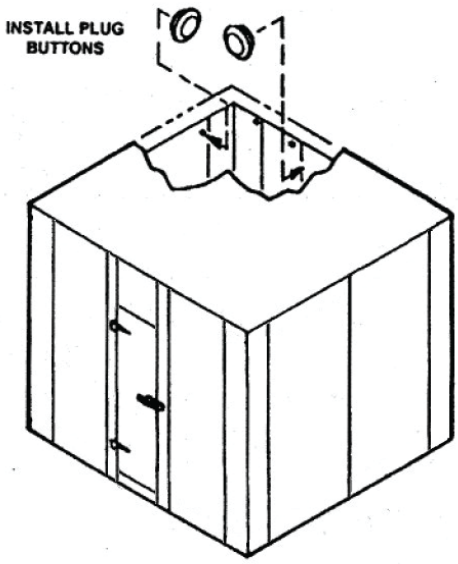
Ceiling panels are the next things to install before the finishing touches can be applied. Ceiling panels, due to the nature of their purpose, are often longer than wall panels. They should always be installed exactly as depicted by the provided diagram. Their structural strength is designed to support one man and a toolbox. Of course, the weight of men and toolboxes can vary greatly. However, the actual maximum weight allowed also depends on the thickness of the panel as well as the length.

1 person holds the first ceiling panel in its appropriate location at the end of the cold room making sure that the cam-lock holes face the inside of the cold room while the other person tightens the cam-locks so that they grab onto the ceiling beam. After positioning the 1st ceiling panel into place, take remaining ceiling panels and position and lock into place ensuring all cam-locks are locked into position.





Complete the finishing work



Silicon Sealing the room

Upon completion of the modular room installation you should now seal any areas that may require it, specifically the sealing between the panel joints.

- Freezer Rooms - Silicon must be used to seal ALL joints.
- Cool Rooms – Silicon sealing is at the discretion of the installer apart from the floor which must be sealed along with any gaps.

NOTE: All construction surfaces are different therefore each room will assemble differently. Small gaps may be present and must be sealed accordingly. A good test once the room is built is to close the door and look for any places where light is visible.

Cold Room Coving (Internal only)

How to install the coving.

1. Install the 4 Coving corner clips in position
2. Measure the internal edges of the room and cut coving into required lengths
3. Lock coving into position using the corner clips
4. Silicon seal the coving along all edges so that no foreign matter can enter.

Condensing Units Installation, Operation, and Service

INTRODUCTION

The Refrigeration Condensing Unit (CDU) integrates the refrigeration Hermetic Sealed / Semi hermetic / Scroll compressor, air cooled / water cooled condenser, simplify installation, and reduce refrigerant charge in order to save time, space, money and energy. With the above advantages, the CDU is able to be a powerful "heart" for refrigeration systems of super-market, cold room, kitchen equipment's, etc.

The characteristic of compact design of the refrigeration CDU enables itself to be one of the most easy and reliable products for installation, commissioning, and Maintenance. As the customer or dealer, you only need to do:

1. To check the model, appearance, and pressure on arrival;
2. To handle and install CDU (including vibration absorption measures, ventilation, and so on);
3. To connect piping;
4. To assemble electrical wiring/control;
5. To test leakage, vacuum, and fill refrigerant;
6. To start the CDU and commission to its best operating condition.

Below sections will show you the detail about system installation, commissioning, and maintenance.

INSPECTION ON ARRIVAL

First of all, please check and confirm whether the CDU type is same as those in the order. The information as type and model of compressor, total horsepower, normal frequency, and temperature range, and so on.

If the CDU type is correct, then please check whether the machines and their accessories are damaged or lost. After checking all the items listed in the below mentioned feature list and if there's something wrong, please record the loss and damage (specify damage type and extent), and inform to the Carrier Sales Agent or the logistic supplier within 48 hours in written format, and request for double check with the suppliers (No repair before inspection).

1. CDU should be inspected by authorized personnel only.
2. De-packaging carefully to avoid any damage to the machine;
3. Dry inert gas is filled into the CDU before transportation from factory (approximately 20 psi).

⚠ CAUTION

Please inspect the unit for inert gas and if there is no gas please inform Carrier Sales Agent immediately;

4. Please confirm to check and accept all the components according to the Bill of Delivery, including the accessories.

HANDLING

Good rigging & handling practices must be used to protect units from damage. Having proper handling equipment at the jobsite is most important & planned. Always lift against a structural part of the skid or unit against center of gravity. Use forklift or lift the unit by hands with proper handling practices.

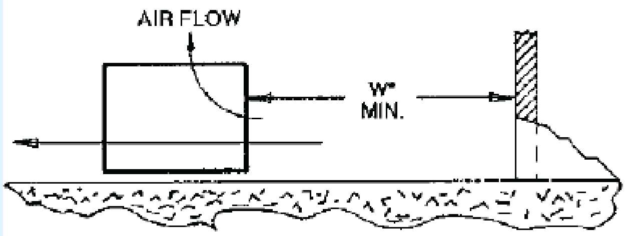
Space and Location Requirements for Air Cooled Condensing Units and Remote Condensers.

The most important consideration which must be taken into account when deciding upon the location of air-cooled equipment is the provision for a supply of ambient air to the condenser, and removal of heated air from the condensing unit or remote condenser area. Where this essential requirement is not adhered to, it will result in higher head pressures, which cause poor operation and potential failure of equipment. Units must not be in the vicinity of steam, hot air or fume exhausts. Corrosive atmospheres require custom designed condensers.

Another consideration which must be taken is that the unit should be mounted away from noise sensitive spaces and must have adequate support to avoid vibration and noise transmission into the building. Units should be mounted over corridors, utility areas, rest rooms and other auxiliary areas where high levels of sound are not an important factor. Sound and structural consultants should be retained for recommendations.

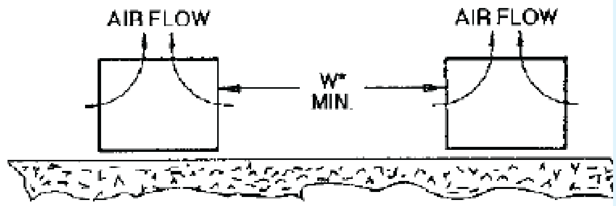
Walls or Obstructions

The unit should be located so that air may circulate freely and not be recirculated. For proper air flow and access all sides of the unit should be a minimum of "W" away from any wall or obstruction. It is preferred that this distance be increased whenever possible. Care should be taken to see that ample room is left for maintenance work through access doors and panels. Overhead obstructions are not permitted. When the unit is in an area where it is enclosed by three walls the unit must be installed as indicated for units in a pit.



Multiple Units

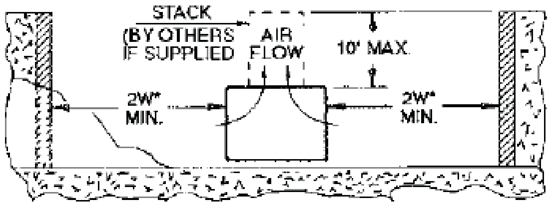
For units placed side by side, the minimum distance between units is the width of the largest unit. If units are placed end to end, the minimum distance between units is 4 feet.



Units in Pits

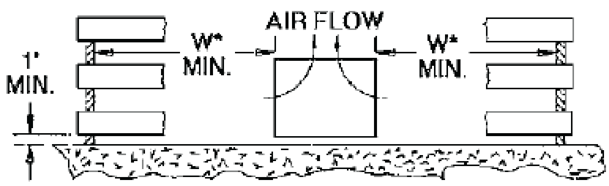
The top of the unit should be level with the top of the pit, and side distance increased to "2W".

If the top of the unit is not level with the top of pit, discharge cones or stacks must be used to raise discharge air to the top of the pit. This is a minimum requirement.

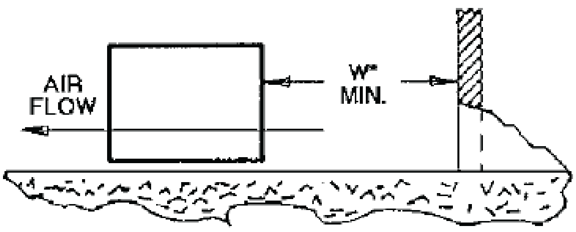


Decorative Fences

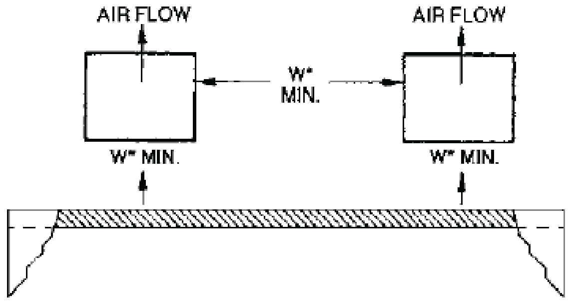
Fences must have 50% free area, with 1 foot undercut, a "W" minimum clearance, and must not exceed the top of unit. If these requirements are not met, unit must be installed as indicated for "Units in pits".



