Inviting Comments on "Technical Standards and Protocols for the Frozen food Processing Industry in India"

A Technical Standard Committee (TSC) has been constituted by Ministry of Food Processing Industries, Govt. of India, to develop technical standards and protocols for cold chain for sub-zero temperature as the same may be required for storing and IQF of perishables like fruits and vegetables, dairy products, meat products, sea food etc. and other food products.

Public notice has been given to invite comments on **"Technical Standards and Protocols for the Frozen food Processing Industry in India"** which must reach MD, NHB within 20 days of Publication of this notice. Comments should be sent by registered post/ speed post super scribing on the envelop comments. Advance copy of comments may preferably be sent by email to **directornhb@yahoo.com** and **jsjpm-fpi@nic.in**

CONTENTS

Part- I - Technical Standard No - NHB – QUICK FREEZING SYSTEMS

1. BASICS OF FOOD FREEZING

FREEZING is one of the oldest and most widely used methods of food preservation, which allows preservation of taste, texture, and nutritional value in foods better than any other method. The freezing process is a combination of the beneficial effects of low temperatures at which microorganisms cannot grow, chemical reactions are reduced, and cellular metabolic reactions are delayed.

Freezing of foods is one of the most prominent technology followed in the Cold Chain, for preservation of foods for longer periods.

A large number of foods which can be processed and frozen and stored at sub zero temperature. For distribution to the market and consumers Food Freezing and Storage is practised in various food sectors e.g.

a) Processed Fruits and Vegetables
b) Milk Products
c) Meat Products
d) Marine and Sweet water fish
e) Poultry Products
f) Ready to eat products

The processing methods followed in each of the products lives are different. However, the freezing and storage methods are adaptable to most of the products.

Specific weights of Unfrozen Foods approx.

Fish Fillets – 1000 kg/m³

Boneless meat – 1000 kg/m³

Fruits and Vegetables – 700 kg/m³

Ice cream – 550 kg/m³

Increase in volume of produce during freezing is about 6%

<u>Processing of various foods before freezing</u>

Different foods need different types of processes before they are frozen

- Items like green peas & corn have to be blanched & then cooled before freezing.
- Pulps like mango, tomato puree have to be pasteurised before packing & freezing

- Meat, carcasses have to be chilled to about 4 deg C before deboning & making of portions. The process halls have to be maintained at 12 to 15 deg C.
- Fish products are chilled before processing & freezing.

The applicable processing technology has to be adopted as per the local FDA rules.

The process of freezing is explained in figure 1

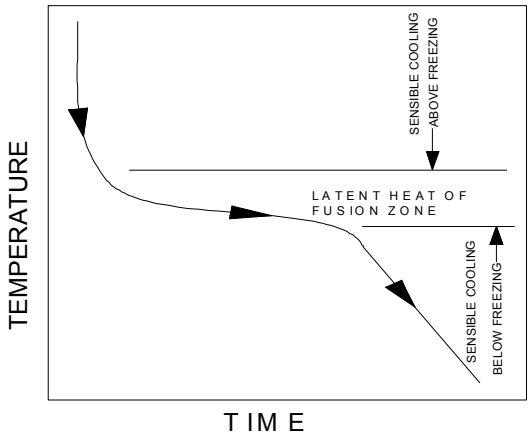


Figure shows the three phases of freezing:

1) Cooling which removes sensible heat, reducing the temperature of the product to the freezing point.

2) Removal of the product's latent heat of fusion, changing the water to ice crystals

3) Continued cooling below the freezing point which removes more sensible heat reducing the temperature of the product to the desired or optimum frozen storage temperature.

It is essential to understand the following factors that govern the ultimate keeping quality and storage life of the produce:

a) Composition of the product and its nature
b) Selection, handling and preparation for freezing
c) Freezing methods
d) Storage conditions post freezing

ADVANTAGES OF QUICK FREEZING OVER SLOW FREEZING

a) Ice crystal formation is much smaller in Quick Frozen products and mouth feel is far better.
b) Quick Freezing takes much less time and hence salt diffusion from the product is far lesser and separation of water from the tissue is minimal.
c) Product is quickly cooled below the TDZ (Temp. danger Zone) so that there is minimal chance of bacteria, yeast growth.

2. SELECTION OF FREEZING METHODS

The following factors should be considered in the selection of freezing methods and systems for specific products:

1) Special handling requirements
2) Capacity
3) Freezing times
4) Quality consideration
5) Yield
6) Appearance
7) First cost
8) Operating costs
9) Automation
10) Space availability
11) Upstream / downstream processes.

3. THE NEED FOR FREEZING AND FROZEN STORAGE

Freezing has been successfully employed for the long-term preservation of many foods, providing a significantly extended shelf life. The process involves lowering the product temperature generally to -18 °C or below. The physical state of food material is changed when energy is removed by cooling below freezing temperature. The extreme cold simply retards the growth of microorganisms and slows down the chemical changes that affect quality or cause food to spoil.

4. METHODS OF FREEZING

There are, mainly, two methods of freezing, generally, employed for freezing of foods and these are described as below.

1. Sharp Freezing

   This can be done using direct or indirect method of refrigeration. The time taken in freezing is longer with possibility of cellular damage in the product. This system is not popular at present.

2. Quick Freezing

In this type of freezing the foods are subjected to temperatures ranging from (-) 30 to (-) 50°C and the freezing occurs much faster, thereby, preventing the possibility of cellular damage.

The various methods of quick freezing are:

a) Direct Immersion Method:

It involves immersion of product in the low temperature brine solution. The method offers a direct contact and faster freezing but the problem of contamination may occur unless adequate precautions are taken.

b) Contact or Plate Freezing:

In this system the products are placed between metal plates which are refrigerated by the refrigerant passing through the hollow passages created in the plates. The equipment is called plate freezer which has a number of plates in horizontal placement or vertical placement. The products kept in the trays are placed between the plates which are then subjected to hydraulic pressure to ensure proper contact between the products in the plates. The freezing time, generally, varies between 60 180 minutes depending on the product thickness. Generally , the plate freezers are designed to handle product thickness from 25 mm to 80 mm. the horizontal plate freezers are, generally used for products in standard sizes and the vertical plate freezers for freezing of bulk of fish or other products. The plate freezers are available as batch type or continuous type freezers.

c) Air Blast Freezing

It is widely used to freeze a large variety of products in standard or irregular shapes. The freezing time, generally, varies from 4 hrs. to 10 hrs. depending on the thickness and the shape of the product. Blast freezers are designed as batch freezers or continuous freezers in the form of tunnels and take full advantage of the heat transfer efficiency of rapidly circulating air over the product. Air cooled by the refrigerated coils and flowing at velocities ranging from 200 to 600 m/min. is then directed over the product loaded in the racks or trolleys. This method is well accepted for a number of packed and unpacked food items.

Batch	Continuous / Process - Line
• Cold storage rooms	Straight belts (two-stage,multipass)
• Stationary blast cells	Fluidized beds
• Push – through trolleys	Fluidized belts
	Spiral belts
	Carton (carrier)

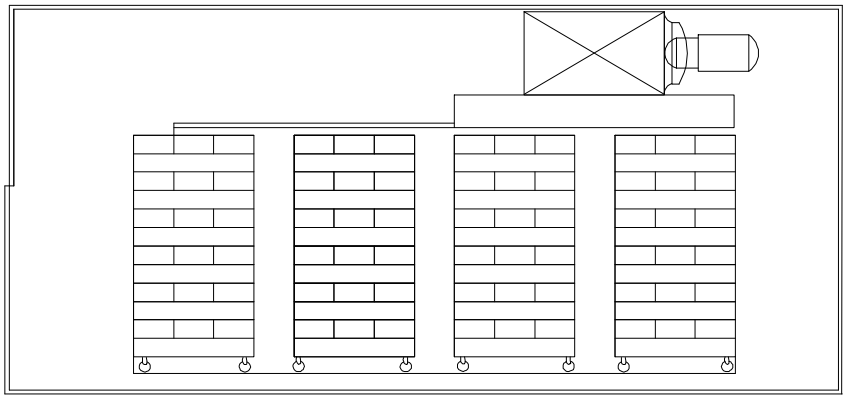
3. Cryogenic Freezing:

These systems are, normally, designed to work on liquid Nitrogen or solid Carbon-di-oxide.

5. TYPES OF FREEZERS

a) STATIONARY AIR BLAST FREEZERS

BLAST FREEZERS use air as the heat transfer medium and depend on the contact between the product and the air. A wide range of blast freezer systems are available, including

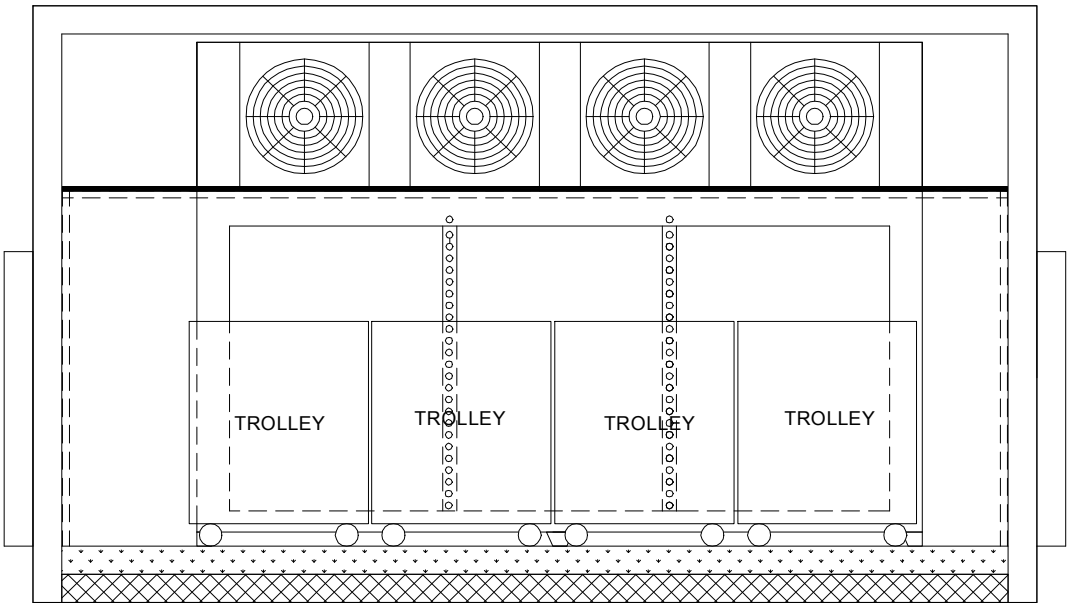


It is the simplest freezer that can be expected to produce satisfactory results for most products. It is an insulated enclosure with refrigeration coils and axial or centrifugal fans that circulate air over the products in a controlled way.

The stationary blast cell is a universal freezer, because almost all products can be frozen in a blast cell.

The flexibility of a blast cell makes it suitable for small quantities of varied products, however, labour requirement is relatively high and product movement is low.

b) BLAST FREEZERS (PUSH – PULL TROLLEY TYPE)



This system is widely used to **CRUST-FREEZE** (quick-chill) wrapped packages or raw poultry and for irregularly shaped products. This type of freezer is similar to the stationary blast cell, except that labour costs and product handling time are decreased.

IQF TYPE FREEZERS

c) STRAIGHT BELT FREEZERS

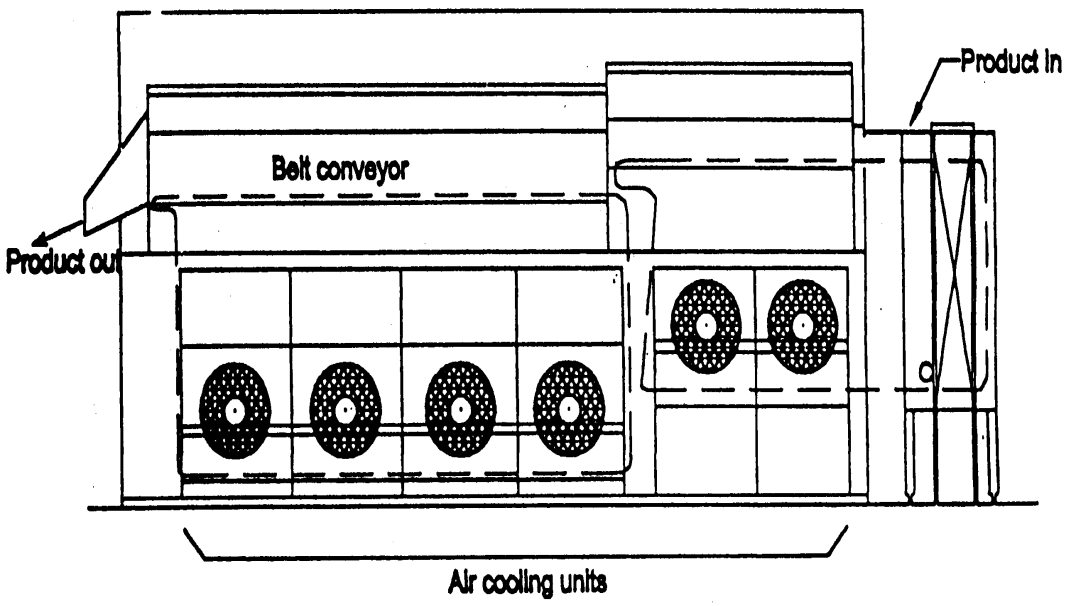
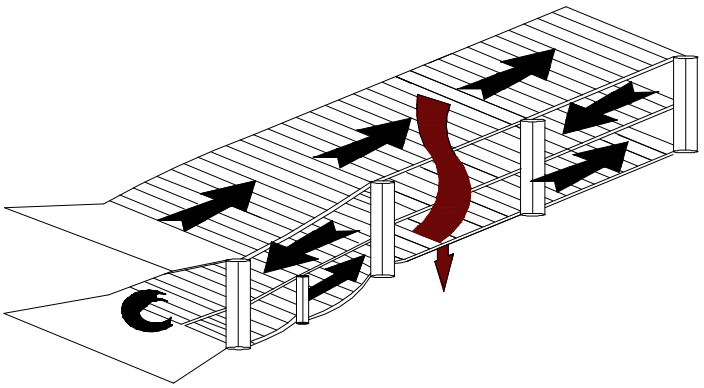


Fig. 7 :- Typical IQF unit with belt conveyor in two sections

The principal design is the **two-stage belt freezer** which consists of two mesh conveyor belts in series.

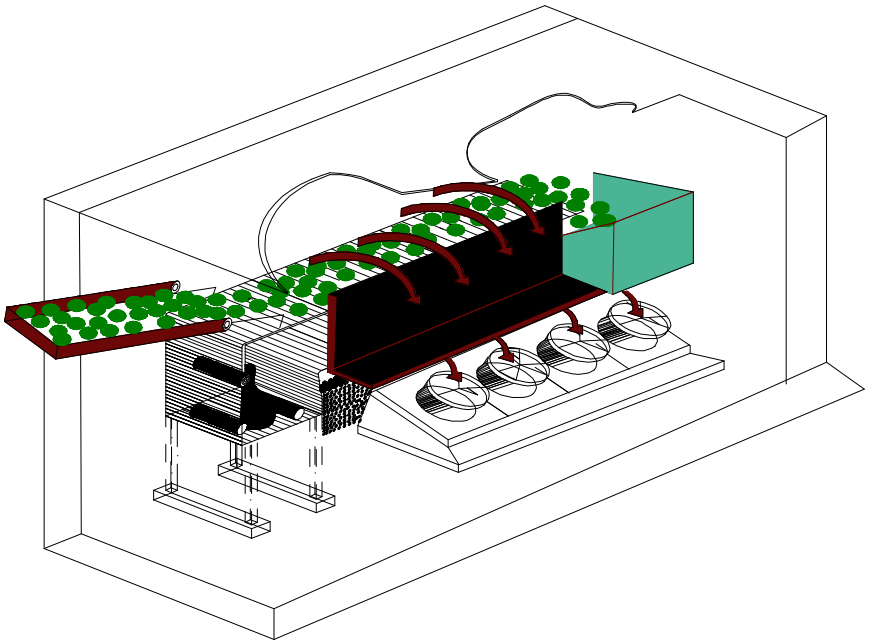
Consist of two mesh conveyor belts in series.
The first belt initially precools.
Second belt for freezing and sensible cooling to (-) 18 Deg C of below.
Two-stage freezers are generally operated at (-) 9 to (-) 4 °C refrigerant temperature in the precool section and (-) 32 to (-) 40 °C in the freezing section. Capacities range from 0.9 to 45 Mg of product per hour, with freezing times from 3 to 50 min.

