Technical Standards and Protocol for the Cold Chain in India

Cold Storage For Fresh Horticulture Produce Requiring Pre-cooling Before Storage (Technical Standards Number NHB-CS-Type 02-2010)

25 Years
राष्ट्रीय बागवानी बोर्ड
NATIONAL HORTICULTURE BOARD

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Preface

A Task Force on development of cold chain in India had been set up by the Ministry of Agriculture vide its order dated 3rd May 2007. The said Task Force had recommended revised normative cost for cold storages and subsidy norms for ensuring technology up gradation in cold storages. It has, therefore, been felt necessary to define appropriate technical standards in respect of various components of cold storages without which exercise of quantification of revised normative cost, subsidy norms etc cannot be substantiated; nor can the desired results of effecting technology up gradation be achieved. Therefore, Department of Agriculture & Cooperation, Ministry of Agriculture, Government of India, vide its communication No. 22011/5/2007-M-II dated 16th June 2009 constituted a Technical Standards Committee. Terms of Reference of the Technical Standards Committee **(TSC)** is to give recommendations on the following issues-

(i) Suitable technical standards and protocols for cold chain infrastructure in the Country

(ii) The mechanism of implementation of such standards and protocols

(iii) Any other issue that the Committee may consider important or relevant for the subject or may be assigned to it by the Government.

The Committee was given initial time frame of two months for submitting its recommendations. However, extension up to end of November 2009 was formally granted at a later stage.

The **TSC** has classified cold storages for fruits & vegetables in following three main categories as listed below and *is hereby, submitting technical standards etc in respect of the second one of them.*

Categories of Cold Storage taken up for determining technical standards

(i) Cold storages for storage of fresh horticulture products which do not require pre-cooling

(ii) Multi-commodity Cold storages for short term and long term storage of fresh horticulture products which require pre-cooling and varying storage requirements

(iii) Control Atmosphere **(CA)** Storages

These Standards cover Cold Storage of Type-(ii) mentioned above and have three sections viz. Technical Standards, Basic Data Sheet and Protocol for Implementation of the Prescribed Technical Standards. While firming up its recommendations by TSC, emphasis is laid on optimum energy efficiency and overall performance and therefore coefficient of performance (CoP) is one of the determining criteria. In addition, aspects of environmental and safety concerns and Human Resource Development too have been taken in to account.

The Technical Standards have general information on the type of produce that can be stored in particular Type/ module, their critical storage conditions, (as much compatible with the World standards as possible by relying on **World Food Logistic Organisation** (WFLO) database in absence of research data for Indian conditions) in terms of temperature, humidity range, CO_2 level, loading rate, pull down time, air circulation and ventilation requirement etc. In order to facilitate improved design, there is a detailed Basic Data Sheet available in the Section 2 of the Standards wherein plotting different specification data into a system shall lead to better coefficient

SECTION - I

Section-I

Technical Standard for Cold Storage for Fruits and Vegetables requiring Pre-cooling before storage

Cold Storage Type – these type of cold stores are meant for storing different types fresh fruits and vegetables and other horticulture products which require pre-cooling or rapid room cooling to "seven-eighth-cooling" in a short time period of 4 hours to 24 hours depending on requirements in order to preserve there freshness, quality and self life. The 7/8 cooling time is the time needed for the product temperature to drop by "seven-eighths" of the difference between the initial product temperature at the time of loading and the temperature of the cooling air circulating in the cold rooms. In case of room cooling the fresh produce can be cooled and stored in the same room without the need of transfer but it requires that the rooms are properly designed with adequate refrigeration, air circulation and most importantly proper stacking and storage arrangement. However for much faster method of pre-cooling, in case the field heat is required to be removed from the fresh produce within 4 to 6 hours, forced-air cooling is adaptable to a wide range of commodity. This allows the cold air to be in direct contract with the warm produce by moving it through the produce rather than around the containers.

Multi commodity cold stores are provided with multiple chambers enabling them to store a wide range of fresh horticulture products together with respect to there storage compability requirements for temperature, relative humidity, atmosphere, protection from odour and sensitivity to other gases like ethylene. The refrigeration system is designed to adjust and operate to a range of temperature and humidity conditions, depending on the compatibility group for storage of fruits and vegetables

Efficiency and performance in such cold stores is linked to appropriate storage systems which greatly optimize space, allows uniform air circulation through the produce and meets the fundamental requirements of stock rotation which is time sensitive due to limited shelf life. This becomes more important for the cold stores being set up for the retail trade, export and food processing industry.