Walls or Obstructions for Horizontal Air Flow



Multiple Units with Horizontal Air Flow



* "W" = Total width of the condensing unit or condenser.

REQUIREMENTS FOR REMOTE AND WATER-COOLED CONDENSING UNITS

GENERAL INSTALLATION

The indoor compressor units are designed to be used with a remote condenser. The water-cooled units are similar, except that they have an integral water-cooled condenser. Inlet and Outlet water connections are to be made in the field. On units having a compressor water jacket, incoming water shall be routed through the jacket prior to entering the condenser. For cleaning purposes, condenser end plates can be removed to give access to the water tubes. Cleaning is accomplished by a simple spiral tool powered by an ordinary electric drill. During installation, allow space for cleaning the condenser. Commercial equipment of this type is intended for installation by qualified refrigeration mechanics.

TYPICAL ARRANGEMENTS

Diagram 1 illustrates a typical piping arrangement involving a remote condenser located at a higher elevation, as commonly encountered when the condenser is on a roof and the compressor and receiver are on grade level or in a basement equipment room.

In this case, the design of the discharge line is very critical. If properly sized for full load condition, the gas velocity might be too low at reduced loads to carry oil up through the discharge line and condenser coil. Reducing the discharge line size would increase the gas velocity sufficiently at reduced load conditions; however, when operating at full load, the line would be greatly undersized, and thereby creating an excessive refrigerant pressure drop. This condition can be overcome in one of two of the following ways:

1. The discharge line may be properly sized for the desired pressure drop at full load conditions and an oil separator installed at the bottom of the trap in the discharge line from the compressor.
2. A double riser discharge line may be used as shown in Diagram 2. Line “A” should be sized to carry the oil at minimum load conditions and the line “B” should be sized so that at the full load conditions both lines would have sufficient flow velocity to carry the oil to the condenser.

WATER REGULATING VALVE

Using this control on the water-cooled condensing units, the head pressure can be maintained by adjusting the flow of water through the condenser section. This type control is most often located on the water entering side of the condenser and is regulated by the refrigerant condensing pressure.

SUBCOOLER

Diagrams 1 and 2 below show typical sub cooler piping. Diagram 1 is the preferred connection with receiver as it provides maximum subcooling. Diagram 2 may be used if the receiver is located far from the condenser.

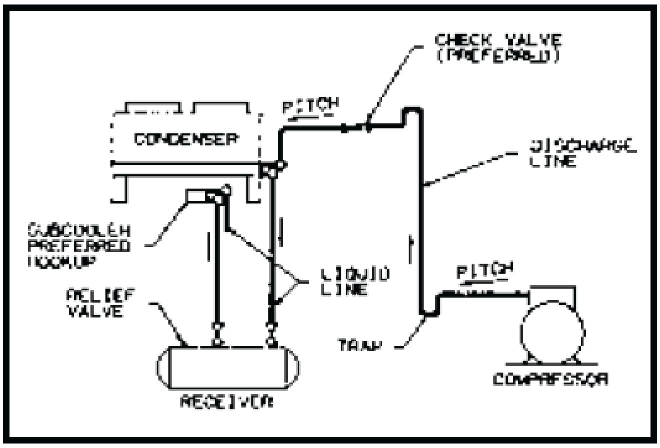


Diagram 1

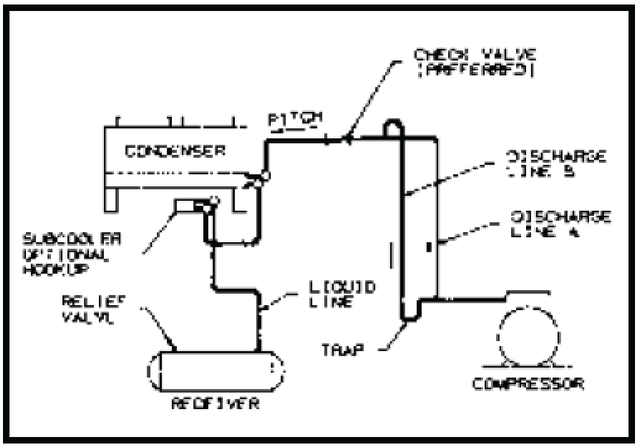


Diagram 2

NOTE:

1. All oil traps are to be as short in radius as possible. Common practice is to fabricate the trap using three 90-degree ells.
2. Pressure relief valves are recommended at the condenser for protection of the coil.
3. A pressure valve at the high point in the discharge line is recommended to aid in removing non-condensable.
4. The placement of a sub cooler should be that it does not interfere with normal airflow of the condenser. Increased static of the unit could cause a decrease in system capacity and fan motor damage.

CONDENSING UNIT RIGGING AND MOUNTING

Rigging holes are provided on all units. Caution should be exercised when moving these units. To prevent damage to the unit housing during rigging, cables or chains used must be held apart by spacer bars. The mounting platform or base should be level and located so as to permit free access of supply air.

GROUND MOUNTING

Concrete slab raised six inches above ground level provides a suitable base. Raising the base above ground level provides some protection from ground water and wind-blown matter. Before tightening mounting bolts, recheck level of unit. The unit should in all cases be located with a clear space in all directions that is at a minimum, equal to the height of the unit above the mounting surface. A condensing unit mounted in a corner formed by two walls, may result in discharge air recirculation with resulting loss of capacity.

ROOF MOUNTING

Due to the weight of the units, a structural analysis by a qualified engineer may be required before mounting. Roof mounted units should be installed level on steel channels or an I-beam frame capable of supporting the weight of the unit. Vibration absorbing pads or springs should be installed between the condensing unit legs or frame and the roof mounting assembly.

ACCESS

Provide adequate space at the compressor end of the unit for servicing. Provide adequate space on the connection side to permit service of components.

SPRING MOUNTED COMPRESSOR

Compressors are secured rigidly to make sure there is no transit damage. Before operating the unit, it is necessary to follow these steps:

a. Remove the upper nuts and washers.
b. Discard the shipping spacers.
c. Install the neoprene spacers. (Spacers located in the electrical panel or tied to compressor.)
d. Replace the upper mounting nuts and washers.
e. Allow 1/16-inch space between the mounting nut/ washer and the neoprene spacer. See Figures 1 and 3 below.

RIGID MOUNTED COMPRESSOR

Some products use rigid mounted compressors. Check the compressor mounting bolts to insure they have not vibrated loose during shipment. See Figure 2 below.

Figure 1: Spring Mount

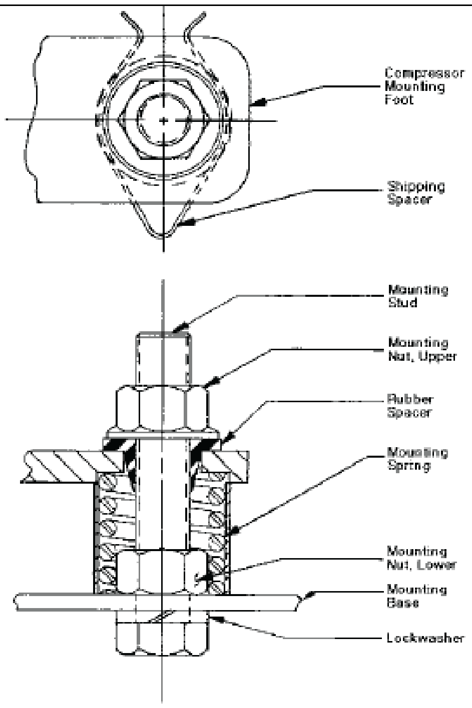


Figure 2: Solid Mount for Mobile or Deep Sump Application.

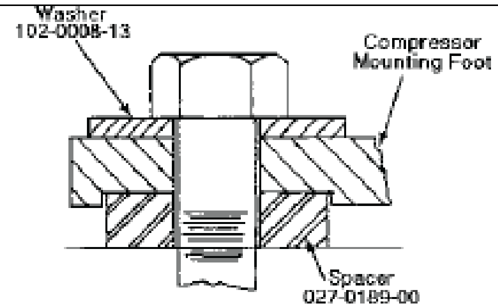
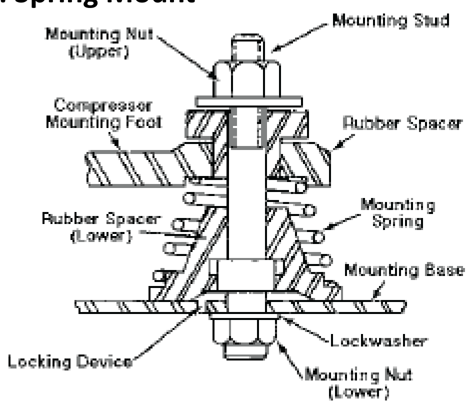


Figure 3: Spring Mount



Mount is shown in properly adjusted position.

PIPING

SYSTEM PIPING APPLICATION

SELECT PIPING

The CDU is only required to connect 2 pipes: the liquid pipe to the evaporators/cases and the suction pipe from the evaporators/cases. In order to choose the right piping, pressure loss and oil return must be considered carefully:

1. Try to avoid using elbows to reduce pressure loss. Use elbows with big bending radii if necessary.
2. Clean copper tube especially for Refrigeration and correct sealing to prevent pollution.