d) MULTIPASS STRAIGHT BELT FREEZERS



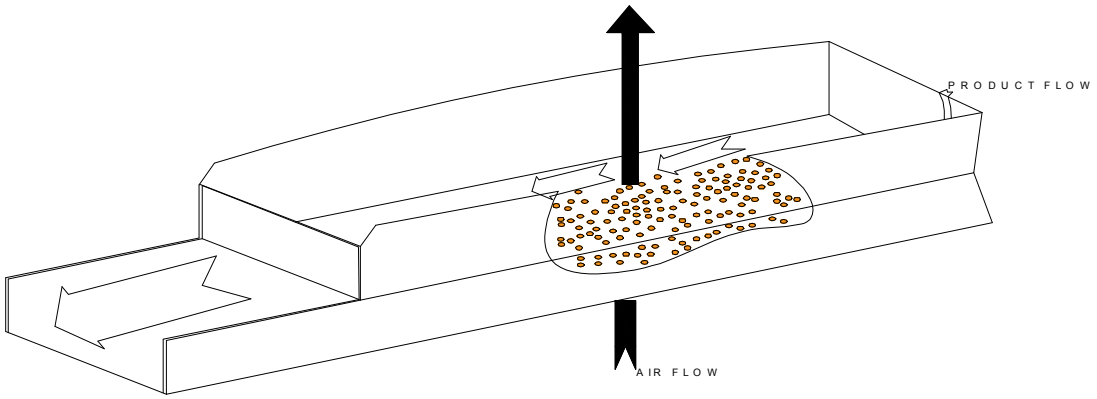
Larger products with longer freezing times (Up to 60 min)
Higher capacity requirements (0.5 to 6 ton /h),
Single straight belt freezer would require a very large floor space.
Required floor space can be reduced by stacking belts above each other to form either (1) a single-feed/single-discharge multipass system (usually infeeds and discharge) stacked one on top of the other.

e) FLUIDIZED BELT FREEZERS



This freezer uses air both as the medium of heat transfer and for transport; the product flows through the freezer on a cushion of upward-flowing cold air. The technique is limited to well de-watered products of uniform size that can be readily fluidized and transported through the freezing zone. Because the principle depends on rapid crust-freeing of the product, the operating refrigerant temperature must be
$-40^{O}C$ or lower, giving air temperatures of $-30^{O}C$ or lower. Fluidized Belt Freezers are normally manufactured as packaged, factory- assembled units with capacity ranges of 0.9 to 9 Mg/h. Particulate products generally having a freezing time 3 to 15 min.

f) FLUIDIZED BED FREEZERS

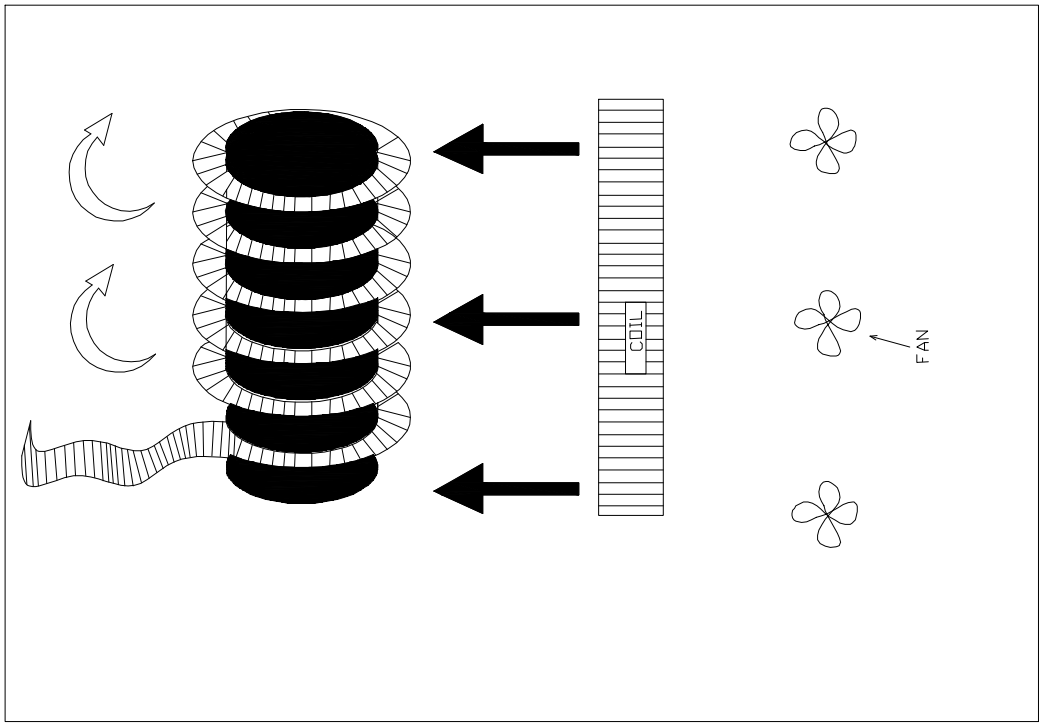


FLUIDIZED BED FREEZER

This freezer uses air both as the medium of heat transfer and for transport; the product flows through the freezer on a cushion of cold air. This design is well suited for small, uniform-sized particulate products such as peas and diced carrots.

The high degree of fluidization improves the heat transfer rate and allows good use of floor space. The technique is limited to well de-watered product of uniform size that can be readily fluidized and transported through the freezing zone. Because the principle depends on rapid crust-freezing of the product, the operating refrigerant temperature must be $-40^{O}F$ or lower. Fluidized bed freezers are normally manufactured as packaged, factory-assembled units with capacity ranges of 1 to 5 ton/h. The particulate products generally have a freezing time of 3 to 11 min.

g) SPIRAL BELT FREEZERS

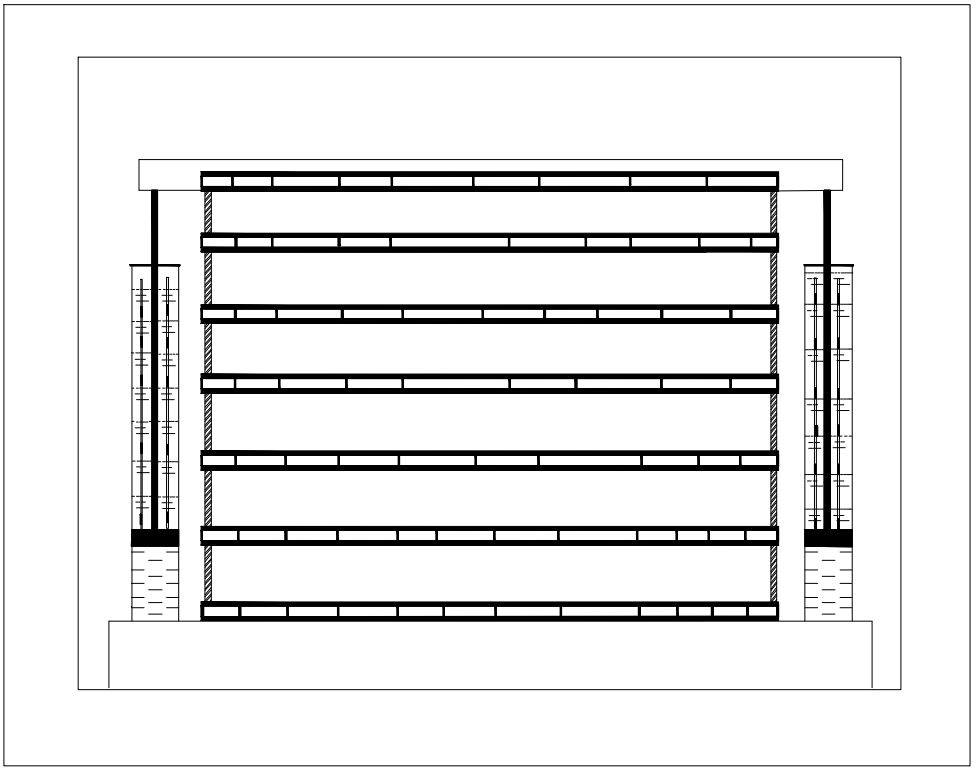


The freezer is advantageous for products with long freezing times (generally 10 min to h), and for products that require gentle handling during freezing. An endless conveyor belt that can be bent laterally is wrapped cylindrically, one tier below the last; this is a configuration that requires minimal floor space for a relatively long belt.
The number of tiers in the spiral can be varied to accommodate different capacities. In addition, two or more spiral towers can be used in series for products with long freezing times.
Spiral freezers are available in a range of belt widths and are manufactured as packaged, modular, and field-erected models to accommodate various upstream processes and capacity requirements.

Horizontal airflows applied to spiral freezers by axial fans mounted along on side. The fans blow air horizontally across the spiral conveyor with minimum baffling limited to two portion of the spiral circumference.

The rotation of the cage and belt produces a rotisserie effect, with product moving past the high-velocity cold air near the discharge, aiding in uniform freezing.

h) CONTACT PLATE FREEZERS



A **CONTACT FREEZER** primary means of heat transfer is conduction. The product or package is placed in direct contact with a refrigerated surface. Contact freezers can be categorized as follows. The most common type of contact freezer is the contact plate freezer, in which the product is pressed between metal plates.

Refrigerant is circulated inside channels in the plates, which ensures efficient heat transfer and results in short freezing times, provided that the product is a good conductor of heat, as in the case of fish fillets, chopped spinach, or meat .However, packages or cavities should be well filled, and if metal trays are used, they should not be distorted.

j) CRYOGENIC FREEZERS

Cryogenic freezers use liquid nitrogen or liquid carbon dioxide (CO_2) as the refrigeration medium, and the freezers may be batch cabinets, straight belt freezers, spiral conveyors, or liquid immersion freezers.

A. <u>GENERAL CONSTRUCTION FEATURES FOR TUNNELTYPE FREEZERS</u> :-

EQUIPMENT DESCRIPTION :-
The IQF Fluidized Belt Tunnel Freezer Should be composed of a plenum chamber that includes the belt, product guards, fan with motors, Coil section that includes water defrost header & belt washer , Dryer.
Enclosure that includes walls, floor, doors, lighting, infeed and discharge. A complete unit Highest Safety Health / Hygiene / Sanitation Standards. In strict compliance with the Standards, U.S.D.A, O.S.H.A, UL, C.S.A, CFIA, BRC.
CONVEYOR BELT OR PRODUCT TRAY
MOC -- Stainless Steel 304 or Acetal food grade material. Side guides for belt to also be in Food grade material SS 304
BELT WASHER / DRYER SYSTEM
Machine should be equipped with Belt washer in line without removing belt or tray.
The freeze with belt dryer will be advantage.
PRODUCT INLET & DISCHARGE WALL BAFFLING & CHUTE
Product inlet wall baffle and stainless steel discharge wall baffle chute is providing to keep air infiltration to minimum.
FREEZER EVAPORATOR
Industrial Quality Evaporator design with continuous plate fin with material of Aluminium, Stainless Steel only.
This should place in a position to be able to clean from all sides.
FANS & MOTOR
MOC to be Aluminium or similar non corrosive.
ALL STEEL STRUCTURE & CATWALKS, CHAMBER
MOC – To be easy to clean & Non corrosive. To be easy for inspect, clean and maintenance of freezer and monitor freezer performance.
ACCESS LADDER
ELECTRICAL CONTROL PANEL
Panel is built to NEMA IV and UL specification

INSULATED ENCLOSURE
The insulated enclosure walls and ceiling to be made of self supporting construction.
MOC - Skin of enclosure is made of SS 304 both inside & outside with good insulating material PUF /PIR.
INSULATED FLOOR SYSTEM
The floor system is build up with MOC S Steel 304 & insulated material of PUF / PIR.
ALL HARDWARE
Should be non corrosive
LUBRICATION FOR MOTOR & BEARING
All lubrication for open bearing or drive unit to be used with only food grade grease certified which is registered in Indian national chemicals inventory lists of suppliers.

B GENERAL CONSTRUCTION FEATURES FOR SPIRAL TYPE FREEZERS

Design to Highest priority for human health and environmental protection

It is designed to freeze or chill any Food product such as. Products to be evenly feed from the production line directly onto the loading freezer belt. Products can be frozen in single layers or individually for I.Q. F. (Individually Quick Freeze) quality.
Spiral Freezer to be Highest Safety Health / Hygiene / Sanitation Standards in strict compliance with the Standards, U.S.D.A, O.S.H.A, UL, C.S.A, CFIA (Canadian), BRC.

Spiral Belting
Freezers to be equipped with heavy duty spiral S Steel 304 or Food grade acetal belting.

Belt Supports and Spiral Frame, Drum, etc
The belt support rails, the spiral frames, Drum, etc to have non corrosive material only.

Drive System
The freezer drive system should be with all safety features

Evaporator Coil
MOC – Aluminium or Stainless Steel. The coil to be furnished with liquid, suction, hot gas and water connections for easy hook up.
Location to be easy to clean from All sides.

Electrical Control Panel
Standard – NEMA IV , UL
MOC -Stainless steel 304 constructed.

Enclosure Construction
MOC – Inside & Out skin to be made up of SS 304 with PUF /PIR insulation material. Self supporting construction & easy to cleaning and maintenance.

Belt Washer, Center Drum Inside & Outside Washer Manifold
The freezer can be equipped with Belt Washer, Inside Center drum & Outside It can also be connected as part of the CIP System

Hot Gas Defrost System
The freezer can be equipped with hot gas defrost (if available).

Freezer Unit base floor
MOC – S Steel 304 or non corrosive material. Completely independent & self supporting.
ALL HARDWARE
Should be non corrosive

LUBRICATION FOR MOTOR & BEARING
All lubrication for open bearing or drive unit to be used with only food grade grease certified which is registered in Indian national chemicals inventory lists of suppliers.

6. FREEZING TIME FOR DIFFERENT PRODUCTS / SIZES

Most products need Quick Freezing upto a core temperature of (-) 18 ºC.
Freezing Time – In case of larger sized products the freezing time could be much longer depending on the product size, and other related factors. Typically such cases are pulps packed in large sized drum, cattle / sheep carcasses, food packing larger than 100mm thickness etc.

Generally most products to be frozen have a thickness of not more than 100 mm. The average time required for freezing for these products is given in the following table.

METHOD	APPROXIMATE FREEZING TIMES
Plate Freezer	30 – 120 minutes
Air Blast – Batch Freezer	180 – 300 minutes or longer
Continuous Air Blast Freezer	
Belt Freezer	20 – 30 minutes
Fluidized Belt or Tray Freezer	5 – 10 minutes
Cryogenic Freezer	½ to 1 minute

FREEZING TIME

The freezing time depends on a number of variables

a) Types of Freezers
b) Evaporating Temperature
c) Types of Foods
d) Produce thickness and shape
e) Type of packing material
f) Product Incoming and Final freezing temperature
g) Condition of trays
h) Condition of plates i.e. quality of frost

Note:

Loading unloading time for products in case of batch freezer may be considered apart from freezing cycle time while estimating the daily production.

7. THERMAL INSULATION FOR FREEZER ENCLOSURES, FROZEN FOOD STORES AND COLD SPACES.

Thermal Insulation are materials or combination of materials that properly applied retard the flow of heat energy by conductive, convective and / or radiative transfer modes. These materials can be particulate, film or sheet block or monolithic, open or closed cell or composites of these materials that can be chemically bound or supported. Thermal bridge should be avoided.

FUNCTIONS OF INSULATION:

1. Conserve energy by reducing heat loss or gain through Freezer enclosures, Cold Store structures, equipment and piping.
2. Help control the temperature of a chemical process, a piece of equipment or a structure.
3. Prevent transmission of moisture / vapour from the surroundings to the Cold interiors.
4. Reduce temperature fluctuations within an enclosure when heating or cooling is not needed or available.

INSULATION MATERIALS

There are various types of insulation materials used for insulating freezer enclosures, cold stores and Frozen food stores, vessels, piping etc. These are as follows:

a) Expanded Polystyrene (EPS)
b) Fire retardant EPS
c) Polyurethane Foam (PUF) / Polyisocyanurate (PIR)
d) Extruded Polystyrene (XPS)
e) Polyethylene
f) Nitrile Rubber
g) EPDM (Ethylene Propylene Diene Monomer

Out of these a, b, c & d are used for insulated enclosures, cold stores and Frozen food stores. The current practice is to use sandwich insulated panels with PUF / PIR / EPS / XPS core insulation.

Type e, f & g are generally used for vessels and piping insulation.

DENSITY AND THERMAL CONDUCTIVITIES OF INSULATION MATERIALS

Type Of insulation	**Material**		**Relevant IS code**
	Density (min) Kg/m^3	**K (at 10 ^{0} c) w/mK**	
Expanded Polyurethane (EPS)	18	0.036	IS 4671
Rigid Polyurethane (PUF)	38	0.023	IS 12436
Extruded Polystyrene (XPS)	32	0.025	-
Phenolic foam	50	0.026	IS 13204

PIPE INSULATION

For piping insulation with PUF/PIR & EPS materials the following tables may be referred to:

Polyurathane(PUF) /Polyisocyanurate Foam (PIR) Insulation Thickness for Pipes

(38^{O}C Ambient Temperature)

Nominal pipe size, mm	Pipe Operating Temperature, ^{O}C					
	+5	-7	-20	-30	-40	-50
15	25	40	40	50	50	65
20	25	40	50	50	65	65
25	25	40	50	50	65	65
40	40	40	50	50	65	65
50	40	40	50	65	75	75
65	40	40	50	65	75	75
75	40	50	65	75	75	90
100	40	50	65	75	90	90
125	40	50	65	75	90	100
150	50	65	75	75	90	100
200	50	65	75	90	100	115
250	50	65	75	90	100	115

Ref: ASHRAE Refrigeration Handbook

RECOMMENDED OVERALL HEAT TRANSMISSION COEFFICIENTS FOR FREEZER ENCLOSURE,FROZEN FOOD STORE & OTHER COLD SPACES - AS PER IS 661 - 2000.