1. General recommendations about pre-cooling

For most fresh horticulture commodities, one hour time loss at the field temperature of 35°C between harvest and pre-cooling can reduce quality as much as 20 hrs in storage under proper conditions. Delay in pre-cooling results in loss of moisture from the produce causes weight loss and combined with active micro-biological organisms result in deterioration of quality and value loss.

The design of the multi-commodity cold store facility and method of pre-cooling depends on various factors like nature of product, category and product type which determines the period of storage for example short term storage (generally refer to as 7 to 10 days storage) or long/medium term storage. Handling, stacking and storage methods, packaging, frequency of entry and exists are also key deciding factors. The requirements of pre-cooling fruits and vegetables are generally classified as under:

(i). Fruits and vegetables which require on farm pre-cooling if transport time to reach them to cold storage is more than a few hours. It is desirable that fresh produce like grapes, mandarins, berries, cherries, leeches, melons, stone fruits, sapotas, okra, tomatoes, capsicum, chilli peppers, brinjal, cucumbers, green beans, peas, spinach should be cooled as rapidly as possible.

(ii). Less perishable fruits & vegetables such as mangoes, papaya, guava, green bananas, pomegranates, radish, cabbage, cauliflower and carrot can be transported from the field and pre-cooled at the cold storage facility.

2. Critical Storage conditions and Grouping of Products

i. Pre-cooling- Pre-cooling requirements vary based on produce and method of cooling such as room cool, hydro cool, forced air cooling, evaporative forced air cooling and ice packaging. However, forced air cooling within 4-6 hours is adoptable to a wider range of commodities than any other pre-cooling method and may suffice for most of the produce and therefore, it is taken for recommending general technical standards for pre-cooling system. General recommendations in this regard for 7/8 cool for selected fruits are as follows-

Most Appropriate Method of Pre-cooling

Fruit	**Room Cool 1+ days**	**Hydro cooling 30 minutes to 1 hour**	**Forced Air 2-6 hours**	**Evaporative Forced Air 2-6 hours**	**Package Ice**
Apples	x	x	x		
Pears	x	x	x		
Mangoes		x	x	x	
Citrus	x (excluding mandarins)		X mandarins		
Grapes			x		
Lychees			x	x	
Melons	Water melons only	x	x	Cantaloupes	only
Cherries			x		
Bananas			x	x	
Papayas			x	x	

ii. Quality of produce – Produce should be mature with required firmness and free from bruises and other external damages. Therefore, for good keeping quality, fresh produce should be carefully handled in all operations including picking, grading and packaging.

iii. **Commodity Storage Conditions-** For designing a cold storage, product storage conditions must be defined in terms of critical storage conditions of temperature, relative humidity, presence of CO_2, ethylene, air circulation, light etc. In absence of research data for Indian conditions, it is recommended to adopt commodity storage conditions as prescribed by *Commodity Storage Manual of WFLO***.**

a. **Temperature range:** The temperature in the multi commodity cold store chambers should be kept within $\pm$ 1°C of the recommend temperature of the produce being stored. For storing at temperatures close to freezing point of the commodity, for increasing storage life, even a narrow range may be needed.

b. **Humidity range:** The humidity (RH) is again dependent on the produce storage requirements and may vary from 95% to 98% RH in case of fresh fruits and vegetables like grapes, kiwi fruit, carrots, cabbage etc and lower in the range of 65% - 75% RH in case of onion and garlic.

c. **CO_2 level –** not more than 4000 PPM during loading and 2000 PPM during holding. *(Source – Industry)*

However if the cold store chambers is being used for Modified Atmosphere Storage for selective commodities like apples etc, the levels of CO_2 & O_2 should be maintained and regulated as recommended in the *Commodity Storage Manual of WFLO*.

d. **Loading Rate-** Generally the refrigeration system capacity is based on 4% to 5% loading rates of the total cold store capacity. The loading pattern is also a design consideration for sizing the storage chamber capacity for optimal utilization and performance.