ARRANGE PIPING LAYOUT

1. CDU is higher than Evaporators/Cases

When the installation position of the unit is higher than that of the evaporator, (e.g., unit is on the 2nd floor, evaporator is on the 1st floor), an oil return bend should be added at the interface of the horizontal gas return pipe and the rising vertical pipe. If the installation position of the unit is much higher than that of the evaporator (> 6m), one oil return bend should be added at every 6 meters, as shown in Figures states the right structure of oil return bend.

2. CDU is lower than Evaporators/Cases

When the installation position of the unit is lower than that of the evaporator, (e.g., unit is on the 1st floor, evaporator is on the 2nd floor), the gas return pipe should rise to the same height as the top of the evaporator surface and then stretch to the CDU, as shown in Figure A.

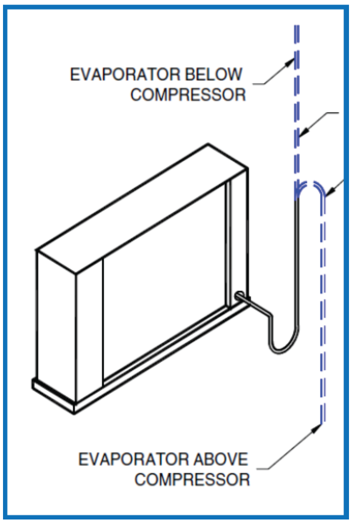


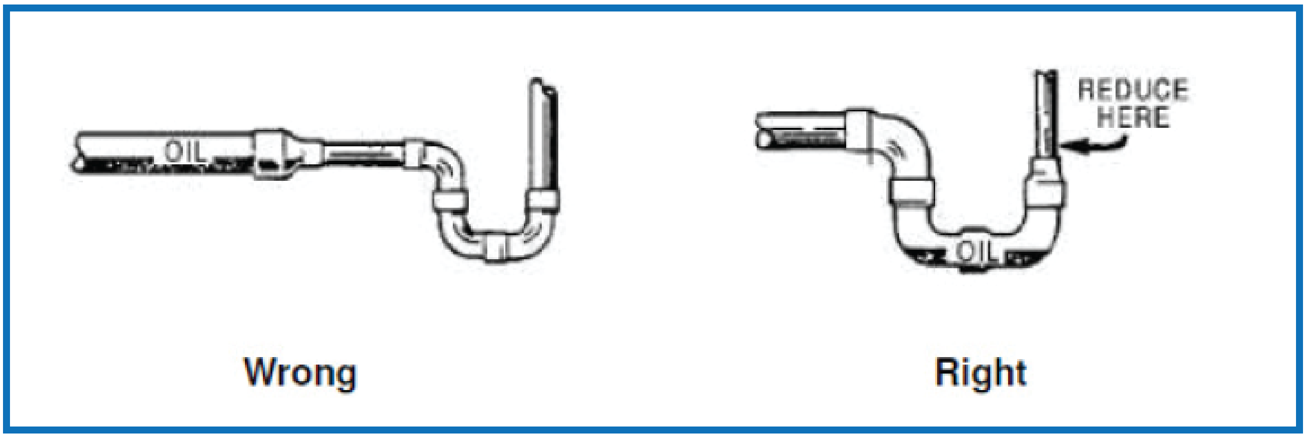
Figure A

SUCTION LINES

Horizontal suction lines should slope away from the evaporator toward the compressor at the rate of 1/4 inch per 10 feet for good oil return. When multiple evaporators are connected in series using a common suction line, the branch suction lines must enter the top of the common suction line.
For dual or multiple evaporator systems, the branch lines to each evaporator should be sized for the evaporator capacity. The main common line should be sized for the total system capacity.
Suction lines that are outside of refrigerated space must be insulated.

SUCTION LINE RISERS

Prefabricated wrought copper traps are available, or a trap can be made by using two street ells and one regular ell. The suction trap must be the same size as the suction line. For long vertical risers, additional traps may be necessary. Generally, one trap is recommended for each length of pipe (approximately 20 feet) to insure proper oil movement. See Figure below for methods of constructing proper suction line P-traps.



1. The CDU should be put to the nearest place from evaporators (Display case, cold room cooler, etc.). The vertical distance or height between the CDU and evaporators must be less than 7 meters!
2. Horizontal pipes should be arranged to decline downward, and the slope should be more than 1/200

LIQUID LINES

Liquid lines should be sized for a minimum pressure drop to prevent “flashing”. Flashing in the liquid lines would create additional pressure drop and poor expansion valve operation. If a system requires long liquid lines from the receiver to the evaporator or if the liquid has to rise vertically upward any distance, the losses should be calculated to determine whether or not a heat exchanger is required. The use of a suction to liquid heat exchanger may be used to subcool the liquid to prevent flashing. This method of subcooling will normally provide no more than 20°F subcooling on high pressure systems. The amount of subcooling will depend on the design and size of the heat exchanger and on the operating suction and discharge pressures. An additional benefit from the use of the suction to liquid type heat exchanger is that it can help raise the superheat in the suction line to prevent liquid return to the compressor via the suction line. Generally, heat exchangers are not recommended on R-22 low temperature systems. However, they have proved necessary on short, well insulated suction line runs to provide superheat at the compressor.

CONNECTING REFRIGERANT LINES

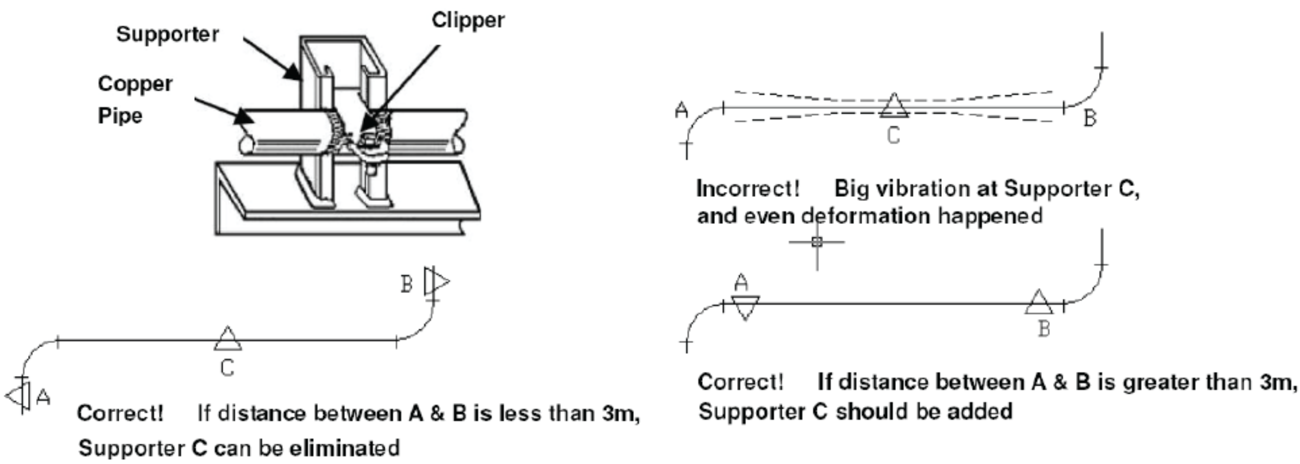
1. Re-check the pressure in the CDU to prevent rework from unit components break or piping split due to violent shock and impact during installation. In case that there’s any pressure loss, it is recommended to put it under leak test of 360 psi for 12~18 hours before start to connect piping (This pressure must be released before connection).
2. Proper brazing rod should be selected according to Refrigeration Installation Standards. Fill nitrogen during brazing;

3. Control amount and method of using scaling powder appropriately to prevent internal pollution in the welding interface.
4. Maintain cleanness and prevent dirt from entering the system during piping installation. Caps fitted on the ends of pipes protect the interior from dirt. Lengths of pipe must be recapped if not used fully. The same care must be exercised when installing valves, filter-dryers, strainers, vessels and other piping equipment sensitive to dirt if necessary. Do not expose the after-dried compressor and filter opening in the air.
5. Brazed joints must be made in a reducing atmosphere or with equivalent protection;
6. Caution is required when installing copper piping in floor ducts, pits and so on, where foul gases may occur in certain circumstances. Hydrogen Sulphide, H2S, present in these gases causes elective corrosion of phosphorus-containing brazing fillers, resulting in leaks at brazed joints;
7. To avoid damage to such copper piping, brazed joints made with phosphorus--containing filler must be painted with a coating adhering to metal.

Alternatively, phosphorus-free brazing filler may be used together with a flux.

SUPPORTING THE REFRIGERANT LINES

The refrigerant lines should be fastened and supported to avoid excess noise and vibration of pipes. All of the fasteners should have insulation material to avoid the direct contact between pipes. For copper pipe whose diameter is from 9.52mm to 22.22mm (3/8"-7/8"), one supporter should be added at every 1,500mm; for copper pipe: 28.58 ~ 34.93mm (1-1/8"~1-5/8"). The supporting method is shown in Figure.