Operational Temp. Range (deg. C)	Max. U Value, W/sq.m.K			
	Exposed Walls	Intermediate Walls/ceilings (on either side, or double thickness for sandwich panel	Roofs	Floors

		/ similar Insulation)		
(-) 40 to (-) 30 (*)	0.13	0.4	0.11	0.17
(-) 30 to (-) 20	0.17	0.47	0.14	0.2
(-) 20 to (-) 15	0.21	0.47	0.17	0.23
(-) 15 to (-) 4	0.23	0.47	0.21	0.27
(-) 4 to 2	0.27	0.58	0.24	0.29
2 to10	0.35	0.93	0.29	0.47
10 to 16	0.47	0.93	0.28	0.64
16 & above	1.28	1.47	1.05	1.63

(*) These figures have been extrapolated.

MINIMUM INSULATION THICKNESS FOR VARIOUS INSULATION MATERIALS BASED ON RECOMMENDED U VALUES FOR (-) 30 TO (-) 40^{O}C TEMPERATURE FOR FREEZERS / STORES.

Type Of insulation	Material		Wall		Ceiling/ roof U value = 0.24 W/m^{2K}	Floor U value = 0.29 W/m^{2K}
			External U value = 0.27w/m^{2}K	Partition* U value = 0.58w/m^{2}K		
	P Density Kg/m^3	K (at 10 ^{0} c) w/mK	Thickness mm	Thickness mm	Thickness mm	Thickness mm
EPS	15	0.036	275	100	300	200
PUF	38	0.023	175	60	200	150
XPS	30-35	0.025	200	75	225	150
Phenolic foam **	50	0.026	200	75	225	150

Note : *Partition - **(on either side, or double thickness for sandwich panel / similar Insulation)**

MINIMUM INSULATION THICKNESS FOR VARIOUS INSULATION MATERIALS BASED ON RECOMMENDED U VALUES FOR (-) 20 TO (-) 30^{O}C TEMPERATURE FOR FROZEN FOOD STORES.

Type Of insulation	Material		Wall		Ceiling/ roof U value = 0.24 W/m^{2K}	Floor U value = 0.29 W/m^{2K}
			External U value = 0.27w/m^{2}K	Partition* U value = 0.58w/m^2 K		
	P Density Kg/m^3	K (at 10 ^{0} c) w/mK	Thickness mm	Thickness mm	Thickness mm	Thickness mm
EPS	15	0.036	200	100	250	175
PUF	38	0.023	150	60	175	125
XPS	30-35	0.025	150	60	175	125
Phenolic foam **	50	0.026	150	60	175	125

Note : *Partition - **(on either side, or double thickness for sandwich panel / similar Insulation)**

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15	25	40	40	50	50	65
20	25	40	50	50	65	65
25	25	40	50	50	65	65
40	40	40	50	50	65	65
50	40	40	50	65	75	75
65	40	40	50	65	75	75
75	40	50	65	75	75	90
100	40	50	65	75	90	90
125	40	50	65	75	90	100
150	50	65	75	75	90	100
200	50	65	75	90	100	115
250	50	65	75	90	100	115

Ref: ASHRAE Refrigeration Handbook

Polystyrene Foam (EPS) Insulation Thickness for Pipes

(38^{O}C Ambient Temperature)

Nominal pipe size, mm	Pipe Operating Temperature, ^{O}C					
	+5	-7	-20	-30	-40	-50
15	40	50	65	65	65	75
20	40	50	65	65	75	75
25	40	50	65	75	75	90
40	50	50	65	75	75	90
50	50	65	75	75	90	100
65	50	65	75	75	90	100
75	65	75	90	90	100	115
100	65	75	90	100	115	115
125	65	75	90	100	115	125
150	65	90	90	115	115	125
200	65	75	115	115	125	140
250	75	90	115	125	140	150

Ref : ASHRAE Refrigeration Handbook

METHOD OF APPLICATION

For Conventional Insulation

Walls & Ceiling

1. Primer Coat followed by two layers of bitumen
2. Fixing aluminium foil min. 50 microns
3. Fixing wooden pegs at suitable intervals
4. Fixing two layers of insulation with staggered joints
5. Fixing G.S sheet runners over the pegs in longitudinal & lateral directions
6. Fixing profiled & pre-coated g.s. sheets, 0.5 / 0.6 mm thick over the runners with proper finishing of joints. Alternatively FRP sheets can be used.

Floor

1. Laying of polythene sheet, min. 250 microns, as vapour barrier
2. Fixing insulation slabs in two layers with bitumen as adhesive for the first layer
3. Covering with tar felt

4. Laying PCC / tremix of 75 mm / 100 mm thickness / with Epoxy / other floor finish.

For Insulated Panel Structure

Walls & Ceiling

1. Perimeter of the plinth to be in level for panel installation
2. Panels to have cam lock or tongue / grove joints
3. Sheet metal flashing to be provided on all concrete / wall ceiling joints internally & externally. PVC coving or concrete curbing to be provided on wall - floor joints.
4. Horizontal Tie bracings to be provided between vertical wall panels & external columns, to take care of wind loads
5. Adequate numbers of Pressure relief ports to be provided on all chambers with electrical connection
6. Insulated doors shall be suitable for panel mounting

CONSTRUCTION FEATURES

Construction Features- The general convention of conventional construction is as follows:

Foundation: Superstructure and Foundation (which may be conventional Footing Type, Pile Foundation, Raft Foundation etc) to be designed by qualified & licensed structural / civil engineer. The design shall meet the BIS standards and relevant seismic zone norms for earthquake proof designs.

Cold Chamber:

Walls Minimum 230 mm Brick walls / solid concrete blocks with sand-cement plaster. However, in RCC structure or pre-fabricated structure insulated panel boards may also be provided in place of masonry walls.

Roof RCC slabs or Truss Roof with G.S / Pre-coated G.S.Sheet cover. RCC slab to have proper water proofing with reflective colour paint / China mosaic finish. Slab to have proper slope for rain water drainage.

In case of truss roof, provision to be made for fixing insulated panels on the ceiling & supporting of cooling units from the trusses (alternatively cooling units can be supported on floor mounted frame structure on top floor).

Provision for FRP sheets for natural lighting to be made in roof sheeting at certain locations. For ventilation of attic, provision of ridge monitor or turbo ventilators (which require no electric power) can be made. Alternatively roof can also be designed by installing insulated roof panels with proper slope & sealing of longitudinal & lateral joints. The work to be handled by experienced agencies to ensure a trouble free roof structure. The roof may be kept walk able for maintenance.

Floor The floor comprises of base concrete, in cold stores with suitably lower levels in cold chambers. The level difference between cold chambers and ante room to be equal to the thickness of floor insulation plus the layer of PCC or tremix finish.

Curbs

Medium to large size cold storages used for bulk storage or warehousing with a concrete floor should have a concrete or steel curb, approximately 20 cm high by 15 cm deep placed along the inside perimeter of the room.

The curb protects the insulated panels from damage by a fork lift or stored products and also maintains refrigeration efficiency by keeping the products away from the walls, thus allowing circulation for cool air all around the product.

Inter-floors The basic structure can be RCC columns & beams or steel columns & steel beams

Grating Wooden batten grating or steel grating using flats / square tubes etc. The inter-floors have to be designed for a product loading of 900 kg/m^2 min. Where AC units are located on top floor, the structure has to be suitable for the unit static & dynamic loads.

Ante Room In case of Multi-floor stores, Ante-room should preferably be designed to accommodate staircase, electrical hoist cage and have wider doors. Provision for fire escape stair & exits to be made as per local norms. The inter-floors in ante room to have doors to each cold room on each floor.

Strip curtains for cold rooms and Air Curtains for external outlets/ inlets- Strip curtains are quite common for reducing infiltration of air during loading/ unloading. Air curtains need power for operation but are more effective if properly installed.

Rodent proof civil structure and proper drainage of water to be ensured.

Rooms for machines, Electricals etc.

Dock Loading & unloading dock shall be designed with RCC slab roof or sheet roofing. However the machine roof can have RCC slab-roof to accommodate the evaporative condensers, pump sets, water tank, water softener etc. The dock area to accommodate suitably sized office & toilet for staff & labour.

Insulated Doors The freezer and frozen food store can be swing or sliding type. The doors shall have heating element on all sides. Water floor heating should be provided on the front side of the door. The heaters should have automatic temperature control and should be low voltage type. All the door hardware shall be rust and corrosion proof.

Access to a cold store must be through an insulated door designed with insulation equivalent in value to that of the wall insulation and constructed using a rigid frame or a heavy duty metal channel incorporating a thermal break between the internal and external temperatures. Door frames should be of material not only capable of supporting the door, but also constructed to ensure the integrity of the wall panels to which the frames are fitted.

Where doors are installed in a sub freezing room, heater elements must be provided on doors or door frames to prevent striking due to ice buildup.

All door hardware should be corrosion resistant and large enough to ensure the easy operation of doors.

Since doors are subject to frequent handling and abuse they must be extremely well designed, rugged and manufactured by specialist insulated door manufacturers, particularly since the variety of door designs is vast and outside the range of all insulated panel manufacturers.

All doors installed in cold store must be protected from damage by fork lift trucks moving in and out of doors at high speeds. The commonest form of protection is in the shape of a goalpost, securely bolted to three floors. All such protection barriers should be boldly painted in black and yellow stripes for easy identification.

Ancillaries Underground fresh water storage, storage for fire fighting, water supply & sanitary arrangements, compound wall / fencing, main gate, security, small canteen / electrical sub-station & D.G. set platform, roads & parking place for vehicles etc. Green landscaping with benches for labourers is desirable.

Pressure Relief Valves: Pressure Relief Valves for insulated panel structure to take care of the pressure changes either inside or outside a low temperature cold room, have to be provided on wall or roof panels. The Pressure Relief Valves have to be panel mounted type and complete with electrical heating element to eliminate frosting.

Coving

The food industry frowns when they see sharp corners, wherever walls meet or along the corners formed by ceiling and wall panels or floor and wall panels. Corners tend to collect dirt and small pieces of stored products and are difficult to keep clean and become a breeding area for bacteria when food products deteriorate.

Rounded corners or ‘covings’ made of PVC, aluminium or stainless steel can be used for the wall/ wall or ceiling panel joints.

Floor Channels

PVC channels can be used for bolting on a finished concrete floor along the perimeter of the room and used to provide a support to the wall panels installed on the floor. Different widths of such channels are available to suit varying panel thickness.

LOADING / UNLOADING DOCKS

Used for in loading of products to be stored as well as out loading the refrigerated products from and to delivery trucks. They should be as spacious as possible because of the high activity levels. They should also be well lit and temperature controlled to about 5 °C. the loading dock acts as a buffer between the temperature controlled areas and the ambient.

Loading Levellers

Since a variety of trucks will be bringing in and taking out the products, it is necessary to provide a ‘dock leveller’ that can cope with differing floor heights of trucks. As a guide, the dock leveller should be long enough to keep the slope down to the lowest vehicle no more than 10%.

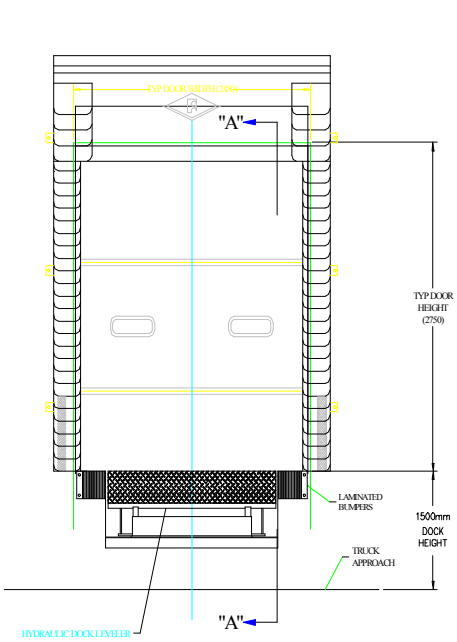
Dock levellers can be electro hydraulically operated or manual. They can have a fixed lip, a folding lip or a hydraulically operated lip. The more vehicle movements there are, the better is the case for hydraulic assistance to raise and lower the leveller.

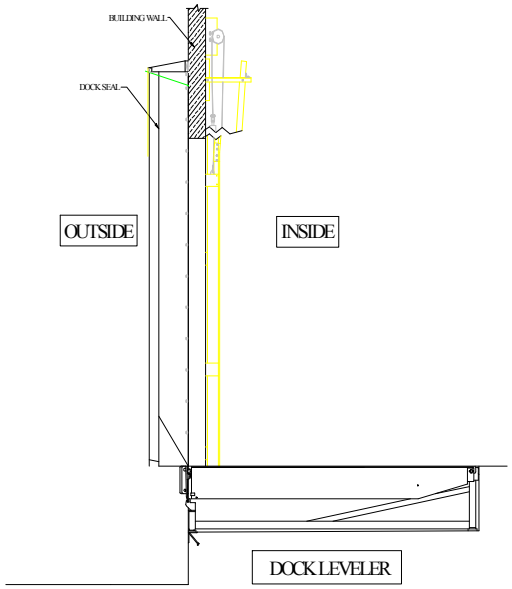
Dock Seals, Dock Shelters and Dock Doors.

To provide a good seal between the truck door opening and the loading dock, a ‘dock seal’ with a stationary foam filled header provides a tight seal at the sides and top of the truck. If the dimensions of the vehicle are known and unlikely to vary, these stationary seals provide a reasonably tight seal preventing hot humid air from the outside infiltrating into the dock area.

With varying sizes, inflatable dock seals using a built in small blower can make universal sealing of all sizes of vehicles a possibility. Since such inflatable seals can be expensive, a ‘dock shelter’ with rubber flaps on the sides and top of the shelter can provide a snug fit between varying vehicle sizes and the dock.

In order to seal off the loading dock from several truck access openings, a segmented manual or power operated overhead door should be installed at each dock seal or dock shelter, for security reasons, open able only from the inside of the dock area.





Note:

1) HYRDAULIC POWER PACK IS LOCATED INSIDE THE DOCK LEVELER PIT.

2) CONTROL PANEL IS LOCATED INSIDE THE BUILDING.

8. REFRIGERATION SYSTEM SELECTION

All the Freezing systems operate at evaporating temperature in the range of (-) 35°C to (-) 45°C.

a. COMPRESSOR SYSTEM

The system requires a two stage refrigeration plant of one of the following types:

a) Combination of Low and High Compressor
b) Compound (two stage) Compressor
c) Cascade system

Provision of standby Compressor is desirable especially, in case of larger plants. The Compressors can be Reciprocating or Screw type. The Reciprocating Compressors shall have capacity control in steps or through VFD. The Screw Compressor should preferably have step less capacity control. The energy efficiency of the Compressors is the most important factor for the selection of the Compressors.

NOTE:

For evaporating temperatures below (-) 30°C CO_2 / NH_3 cascade refrigeration system can be considered.

b. TYPES OF CONDENSERS

Condensers can be:

a) Evaporative Condenser
b) Atmospheric Condenser
c) Shell and Tube / PHE Condenser with cooling towers for water cooling.
d) Air Cooled Condensers to be used for HFC systems in case soft water is not available. Condenser Air Pre-cooling system should be incorporated along with Air cooled condensers for energy saving. Air cooled condensers work best in open areas with lots of ventilation, but can be protected from rain by providing shed.

Water needs to be soft quality and de-contaminated for which water softening / other relevant equipment has to be installed for the makeup water. The Condenser should be selected for the lowest possible Condensing temperature. Generally, a condensing max temperature of 38°C (or lower, if possible) is recommended.

Evaporative condensers offer better energy efficiency as compared to other types. Atmospheric / Evaporative Condensers should be kept in open areas where airflow is not restricted.

c. TYPES OF AIR COOLING UNITS

The air cooling unit used in Air Blast Freezing systems shall have finned coils and heavy duty axial flow fans. The Air Cooling units shall be either located on the floor or overhead depending on the freezer design.

Ammonia coils are typically MS hot dip galvanised or SS/ aluminium tubes with Aluminium fins. The cooling units for HFC refrigerants have coils with copper tubes and aluminium fins. Coils with Aluminium tubes and Aluminium fins can also be used. The fin spacing on these coils should be in the range of 10 mm – 25 mm. A combination of fin spacings in this range can also be used over the coil depth.

d. AIR PURGER (MANUAL OR AUTOMATIC)

It is desirable to remove air and other non condensable gases from the refrigeration circuit to keep the compressor head pressures lower and also improve heat transfer coefficients.