In case separate pre-cooling chambers are provided in the multi commodity storage facility, the load per batch is to be considered along-with initial and final desired product temperature, pull down rate etc while sizing the pre-cooling chambers and the refrigeration requirements.

e. **Pre-cooling Time-** 4-6 hours for pre-cooling to 7/8th cooling time as recommended for majority of fresh fruits and vegetables. However, in case of fresh produce like carrots, apples etc meant for long/medium term storage, which are directly cooled and stored in the cold rooms, the cooling period, can be up-to 20 hrs per day and should meet the requirements specified in the commodity storage manuals.

f. **Air Circulation**- Multi Commodity stores should be design to provide an air flow of 170 CMH per metric ton of product, based on maximum amount of product that can be stored in each chamber. This is essential for rapid cooling of the produce. However the system should be designed to reduce air flow to 34 to 68 CMH per metric ton of product after the produce has reached the storage temperature. This is achieved by variable frequency drive and control system to automatically maintain the temperature variation within each chamber at less than $\pm$ 1°C through out the storage period. In case the fresh produce is pre-cooled in a separate pre-cooling chamber before loading and storage in the main cold store chambers, the air flow requirements may range from 67 CMH to 100 CMH.

g. **Stacking** – During room cooling, cold air from the coils flows past the produce stored in crates/ pallet racks/bins thereby removing the product heat. For best result the pallets/crates/ boxes/ bins should be stacked so that the moving air can contact all the container surfaces for adequate

and rapid cooling. Well ventilated boxes/crates with vent alignment should be considered as they great speed-up the cooling rate by allowing the cooling air to uniformly flow. It is recommended that the storage pallets must be stacked to form air channels 4 to 6 inches wide to direct air movement. They should also be space between the product and walls to allow refrigerated air to absorb the heat of conduction through the walls. Since, air takes the path of least resistant, in proper stacking in hips or partly filled rooms have poor air distribution and effect the cooling rate.

It is therefore recommended that such multi commodity cold store chambers / facility are designed for storage in PVC crates, bins and ventilated card board boxes stacked in pallet frames. However commodities which do not require rapid cooling like onion, garlic, potatoes etc may be stored in jute / nylon net bags, stacked in pallet frame. The pallets are required to be handled with fork lift / stackers. Generally steel pallet frame are of size 1200mm x 1000 mm x 1600 mm high suitable for holding crates and boxes and can be easily stacked up to 4 high. Some times pallets frame of size 1300mm x 1000mm x 1800mm are preferred for storing in 50 kgs bag of potatoes / onion/ garlic for optimal utilization. Generally each pallet frame can hold upto 1000 kg produce

g. Ventilation requirements in the cold store chambers- it may range between 2 to 6 air changes per day to maintain CO_2 less than 4000 ppm .

h. Lighting Condition- Dark

i. Application of Smart Fresh

3. Compatibility groups for storage of fruits and vegetables

In absence of our own R & D data in this regard, we adopt recommendations made by USDA office of transportation and fresh fruits and vegetables are grouped in seven distinct groups (*Source: McGregor, B.M. 1989. Tropical Products Transport Handbook. USDA Office of Transportation, Agricultural Handbook 668).*

Group 1: Fruits and vegetables, 0 to 2°C (32 to 36°F), 90-95% relative humidity. Many products in this group produce ethylene.

apples	grapes (without sulphur dioxide)	parsnips
apricots	horseradish	peaches
Asian pears	kohlrabi	pears
Barbados cherry	leeks	persimmons
beets, topped	longan	plums
berries (except cranberries)	loquat	pomegranates
cashew apple	lychee	prunes
cherries	mushrooms	quinces
coconuts	nectarines	radishes
figs (not with apples)	oranges* (Florida and Texas)	rutabagas turnips

*Citrus treated with biphenyl may give odours to other products

Group 2: Fruits and vegetables, 0 to 2°C (32 to 36°F), 95-100% relative humidity. Many products in this group are sensitive to ethylene.

Amaranth*	cherries	parsley*
anise	daikon*	parsnips*
artichokes*	endive*	peas*
asparagus	escarole*	pomegranate
bean sprouts	grapes (without sulfur dioxide)	raddichio
beets*	horseradish	radishes*
Belgian endive	Jerusalem artichoke	rhubarb
berries (except cranberries)	kiwifruit	rutabagas*
bok choy	kohlrabi*	salsify
broccoli*	leafy greens	scorzonera
brussels sprouts*	leeks' (not with figs or grapes)	snow peas
cabbage*	lettuce	spinach*
carrots*	lo bok	Sweet corn*
cauliflower	mushrooms	turnips*
celeriac*	onions, green* (not with figs, grapes, mushrooms, rhubarb, or corn)	water chestnut
celery*		watercress*

*these products can be top-iced

Group 3: Fruits and vegetables, 0 to 2°C (32 to 36°F), 65-75% relative humidity. Moisture will damage these products.

garlic	onions, dry

Group 4: Fruits and vegetables, 4.5°C (40°F), 90-95% relative humidity.

cactus leaves	lemons*	tamarillo
cactus pears	lychees	tangelos*
caimito	kumquat	tangerines*
cantaloupes**	mandarin*	ugli fruit*
clementine	oranges (Calif. and Arizona)	yucca root
cranberries	pepino	

* citrus treated with biphenyl may give odours to other products.
** can be top-iced.