CONDENSING UNIT ACCESSORIES SUCTION FILTERS, DRIERS, SIGHT GLASSES

Suction filters, regardless of type, are always installed upstream of the compressor suction service valve, and any accumulators or other options that may be installed. Suction filters are equipped with "Schrader" type access valves to allow field measurement of pressure drop across the device. This allows plugged filters and elements to be identified very quickly and easily so they can be replaced when the pressure drop is excessive. Refer to the specific manufacturers' recommendation on servicing these units by make and model.

Liquid filter/driers, regardless of type, are always installed downstream of the receiver outlet service valve, and upstream of the liquid line solenoid valve (if supplied). Liquid line driers may or may not have an access valve, dependent on the size and application. The basic servicing of these units is similar to suction filters. Liquid line driers should be replaced whenever there is evidence of excessive pressure drop across the filter, or the system becomes contaminated due to system leaks, compressor burnouts, acid formation, or moisture accumulation as indicated by the liquid line sight glass.

The sight glass is installed in the main liquid line assembly, downstream from the receiver outlet service valve, and immediately after the liquid line drier. The sight glass is designed to give a visual indication of moisture content in the system. Generally, it requires no field service. However, in cases of extreme acid formation in a system after a compressor burnout, the acid may damage the sensing element or etch the glass. This would require that the sight glass be replaced, along with the liquid line drier after any compressor motor burnout.

Recommended Low Pressure Control Settings for Outdoor Air-Cooled Condensing Units

*Minimum Temp. °F	R-22		R-404A/R-507		R-134a	
	Cut-In PSI	Cut-Out PSI	Cut-In PSI	Cut-Out PSI	Cut-In PSI	Cut-Out PSI
50	70	20	90	35	45	15
40	55	20	70	35	35	10
30	40	20	55	35	25	10
10	30	10	45	25	13	0
0	15	0	25	7	8	0
-10	15	0	20	1	---	---
-20	10	0	12	1	---	---
-30	6	0	8	1"Hg.	---	---

* Minimum ambient or box temperature anticipated, Hi pressure control setting: R-22, 360 PSI; R-404A, R-507, 400 PSI; R-134a, 225 PSI.

REFRIGERATION OILS

With the changes that have taken place in our industry due to the CFC issue, we have reevaluated our lubricants to ensure compatibility with the new HFC refrigerants and HCFC interim blends offered by several chemical producers. As a secondary criterion, it is also desirable that any new lubricant be compatible with the traditional refrigerants such as HCFC-22 or R502. This “backward compatibility” has been achieved with the introduction of the Polyol ester lubricants.

POLYOL ESTER LUBRICANTS

Hygroscopicity

Ester lubricants (POE) have the characteristic of quickly absorbing moisture from the ambient surroundings.
Since moisture levels greater than 100 ppm will results in system corrosion and ultimate failure, it is imperative that compressors, components, containers and the entire system be kept sealed as much as possible. Lubricants will be packaged in specially designed, sealed containers. After opening, all the lubricant in a container should be used at once since it will readily absorb moisture if left exposed to the ambient. Any unused lubricant should be properly disposed of. Similarly, work on systems and compressors must be carried out with the open time as short as possible. Leaving the system or compressor open during breaks or overnight MUST BE AVOIDED!

Color

As received, the POE lubricant will be clear or straw colored. After use, it may acquire a darker color. This does not indicate a problem as the darker color merely reflects the activity of the lubricant's protective additive.

Oil Level

During Copeland's testing of Polyol ester oil, it was found that this lubricant exhibits a greater tendency to introduce oil into the cylinder during flooded start conditions. If allowed to continue, this condition will cause mechanical failure of the compressor.

A crankcase heater is required with condensing units and it must be turned on several hours before start-up.

Oil level must not exceed 1/4 sight glass.

MINERAL OILS

The BR and Scroll compressors use Sontex 200, a "white oil". This oil is not suitable for low temperature applications nor is it available through the normal refrigeration wholesalers. For field "top-off" the use of 3GS or equivalent, or Zerol 200TD is permissible, as long as at least 50% of the total oil charge remains Sontex 200. Suniso 3GS, Texaco WF32 and Calumet R015 (yellow oils) are available through normal refrigeration wholesalers. These oils are compatible if mixed and can be used on both high and low temperature systems.

POLYOL ESTER LUBRICANTS

The Mobil EAL ARCTIC 22 CC is the preferred Polyol ester due to unique additives included in this lubricant. ICI Emkarate RL 32S is an acceptable Polyol ester lubricant approved for use when Mobil is not available. These POE's must be used if HFC refrigerants are used in the system. They are also acceptable for use with any of the traditional refrigerants or interim blends and are compatible with mineral oils. They can therefore be mixed with mineral oils when used in systems with CFC or HCFC refrigerants. These lubricants are compatible with one another and can be mixed.

PHASE LOSS MONITOR

The combination phase sequence and loss monitor relay protect the system against phase loss (single phasing), phase reversal (improper sequence) and low voltage (brownout). When phase sequence is correct and full line voltage is present on all three phases, the relay is energized as the normal condition indicator light glows.

Note: If compressor fails to operate and the normal condition indicator light on the phase monitor does not glow, then the supplied electrical current is not in phase with the monitor. This problem is easily corrected by the following steps:

1. Turn power off at disconnect switch.
2. Swap any two of the three power input wires.
3. Turn power on. Indicator light should glow, and compressor should start.
4. Observe motors for correct rotation.

THERMAL INSULATION

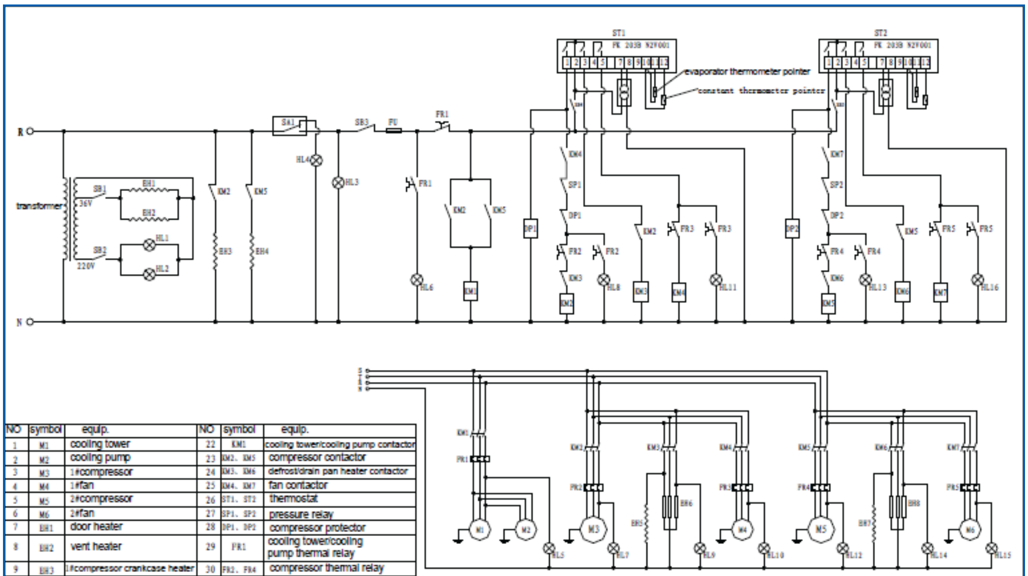
1. For Medium Temperature units, the thickness of the thermal insulation material on the vapor return pipe should be greater than 12.7 mm (it will vary based on ambient & return pipe temperature);
2. The thickness of the thermal insulation material on the sub-cooled liquid pipe should be greater than 12.7 mm. Provide if Sub cooling is occurring in the liquid line.
3. The vapor return pipe and the liquid pipe is prohibited to be bundled by band or brazed together.