LIQUID FEED

The liquid feed can be

a) Direct Expansion – In case of HFC system
b) Gravity feed – In case of Ammonia system
c) Refrigerant pump recirculation (Over feed) – In case of Ammonia / HFC

The Direct Expansion system results in about 20% lower capacity of freezing.

DEFROSTING

Defrosting system can be of the following types:

a) Water Defrosting
b) Hot gas Defrosting
c) Off Cycle Defrosting ((Between shifts)
d) Electrical defrosting – can be used in HFC (Freon) based systems

e. TESTING AND COMMISSIONING THE SYSTEM

Installation, Testing & Commissioning should be carried out as per BIS standards. ASHRAE standards may be referred to as guidelines but not mandatory.

f. EQUIPMENT DERATING AT HIGHER AMBIENT

A designer should match the loads with the de-rated equipment capacity at higher ambient conditions.

GENERAL SPECIFICATIONS FOR REFRIGERATION SYSTEM

Brief Specifications for Equipment / Materials / Services

i. Refrigeration Compressors & Motors

Compressor Arrangement	A combination of low stage and high stage compressors or compound compressors. Standby compressor preferred in case of larger units. In case of HFC refrigerant two stage compressors or rack system can be used.
Type	For ammonia as refrigerant, reciprocating, multi cylinder complete with water-cooled head / jackets, with accessories like oil separators, capacity control & unloaded start. Alternatively screw compressor, open type with accessories can be provided. For HCFC / HFC, reciprocating. / scroll / screw can be provided. If Air cooled cylinder heads are to be used for low stage compressors adequate ventilation should be provided for the plant room.
Capacity at critical operating conditions	To be configured in Kw
Estimated Motor rating	To be configured in kW, RPM, type of insulation, Input AC power supply

ii. Evaporative Condenser for Ammonia / HFC:-

Coil section	Hot dip galvanised M.S. pipes / CDW Boiler quality tubes / S.S.304 tubes
Fan section	With 2 / 3 Axial Flow Fans with Cast Aluminium / S.S / GRP impellers, complete with TEFC Sq. cage motors, Class F insulation & IP-55 protection
Water sump tank	S.S.304 /M.S. Epoxy coated with necessary connections
Other provisions	Water spray arrangement, air inlet grilles, eliminators of suitable design
Unit casing	with removable G.S sheet panels & inspection windows etc.
Estimated Heat rejection capacity at 38 deg C condensing & and applicable WB temp	To be configured in KW
Suggested Standard	ARI Std 490

Air-cooled / water-cooled condenser for HFC.

Capacity	To be configured in KW
Size	To be furnished

iii.) Gas and Liquid Intercooler

Gas Intercooler and Liquid Sub-cooler	M.S. Construction with gas inlet and outlet connections, liquid sub-cooling coil and liquid injection connection to be provided.

iv. H.P. Receiver for Ammonia / HFC:-

Horizontal Receiver complete	With necessary connections, reflex type level gauge etc.
Capacity	To be configured
Material of Construction	Boiler quality steel plates
Quantity	2 Nos. (Two Nos. are suggested in case some States' regulations call for Pressure testing of high pressure vessels on a periodic basis)
Suggested Standard	ANSI / ARI 495 / BIS Code IS 2825

v. Air Cooling Units for Air Blast Freezers / Deep Freeze chambers.

a) Finned cooling coil	Coil design to be suitable for gravity feed / pump re-circulation/overfeed system for ammonia & DX operation for HFC as per design
M.O.C	Hot dip galvanised coil with M.S. pipes CDW Boiler quality tubes – ASTM A 214 with MS fins / S.S.304 tubes &Aluminium fins / Aluminium Tubes & Aluminium fins with proper bonding system with bullet drawn expansion/ equivalent expansion for Ammonia; For HFC / HCFC coils with copper tubes & aluminium fins or aluminium tubes with aluminium fins with bullet drawn or equivalent expansion may be used.

Fin spacing	In range of 10 to 25 mm in steps in the coil depth.
b) Axial Flow fans	With cast aluminium / S.S. / FRP impellers, with variable pitch, TEFC Squirrel cage motors with class 'F' insulation, IP-55 protection
c) Accumulator	Vertical / horizontal with necessary connections (in case of gravity feed units) for Ammonia
d) Unit casing	G.S. sheet duly painted, drain pan of G.S / M.S with epoxy paint
e) Defrosting arrangement	Water / Hot gas / Air
f) Electrical heat tracing	Drain pan, Drain pipe, Fan casing
Unit capacities	
Number per chamber	To be configured
Estimated capacity each at critical operating conditions	To be configured
Estimated coil surface area	To be configured
Estimated air flow capacity with adequate external static pressure	To be configured

vi. Refrigerant Piping, Fittings & Valves

Piping Interconnecting piping between compressor, condenser, receiver and cooling units	M.S. black piping conforming to IS-1239/ ASTM A Gr.106B for 40 NB & smaller sizes / ASTM A Gr.53B for 50 NB & larger sizes in case of ammonia plants. For Low temp refrigerant line below (-) 30 Deg C upto (-) 45 Deg C SA 333 Gr 1, Grade 6 to be used. For Ammonia fittings shall be of forged steel. For HFC / HCFC, hard Copper piping type L Piping as per. ANSI guidelines and pressure vessels as per BIS Code IS 2825). Reference to ASHRAE B-31.5 recommended.

vii. Water Piping, Fittings & Valves

Piping shall be used for a. Condenser water circulation b. Compressor cooling c. Defrosting d. Drain lines	Piping to be G.I class B or sizes up to 65 NB & M.S. black pipe conforming to IS-1239. Valves up to 40 NB to be Gate / Globe type. Valves 50 NB / larger to be butterfly type.

viii. Water Pump sets

Water flow capacity to take care of condenser water flow & compressor head / jacket cooling	At least 2 nos. operational during peak load and 1 no standby
Capacity	To be configured

ix. Thermal insulation for refrigerant piping etc.

Material for insulation for refrigerant suction line, accumulators etc.	a. EPS pipe section b. PUF pipe section With 0.6 mm Aluminium or 0.5 mm G.S. pre-coated sheet cladding c. Nitrile Rubber / EPDM / chemically cross linked polyethylene pipe section / other acceptable materials with woven glass cloth with UV treated pigmented epoxy Coating

x. Controls.

Temperature control	Temp Indicators cum controllers for individual freezers and chambers. Temperature scanners and a centralized temperature indication in machine room
Refrigerant flow controls	Liquid level controls, solenoid valves etc.
Defrost Controls for automatic defrosting if required	Recommended in case of continuous freezers and deep freeze chambers.
PLC control systems	For overall control of various parameters

Note. Location for installing the sensors will depend on site conditions and stacking pattern etc. Therefore Programmable Logic Controllers (PLC) is recommended for large units with the display point in the manager's cabin.

xi. Installation, Testing & Commissioning

Installation	The plant shall be installed, tested & commissioned as per IS 660 / ASHRAE. Std 15.

General Notes:

1. In case refrigerant pumping system (over feed system) is used it will incorporate the following components.
   a. Centralised L.P receiver
   b. Refrigerant pumps including standby
   c. Refrigerant flow & safety controls
   d. Interconnecting piping – both supply & return lines shall be insulated. In this case the individual accumulators for AC units & level controls etc. are not required.

ELECTRICAL INSTALLATIONS

- Power Factor – not less than 0.95
- Transformer of minimum required capacity

Substation with adequate rating

Substation with a rating adequate capacity	a. Step down transformer suitable for incoming H.T. voltage / 433 V as per IS-2026 / other applicable standards b. Two pole / four pole structure as per local requirements c. Outdoor type metering cubicle with approved meter, CTs / PTs etc. d. Earthling station as per requirement e. Switchyard fencing with gates as per Electrical Board requirements

D.G. Set for standby power

D.G. set complete with accessories and with weather-proof and noise-proof canopy as per local pollution control norms	Estimated Rating: as per design. One big for pull down period and one small for holding period may be used. The use of Diesel engines on compressors is left to the promoter to assess but keeping in view overall CoP of the plant.

Main power distribution panel

Main power distribution panel with changeover facility for normal electric supply & D.G. set supply. With ongoing feeders for various electrical panels.

Electric panels

Electric panels for	a. Refrigeration b. Lighting, Electric hoist, Fans c. APFC (automatic power factor correction) panel d. Water supply, fire fighting etc.

Power & Control cabling etc

Power and Control cabling, earthing etc for various electrical circuits	Aluminium armoured conductors for main power lines & equipment lines & copper conductors for lighting, control wiring etc.

vi. Lighting

Lighting in a. Freezers, Process Halls, Packing Room, ante room, Dock and outside areas. b. Other areas c. Outside areas	For freezer & frozen food stores – S.V. Lamps / LED Lamps. For medium temp cold stores – CFL/LED with vapour proof fittings. For process / other areas – T – 5 type TL / CFL / LED Lamps.

SAFETY MEASURES

Provision for handling accidental leakage of ammonia	Ammonia sensors at proper places and Machine room near ACUs & machine room Emergency ventilation for machine room Safety release of refrigerant to water sump Ammonia masks First aid kit Instructions for handling emergencies. Resettable dual safety valves for all pressure vessels. Provision for Face Washing Quick oil drain valve on receivers

	and other equipment.
Fire protection	Fire sensors in suitable places and machine rooms & machine room. Dry & water based fire fighting systems as per specs below. Sprinklers for high pressure and low pressure receivers.
Emergency lighting system	May be solar PV cells with batteries & controller
Emergency alarm system	To be provided with switches near all cold store doors and alarms located in common public areas
Lightning arrestors for the building as per local regulations	

Fire Fighting

a) Dry Type

Fire fighting equipment necessary for extinguishing liquid, solid and electrical fire :	i) Dry chemical powder type 5.0 Kg Cap with ISI Mark Fire Extinguisher complete with wall mounting bracket. ii) Carbon Di-Oxide (CO_2) type 4.5 Kg. capacity Fire Extinguisher complete with wall mounting bracket. iii') G.I. Fire Buckets iv) M.S. Stand for Fire Buckets

b) Water based (mandatory if local code so prescribes)

System shall comprise of	i) 2 sets of Water supply pumps. ii) 2 sets Fire fighting pumps iii) G.I. piping, class C with necessary fittings & valves iv) Rubber Hose reel v) Canvas Hose pipe vi) M.S. Fabricated hose box with key vii) any other requirements as per local fire officer.

Coefficient of Performance (COP) – For optimum energy efficiency the plant should be selected with best possible COP.

Operation & Maintenance- Plant design must be accompanied by Operation & Maintenance Manual for plant operator which should cover following points in English as well as Hindi languages-

- No. of operating hours
- Training of operators
- Monitoring & control – temperature, humidity, CO_2
- Door seals – checking methods
- Maintenance of equipment / cold store
- Hygiene issues

Variation / amendment Clause-

The standards prescribed above are not intended to prevent or discourage variations arising out of new concepts, innovations and R & D in building design & construction, thermal insulation and cooling & refrigeration technology etc. However, any variations or deviations from the above prescribed standards must be supported by scientific / technical details for prior approval of the competent authority, on the basis of merit who may decide the proposal in view of relevant technical details including critical storage requirements, energy efficiency (coefficient of performance), availability of *Standards*, environmental concerns, safety etc. Similarly, periodic amendment of standards for general application may also be undertaken by the National Horticulture Board; in consultation with a committee of subject matter experts duly constituted for this purpose.

9. REFRIGERATION SYSTEMS – LOAD CALCULATIONS

Total Refrigeration Load - Heat Load Calculation

- **Procedure for load calculation**
  Procedures laid out by ASHRAE Fundamentals and Refrigeration handbooks may be followed.ASHRAE refrigeration handbook elaborates a more traditional approach. Thus, based on the overall impact/ sensitivity of important parameters, some estimates can be made. Designers also tend to take a safety factor of 5-10% on the estimated loads.

- **Ambient conditions**
  0.4% annual design conditions of that location as per ASHRAE/ ISHRAE data may be used for holding period. For the loading and pull down periods, 0.4% design conditions for those months may be taken.

- **The Refrigeration load for freezing shall include**
  a) The Transmission gains through the freezer enclosure
  b) The fan motor load, in case of Blast and IQF type freezers
  c) Loads due to mechanical conveyors
  d) Product cooling and freezing load
  e) Any other load if applicable

- **Product Incoming temperature**
  It depends on the process followed and the Chilling / Precooling method. Generally the product temperatures entering the freezer may be in the range of 10- 20 Deg C.

- **Final Product Temperature**
  Unless otherwise specified the final core temperature of the product after freezing can be considered as (-) 18 Deg C. However in some cases the processors specify lower temperatures of (-) 23 to (-) 25 Deg C

- **Product Load**

  The product load during the freezing process shall comprise of

  a) The load during cooling of product upto freezing temperature
  b) The latent heat of fusion
  c) The sub-cooling of product from freezing temperature to the final temperature of the frozen product.

Heat Load Calculation of Cooling System – Summary

Heat Load Calculations – Summary for Freezer	
Ambient	
Freezing suction Room Temp ^{O}C	
Incoming Product Temp	
Final Product Temp (Core)	
Product load per batch or per hour	
Processing Hall Conditions – DB temp °C ± RH % ±	
Transmission Load KW	
Product load including	
a) Initial cooling	
b) Freezing	
c) Sub cooling to final stage Temp.	
Load due to Belt conveyor / other	
Mechanism in freezer	
Fan motor load in case of Air Blast Freezer (kW)	
Total load	
Safety factor	
Total Refrigeration Load (kW)	

NOTE 1: Separate sheets be submitted for different freezers.

NOTE 2: A good order of magnitude estimate of total Refrigeration load for IQF is 155 kW of Refrigeration / MT of product / hour. In case of small freezers the capacity may be 10 – 15 % higher.

Packaging Materials of Frozen Foods

Packaging materials of frozen foods impose special requirements. Selection of these materials should include consideration of their intended product use and storage period. These materials should resist water vapour permeability from condensation occurring as a result of frozen food surfaces being affected by colder surfaces in freezers and storage rooms. These packaging materials should be strong, have a degree of flexibility, or should not be completely filled. Materials also should protect against light and air penetration. Vacuum packaging or gas flushing will when chosen, act to retard deterioration of certain products.

Food Safety Systems

Food safety and quality in agricultural food products is maintained throughout the food continuum, including primary producers, processors and other partners such as transporters, distributors, retailers including restaurants and even manufacturers of packaging materials and ice.

It was designed to encourage the establishment and maintenance of Hazard Analysis Critical Control Point (HACCP) based systems in registered agricultural food processing establishments.

The food industry sector already has developed generic models for many commodities including one specific to cold storage / freezer facilities (meat, nonmeat, food, nonfood). This model is based on HACCP, using this approach to fully control hazards (biological, chemical and physical) with prerequisite programs, and when necessary, Critical Control Points (CCP).

An industry / government standard of (-) 18 °C (0°F) or colder has been adopted. Stored and transported product ideally should be at (-) 18 °C (0°F) or colder.

Temperature control is not the only factor that influences the safety of foods throughout its journey along the continuum. Each sector, from manufacturer, warehouse, distributor, transporter to retailer, is charged with the responsibility of adhering to and using proper handling techniques. These are comprised of codes of practice, good manufacturing practices, codes of hygiene, and acceptable industry practices where no legislation exists.

SECTION 2

Typical Design Parameters & Layout for food freezing & Storage Plant

1) Plant Location
2) Outside dry-bulb temp
3) Outside wet-bulb temp
4) Power supply
5) Control Power supply
6) Product receiving system – covered / container
7) Product temperature at the time of loading
8) Storage system
9) Type of products
10) Size of product, mm & Weight, kg
11) Type of processing before freezing
12) Types of Freezers
13) Estimated time of freezing per batch for batch freezers
14) Estimated freezing capacity per hour for continuous freezers
15) Product temperature before freezing
16) Final temperature after freezing
17) Type of size of packages for storage
18) No of frozen food storage Deep Freeze
19) Chamber sizes & their capacities
20) Loading Rate % of storage capacity
21) Design storage temperature with tolerance
22) Process Hall
23) Design Conditions
    a. DB Temperature
    b. RH
24) Packing Hall
    a. DB Temperature
    b. RH
25) Ante Room
26) Dock
27) Compressor running hours during peak season hours per day
28) Compressor running hour during holding hours per day

OTHER CONSIDERATIONS

- Heat load in case of batch freezers shall be done on the basis of batch duration. The heat load in case of continuous freezers shall be done on per hour basis.
- The air velocity in the air blast freezers shall be in the range of 5m/s to 10 per m/s.
- The freezing load in case of most products would be in the range of 110 to 116 w/kg of product. However proper load calculation should be done for each type of product & freezing system.

TYPICAL DESIGN PARAMETERS AND LAYOUT OF FOOD FREEZING AND STORAGE PLANT

Part-II- Technical Standard No- NHB- Frozen Food Storage & Systems Integrated to Reefer Transport

SECTION 1

1. THE NEED FOR FREEZING AND FROZEN STORAGE

Freezing has been successfully employed for the long-term preservation of many foods, providing a significantly extended shelf life. The process involves lowering the product temperature generally to -18 °C or below. The physical state of food material is changed when energy is removed by cooling below freezing temperature. The extreme cold simply retards the growth of microorganisms and slows down the chemical changes that affect quality or cause food to spoil.