Group 5: Fruits and vegetables, 10°C (50°F), 85-90% relative humidity. Many of these products are sensitive to ethylene. These products also are sensitive to chilling injury.

beans	kiwano	pummelo
calamondin	malanga	squash, summer (soft shell)
chayote	okra	tamarind
cucumber	olive	taro root
eggplant	peppers	
haricot vert (fine beans)	potatoes, storage	

Group 6: Fruits and vegetables, 13 to 15°C (55 to 60°F), 85-90% relative humidity. Many of these products produce ethylene. These products also are sensitive to chilling injury.

atemoya	granadilla	papayas
avocados	grapefruit	passionfruit
babaco	guava	pineapple
bananas	jaboticaba	plantain
bitter melon	jackfruit	potatoes, new
black sapote	langsat	pumpkin
boniato	lemons*	rambutan
breadfruit	limes*	santol
canistel	mamey	soursop
carambola	mangoes	sugar apple
cherimoya	mangosteen	squash, winter (hard shell)
coconuts	melons (except cantaloupes)	tomatillos
feijoa		tomatoes, ripe
ginger root		

*citrus treated with bipheny may give odors to other products

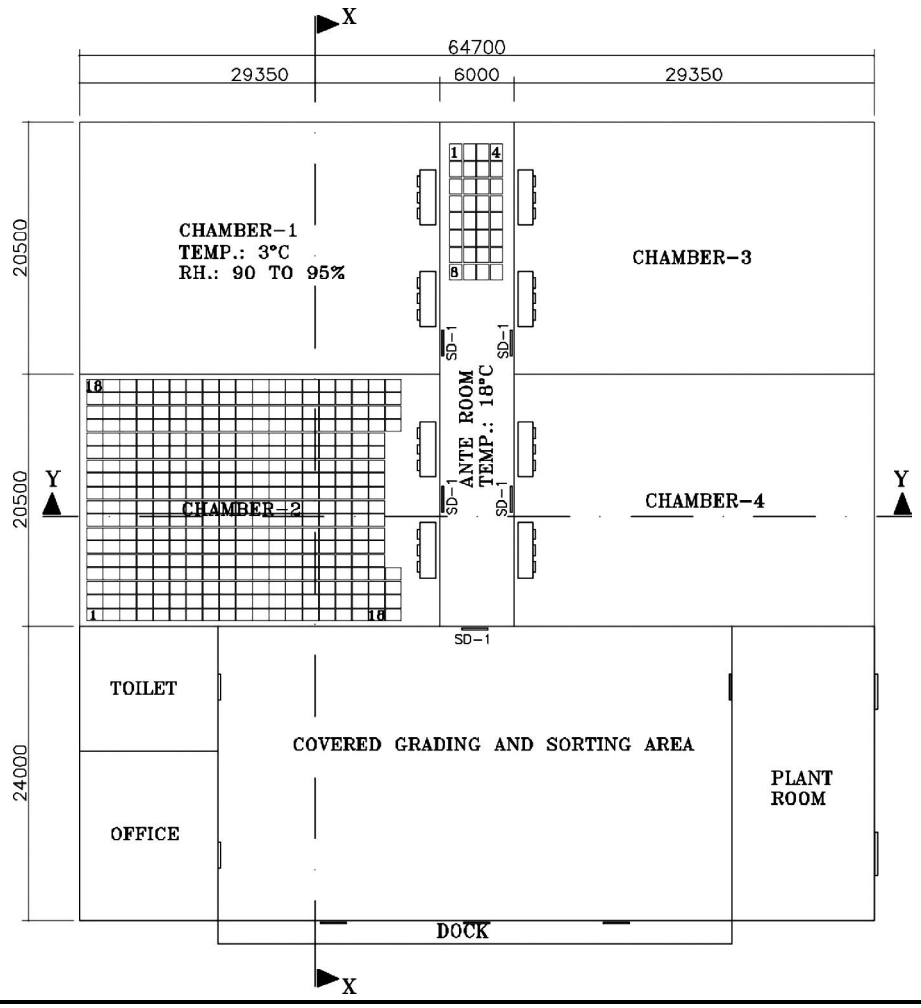
Group 7: Fruits and vegetables, 18 to 21°C (65 to 70°F), 85-90% relative humidity.