ELECTRICAL CONNECTION

1. CDU Power Supply must satisfy:
   a) The power supply, including the Power rating, Voltage, and the Frequency, must be consistent with the values specified on the CDU Name Plate
   b) The power supply should have enough power rating
   c) The voltage fluctuation must be kept within 93%~107% of rated value on the Name Plate
   d) Phase imbalance must be no greater than 2 %

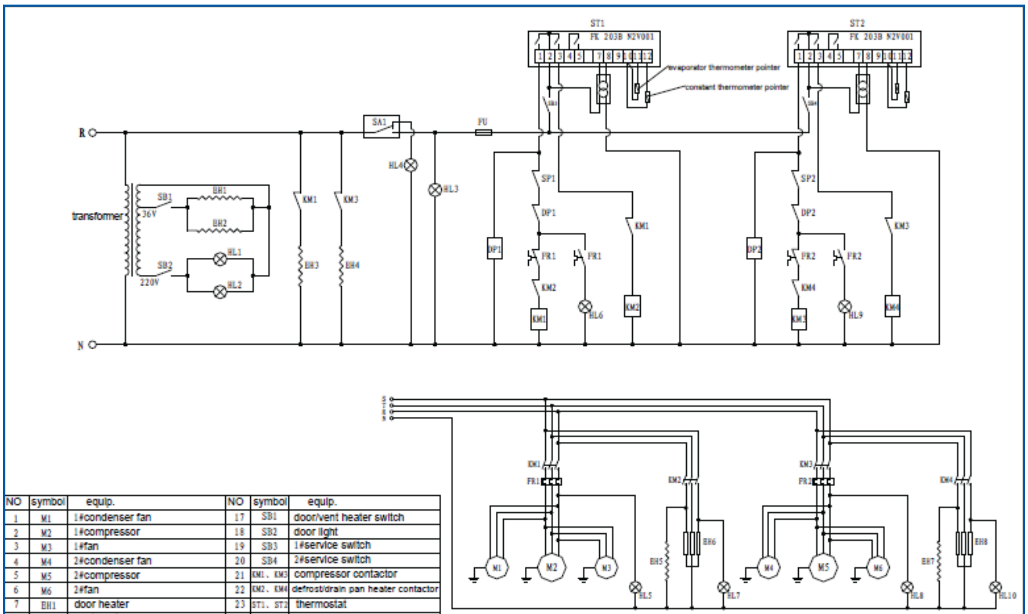
2. All electrical construction should comply with the relevant National and local electrical standards and regulations
3. All the customer onsite electrical connection should be strictly according to the electrical drawings. Any other modification for the Factory electrical assembly is forbidden without the Factory agreement in written format
4. CDU should run within the working condition envelop.

The electrical connections should be made according to the wiring diagram. The wiring diagram included in this manual is only for reference. Real construction should adhere to the actual cold room plant planning drawing of the walk in cold room.



NO	symbol	equip.	NO	symbol	equip.
1	M1	cooling tower	22	KM1	cooling tower/cooling pump contactor
2	M2	cooling pump	23	KM2、KM5	compressor contactor
3	M3	1#compressor	24	KM3、KM6	defrost/drain pan heater contactor
4	M4	1#fan	25	KM4、KM7	fan contactor
5	M5	2#compressor	26	ST1、ST2	thermostat
6	M6	2#fan	27	SP1、SP2	pressure relay
7	EH1	door heater	28	DP1、DP2	compressor protector
8	EH2	vent heater	29	FR1	cooling tower/cooling pump thermal relay
9	EH3	1#compressor crankcase heater	30	FR2、FR4	compressor thermal relay
10	EH4	2#compressor crankcase heater	31	FR3、FR5	fan thermal relay
11	EH5	1#evaporator drain pan heater	32	HL1、HL2	door light
12	EH6	1#evaporator defrost heater	33	HL3	proper power supply light
13	EH7	2#evaporator drain pan heater	34	HL4	failure power supply light
14	EH8	2#evaporator defrost heater	35	HL5	cooling tower/cooling pump operating light
15	SA1	phase loss monitor			
16	FU	heater	36	HL6	cooling tower/cooling pump malfunction light
17	SB1	door/vent heater switch	37	HL7、HL12	compressor operating light
18	SB2	door light	38	HL8、HL13	compressor malfunction light
19	SB3	emergency switch	39	HL9、HL14	defrosting/draining light
20	SB4	1#service switch	40	HL10、HL15	fan operating light
21	SB5	2#service switch	41	HL11、HL16	fan malfunction light

water-cooled walk-in electrical wiring diagram for unit >10HP



NO	symbol	equip.	NO	symbol	equip.
1	M1	1#condenser fan	17	SB1	door/vent heater switch
2	M2	1#compressor	18	SB2	door light
3	M3	1#fan	19	SB3	1#service switch
4	M4	2#condenser fan	20	SB4	2#service switch
5	M5	2#compressor	21	KM1、KM3	compressor contactor
6	M6	2#fan	22	KM2、KM4	defrost/drain pan heater contactor
7	EH1	door heater	23	ST1、ST2	thermostat
8	EH2	vent heater	24	SP1、SP2	pressure relay
9	EH3	1#compressor crankcase heater	25	DP1、DP2	compressor protector
10	EH4	2#compressor crankcase heater	26	FR1、FR2	compressor thermal relay
11	EH5	1#evaporator drain pan heater	27	HL1、HL2	door light
12	EH6	1#evaporator defrost heater	28	HL3	proper power supply light
13	EH7	2#evaporator drain pan heater	29	HL4	failure power supply light
14	EH8	2#evaporator defrost heater	30	HL5、HL8	compressor operating light
15	SA1	phase loss monitor	31	HL6、HL9	compressor malfunction light
16	FU	heater	32	HL7、HL10	defrosting/draining light

air-cooled walk-in electrical wiring diagram for unit ≤10HP

REFRIGERATION SYSTEM OPERATING INSTRUCTIONS

WARNING AND SAFETY INFORMATION

BEFORE START-UP

- Dedicated power supply should be provided for the cold room plant and should not be shared with other electrical apparatus.
- Ground wire must be properly connected to electrical cabinet screws for protection against shock hazard.
- Ground insulation resistance must be over 2 megohm.
- No flammable or explosive material should be placed in the vicinity of this appliance.

AFTER START-UP

- Do not touch any electrical components except operating parts.
- Avoid touching air-cooled condenser and fan with hands or with other objects when they are in operation.
- Avoid touching compressor, discharge line and condenser in case of scald when in operation.
- Do not adjust safety control settings when machine is in operation for prevention of unit damage of the cold storage room.
- Make sure all power sources are disconnected before any circuit check-up.
- When unusual noise happens during operation, stop machine immediately and take corrective action.
- When walk-in cooler and walk-in freezer are off-work for a long period of time, main power supply should be shut down.

CHECK-OUT BEFORE START-UP

Make sure that

- All electrical terminals are correctly tightened.
- All valves are set properly for efficient operation.
- Power voltage is within 10% of that indicated on the condensing unit nameplate.
- Cold room ambient temperature range is 5°C to 40°C
- Oil level is at the designed limits.
- Thermostat and other control units of the cold storage room are properly set.
- On initial operation or restart after a long time the crankcase heater should be energized for 6 hours prior to start-up.

START-UP

Walk-in coolers and walk-in freezers are automatic control system design. Start-up is simply a press of ON button.

OPERATIONAL CHECK-OUT

- Compressor should not be forced to stop before it operates at least three minutes, and vice versa reset cannot be done until 3 minutes after shut-down. Frequent start-ups are not acceptable and there should be no more than 5 times per hour.
- The oil level should be at or slightly above the center of the sight glass at normal operation conditions. If the oil level is low, more oil of the same type should be added to bring the level up.
- Observe the condition of moisture in the liquid line sight glass. When moisture content level is over system limits, replace filter-dryer. The relations between liquid line sight glass colour and moisture content level:

  Blue: low, normal

  Violet: slightly high, replacement of filter-dryer is recommended

  Purple: high, alarm limits, replacement of filter-dryer is necessary

  Rosiness: seriously high

NOTE: If refrigeration system repair needs adding more refrigerant, replace the filter-dryer before adding.

- Inspect operational conditions of compressor, condenser and fan motor for loose screws and unusual noise. Tighten or stop and repair.
- Check the fan is rotating in the correct direction. i.e. Direction symbol provided on the fan motor.
- Check piping insulation for prevention of refrigerated air loss.

GENERAL SAFETY INFORMATION

- Refrigeration compressors must be used with approved refrigerants and refrigeration oils only.
- It is not allowed to run a test without the compressor being connected to the system and without refrigerant.
- It is of vital importance that the Suction valve has been fully opened before the compressor is started.
- If the liquid service valve is closed or partly closed is unacceptable.
- Natures may develop in the cylinder head. Even when handling the compressor correctly high temperatures may develop and cause injuries when touching.
- Installation Guidance
  - Do not use the units outside of the operating limits specified.
  - Install only in a properly ventilated area.
  - Check tightness of all screw terminals.
  - Check that the electrical supply to the installation is suitable and that the motor is connected correctly.
  - Check the currents drawn. It should be within operating range of compressor.
  - The refrigerant circuit must be perfectly clean, dry and installed according to best refrigeration practice.
  - Check settings of all safety devices.
  - Limit the superheat of the suction gas to 11K for low temperature range operation.

LEAK TESTING

- Leak test is made on the CDU unit at the factory. Even so, new leaks may occur during handling, sitting and installation. Therefore, the CDU unit installed in a refrigeration system must be included in leak testing performed on the system when completed (this also includes evaporators in refrigerated display cases, cold rooms, etc.)
- Close all the valves on the suction line, liquid line, and hot gas collection pipe and fill dry nitrogen at maximum 150 psi (gauge) pressure into each circuit for separate checking.
- After checking each circuits, open the following valves: compressor discharge valve, compressor suction valve, liquid return valve for liquid receiver, and supply liquid valve for liquid receiver to make sure the pressure has gone into every part of the CDU unit.
- Test should preferably be made at allowable working pressure (approximately 360psi for detection of leaks by foaming agents, leak detector lamp or electronic leak detector.
- In every instance, inspection for leaks must be made once a year. When inspecting for leaks, first test critical locations such as screwed joints. Major leaks can be located with a foaming agent.