2. FROZEN FOOD STORES

There are number of commodities which have to be processed and frozen for preserving them for long periods of time. These include Green Peas, Corn, Okra (Ladies Fingers), mixed vegetables, Mango Pulp & Slices, Pineapple Slices, Tomato Puree etc. Other items are ice cream, butter, fish and meat products. The frozen food stores are generally designed for a temperature (-) 20 ☜C to ± 2 ☜C for most foods but for items like ice cream lower temperature in the range of (-) 25 ☜C to (-) 30 ☜C are specified.

The frozen food stores are, normally, a part of the food processing and freezing complex. However they could be set up as a part of multipurpose cold store or as independent units to offer facilities for storage of products, already frozen at the food freezing plants.

3. STORAGE TEMPERATURE CHART

PRODUCT	STORAGE TEMP; ^{0}C	RELATIVE HUMIDITY,%	APPROXIMATE STORAGE LIFE[A]
Frozen Fish	(-)30 to (-)20	90 to 95	6 to 12 month
Beef, Frozen	(-)20	90 to 95	6 to 12 month
Pork Frozen	(-)20	90 to 95	4 to 8 month
Poultry, frozen	(-)20	90 to 95	12 month
Butter frozen	(-)23	70 to 85	12 to 20 month
Ice cream, 10% fat	(-)30 to (-)25	90 to 95	3 to 23 month

Lamb Frozen	(-)20	90 to 95	8 to 12 month
Ham Frozen	(-)20	90 to 95	6 to 8 month
Frozen Fruit & Veg. Products	(-)18 to (-)20	-	6 to 9 month
Ready to eat foods	(-)18 to (-)20	-	6 to 9 month

4. THERMAL INSULATION

Thermal Insulation are materials or combination of materials that properly applied retard the flow of heat energy by conductive, convective and / or radioactive transfer modes. These materials can be particulate, film or sheet block or monolithic, open or closed cell or composites of these materials that can be chemically bound or supported.

FUNCTIONS OF INSULATION:

1. Conserve energy by reducing heat loss or gain through Freezer enclosures, Cold Store structures, equipment and piping.
2. Help control the temperature of a chemical process, a piece of equipment or a structure.
3. Prevent transmission of moisture / vapour from the surroundings to the Cold interiors.
4. Reduce temperature fluctuations within an enclosure when heating or cooling is not needed or available.

INSULATION MATERIALS

There are various types of insulation materials used for insulating freezer enclosures, cold stores and deep freezers, vessels, piping etc. These are as follows:

a) Expanded Polystyrene (EPS)
b) Fire retardant EPS
c) Polyurethane Foam (PUF) / Polyisocyanurate (PIR)
d) Extruded Polystyrene (XPS)
e) Polyethylene
f) Nitrile Rubber
g) EPDM (Ethylene Propylene Diene Monomer

Out of these a, b, c & d are used for insulated enclosures, cold stores and deep freezers. The current practice is to use sandwich insulated panels with PUF / PIR / EPS / XPS core insulation.

DENSITY AND THERMAL CONDUCTIVITIES OF INSULATION MATERIALS

Type Of insulation	Material		Relevant IS code
	Density (min) Kg/m^3	K (at 10^0 c) w/mK	
Expanded Polyurethane (EPS)	18	0.036	IS 4671
Rigid Polyurethane (PUF)	38	0.023	IS 12436
Extruded Polystyrene (XPS)	32	0.025	-
Phenolic foam	50	0.026	IS 13204

RECOMMENDED OVERALL HEAT TRANSMISSION COEFFICIENTS FOR FREEZER ENCLOSURE,FROZEN FOOD STORE & OTHER COLD SPACES - AS PER IS 661 - 2000.

Operational Temp. Range (deg. C)	Max. U Value, W/sq.m.K			
	Exposed Walls	Intermediate Walls/ceilings (on either side, or double thickness for sandwich panel / similar Insulation)	Roofs	Floors
(-) 40 to (-) 30 (*)	0.13	0.4	0.11	0.17
(-) 30 to (-) 20	0.17	0.47	0.14	0.2

(-) 20 to (-) 15	0.21	0.47	0.17	0.23
(-) 15 to (-) 4	0.23	0.47	0.21	0.27
(-) 4 to 2	0.27	0.58	0.24	0.29
2 to10	0.35	0.93	0.29	0.47
10 to 16	0.47	0.93	0.28	0.64
16 & above	1.28	1.47	1.05	1.63

(*) These figures have been extrapolated.

MINIMUM INSULATION THICKNESS FOR VARIOUS INSULATION MATERIALS BASED ON RECOMMENDED U VALUES FOR (-) 30 TO (-) 40^{O}C TEMPERATURE FOR FREEZERS / STORES.

Type Of insulation	**Material**		**Wall**		**Ceiling/ roof U value = 0.24 W/m^{2K}**	**Floor U value = 0.29 W/m^{2K}**
			External U value = 0.27w/m^{2}K	**Partition U value = 0.58w/m^2 K**		
	P Density Kg/m^3	**K (at 10 ^{0} c) w/mK**	**Thickness mm**	**Thickness mm**	**Thickness mm**	**Thickness mm**
EPS	15	0.036	275	100	300	200
PUF	38	0.023	175	60	200	150
XPS	30-35	0.025	200	75	225	150
Phenolic foam **	50	0.026	200	75	225	150

MINIMUM INSULATION THICKNESS FOR VARIOUS INSULATION MATERIALS BASED ON RECOMMENDED U VALUES FOR (-) 20 TO (-) 30^{O}C TEMPERATURE FOR FROZEN FOOD STORES.

Type Of insulation	Material		Wall		Ceiling/ roof U value = 0.24 W/m^{2K}	Floor U value = 0.29 W/m^{2K}
			External U value = 0.27w/m^{2}K	Partition U value = 0.58w/m^2 K		
	P Density Kg/m^3	K (at 10 ^{0} c) w/mK	Thickness mm	Thickness mm	Thickness mm	Thickness mm
EPS	15	0.036	200	100	250	175
PUF	38	0.023	150	60	175	125
XPS	30-35	0.025	150	60	175	125
Phenolic foam **	50	0.026	150	60	175	125

PIPE INSULATION

For piping insulation with PUF/PIR & EPS materials the following tables may be referred to:

Polyurathane(PUF) /Polyisocyanurate Foam (PIR) Insulation Thickness for Pipes

(38^{O}C Ambient Temperature)

Nominal pipe size, mm	Pipe Operating Temperature, ^{O}C					
	+5	-7	-20	-30	-40	-50
15	25	40	40	50	50	65

20	25	40	50	50	65	65
25	25	40	50	50	65	65
40	40	40	50	50	65	65
50	40	40	50	65	75	75
65	40	40	50	65	75	75
75	40	50	65	75	75	90
100	40	50	65	75	90	90
125	40	50	65	75	90	100
150	50	65	75	75	90	100
200	50	65	75	90	100	115
250	50	65	75	90	100	115

Ref : ASHRAE Refrigeration Handbook

Polystyrene Foam (EPS) Insulation Thickness for Pipes

(38^{O}C Ambient Temperature)

Nominal pipe size, mm	**Pipe Operating Temperature, ^{O}C**					
	+5	**-7**	**-20**	**-30**	**-40**	**-50**
15	40	50	65	65	65	75
20	40	50	65	65	75	75
25	40	50	65	75	75	90
40	50	50	65	75	75	90
50	50	65	75	75	90	100
65	50	65	75	75	90	100
75	65	75	90	90	100	115
100	65	75	90	100	115	115
125	65	75	90	100	115	125
150	65	90	90	115	115	125
200	65	75	115	115	125	140
250	75	90	115	125	140	150

Ref : ASHRAE Refrigeration sHandbook

METHOD OF APPLICATION

For Conventional Insulation

Walls & Ceiling

1. Primer Coat followed by two layers of bitumen
2. Fixing aluminium foil min. 50 microns
3. Fixing wooden pegs at suitable intervals
4. Fixing two layers of insulation with staggered joints
5. Fixing G.S sheet runners over the pegs in longitudinal & lateral directions
6. Fixing profiled & pre-coated G.S. sheets, 0.5 / 0.6 mm thick over the runners with proper finishing of joints. Alternatively FRP sheets can be used.

Floor

1. Laying of polythene sheet, min. 250 microns, as vapour barrier
2. Fixing insulation slabs in two layers with bitumen as adhesive for the first layer
3. Covering with tar felt
4. Laying PCC / tremix of 75 mm / 100 mm thickness / with Epoxy / other floor finish.

For Insulated Panel Structure

Walls & Ceiling

1. Perimeter of the plinth to be in level for panel installation
2. Panels to have cam lock or tongue / grove joints
3. Sheet metal flashing to be provided on all concrete / wall ceiling joints internally & externally. PVC coving or concrete curbing to be provided on wall - floor joints.
4. Horizontal Tie bracings to be provided between vertical wall panels & external columns, to take care of wind loads
5. Adequate numbers of Pressure relief ports to be provided on all chambers with electrical connection
6. Insulated doors shall be suitable for panel mounting

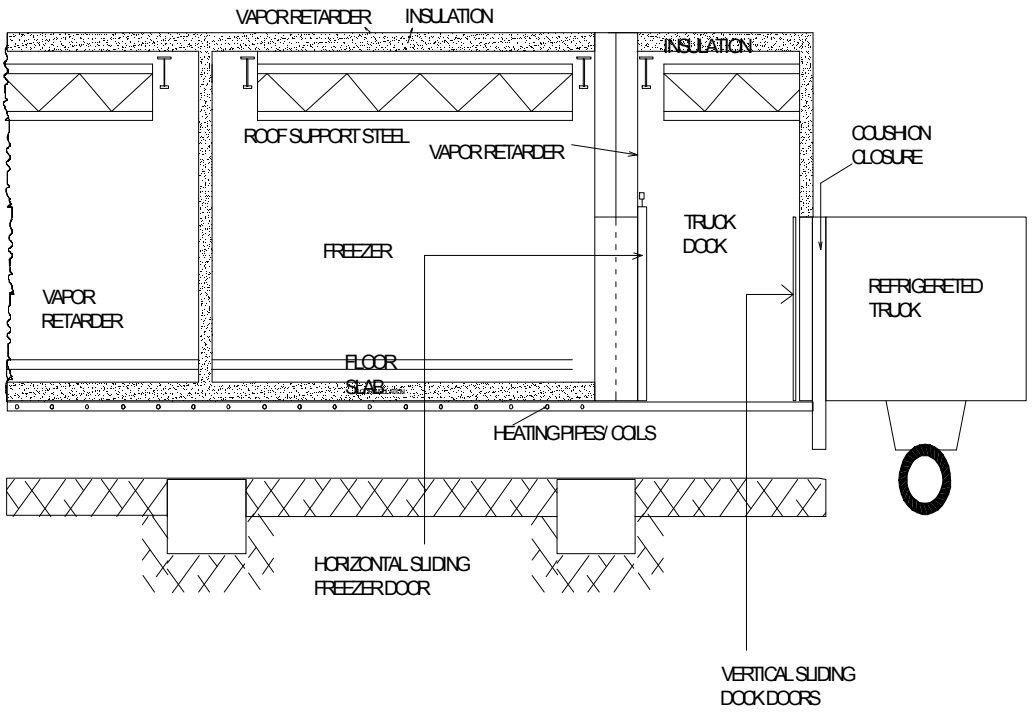
UNDER FLOOR HEATING

Considering the possibility of freezing of subsoil water under the floor (phenomenon called frost hieve), it is necessary to provide under floor heating in one of the following ways.

a) Providing Air vent pipes in warmer climate zones.
b) Providing piping network for circulation of heated glycol.
c) Providing electrical heat tracing with temperature control.

NOTE: Vent pipes should have ends provided with cleanable mesh covers. Pipes should be laid with proper slope for draining condensate, which may be formed in the pipes.

TYPICAL VIEW OF UNDER FLOOR VENT PIPES



STACKING ARRANGEMENT

Frozen Food stores can be constructed for different product loading practices. e.g.

1) Multi floor stores for manual loading / unloading.
2) Single floor stores with racks for palletized loading / unloading both stationary and mobile rack can be done with fork lift trucks.
3) Single floor structure with racks for Semi – manual operation with reach in type order pickers.

CONSTRUCTION FEATURES

Construction Features- The general convention of conventional construction is as follows:

Foundation: Superstructure and Foundation (which may be conventional Footing Type, Pile Foundation, Raft Foundation etc) to be designed by qualified & licensed structural / civil engineer. The design shall meet the BIS standards and relevant seismic zone norms for earthquake proof designs.

Cold Chamber:

Walls Minimum 230 mm Brick walls / solid concrete blocks with sand-cement plaster. However, in RCC structure or pre-fabricated structure insulated panel boards may also be provided in place of masonry walls.

Roof RCC slabs or Truss Roof with G.S / Pre-coated G.S.Sheet cover. RCC slab to have proper water proofing with reflective colour paint / China mosaic finish. Slab to have proper slope for rain water drainage.

In case of truss roof, provision to be made for fixing insulated panels on the ceiling & supporting of cooling units from the trusses (alternatively cooling units can be supported on floor mounted frame structure on top floor).

Provision for FRP sheets for natural lighting to be made in roof sheeting at certain locations. For ventilation of attic, provision of ridge monitor or turbo ventilators (which require no electric power) can be made. Alternatively roof can also be designed by installing insulated roof panels with proper slope & sealing of longitudinal & lateral joints. The work to be handled by experienced agencies to ensure a trouble free roof structure. The roof may be kept walk able for maintenance.

Floor The floor comprises of base concrete, in cold stores with suitably lower levels in cold chambers. The level difference between cold chambers and ante room to be equal to the thickness of floor insulation plus the layer of PCC or tremix finish.

Inter-floors The basic structure can be RCC columns & beams or steel columns & steel beams

Grating Wooden batten grating or steel grating using flats / square tubes etc. The inter-floors have to be designed for a product loading of 900 kg/m^2 min. Where AC units are located on top floor, the structure has to be suitable for the unit static & dynamic loads.

Ante Room In case of Multi-floor stores, Ante-room should preferably be designed to accommodate staircase, electrical hoist cage and have wider doors. Provision for fire escape stair & exits to be made as per local norms. The inter-floors in ante room to have doors to each cold room on each floor.

Strip curtains for cold rooms and Air Curtains for external outlets/ inlets- Strip curtains are quite common for reducing infiltration of air during loading/ unloading. Air curtains need power for operation but are more effective if properly installed.

Rodent proof civil structure and proper drainage of water to be ensured.

Rooms for machines, Electricals etc.

Dock Loading & unloading dock shall be designed with RCC slab roof or sheet roofing. However the machine roof can have RCC slab-roof to accommodate the evaporative condensers, pump sets, water tank, water softener etc. The dock area to accommodate suitably sized office & toilet for staff & labour.

Insulated Doors The freezer and frozen food store can be swing or sliding type. The doors shall have heating element on all sides. Water floor heating should be provided on the front side of the door. The heaters should have automatic temperature control and should be low voltage type. All the door hardware shall be rust and corrosion proof.

Ancillaries Underground fresh water storage, storage for fire fighting, water supply & sanitary arrangements, compound wall / fencing, main gate, security, small canteen / electrical sub-station & D.G. set platform, roads & parking place for vehicles etc. Green landscaping with benches for labourers is desirable.

8. REFRIGERATION SYSTEM SELECTION

All the Refrigeration system for Frozen Food Stores operate at evaporating temperature in the range of (-) 25°C to (-) 30°C.

a. COMPRESSOR SYSTEM

The system requires a two stage refrigeration plant of one of the following types:

a) Combination of Low and High Compressor
b) Compound (two stage) Compressor
c) Cascade system

Provision of standby Compressor is desirable especially, in case of larger plants.
The Compressors can be Reciprocating or Screw type. The Reciprocating Compressors shall have capacity control in steps or through VFD. The Screw Compressor should preferably have step less capacity control. The energy efficiency of the Compressors is the most important factor for the selection of the Compressors.

NOTE:

For evaporating temperatures below (-) 30°C CO_2 / NH_3 cascade refrigeration system can be considered.

2. TYPES OF CONDENSERS

Condensers can be:

a) Evaporative Condenser
b) Atmospheric Condenser
c) Shell and Tube / PHE Condenser with cooling towers for water cooling.
d) Air Cooled Condensers to be used for HFC systems in case soft water is not available. Condenser Air Pre-cooling system should be incorporated along with Air cooled condensers for energy saving.

Water needs to be soft quality for which water softening has to be installed for the makeup water. The Condenser should be selected for the lowest possible Condensing temperature. Generally, a condensing temperature of 38°C (or lower, if possible) is recommended.
Evaporative condensers offer better energy efficiency as compared to other types.