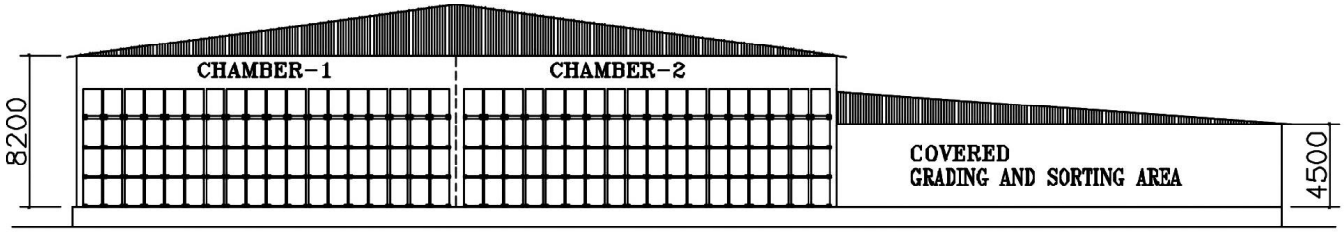
jicama	sweetpotatoes*	watermelon*	yams*
Pears (for ripening)	tomatoes, mature green	white sapote	

*separate from pears and tomatoes due to ethylene sensitivity.

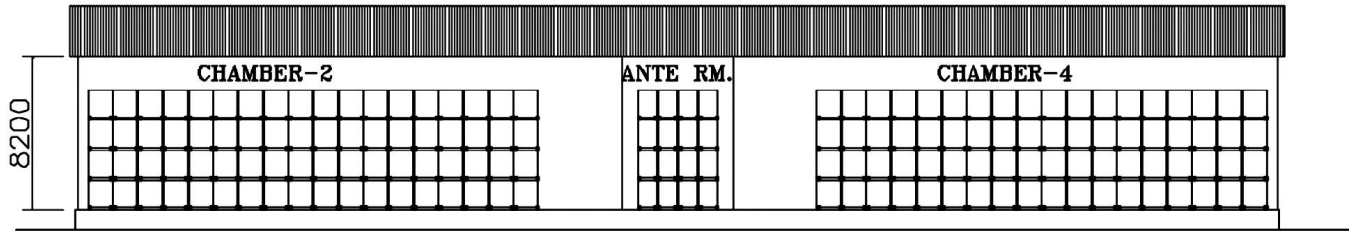
4. Typical Layouts of Multi Commodity Cold Store Facilities

OPTION-1: Typical 5000 MT Multi Commodity Cold Store with provision of rapid room cooling and palletized storage, suitable for long/medium term storage of Fruit and vegetables.





SECTION AT "X-X"



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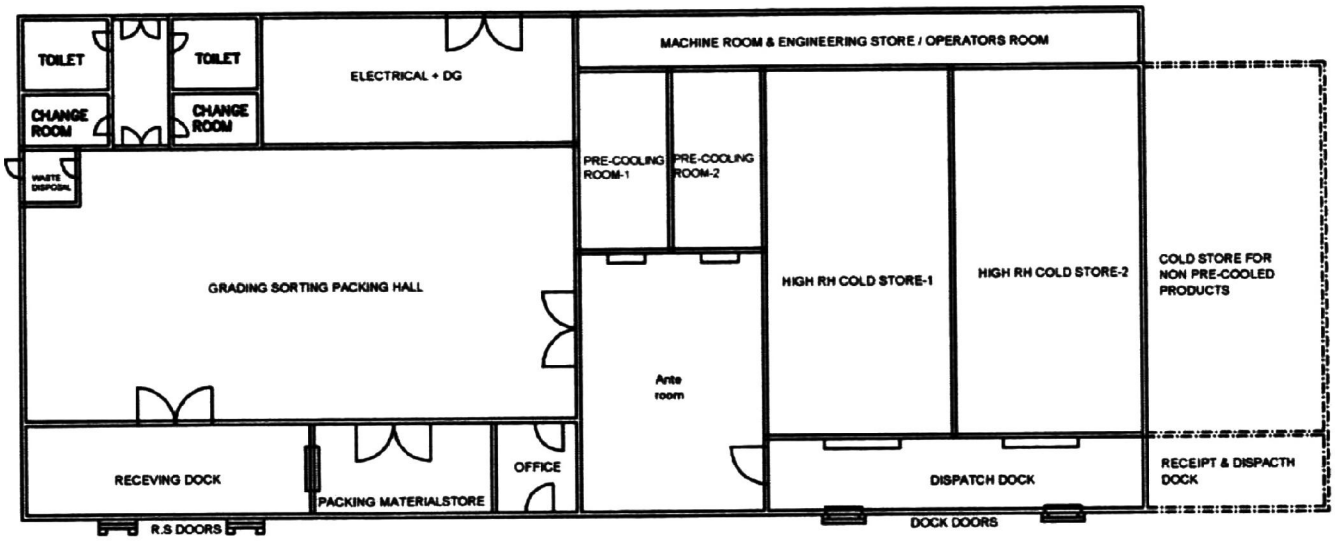
Note: In case of cold stores which are sized to store pallets stacked four levels high, the floor to ceiling height can vary between 7400 mm to 8200 mm depending on pallet frame height to allow sufficient space for air circulation