CREATION OF VACCUM

If there is no leak problem in the leak test, the system should be vacuumized

1. Suggested that all the ports should be opened to improve the working efficiency.
2. Be sure that all the interrelated valves should be opened.
3. When the system pressure is vacuumized to 180 Pa, the refrigerant should be charged, until the pressure rises to 0.12~2bar.

HEAT LOAD CALCULATIONS

The optimal storage temperature must be continuously maintained to obtain the full benefit of cold storage. To make sure the storage room can be kept at the desired temperature, calculation of the required refrigeration capacity should be done using the most severe conditions expected during operation. These conditions include the mean maximum outside temperature, the maximum amount of produce cooled each day, and the maximum temperature of the produce to be cooled. The total amount of heat that the refrigeration system must remove from the cooling room is called the heat load. If the refrigeration system can be thought of as a heat pump, the refrigerated room can be thought of as a boat leaking in several places with an occasional wave splashing over the side. The leaks and splashes of heat entering a cooling room come from several sources:

- **Heat Conduction** – Heat entering through the insulated walls, ceiling, and floor;
- **Field Heat** – Heat extracted from the produce as it cools to the storage temperature;
- **Heat of Respiration** – Heat generated by the produce as a natural by-product of its respiration;
- **Service Load** – Heat from lights, equipment, people, and warm, moist air entering through cracks or through the door when opened.

FUNDAMENTALS FOR DESIGNING A COLD STORAGE PROJECT

The design of cold storage facilities is usually directed to provide for the storage of perishable commodities at selected temperature with consideration being given to a proper balance between initial, operating, maintenance, and depreciation costs. The basic procedures for constructing (or) implementing the cold store units have the following requirements:

Process Layout

The most important requirement for any food project using insulated envelopes is to determine the process layout of the operation which is to be housed by the envelope. In the case of a meat plant, this can be a carcass dressing line or a boning room, or for a cold store, the pallet layout and mode of operation must be established. It is simply no good building an envelope and then attempting to place the processing machinery inside it.

Planning Drawings and Application

It is only after concluding the process layout that a planning application can be made when the dimensions of the envelope and supporting buildings can be frozen.

Design Drawings and Specifications

Once planning approval has been obtained then the preparation of design drawings and specifications can proceed. For a competitive design and construct tender, it is essential to prepare some 15 – 20 detailed drawings covering, at the minimum, the process layout, elevations and sections, the refrigeration system layout, mechanical and electrical systems reticulation and the lighting layout.

In addition to make up package at least six separate detailed specifications are required covering the project's requirements on:

- Contractual requirements
- Building specification
- Refrigeration specification
- Insulation panel supply and erection
- Electrical requirements
- Mechanical services.

The location chosen for the cooling facility should reflect its primary function. If the plan is to conduct retail sales of fresh produce from the facility, it should be located with easy access to public roads. A retail sales operation located away from the road, particularly behind dwellings or other buildings, discourages many customers. Adequate parking for customers and employees, if any, must be provided.

If, however, the primary function of the cooling facility is to cool and assemble wholesale lots, ease of public access is less important. In this case, the best location may be adjacent to the packing or grading room. In addition to housing grading and packing equipment, the space could be used to store empty containers and other equipment and supplies when it is not needed for cooling. All cooling and packing facilities should have convenient access to fields or orchards to reduce the time from harvest to the start of cooling.

Regardless of how it is used, the facility will need access to electrical power and water. For larger cooling rooms requiring more than about 10 tons of refrigeration in a single unit, access to three-phase power will be necessary. The location of existing utility lines should be carefully considered, as connection costs can be prohibitive in some rural areas. Consult local power company for details.

In addition, it is a good idea to anticipate any future growth when locating and designing your facility. The cold storage unit should be built on a site, a where the ground in clean, well drained and preferably leveled and near to supplies of energy and water. If possible, it should be in the shade of prevailing wind and direct sunlight. A refrigerated store, with one (or) more thermally insulated places, and refrigerating machines can be planned with the aim of assuring certain services. The details about :

1. Nature of the products
2. Frequency of loading and unloading
3. Calendar for harvest and dispatch
4. Field heat of the produce
5. Daily tonnage of produce to be handled
6. Daily tonnage of ice to be manufactured
7. Nature and dimension of packages

The above particulars are to be collected before initiating the cold storage unit work. The conditions to be considered for planning, a cold storage are temperature and duration of storage, handling and stacking method, type of; commodities to be stored together, prevailing climatic factors like temperature, relative humidity, rainfall, wind and water. Availability of skilled and unskilled labor from the local area is the major factor to be considered for the successful operation.