3. TYPES OF AIR COOLING UNITS

The air cooling unit used in Air Blast Freezing systems shall have finned coils and heavy duty axial flow fans. The Air Cooling units shall be either located on the floor or overhead depending on the freezer design.

Ammonia coils are typically MS hot dip galvanised or SS/ aluminium tubes with Aluminium fins. The cooling units for HFC refrigerants have coils with copper tubes and aluminium fins. Coils with Aluminium tubes and Aluminium fins can also be used. The fin spacing on these coils should be in the range of 8 mm – 12 mm. A combination of fin spacings in this range can also be used over the coil depth.

4. AIR PURGER (MANUAL OR AUTOMATIC)

It is desirable to remove air and other non condensable gases from the refrigeration circuit to keep the compressor head pressures lower and also improve heat transfer coefficients.

LIQUID FEED

The liquid feed can be

a) Direct Expansion – In case of HFC system
b) Gravity feed – In case of Ammonia system
c) Refrigerant pump recirculation (Over feed) – In case of Ammonia / HFC

The Direct Expansion system results in about 20% lower capacity of freezing.

DEFROSTING

Defrosting system can be of the following types:

a) Water Defrosting
b) Hot gas Defrosting
c) Off Cycle Defrosting ((Between shifts)

5. TESTING AND COMMISSIONING THE SYSTEM

Installation, Testing & Commissioning should be carried out as per BIS standards. ASHRAE standards may be referred to as guidelines but not mandatory.

6. EQUIPMENT DERATING AT HIGHER AMBIENT

A designer should match the loads with the de-rated equipment capacity at higher ambient conditions.

GENERAL SPECIFICATIONS FOR REFRIGERATION SYSTEM

Brief Specifications for Equipment / Materials / Services

i. Refrigeration Compressors & Motors

Compressor Arrangement	A combination of low stage and high stage compressors or compound compressors. Standby compressor preferred in case of larger units. In case of HFC refrigerant two stage compressors or rack system can be used. Single stage compressors can also be used in case of screw compressors
Type	For ammonia as refrigerant, reciprocating, multi cylinder complete with water-cooled head / jackets, with accessories like oil separators, capacity control & unloaded start. Alternatively screw compressor, open type with accessories can be provided. For HFC, reciprocating. / scroll / screw can be provided. If Air cooled cylinder heads are to be used for low stage compressors adequate ventilation should be provided for the plant room.
Capacity at critical operating conditions	To be configured in kW
Estimated Motor rating	To be configured in kW, RPM, type of insulation, Input AC power supply

ii. Evaporative Condenser for Ammonia / HFC:-

Coil section	Hot dip galvanised M.S. pipes / CDW Boiler quality tubes / S.S.304 tubes
Fan section	With 2 / 3 Axial Flow Fans with Cast Aluminium / S.S / GRP impellers, complete with TEFC Sq. cage motors, Class F insulation & IP-55 protection
Water sump tank	S.S.304 /M.S. Epoxy coated with necessary connections
Other provisions	Water spray arrangement, air inlet grilles, eliminators of suitable design
Unit casing	with removable G.S sheet panels & inspection windows etc.
Estimated Heat rejection capacity at 38 deg C condensing & and applicable WB temp	To be configured in KW
Suggested Standard	ARI Std 490

Air-Cooled / Water-Cooled Condenser for HFC.

Capacity	To be configured in KW
Size	To be furnished

iii.) Gas and Liquid Intercooler

Gas Intercooler and Liquid Sub-cooler	M.S. Construction with gas inlet and outlet connections, liquid sub-cooling coil and liquid injection connection to be provided.

iv. H.P. Receiver for Ammonia / HFC:-

Horizontal Receiver complete	With necessary connections, reflex type level gauge etc.
Capacity	To be configured
Material of Construction	Boiler quality steel plates
Quantity	2 Nos. (Two Nos. are suggested in case some States' regulations call for Pressure testing of high pressure vessels on a periodic basis)
Suggested Standard	ANSI / ARI 495 / BIS Code IS 2825

v. Air Cooling Units for Frozen Food Stores.

a) Finned cooling coil	Coil design to be suitable for gravity feed / pump re-circulation/overfeed system for ammonia & DX operation for HFC as per design
M.O.C	Hot dip galvanised coil with M.S. pipes CDW Boiler quality tubes – ASTM A 214 with MS fins / S.S.304 tubes &Aluminium fins / Aluminium Tubes & Aluminium fins with proper bonding system with bullet drawn expansion/ equivalent expansion for Ammonia; *For HFC / HCFC coils with copper tubes & aluminium fins or aluminium tubes with aluminium fins* with bullet drawn or equivalent expansion *may be used.*
Fin spacing	*In range of 8 to 12 mm in steps in the coil depth.*

b) Axial Flow fans	With cast aluminium / S.S. / FRP impellers, with variable pitch, TEFC Squirrel cage motors with class 'F' insulation, IP-55 protection
c) Accumulator	Vertical / horizontal with necessary connections (in case of gravity feed units) for Ammonia
d) Unit casing	G.S. sheet duly painted, drain pan of G.S / M.S with epoxy paint
e) Defrosting arrangement	Water / Hot gas / Air
f) Electrical heat tracing	Drain pan, Drain pipe, Fan casing
Unit capacities	
Number per chamber	To be configured
Estimated capacity each at critical operating conditions	*To be configured*
Estimated coil surface area	*To be configured*
Estimated air flow capacity with adequate external static pressure	To be configured

vi. Refrigerant Piping, Fittings & Valves

Piping Interconnecting piping between compressor, condenser, receiver and cooling units	M.S. black piping conforming to IS-1239/ ASTM A Gr.106B for 40 NB & smaller sizes / ASTM A Gr.53B for 50 NB & larger sizes in case of ammonia plants. For Low temp refrigerant line below (-) 30 Deg C upto (-) 45 Deg C SA 333 Gr 1, Grade 6 to be used. For Ammonia fittings shall be of forged steel. For HFC / HCFC, hard Copper piping type L Piping as per. ANSI guidelines and pressure vessels as per BIS Code IS 2825). Reference to ASHRAE B-31.5 recommended.

vii. Water Piping, Fittings & Valves

Piping shall be used for a. Condenser water circulation b. Compressor cooling c. Defrosting d. Drain lines	Piping to be G.I class B or sizes up to 65 NB & M.S. black pipe conforming to IS-1239. Valves up to 40 NB to be Gate / Globe type. Valves 50 NB / larger to be butterfly type.

viii. Water Pump sets

Water flow capacity to take care of condenser water flow & compressor head / jacket cooling	At least 2 nos. operational during peak load and 1 no standby
Capacity	To be configured

ix. Thermal insulation for refrigerant piping etc.

Material for insulation for refrigerant suction line, accumulators etc.	a. EPS pipe section b. PUF pipe section With 0.6 mm Aluminium or 0.5 mm G.S. pre-coated sheet cladding c. Nitrile Rubber / EPDM / chemically cross linked polyethylene pipe section / other acceptable materials with woven glass cloth with UV treated pigmented epoxy Coating

x. Controls.

Temperature control	Temp Indicators cum controllers for individual freezers and chambers. Temperature scanners and a centralized temperature indication in machine room
Refrigerant flow controls	Liquid level controls, solenoid valves etc.

Defrost Controls for automatic defrosting if required	Recommended in case of continuous freezers and deep freeze chambers.
PLC control systems	For overall control of various parameters

Note. Location for installing the sensors will depend on site conditions and stacking pattern etc. Therefore Programmable Logic Controllers (PLC) is recommended for large units with the display point in the manager's cabin.

xi. Installation, Testing & Commissioning

Installation	The plant shall be installed, tested & commissioned as per IS 660 / ASHRAE. Std 15.

General Notes:

1. In case refrigerant pumping system (over feed system) is used it will incorporate the following components.
    a. Centralised L.P receiver
    b. Refrigerant pumps including standby
    c. Refrigerant flow & safety controls
    d. Interconnecting piping – both supply & return lines shall be insulated. In this case the individual accumulators for AC units & level controls etc. are not required.

ELECTRICAL INSTALLATIONS

- Power Factor – not less than 0.95
- Transformer of minimum required capacity

i. Substation with adequate rating

Substation with a rating adequate capacity	a. Step down transformer suitable for incoming H.T. voltage / 415 V as per IS-2026 / other applicable standards b. Two pole / four pole structure as per local requirements c. Outdoor type metering cubicle with approved meter, CTs / PTs etc. d. Earthling station as per requirement e. Switchyard fencing with gates as per Electrical Board requirements

ii. D.G. Set for standby power

D.G. set complete with accessories and with weather-proof and noise-proof canopy as per local pollution control norms	Estimated Rating: as per design. One big for pull down period and one small for holding period may be used. The use of Diesel engines on compressors is left to the promoter to assess but keeping in view overall COP of the plant.

Iii. Main power distribution panel

Main power distribution panel with changeover facility for normal electric supply & D.G. set supply. With ongoing feeders for various electrical panels.

Iv. Electric panels

Electric panels for	a. Refrigeration b. Lighting, Electric hoist, Fans c. APFC (automatic power factor correction) panel d. Water supply, fire fighting etc.

V. Power & Control cabling etc

Power and Control cabling, earthing etc for various electrical circuits	Aluminium armoured cables for main power lines & equipment lines & copper conductors for lighting, control wiring etc.

i. Lighting

Lighting in a. Freezers, Process Halls, Packing Room, ante room, Dock and outside areas. b. Other areas c. Outside areas	For freezer & frozen food stores – S.V. Lamps / LED Lamps. For medium temp cold stores – CFL/LED with vapour proof fittings. For process / other areas – T – 5 type TL / CFL / LED Lamps.

SAFETY MEASURES

Provision for handling accidental leakage of ammonia	Ammonia sensors at proper places and Machine room near ACUs & machine room

	Emergency ventilation for machine room Safety release of refrigerant to water sump Ammonia masks First aid kit Instructions for handling emergencies. Resettable dual safety valves for all pressure vessels. Provision for Face Washing Quick oil drain valve on receivers and other equipment.
Fire protection	Fire sensors in suitable places and machine rooms & machine room. Dry & water based fire fighting systems as per specs below. Sprinklers for high pressure and low pressure receivers.
Emergency lighting system	May be solar PV cells with batteries & controller
Emergency alarm system	To be provided with switches near all cold store doors and alarms located in common public areas
Lightning arrestors for the building as per local regulations	

Fire Fighting

a) Dry Type

Fire fighting equipment necessary for extinguishing liquid, solid and electrical fire :	i) Dry chemical powder type 5.0 Kg Cap with ISI Mark Fire Extinguisher complete with wall mounting bracket. ii) Carbon Di-Oxide (CO_2) type 4.5 Kg. Capacity Fire Extinguisher complete with wall mounting bracket. iii') G.I. Fire Buckets iv) M.S. Stand for Fire Buckets

b) Water based (mandatory if local code so prescribes)

System shall comprise of	i) 2 sets of Water supply pumps. ii) 2 sets Fire fighting pumps iii) G.I. piping, class C with necessary fittings & valves iv) Rubber Hose reel v) Canvas Hose pipe vi) M.S. Fabricated hose box with key vii) any other requirements as per local fire officer.

Coefficient of Performance (COP) – For optimum energy efficiency the plant should be selected with best possible COP.

Operation & Maintenance- Plant design must be accompanied by Operation & Maintenance Manual for plant operator which should cover following points in English as well as Hindi languages-

- No. of operating hours
- Training of operators
- Monitoring & control – temperature, humidity, CO_2
- Door seals – checking methods
- Maintenance of equipment / cold store
- Hygiene issues

Variation / amendment Clause-

The standards prescribed above are not intended to prevent or discourage variations arising out of new concepts, innovations and R & D in building design & construction, thermal insulation and cooling & refrigeration technology etc. However, any variations or deviations from the above prescribed standards must be supported by scientific / technical details for prior approval of the competent authority, on the basis of merit who may decide the proposal in view of relevant technical details including critical storage requirements, energy efficiency (coefficient of performance), availability of *Standards*, environmental concerns, safety etc. Similarly, periodic amendment of standards for general application may also be undertaken by the National Horticulture Board; in consultation with a committee of subject matter experts duly constituted for this purpose.

REFRIGERATION SYSTEMS – LOAD CALCULATIONS

Total Refrigeration Load - Heat Load Calculation

- **Procedure for load calculation**
  Procedures laid out by ASHRAE Fundamentals and Refrigeration handbooks may be followed. ASHRAE refrigeration handbook elaborates a more traditional approach. Thus, based on the overall impact/ sensitivity of important parameters, some estimates can be made. Designers also tend to take a safety factor of 5-10% on the estimated loads.

- **Ambient conditions**
  0.4% annual design conditions of that location as per ASHRAE/ ISHRAE data may be used for holding period. For the loading and pull down periods, 0.4% design conditions for those months may be taken.

- **The Refrigeration load for freezing shall include**
  f) The Transmission gains through the walls / ceiling / floor
  g) The fan motor load of AC Units.
  h) Loads due to material handling equipment.
  i) Product cooling load if any.
  j) Air change load.
  k) Load due to workmen.

- **Product Incoming temperature**
  It depends on the process followed and the Chilling / Precooling method. Generally the product temperatures entering the storage may be in the range of (-)15° to (-) 18° C or lower.

- **Final Product Temperature**
  Unless otherwise specified the final core temperature of the product after freezing can be considered as (-) 18 Deg C. However in some cases the processors specify lower temperatures of (-) 23 to (-) 25 Deg C.

- **Product Load**

  The product load in the storage shall comprise of

  a) The load during cooling of product from incoming temperature upto storage temperature.

Heat Load Calculation of Cooling System – Summary

Heat Load Calculations – Summary for Frozen Food Stores	
Ambient Conditions	
Temperature (°C)	
RH %	
Frozen Store Temp ^{O}C	
Incoming Product Temp	
Processing Hall Conditions – DB temp °C ± RH % ±	
Transmission Load KW	
Product load including Sub cooling to final stage Temp (kW)	
Load due to material handling equipment. (kW)	
Air change load. (kW)	
Load due to workmen. (kW)	
Fan motor for ACU's (kW)	
Total load (kW)	
Safety factor %	
Total Refrigeration Load (kW)	

NOTE 1: Separate sheets be submitted for different freezers.

SECTION 2

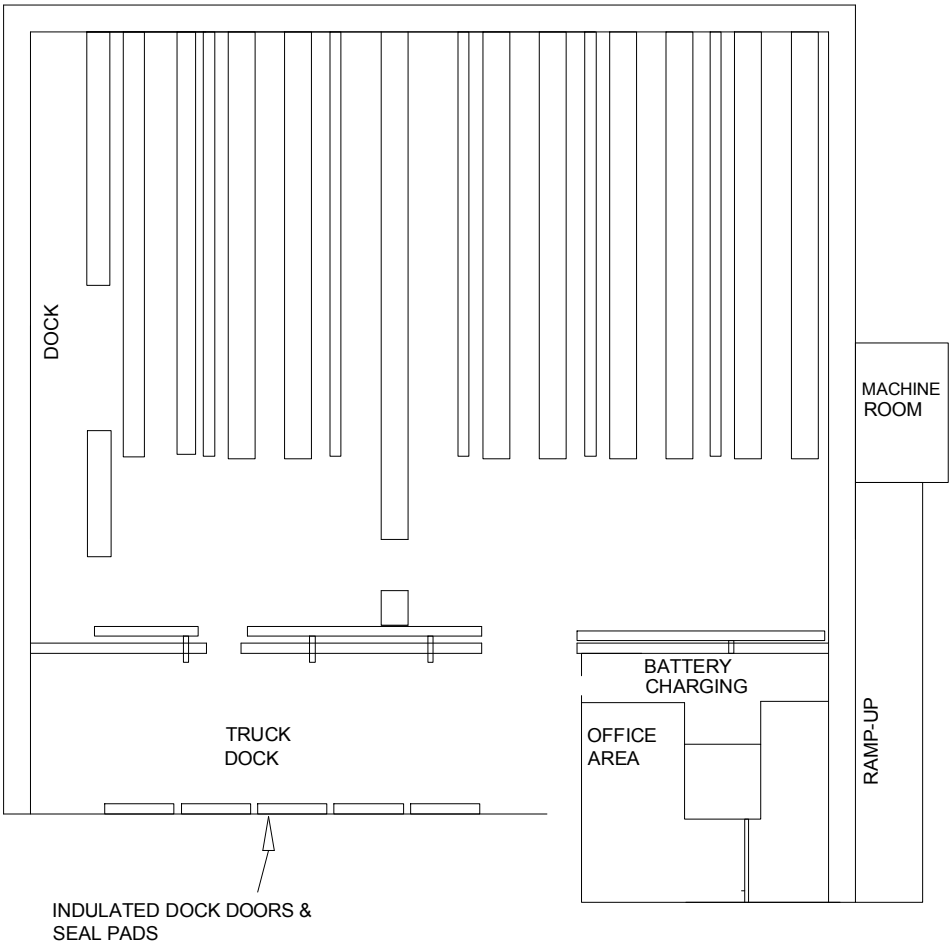
Typical Design Parameters & Layout for Frozen Food & Storage Plant

1. Plant Location
2. Outside dry-bulb temp
3. Outside wet-bulb temp
4. Power supply
5. Control Power supply
6. Product receiving system – Reefer Vans / Containers
7. Product temperature at the time of loading
8. Storage system
9. Type of products
10. Type of size of packages for storage
11. No of frozen food storage Chambers
12. Chamber sizes & their capacities
13. Loading Rate % of storage capacity
14. Ante Room – Design Temp ^{0}C
15. Dock - Design Temp ^{0}C
16. Compressor running hours during peak season hours per day
17. Compressor running hour during holding hours per day.