OPTION-2: Typical Multi Commodity Cold Store with provision of separate pre-cooling rooms and high humidity cold stores.



Typical Configuration: Multi Commodity cold stores will have multiple chambers each having capacity of 30 MT to 1250 MT, anti rooms, docking area, grading/sorting area, grading /sorting line, crates/ palletized storage System & material handling system packing material store, machine room, toilets and changing room, waste disposal, electrical room etc. The facility must be sized to handle peak amount of product. The floor area of each chamber can be calculated based on volume and weight of the produce in crates / pallets, its stackable height and considering floor area for aisle, fork lift manoeuvring and staging. The maximum storage height is limited by stackability of bin or / and fork lift reach.

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: Cold stores with room cooling facility for long / medium term storage will generally have at least four chambers having capacity of 250-1250 MT. However, multi commodity cold stores facilities for short term storage / transit storage which are provided with separate pre-cooling chambers generally have storage capacities ranging from 30 MT to 150 MT depending on frequency of container loading. Total capacity of cold stores can be estimated based on Pallet Frame positions considering 1000 Kg per pallet position or on PVC crate layout and product weight per crate.

Cold Store Building: The Building should be constructed as per approved drawings and dimensions indicated. These facilities can be completely civil construction or steel construction / pre-engineered construction conforming to relevant BIS Codes for live load as per IS 875 Part-II, wind load as per IS 875 Part-III, seismic load as per IS 1893 and other codes and standards if applicable.

In case of conventional civil construction the general specifications are as under:

Walls: 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 walkable for maintenance.

However, in case of Steel / Pre-engineered construction the steel structure components / construction sections are fabricated conforming to relevant codes and standards of ASTM/BIS as applicable. The walls ceiling and partition are generally constructed of Insulated metal skin composite structural panels with core insulation of polyurethane. The insulation requirements or equivalent "U" values are mentioned in the subsequent para. The insulated panels are generally 1 to 1.2 Mtr. wide and in single piece and are extended from floor to the ceiling and held together by fasteners and fixing system. All the joints are properly sealed with silicon sealants for leak proof joint.

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,

Ante Room: The cold rooms should be provided with at least one common ante room area to avoid direct infiltration of warm ambient air into the cold rooms. The ante room also serves as warm-up chambers for produce stored so they do not get wet due to condensation on unloading for dispatch.

Process Grading and Sorting Area: The process area will be maintained at comfortable conditions by using evaporative cooling particularly in dry areas. In high humidity areas, air-conditioning with humidifiers control to maintain temperature range of 20°C to 24°C can be provided which would be suitable for handling of fresh fruit and vegetable produce. Dock shelters will be provided in the dispatch areas of pre-cooled / chilled product.

Grading & Sorting Line: Suitable mechanized sorting; grading, washing and packing line should be provided.

Palletization & Strapping Facility: Pallets / Racks for bulk storage in bags or in bins are to be provided. Moreover, sufficient space for Drive in / Drive through Racks need to be provided, if such storage systems are provided.

Pallet Jack & Fork Lift: Fork lift need to be provided for movement of palletized crates. High reach Stackers / pallet Jack are needed depending on height of palletization.

Bins, Crates, Pallets and Racks: These are required in sufficient numbers for storing and vertical stacking of

produce. Bins and Crates may be replaced by ventilated CFB boxes provided they meet the commodity storage requirements and in view of the period of storage.

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.

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.

4. Thermal Insulation:

It is recommended that appropriate BIS standards are adopted for selection of design parameters (IS 661:2000) and method of application of thermal insulation **(IS 661 & 13205).** For fresh F & V stored at + 0° C , it is recommended to design thermal insulation for (- 4° C to + 2° C) temperature condition to have lower heat load.