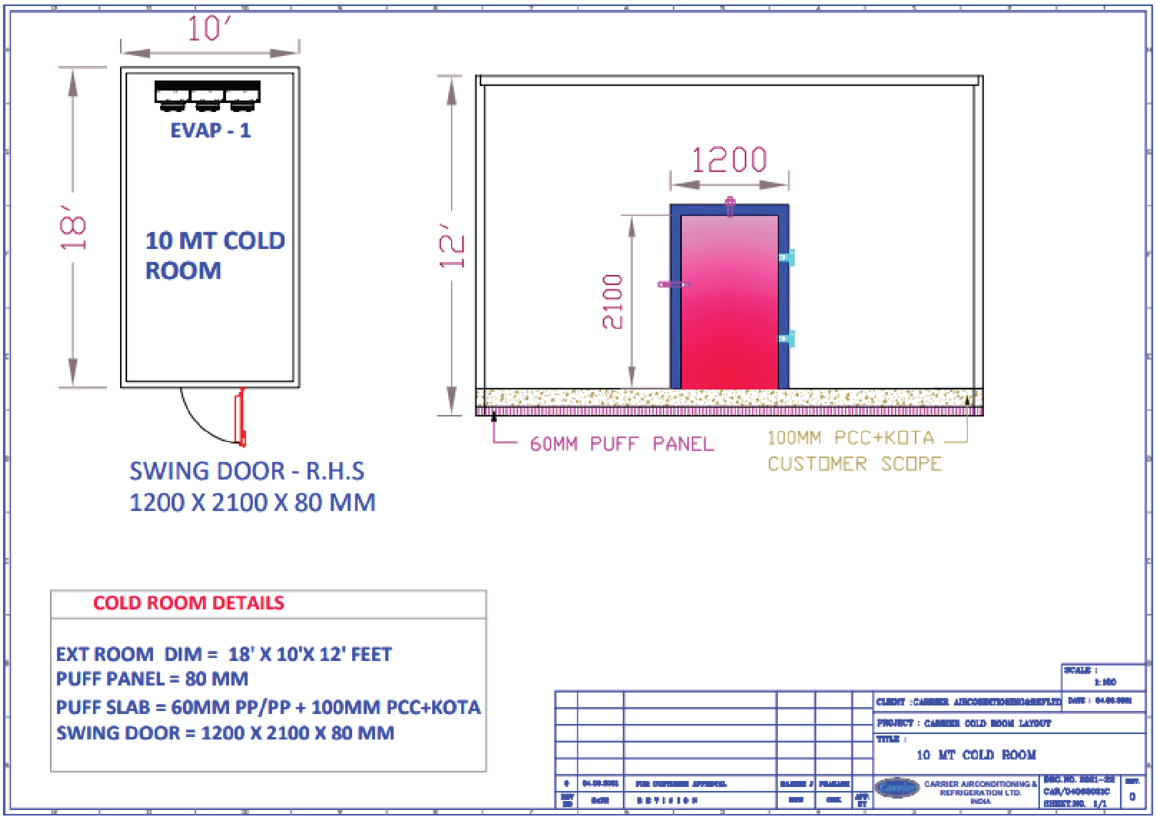
COMPONENTS OF COLD STORAGE

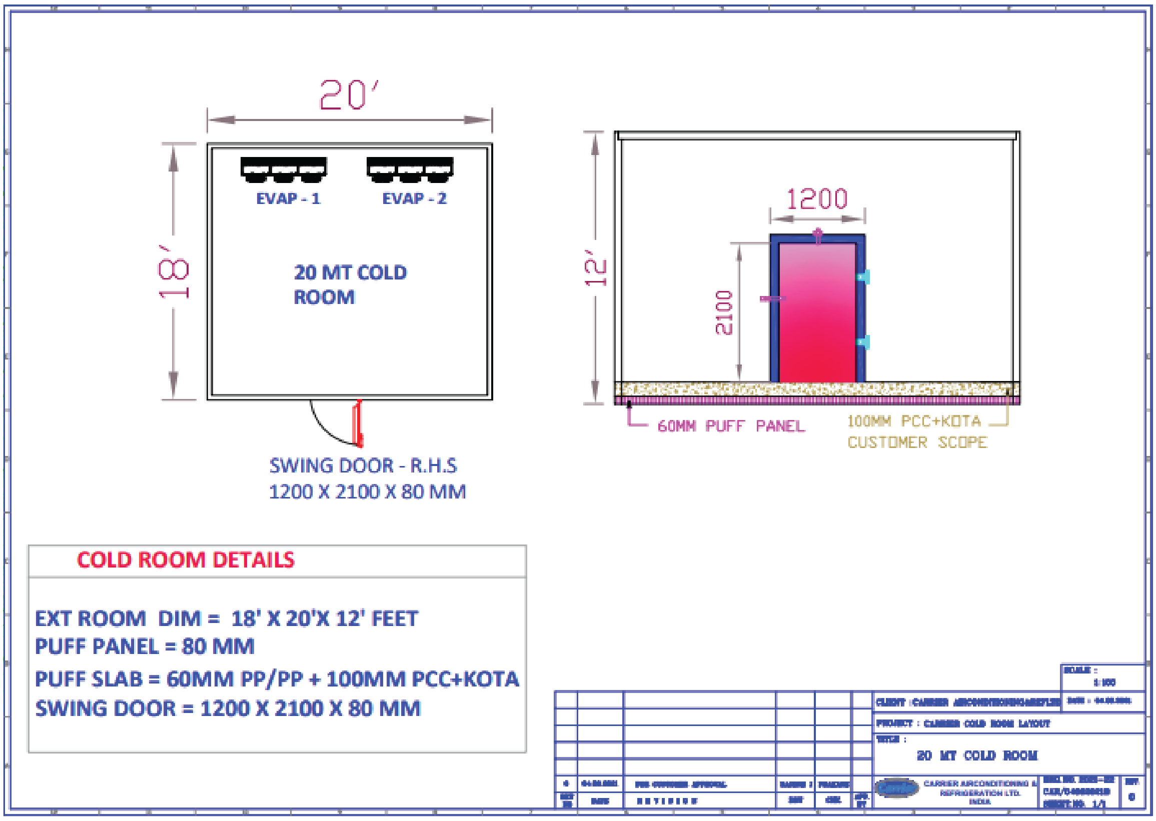
PUF PANELS FOR INSULATION

CONDENSING UNITS

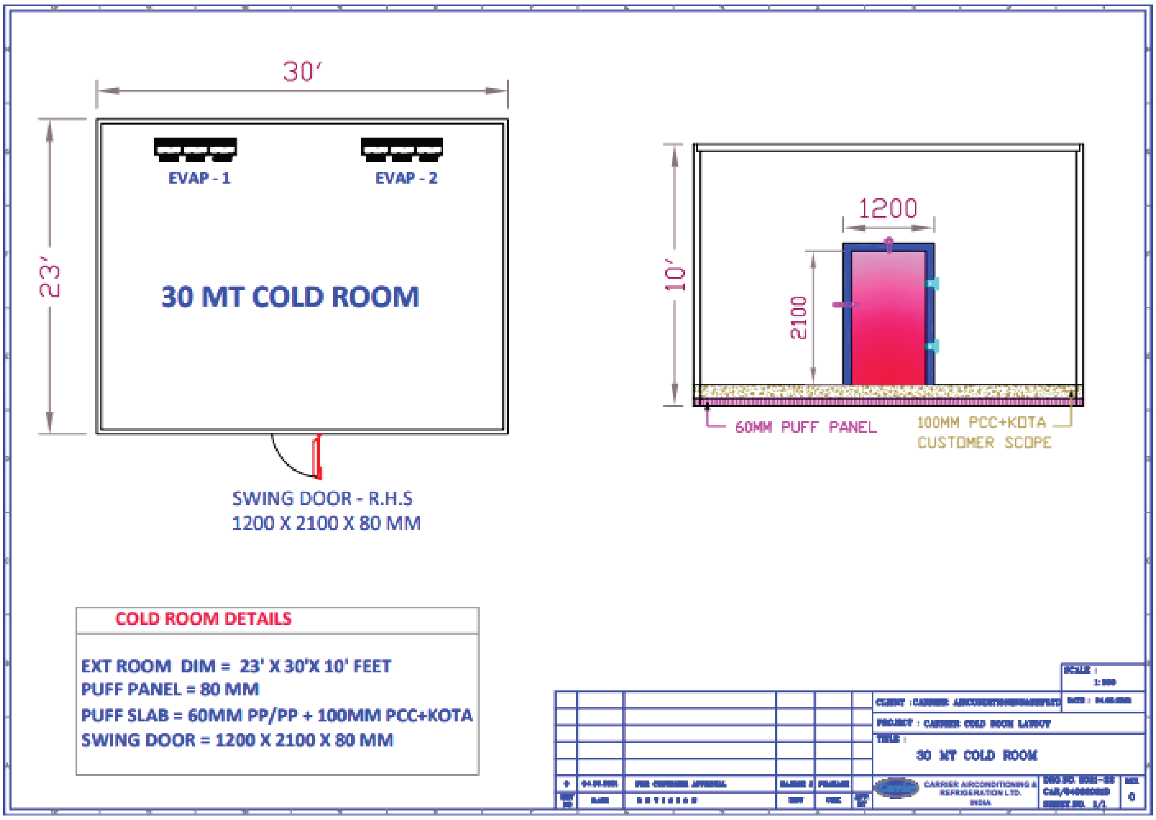
EVAPORATOR UNIT

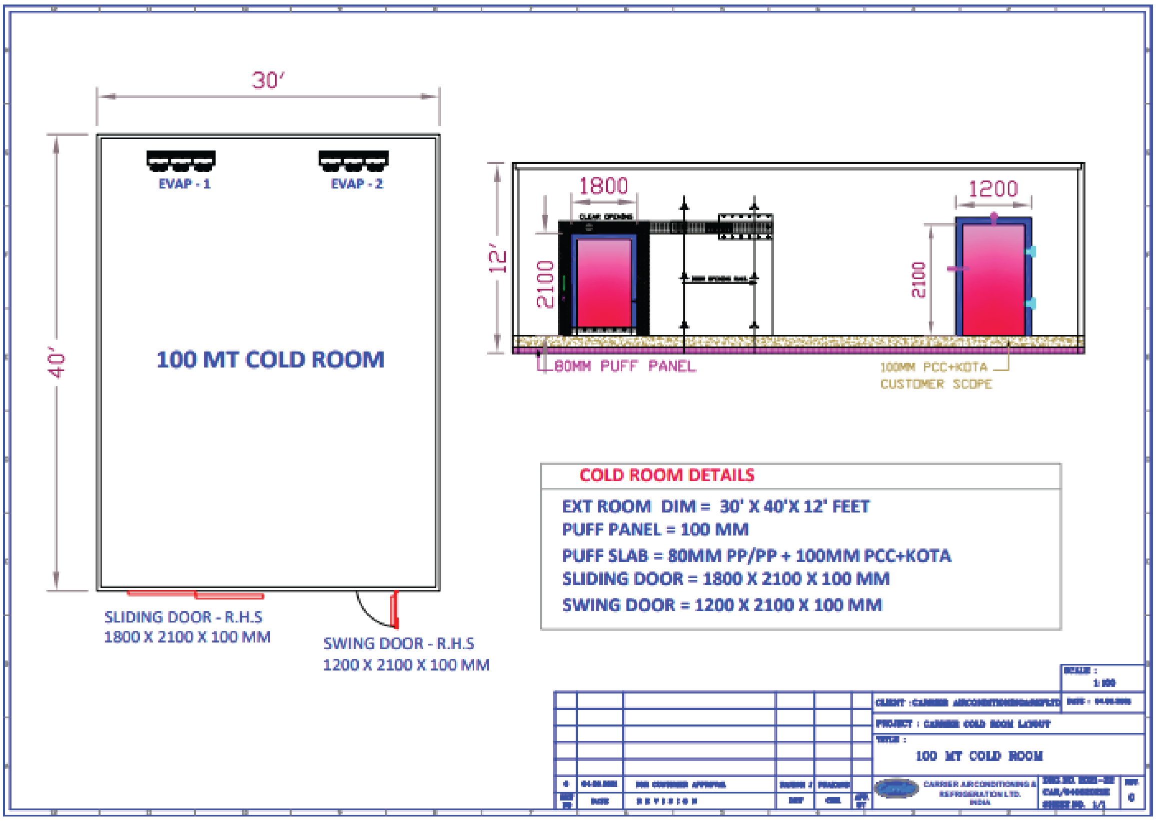
DESIGN FOR THE COLD ROOM



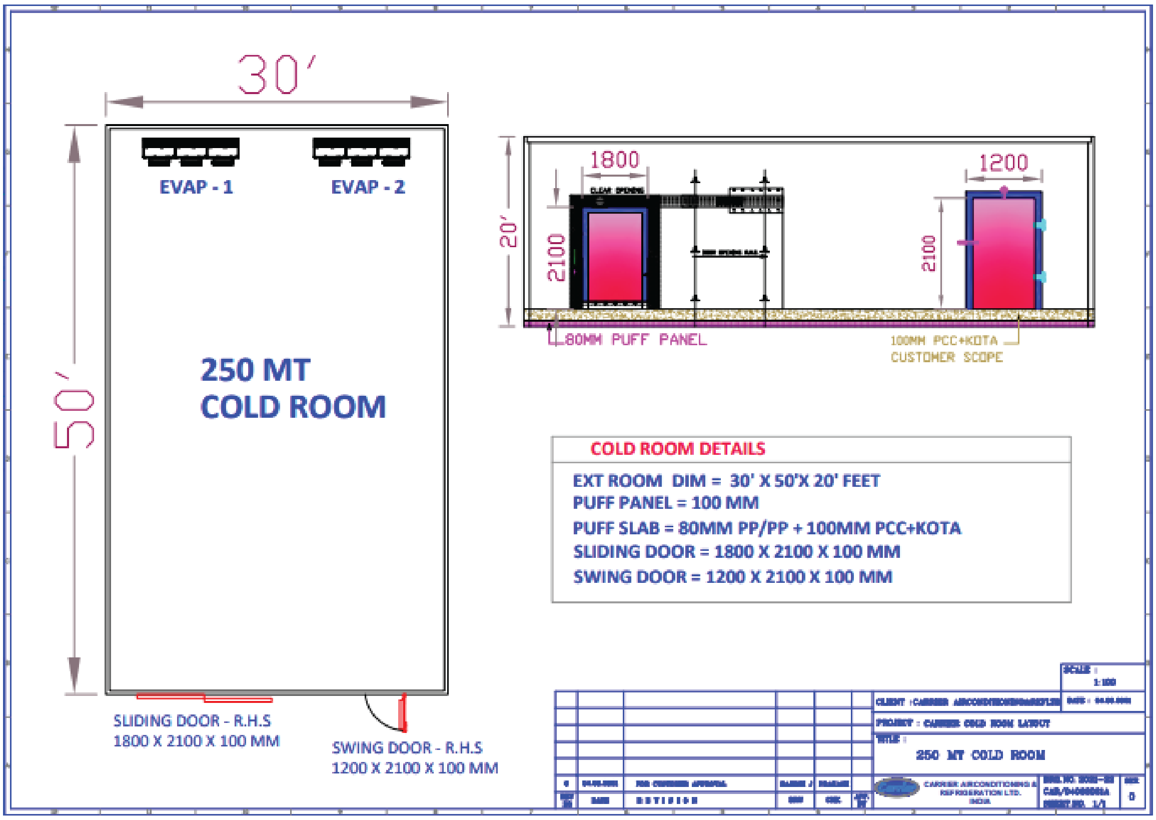


DESIGN FOR THE COLD ROOM





DESIGN FOR THE COLD ROOM



ENERGY EFFICIENCY MEASURES

Energy efficiency interventions can be identified in three broad categories- (i) building design (improving thermal performance), (ii) equipment and system design (optimizing refrigeration and cooling system performance), and (iii) infrastructure processes and operation and maintenance (process improvement and O&M best practices).

EEMS - BUILDING DESIGN

Energy efficiency interventions at the building design level are applicable for both existing and upcoming infrastructure for various produce and include interventions focusing on building design, materials, and different design strategies to reduce heat gain.

S. No.	Energy Efficiency Measure	Prioritization remarks
1	Natural lighting to reduce lighting load, proper orientation and shading for minimizing solar heat gains	Minimal cost measure. Applicable for all types of upcoming (new) infrastructure
2	Cool roof treatment	No-to-low cost measure. Applicable for all types of existing and upcoming (new) infrastructure
3	Optimized size of pre-cooling and cold rooms	No-to-low cost measure. Applicable for all types of existing and new pack-houses.
4	Provision for natural ventilation - ceiling-mounted turbo ventilators	Low cost measure. Applicable for all types of upcoming new infrastructure having no active air conditioning in the sorting/grading or packing areas.
5	Airtight doors for pre-cooling and cold rooms	Low cost measure. Applicable for all types of existing and new infrastructure without active air conditioning in the sorting/grading or packing areas.
6	Pre-cooling and staging cold room insulation with optimum thermal performance	Medium cost measure. Applicable for all types of new infrastructure and existing pack-houses, where feasible.
7	Wall and roof Insulation	Medium cost measure. Applicable for large upcoming (new) infrastructure with high refrigeration loads and operating hours
8	Fast roll-up doors to prevent hot/moist air infiltration.	High cost measure. Applicable for large facilities operating in the peak-summer season.

EEMS - EQUIPMENT AND SYSTEM DESIGN

Energy efficiency interventions at equipment and system design are generally applicable for both existing and upcoming infrastructure for various types of produce and include interventions focussing on – low energy cooling systems, efficient equipment and refrigerants, adequate metering and monitoring and controls and automation. The prioritized list of EEMs under the infrastructure equipment and system design are compiled below.

S. No.	Energy Efficiency Measure	Prioritization remarks
1	Sub-metering individual energy loads, including pre-cooling, staging cold rooms, process machinery, etc.	Low cost measure. Applicable for all types of upcoming (new) pack-house. Also applicable for existing infrastructure having dedicated electrical feeders for different end-use categories
2	Low energy evaporative cooling system for temperature control in the packing hall	Low cost measure. Applicable for all types of existing and upcoming (new) infrastructure elocated in the hot & dry and composite climatic zones of India
3	Electronic expansion and subcooling	Low cost measure. Applicable for all types of existing and upcoming (new infrastructure
4	Energy Management Systems (with control and automation) to effectively manage refrigeration plant and indoor environmental parameters	Medium cost measure. Applicable for all types of existing and upcoming (new) infrastructure
5	Selection of energy efficient equipment - Semi-hermetic reciprocating or scroll compressors in a rack system	Medium cost measure. Applicable for all types of upcoming (new) infrastructure
6	Selection of energy efficient equipment - Water-cooled / evaporative condenser	Medium cost measure. Applicable for all types of upcoming (new) infrastructure contingent upon the availability of water.