OTHER CONSIDERATIONS

- Ideally, there should not be any product cooling load in Frozen Food stores. However, due to transport and handling of product before storage, many times the products arrive at temperature of (-) 15 °C to (-) 16 °C. Considering this load for sub cooling of product from the incoming temperature to storage temperature has to be considered.

TYPICAL LAYOUT OF FROZEN FOOD STORAGE



SECTION 3 (Common for Part I & II)

BASIC DATA SHEET

A. Identification

Name of Frozen Food Project	
Location of Plant	Area / Village Town
	District State
Name of Promoter Company / Owner	
Type of company (Proprietorship / Partnership / Pvt. Ltd. Ltd)	
Postal address of Promoter	Tel / Fax Mob. No. E-mail.
Present activity in brief	
Name of CEO / MD	
Name of Manager / Contact Person	Phone / Mobile No.

A. Basic Freezer Design Considerations

i) Commodity Storage Requirements

Type of Commodities/Produce		
Ideal / Recommended Storage Conditions		
Type of products		
Sizes of products		

Refrigerant duty at the design operating conditions (kW)		
Evaporating Temp (Deg C)		
Condensing Temp (Deg C)		
Average weights , kg of products		
Type of packing – Material, thickness (mm, micron)		
– Incoming Temperature (DB in ^{O}C)		
Final product core temp (Deg C)		
Period of Freezing (mins / hours)		
Type of Freezer proposed – Plate / Air Blast / Batch / IQF		
Capacity of freezer / batch (in case of batch freezer)		
Capacity of freezer / hour (in case of continuous freezer)		
Total Estimated Freezing Capacity per day		
Power requirement for belts/conveyor in the freezer (kW)		
Frozen Food Storage Facilities provided		
Size of the stores		
No. of stores		
Estimated storage capacity (MT)		
Type of storage system		
a) Multi-floor		

This point to be filled in only for IQF

b) Singe0floor with pallet loading c) Rack system Types of Racks – Single / Double deep / drive in / drive out/ mobile		

iii) Deep Freeze Chamber Sizing and Capacity

- No. of chambers: Two
- Type: Mezzanine/ Palletized Mezzanine
- Max Height of Building 15.20 Meter

Details	FFS 1	FFS 2	FFS 3	FFS 4
Total Capacity of Each Deep Freeze Chamber (MT)				
Internal Chamber Dimensions L x B x H (m)				
No. of mezzanine floors X Height (m) per floor				
Size &Weight of Bags or Boxes being stored				
Total number of Bags/Boxes stored in each Chamber				

iv) Ante Room & Process Areas

Details	Length (m)	Width (m)	Height (m)
Ante Room			
Processing Area			
Receiving dock			

Dispatch dock			
Packing Area			

v) Machine Room & Utility Areas

Details	**Length (m)**	**Width (m)**	**Height (m)**
Machine Room			
Office Area			
Toilets & Changing rooms			
Any other (Labour Rest Room)			

vi) Building & Construction Details

- **Type of construction :** Civil/ Pre-engineered Building

Type of External walls of cold chambers	
Type of Internal / Partition walls	
Type of Roof / Ceiling	
Type of Internal structure / Racks	
Type of mezzanine grating	
Types of Lighting fixtures in cold Chambers	
Types of Lighting fixtures in Process & Other Areas	

Process hall construction and sanitary features

Pertaining only for IQF

- **There are various national & international guidelines such as APEDA, which are to be followed for relevant details.**
- **Water quality used for processing as well as defrosting od ACUs / Freezers should be properly treated and potable.**

vii) Insulation and Vapor Barrier

- **Type of Insulation :** Insulating Sheets / Metal Skin Composite panels

Type of Insulation	**Wall**		**Ceiling / Roof**	**Floor**
	External	**Internal**		
Type of material **EPS** / Metal Skin PUF Composite Panels / XPS/ PUR, Others				
Relevant IS Code				
Density (kg/m^3)				
Thermal Conductivity at +10°C k value (W/m.K)				
Thermal diffusivity m2/h				
Water vapour transmission rate, ng/Pa.sm, Max.g / m^2 hhmm/g				
Water absorption after 24h immersion, percentage by mass.				
Relevant IS Code of Practice for Thermal Insulation of Cold Store				
Total Insulation Thickness (mm)				
No. of layers & Thickness / layer (mm)				
Type of vapor barrier & thickness (microns)				
Type of Bituminous/Sticking Compound				

Type of Cladding / Covering/External Finish				
Locking/Fixing & Sealing System in case of Metal Skin Composite Panels				
Any other info				

viii) Freezer / Frozen food store Doors & Strip Curtains

Type of Insulation	**Details**
No. Of Insulated doors	
Type hinged / sliding	
Insulation Material EPS / PUF / Others	
Thickness of Insulation (mm)	
Type of cladding	
Size of door opening	
Provision of Strip curtains – nos. & overlap %	
Air curtains, if any	
Others	

ix) Material Handling

- **Proposed Practice :** Manual / Semi Automated /Automated

Procedure	**Brief Description**
Material Handling Procedures & Equipments	
Cap of Electric Elevator Rating of motor (kW)	

Type of lifting devices – Forklift truck , Reach in truck – Capacity in kg Lifting height Power required	
Any other device	

x) Grading, Sorting Washing & Packing/ Pre-processing / Processing / De-boning Line (optional)

Proposed Practice : Manual / Semi Automated /Automated

Procedure	**Brief Description**
Process Line	
Total Connected Electrical Load (kW) of Processing lines	

Please attach a Plan & Layout of the proposed Cold Store unit in accordance to the Statutory Building By-Laws and BIS Building Codes & Standards duly approved by a Registered Architect and Structural Engineer. The drawings should detail out insulation type, thickness, and fixing methodology in sectional details.

Please attach detailed heat load calculation sheets of the proposed cold store unit in accordance to the prescribed Technical Standards and Guidelines duly approved by a Certified Engineer.

D. Cooling System Design & Equipment Selection

i) Cooling System Configuration

Type of Refrigerant	Ammonia /HFC (Freon) /Others
Type of System	Direct Exp / Gravity Feed / Overfeed
Type of compressor	Reciprocating / Screw / Scroll / Others
Type of capacity control	Automatic In steps / Step less
Type of condenser	Atmospheric / Evaporative / Shell & Tube / Plate Heat Exchanger / Other

Cooling Towers (if applicable)	FRP Induced Draft / Others
Type of cooling coil	Ceiling suspended / Floor Mounted / Others
Type of defrosting	Air / Water / Electric / Hot gas
Humidification System & Control (Brief Description)	

ii) Compressor Detail

Compressor Make & Model	Nos.	Comp. RPM	Operating Parameters Evap. SST. / Cond. Temp (^{O}C)	Refrigeration Capacity (KW)	Motor Rating. (KW)	Total Electric Power.(BkW)	Remarks Working /Standby

iii) Condenser Details

Condenser Make & Model	Nos.	Operating Parameters Cond.Temp.(SDT)/ in/out water temp(^{O}C) &flow (lps)	Condenser Capacity (kW)	Electric Fan /Pump Motor Rating (kW)	Total Electric Power (BkW)	Remarks Working /Standby

iv) Cooling Tower Details (if applicable)

Cooling Tower Make & Model	Nos.	Operating Parameters DB & WB Temp, in/out water temp (^{O}C)	Cooling Tower Capacity (KW)	Fan & Pump Capacity (CMH/LPS) & Motor (kW)	Total Electric Power (BkW)	Remarks Working /Standby

v)Air Cooling Units (ACU)

ACU Make & Model	Nos.	Operating Parameters Evap. (SST) & TD* (^{O}C)	Cooling Capacity (kW)	No. of fans per ACU	Total Air Flow (CMH) & Ext Static pressure (mm wg)	Material of Coil Tubes & Fins	Fin spacing (mm)	Total Fan Electric Power (BKW)

(*) TD – Temperature difference between Evap. (SST) ^{O}C & Return Air (at coil inlet).

Please attach Detailed Technical Data Sheets of each equipment namely Compressors, Condensers, Cooling Towers, Air Cooling Units giving General Layout, Dimensions, Material of Construction, Rated Capacity, Operating Parameters and COP (please note that the Air Cooling Unit data sheet should include heat transfer area, fin spacing, no. of rows, air flow, face velocity, fan static, air throw, Fan Motor BKW/KW, fin spacing, etc) duly Certified by the respective equipment manufacturers with reference to the Relevant Codes & Standards.

E. Electrical Installation

Total Connected load (kW)	
Estimated power requirement at Peak Load Period (BkW)	
Estimated power requirement at Holding Load Period (BkW)	
Estimated power requirement at Lean Load Period (BkW)	
Capacity of Transformer (KVA)	

Size of Capacitor for power factor correction Type : Manual / Automatic	
Make & Capacity of standby D.G.Set (KVA)	

F. **Safety Provisions**

Details of Fire Fighting equipment		
Safety devices – LP/HP cut outs, safety valves, shut off valves etc.		
Details of Emergency alarm system & Push button system in cold chambers		
Emergency lighting in Cold chambers & other essential areas with inverter back-up		
Lightening arrestors as per local regulations		
Face – wash and eye shower provision near the exit inside or outside the plant room		
Any other safety provisions		

G. **Codes & Standards Followed**

Building Design & Structure	
Construction Materials	
Thermal Insulation & Application	
Refrigeration Equipment & Systems	

Electrical & Mechanical Systems	
Food Safety	
Others	

H. **Energy Saving Equipment & Measures**

Details of Energy Saving devices	**Brief Description and Savings**
Light Fixtures Sodium vapour / CFL / LED / TL	
Natural Lighting for general areas	
VFD for fans / compressors	
Refrigerant Controls and Automation	
Air Purger – manual / automatic	
Power Factor Controller	
Renewable/ Solar Energy e.g. PV lighting	
PLC Control, & Data Acquisition	
Any other features e.g. water recycling, rain water harvesting	

I. **Operation & Maintenance**

Description	**Nos. / Details**
Proposed staff for Operation & Maintenance	
Proposed Annual Maintenance Contracts (if any)	
Training & Preventive Maintenance	

procedures	
Sanitation & Hygiene practice	
Pollution Control	

J. Estimated Performance Parameters of Proposed Cold Store

Parameters	**Peak / loading Period**	**Holding Period**	**Lean Period**
Coefficient Of Performance (COP) b) For Freezer Unit c) For Frozen Food Store			
Power Consumption (KWH/Day) b) For Freezer Unit c) For Frozen Food Store			
Total Electricity Cost (Rs/Day) b) For Freezer Unit c) For Frozen Food Store			
Electricity Consumption a) For Freezer per MT/Day b) For Frozen Food Store per MT/Day			

K. Other Information

Place –
Dated –

DATA SHEET FOR AIR BLAST FREEZING / IQF SYSTEM	
Type of Freezer	
Refrigerant used	
Insulation of the Cabinet	
Material	
Internal & External cladding material & finish	
Thickness (mm)	Wall / Ceiling / Floor
Size of the Cabinet - L, B, H, mm	
No of freezing stations	
No of belts / belt width, mm	
Belt tension sensor	
Product height limit control	
Interlinking with feeding devices & automatic packaging machinery	
A.C.Unit capacity, KW	
No of fan	

Air flow capacity cmh & external sp. mm mg.	
Initial product temperature ^{0}C	
Final product temperature ^{0}C (core)	
Estimated Freezing time per batch in minutes	
Expected freezing capacity per day, MT	
Refrigeration capacity required, KW	
Evap. Temp. (-) ^{0}C	
Refrigerant feed system Gravity / Pump circulation / DX	
Provision for digital thermometer & other controls	
Defrosting Type Hot gas / water / off cycle	
Cabinet Dimensions, mm	
Freezer Make & Model No	
Electrical Control Panel	
Refrigeration system to be offered as package/to be procured separately	
Any other related information	

DATA SHEET FOR PLATE FREEZING SYSTEM	
Type of Freezer Horizontal / Vertical	
Refrigerant used	
Insulation of the Cabinet Material Internal & External cladding material & finish Thickness (mm)	Wall / Ceiling / Floor
Size of the Cabinet - L, B, H, mm	
No of freezing stations	
Plate Dimensions, mm	
Material of Plates	
Maximum opening between plates, mm	
Initial product temperature ^{0}C	
Final product temperature ^{0}C (core)	
Estimated Freezing time per batch in minutes	
Estimated Freezing capacity per batch, Kg	

Expected freezing capacity per day, MT	
Refrigeration capacity required, KW	
Evap. Temp. (-) 0C	
Refrigerant feed system Gravity / Pump circulation / DX	
Provision for digital thermometer	
Defrosting Type Hot gas / water / off cycle	
Freezer Make & Model No	
Refrigeration system to be offered as package/to be procured separately	
Electrical Control Panel	
Any other related information	

SECTION 4 (Common for Part I & II)

PROTOCOL FOR IMPLEMENTATION OF TECHNICAL STANDARDS

Subject to provisions of *Variation Clause*, only those cold storage projects that are in conformity with the prescribed technical standards will be eligible for Central Government Subsidy. In order to verify this, following mechanism needs to be put in place-

A. System of *Letter of Intent* (LOI)- LOI to be obtained by the promoter prior to undertaking construction of cold storage needs to be introduced. An application for Letter of Intent must be accompanied by following documents, in addition to any other documents prescribed-

ii. A copy of the detailed project report
iii. Information in prescribed Basic Data Sheet accompanied by requisite documents

Technical scrutiny of the above documents will be undertaken to ensure that the project is in conformity with the prescribed technical standards or any variation is fully justified keeping in view the product to be stored, prescribed storage conditions, energy efficiency and environmental and safety concerns.

B. Civil Structure- Following documents must be submitted by the promoter in respect of civil construction

ii. Certificate of approval of the building plan by local planning authority,
iii. Certificate issued by registered civil design engineer about conformity with relevant BIS Standards and prescribed standards and safety concerns,
iv. Certificate by site engineer / architect to the effect of construction of the civil structure as per approved building plan and design and completion of the civil components accordingly in all respects as per prescribed plan and standards,

C. Thermal Insulation & Refrigeration System, Control and Safety Devises

ii. The components of insulation and refrigeration system should be certified in form of a technical data sheet by the manufacturer confirming the rating and performance as per prescribed standards.
iii. Further, site inspection at appropriate stages of construction / erection and commissioning may be undertaken by an inspection team constituted by competent authority for this purpose.
iv. Finally, the manufacturer/refrigeration contracting agency will issue a certificate of satisfactory commissioning of the cooling system in conformance to the performance indicators as per prescribed standards.
v. The manufacturer/refrigeration contracting agency will also provide “as built drawings”, including cold store layout, P&I and electrical drawing and an operation & maintenance manual along with a list of essential spare parts.
vi. A set of above documents along-with the refrigeration system performance certificate issued by the refrigeration company / contracting agency, duly signed by an authorized graduate engineer of the company/agency, must be submitted to competent authority for record and a copy of the same must be issued to the promoter / owner of the project.

Annexure – I

List of Relevant BIS and Other Standards

The Codes and Standards listed in this annexure represent practices and methods published by Bureau of Indian Standards (BIS) and other International Organizations applying to design and construction of Cold Stores, Pack House, Ripening Chambers, and Food Processing Facilities etc. They are valuable guides for the practicing engineer in determining test methods, rating, performance requirement and limits applying to design construction and equipments used.

The codes and standards listed are intended to serve as minimum requirement, and are not to be construed as limiting good practice. Wherever IS-Code is not available, relevant standard codes of ASME / ASHRAE / IIAR or other International Codes are to be followed. Latest revisions will be followed in all cases.

The responsibility for deciding whether other requirements additional to the ones listed in this document are necessary to ensure system integrity, efficiency and overall safety, including operation, maintenance and servicing and/or the necessity to adopt additional requirements in the system design and construction to guarantee the overall performance, still rests with the supplier / manufacturer. The suppliers / manufacturers shall furnish to the owner copies of instruction manual which shall include operation & maintenance instruction, as built drawings, wiring diagrams, recommended spare parts and replacement part list.

The suppliers / manufacturers shall provide training for the plant and machinery installed including safety and emergency procedures. The supplier /manufacturer will follow all practices set forth by “good manufacturing practices” by various applicable Codes and Standards listed in this document and shall fully certify the equipment, plant and machinery supplied / installed in compliance to the relevant codes and standards.

Where there is a requirement for deviation, the difference(s) must be brought to the intention of the regularity body and the customer in writing.