Materials of thermal insulation and its application:

Cold chambers have to be insulated on walls, ceilings / roofs & floors with proper insulating material of adequate thickness, with provision for vapour barrier on outer side & proper cladding/ cover on inner side. The commonly used insulation materials are:

a) Expanded polystyrene

b) Rigid Polyurethane foam

c) Rigid phenolic foam

d) Mineral wool / glass wool

e) Extruded polystyrene

The ancillary materials to be used include:

a) Vapour barrier e.g. aluminium foil, polyurethane sheet, with bitumen / cold mastic adhesives

b) Teakwood batten pegs, Tees etc.

c) G.S. sheet runners (avoid wooden batten runners)

d) Cladding of profiled / pre-coated G.S. Sheets 0.5 / 0.6 mm thick / Fibre-glass sheets of suitable thickness

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

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 and 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

MINIMUM INSULATION THICKNESS FOR VARIOUS INSULATION MATERIALS BASED ON RECOMMENDED U VALUES FOR -4 TO +2 ° COLD STORAGE

Type of insulation	Material		Wall		Ceiling/ roof U value = 0.24 W/m²K	Floor U value = 0.29W/m²K
			External U value = 0.27W/m²K	Partition U value = 0.58W/m²K		
	p Density Kg/m³	K (at 10 °C) W/mK	Thickness mm	Thickness mm	Thickness mm	Thickness mm
EPS	15	0.036	150	75	150	125
PUF	32	0.023	100	50	100	100
XPS##	30-35	0.025	100	50	100	100
Phenolic foam ***	50	0.026	100	50	125	100
Mineral wool ***	48	0.033	125	50	125	100
Bonded fibre glass/ glass wool***	32	0.033	125	50	125	100

*** Recommended only with vapour barrier and metal or FRP cladding min 0.5 mm TCT

Recommended in conformance to ISO/FDIS 4898:2008(E) for properties of XPS used for thermal insulation of buildings, Categories II, III & IV only.

Notes-

- **K** values from IS661:2000.
- **U** values are the recommended heat transmission coefficients for cold storage temperature range -4 to 2°C by IS661:2000
- All values rounded off in multiples of inch (25 mm)

4. Total Refrigeration Load - Heat Load Calculation

- **Procedure for load calculation**

  Procedures laid out by ASHRAE Fundamentals and Refrigeration handbooks may be followed. The current method prescribed by ASHRAE Fundamentals is RTS (radiant time series) method in which room by room analysis for each hour is carried out. However, the assumptions used for the building envelope and the loads are very crucial. 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.

- **Product incoming temperature**

  It varies with location and harvesting time. The initial product temperature and the final product temperature along-with the temperature pull down period has to be considered for estimating the refrigeration requirement.

- **Capacity during loading, pull down, holding and lean periods**

  Refrigeration capacities should be calculated at various operating conditions and necessary arrangements for capacity control are included in the equipments to be provided.

5. Refrigeration System & Equipment Selection

Vapour Compression systems are commonly used. However, absorption systems can also be used for cold storages, where heat is readily available instead of electricity e.g. solar, geothermal, waste heat etc. A 7.5TR ammonia-water absorption system was installed at Manikaran by IIT Delhi in 1980's. It worked on Geo-thermal energy.

Refrigerant issues – eco-friendly, safety, energy efficiency.

Ammonia seems to be the best refrigerant in terms of environment (being natural) and energy efficiency for this application. However, it is toxic and precautions should be taken in its handling. In case there is a restriction of using ammonia at certain locations, the refrigeration system can be designed to work on R134a, R404A etc.

- **Type of system – direct expansion (in case of HFC and others) , liquid overfeed and gravity with a surge drum in case of ammonia**

  Liquid overfeed systems force excess liquid through the evaporator to improve the system efficiency and reduce the operating costs. It becomes more favourable as the number of evaporators goes up. Details of a gravity feed system are included in details on subsequent pages with list of additional equipment for a liquid overfeed system.

- **Compressor – reciprocating/ screw with capacity control**

  In case separate pre-cooling chambers are provided for pre-cooling produce before transferring it to the CA cold store chambers, independent compressors shall be provided for each pre-cooling chamber or the refrigeration system suitably designed to accommodate such batch cooling process.. For cold stores, a common compressor system can be provided. Multiple multi-cylinder reciprocating compressors or screw compressors with appropriate capacity control may be used. Typically the holding capacity may just be 50% of the peak capacity during loading. So, it may be suitable to go for two same sized compressors each suitable for holding capacity at peak loads. A third compressor as standby compressor is recommended. Compressors should be able to deliver the desired capacity at worst conditions not at rated conditions. VFD's can also be used for closer control in some cases. Capacity of compressor shall be confirmed by data-sheet of manufacturer.