7	Refrigerant selection meeting environmental and thermal performance requirements	High cost measure, sometimes, due to safety measures needed if the refrigerant is flammable or toxic, with respect to energy savings and safety but recommended for better environmental performance

EEMS - OPERATION AND MAINTENANCE PROCESSES

Energy efficiency interventions at operation and maintenance level are applicable for existing infrastructure for various types of produce and include interventions focussing on training and capacity, operational manuals with EE in perspective.

PERIODIC MAINTENANCE SCHEDULE

In order to ensure energy efficient operation of all energy systems, it is proposed first to develop a rigorous periodic maintenance schedule. The PMS should cover equipment/system-wise check-points, frequency, and maintenance procedures including

- Daily checks on refrigeration plant operating parameters, compressor motor current consumption, oil level, refrigerant level, pre-cooling and cold room temperature & RH, air inlet and outlet, temperature of the coil
- Monthly inspection checks covering operation of expansion valves, filters, cleanliness of the condenser, water quality, oil quality, defrost lines, vibration and noise levels, door gasket condition, integrity of insulation etc.
- Periodic inspection of product process flow adopted in the packing hall, water drainage, door opening in receiving and delivery areas.
- The proposed PMS needs to be enforced through appropriate government guidelines and regulations.

TRAINING OF INFRASTRUCTURE OPERATORS AND TECHNICIANS

Training program for refrigeration plant operation: In order to plug the need for skilled infrastructure operators and technicians, a training program should be developed focused on infrastructure operation including refrigeration plant for pre-cooling and staging cold room.

APPROACH TO DEVELOP AN ENERGY EFFICIENT INFRASTRUCTURE

The energy efficiency should be addressed at multiple levels while designing a new infrastructure and/or operating an existing one. To ensure integration of energy efficiency aspects during the design and operation of a pack-house, a series of steps is proposed as outlined below.

Step 1- Design of the building. The design of the building, including orientation, natural lighting, shading of wall and roof should be considered at the design and planning stage. These no-cost considerations reduce the cooling load and enhance the thermal and visual comfort for the infrastructure operators and workers, thereby enhancing their productivity.

Step 2- Choice of building materials. The building materials used for roofing and walling should be selected to minimize the solar heat gains. At present, Energy Conservation Building Code (ECBC) developed by the BEE specifies the thermal performance of the wall and roof, and the same can be referred for building materials to be selected for the construction of pack-house. Apart from the external building envelope, the walls, ceiling and flooring of all temperature-controlled areas such as pre-cooling and staging cold rooms should be selected with appropriate insulation levels to minimize heat ingress.

Step 3- Infrastructure facility layout. The layout of the infrastructure facility should focus on optimizing the flow of produce and people within the infrastructure to reduce the temperature variation and energy requirement.

Step 4- Infrastructure process design. Good practices for the infrastructure process design for functions such as cleaning, sorting and grading, fruit-specific treatment, packaging, palletization, etc., from the point of view of fruit care should be aligned with energy efficiency considerations as well.

Step 5- Refrigeration system design and equipment selection. The refrigeration systems for pre-cooling and staging cold room applications should be designed and selected to maintain the right environmental parameters for given produce and keep energy efficiency considerations. Apart from energy efficiency (EE), the selection of refrigerants (low Global Warming Potential where possible) should be made to avoid/minimize the environmental consequences resulting from any inadvertent leakage of the refrigerants. Wherever possible, low energy cooling solutions such as evaporative cooling should be deployed, especially in the packing hall area.

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