All “exceptions/deviations” to the codes and standards for the plant and machinery including civil works and design shall be identified and detailed in the proposal / bid documents to the customers /owner and his specific approval in writing will be taken before commencement of supply/work.

The supplier / manufacturer/contractor should be fully aware of all details in his scope etc, and it is imperative that all work performed shall be done by personnel trained and skilled in the installation of plant and machinery.

CODES AND STANDARDS

A. Electrical
Bureau of Indian Standards (BIS)

S. No.	Title	Reference
1.	PVC Insulated cables (light duty) for working voltage up to 1100 volts	IS 694-1977 Part I & II
2.	PVC Insulated cables (heavy duty) for working voltage up to 1100 volts	IS 1554-1976 Part-I
3.	PVC Insulated cables for voltage 3.3 KV to 11 KV	IS 1554-1976 Part-II
4.	Specification of Polyurethane insulated PVC sheeted heavy duty electrical cables, voltage not exceeding 1100 V	IS 5959-1970 Part-I
5.	Specification of Polyurethane insulated PVC sheeted heavy duty electrical cables, voltage 3.3 KV to 11 KV	IS 5959-1970 Part-II
6.	Guide for making of insulated conductors	IS 5578-1970
7.	Code of practice for installation and maintenance of paper insulated power cables	IS 1255-1967
8.	Code of practice for earthling	IS 3043-1966
9.	Guide of practice for installation and maintenance of induction motors	IS 5216-1969
10.	Code of practice for installation and maintenance of AC induction motor starters	IS 5214-1969
11.	Code of practice for installation and maintenance of AC induction motors	IS 900-1965
12.	Code of practice for installation and maintenance of switchgears	IS 372-1975

13.	Code of practice for installation and maintenance of transformers	IS 1886-1967
14.	Code of practice for electrical wiring installation, voltage not exceeding 650 V	IS 732-1963
15.	Code of practice for electrical wiring installation (system voltage exceeding 650 V)	IS 2274-1963
16.	Guide for testing three-phase induction Motor	IS 4029-1967
17.	Three Phase induction Motors	IS 325
18.	Electrical measuring instruments and there accessories	IS 248
19.	Current transformers	IS 2705
20	Dimensions of slide rails of electric motors	IS 2968
21.	Flexible Steel conduits for electric wiring	IS 3480
22.	Air-Break Switches	IS 4064
23.	Motor Starters for voltage not exceeding 1000 Volts	IS 8544
24.	Conduits for electrical installation	IS 9537
25.	Selection, installation & maintenance of Transformers	IS 10028
26.	Selection, installation & maintenance of switch gear and control gear	IS 10118
27.	National Electrical Codes	SP: 30
28.	Self blasted lamps for general lighting service	IS 15111 Part 1 and 2

B. Mechanical
Bureau of Indian Standards (BIS)

S. No.	Title	Reference
1.	Safety codes for Mechanical Refrigeration	IS 660
2.	Code of practice for thermal insulation of cold storages	IS 661
3.	Code of practice for application of polyurethane insulation by in-situ pouring method	IS 13205
4.	Rigid phenolic foams for thermal insulation	IS 13204
5.	Application for spray applied insulation code of practice – Polyurethane / Poly-isocyanurate	IS 12432 Part-III
6.	Specifications for preformed rigid polyurethane (Pur) and poly isocyanurate (Pir) foams for thermal insulation	IS 12436
7.	Expanded polystyrene for thermal insulation	IS 4671
8.	Code for practice for fire safety of industrial buildings: General Storage and warehousing including cold storage	IS 3594
9.	Anhydrous ammonia	IS 662
10.	Industrial Bitumen	IS 702
11.	Gunmetal gate, globe and check valve for general purpose	IS 778
12.	Ball Valves including floats for water supply purposes	IS 1703
13.	Mild Steel Tubes, tubular and other wrought steel pipes fittings	IS 1239
14.	Steel Plates for pressure vessels used at moderate and low temperature	IS 2041

15.	Color code for identification of pipe lines	IS 2379
16.	V-belts for industrial purposes	IS 2494
17.	Hot dip galvanizing of iron and steel	IS 2629
18.	Code for unfired pressure vessels	IS 2825
19.	Glossary of terms for safety and relief valves	IS 3233
20	Steel for pressure vessels and welded structures	IS 3503
21.	Steel tubes for mechanical and general engineering purposes	IS 3601
22.	Steel for general structural purposes	IS 2062
23.	Steel tubes for structural purposes	IS 1161
24.	Specifications for steel doors, windows and ventilators	IS 1038
25.	Code of practice for design loads (other than earthquake) for building and structures	IS 875 Part I to V
26.	Criteria for earthquake resistant design of Structures	IS 1893
27.	Specifications for cold formed light gauge structural steel sections	IS 811
28.	Code of practice for use of Steel Tubes in general building construction	IS 806
29.	Code of practice for use of cold form light gauge steel structural members in general building construction	IS 801
30.	Code of practice for general construction in steel	IS 800
31.	Glossary of terms used in refrigeration and air-conditioning	IS 3615
32.	Pressure and vacuum gauges	IS 3624
33.	Safety Codes for scaffolds and ladders	IS 3696
34.	Formed ends for tanks and pressure vessels	IS 4049

35.	Shell an tube type heat exchangers	IS 4503
36.	Code of safety for ammonia	IS 4544
37.	Expanded polystyrene for thermal insulation purposes	IS 4671
38.	Hot-dip Zinc coating on steel tubes	IS 4736
39.	Units and symbol for refrigeration	IS 4831
40.	HDPE pipes for potable water supplies, sewage and industrial effluents	IS 4984
41.	Gauge glasses	IS 5428
42.	Specification for sprayed aluminum and zinc coating on iron and steel surfaces	IS 5905
43.	Steel Pipe flanges	IS 6392
44.	Injection molded HDPE fittings for portable water supplies	IS 8008
45.	Vertical steel ladders	IS 8172
46.	Treatment of water for industrial cooling systems	IS 8188
47.	Nominal sizes of valves	IS 9520
48.	Selection, use and maintenance of respiratory protective devices	IS 9623
49.	Polythene floats for ball valves	IS 9762
50.	General purpose ball valves	IS 9890
51.	SI units	IS 10005
52.	Recommendations for general pipeline welding	IS 10234
53.	Ammonia valves	IS 11132
54.	Finned type heat exchanger for room air conditioner	IS 11329
55.	Refrigeration oil separators	IS 11330
56.	MS tubes for vertical condenser	BS 3059
57.	Specification for metal air duct	IS 655

58.	Specification for galvanized steel sheet	IS 227
59.	Specifications for Performed Rigid Polyurethane	IS 12436 -1988
60.	Glossary of Terms used in Refrigeration& Air conditioning	IS 3615: 2007
61.	Code of Practice for Fire Safety of Ware housing including cold storages	As per elevant IS specification
62.	Food Hygiene – General Principle – Code of Practice	IS 2491-1998

C. Publication by International Societies and Associations Pre Engineered Building

S. no.	Title	Reference
1.	Building Code	IBC 2006
2.	Design Code	AISC 2005
3.	Tolerance Code	MBMA 2002
4.	Purlin Code	AISI 2001
5.	Welding Code	ANS 2006
6.	Wind Load & Seismic Load	IS 875 & IS A893-2002& Relevant Codes

D. European Organization for Technical Approvals (EOTA)

S. no.	Title	Reference
1.	External Thermal Insulation Composite Systems with Rendering	ETAG 004
2.	Cold Storage Premises Kits Part-1: Cold Storage Room Kits	ETAG 21
3.	Cold Storage Premises Kits Part-2: Cold Storage Building Envelope and building its	ETAG 021

American Society of Heating, Refrigeration and Air Condition Engineers, Inc - ASHRAE

Refer to REFRIGERATION - Systems and Applications, Handbook

Chapter – 51 Codes and Standards.

OTHER STANDARDS AND REFERENCES

There is sufficient data available on design of energy efficient cold stores and commercial storage practices of fresh fruits and vegetables and other perishable commodities from various publications by organizations such as:

1. International Association of Refrigerated Warehouses (IARW) and World Food Logistics Organizations,
   b) Commodity Storage Manual
   c) Crisis Management Manual
   d) Guide to Effective Ware House Operations
   e) Maintenance and Modernization Manual

2. American Society of Heating, Refrigeration and Air Condition Engineers, Inc - ASHRAE Handbooks

   b) REFRIGERATION – Systems & Applications
   c) FUNDAMENTALS
   d) HVAC Systems and Equipment
   e) HVAC Applications

3. The International Institute of Refrigeration (IIR),
4. International Institute of Ammonia Refrigeration (IIAR),
5. United States Department of Agriculture (USDA),
6. Post-harvest Technology-Research & Information Center UC DAVIC

Annexure – II

FLOW CHART VEGETABLES & FRUITS

process as per product requirement

RAW MATERIAL (CHOICE OF CULTIVATOR)

MATURITY ASSEMENT

HARVESTING & TRANSPORTATION

FACTORY GATE INSPECTION

PREPARATION

a	**WASHING / INSPECTION**	**CCP 1**
b	**CUTTING / DEPODDING/SNIPPING/PEELING**	
c	**CLEANING / AIR CLEANING/ VIBRATING SEIVING**	
d	**WASHING**	
e	**SLICING / DICING / SHREDDING/ WHOLE**	
f	**WASHING**	**CCP 2**
g	**BLANCING (VEGETABLES ONLY)**	**CCP 3**
h	**COOLING**	
i	**INSPECTION**	
j	**DEWATERING**	
k	**FREEZING**	**CCP 4**
l	**SEIVING**	
m	**METAL DETECTION / X RAY INSPECTION**	**CCP 5**

	n	**PACKING**	
	o	**COLD STORAGE @ BELOW -18 DEG C**	**CCP 6**
	p	**TRANSPORTATION @ -18 DEG C**	**CCP 7**
	q	**CITY OULET STORES @ -18 DEG C**	**CCP 8**
	r	**CUSTOMER TO STORE IN HOUSE FREEZER** *(home freezer -2 deg C for max 8 days & -18 deg C for long time as per mfg date)*	**CCP 9**

Annexure-III

No. 4-36/2009-Infra (ICC)
Government of India
Ministry of Food Processing Industries
Panchsheel Bhawan, August Kranti Marg
New Delhi – 110049

Dated: 09.09.2010

OFFICE ORDER

Subject: Constitution of Technical Standard Committee (TSC) for development of technical standards and protocols for cold chain for processed food products – reg.

With the approval of Competent Authority, it has been decided to constitute a Technical Standard Committee (TSC) for development of technical standards and protocols for cold chain for processed food products such as dairy product, meat product, sea food and other processed foods, which require cold chain for preservation, with the following composition:

(i) The Managing Director, National Horticulture Board, DAC	-	Chairman
(ii) The Chairman, CII Cold Chain Initiative	-	Member
(iii) A Representative of Chairman Railway Board	-	Member
(iv) Mission Director (NHM), DAC or his representative	-	Member
(v) A Representative of Chairman, APEDA	-	Member
(vi) A Representative of DG, ICAR (not below the rank of ADG)	-	Member
(vii) A Representative of Bureau of Indian Standards-Dy. DG (Technical)		Member
(viii) A Representative of Chairman & Managing Director, Central Warehousing Corporation	-	Member
(ix) Representative of CONCOR	-	Member
(x) Representative of FSSAI	-	Member
(xi) A Representative of Global Agri System Pvt. Ltd.	-	Member
(xii) Director, M/o Food Processing Industries	- Member Secretary -	

The TSC shall give recommendations on the following issues:

(i) Development of technical standards and protocols for cold chain for sub-zero temperature as the same may be required for storing and IQF of perishables like fruits and vegetables, dairy products, meat products, sea food etc. and other food products.

28/9

(ii) The Mechanism of implementation of such standards and protocols.
(iii) Any other issues that the committee may consider important or relevant to the subject.

The committee will submit its recommendations within a period of 3 months.

28.7.17

(Amrit Lal Meena)
Joint Secretary

To,

1. Shri Bijay Kumar, MD, NHB, 85, Institutional Area, Sector-18, Gurgaon-122015 (Haryana).
2. Shri Vivek Sahai, Chairman, Railway Board, Rail Bhawan, New Delhi.
3. Shri Asit Trapathi, Chairman, APEDA, NCUI Auditorium, 3 Siri Institutional Area, Hauz Khas, New Delhi.
4. Shri Rajendra Kumar Tiwari, Joint Secretary (M), Deptt. of Agriculture and Cooperation, Krishi Bhawan, New Delhi.
5. Shri Sharad Gupta, Director General, DDG, Bureau of India Standards, Manak Bhawan, 9, Bahadur Shah Zafar Marg, New Delhi-110002.
6. Shri P.I. Suvarathan, Chairman, Food Safety and Standards Authority of India, FDA Bhawan, Near Bal Bhawan, Kotla Road, New Delhi.
7. Dr. S. Ayyappan, Director General, ICAR, Krishi Bhawan, New Delhi.
8. Shri B.B. Pattanaik, Managing Director, Central Warehousing Corporation, "WAREHOUSING BHAWAN" 4/1 Siri Institutional Area, August Kranti Marg, New Delhi – 110016.
9. Shri A.K. Gupta, Managing Director, Container Cooperation of India, Ltd., CONCOR Bhawan, C-3, Mathura Road, Opp. Apollo Hospital, New Delhi.
10. Shri Daljit Mirchandani, Confederation of India Industries (CII) Indian Habitat Centre, Core 4 A, 4th Floor, Lodi Road, New Delhi.
11. Shri Gokul Patnaik, Chairman, Global Agri Sysytem Pvt. Ltd., K-13A, Hauz Khas Enclave, New Delhi.

Annexure - IV

Technical Standards Core Committee Experts

1. Sh. Bijay Kumar, Managing Director, National Horticulture Board, Ministry of Agriculture, Govt. of India, Plot No. 85, Institutional Area, Sector-18, Gurgaon (Haryana)
2. Dr. S. K. Malhotra, Principal Secretary (Hort), ICAR, New Delhi
3. Mr. Sushil Kumar Singla, Director, DAC, New Delhi
4. Mr. Gokul Patnaik, Managing Director, Global Agri System Pvt. Ltd., K-13A, Hauz Khas Enclave, New Delhi
5. Mr. P. K. Chakraborty, Director, FSSAI, New Delhi.
6. Mr. A. K. Lal, Sc. 'D', Bureau of Indian Standards, Manak Bhawan' 9, Bahadur Shah Zafar Marg, New Delhi
7. Sh. Chinmay Dwivedi , Scientist 'C', Food and Agriculture , Bureau of Indian Standards, Manak Bhawan' 9, Bahadur Shah Zafar Marg, New Delhi
8. Mr. Rajinder Singh, Senior Faculty, GB Pant Polytechniq, Okhla, New Delhi
9. Mr. Abhay Anand, Amit Finishers, Pune
10. Dr. R. K. Sharma, Director, National Horticulture Board, Ministry of Agriculture, Govt. of India, Plot No. 85, Institutional Area, Sector-18, Gurgaon-122 015 (Haryana)
11. Mr. Davishi Verma, IL&FS, New Delhi
12. Mr. Sandeep Ktiyan, IL&FS Clasters, New Delhi
13. Mr. Gurmit Singh, Managing Director, M/s Walco Engineering Ltd., 7/15, Kirti Nagar, Industrial Area, New Delhi-110 015 (and Chairman of CII, Technical Standards Committee).
14. Mr. M. S. Manjunath, Ingersoll Rand, Bangalore
15. Mr. Dilip Wagh, 6 Sigma Food tech, Pune
16. Mr. Menon Venugopal, RAC Global/Cabin Plant A/s Denmark
17. Mr. Allan Moller Hansen, Cabin Plant A/s Denmark
18. Mr. Nitin Shilaskar, Urschel, Pune
19. Mr. Arvind Surange, Consultant, H.O. Vijay Apts., 39/35 Erandavana, Pune-411 004 (Maharashtra)
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24. Mr. V. K. Seth, ISHRAE
25. Mr. Supriyo Saha, Management Consultant, M/s Financial Escort Pvt. Ltd, West Bengal
26. Mr. R. Shivakumar, Voltas Ltd
27. Mr. M. Verma, ICL
28. Mr. Atul Garg, KPMG
29. Mr. J. M. Gupta, APC Polycoat (P) Ltd
30. Sh. S.S. Malik, Interko
31. Col. Deswal, Sunshine Pvt. Ltd
32. Mr. Ajay Mahendirata, ISHRAE
33. Mr. Pankaj Mehta, Carrier
34. Mr. Sanjay Gupta, Infracol
35. Mr. Tarun Malhotra, Carrier Trans
36. Mr. Asish Goswami, Carrier Refrigeration
37. Mr. Parvinder Singh, Vertrieb Indien Sales India
38. Mr. Umesh Agarwal, ISOPAN
39. Mr. Mahesh Shastri, Starfrost Asia
40. Mr. Navneet S. Pruthi, Goblin Foods Pvt. Ltd, Mumbai
41. Mr. Sanjeev Saini, Bayer Material