- **Condenser – atmospheric, evaporative, water cooled**

  Condensers can be air cooled with water spray or with provision of pre-cooling of condenser air in case of HFC / HCFC or water cooled with S&T condenser or Plate Heat Exchangers (PHE) with cooling tower arrangement in case of HFC / HCFC/Ammonia plant or of evaporative / atmospheric type or shell and tube water cooled type with cooling tower arrangement in case of ammonia plant. Capacity of condenser shall be confirmed by data- sheet of manufacturer. Coils with Aluminium tubes and Aluminium fins can also be used.

- **Cooling coils – ceiling / wall mounted**

  Delta T (difference between evaporating and air inlet temperatures) should be kept low for higher humidity in the chamber. Typical values shall be 4.4 or less during holding period and can go up to 6 during peak loading period. This shall be confirmed by data sheet of manufacturer. This increases the coil surface substantially. The coils selected are kept on the higher side to keep higher humidity levels even during loading/ pull down periods. Ammonia coils are typically MS hot dip galvanised or SS/ aluminium tubes with Aluminium fins. The cooling units for other refrigerants have coils with copper tubes and aluminium fins.

- **Air handlers for ultra high humidity forced air pre-cooling**

  Forced air pre-cooler is a separate room from the cold store chamber and is a much faster method of cooling fresh produce than room cooling because it causes cold air to move through the produce rather than around the containers. This is accomplished by producing a difference of pressure of opposite faces of stacks of ventilated containers. This pressure difference forces air through the stacks and carries the field heat away. Various air flow designs can be used depending on need and design of the facility such as Tunnel-Type, Cold Wall and Serpentine forced air cooling. The air handling units for pre-cooling shall be specially designed units for faster rate of cooling with high RH in the range of 96-98 %. The generally used design incorporates a DX cooling coil in case of HCFC/HFC refrigerants or a flooded ammonia cooling coil with adequate water circulation and spray system over the cooling coil and heat exchange surface deck and is provided with a high airflow & high static fan mounted on the unit.

- **Humidification system**

  Although higher humidity levels of 85-90% can be achieved by keeping low delta T in the cooling coil. But during loading periods and for RH>90%, humidification system is a must. Several techniques are available, but it should preferably be done using water mist with 2 - 10 micron and uniformly distributed all over the chamber ensuring that the product does not get wet.

- **De-Humidification system –** *In case of compatibility with Group-3 commodity namely Onion and Garlic*

  For achieving low humilities in case of dried roots / bulbs / dry fruits / nuts, the cooling coils are selected at a higher delta T of 11°C and are specially design in which the first section of the

cooling coil cools the air much below the desired room temperature to remove extra moisture and then the air passes through a reheat section to increase its temperature in accordance to the cold room storage temperature requirements. This heat is supplied by the hot refrigerant gas from the compressor discharge pipeline and controlled through special controls.

- **Commodity Generated Modified Atmosphere**

  For some commodities, better storage results may be obtained by storing them in a modified atmosphere conditions combining the effects of temperature, relative humidity and gas compositions of CO_2 and O_2. In Multi Commodity Cold store chambers can be used for modified atmosphere storage, where the CO_2 content in the atmosphere is increased during the natural respiration of the products. The CO_2 level can be increased or decreased by natural controlled ventilation with outside air. Accurate monitoring of CO_2 and O_2 concentration is essential for such MA Storage. Such Modified Atmosphere cold rooms are beneficial for mid term storage of apples and short term storage of fruits like bananas.

- **Capacity control of fans**

  Fans' operation can be cycled to save power during part load operation. VFD's *may* also be used on the fans to get good savings.

- **Testing and Charging the system**

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

- **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.

- **Defrosting method – water/ hot gas etc.**

  Water defrosting is a simple method and can be done manually or through a timer.

- **Equipment de-rating at higher ambient**

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

6. GENERAL SPECIFICATIONS FOR REFRIGERATION SYSTEM

Brief Specifications for Equipment / Materials / Services

i. Refrigeration Compressors & Motors

Quantity	For pre-cooling, one compressor shall be provided for each chamber to facilitate independent operation of the batch. For Cold stores, 3 No. each of 50% capacity (*one preferred as standby)* can be provided in case of ammonia. In case of HFC / HCFC, individual condensing units or rack system can be provided.
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.
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

Coil section	Hot dip galvanised M.S. pipes CDW Boiler quality tubes / ASTM A 214 or S.S.304 tubes,
Fan section	With 2 / 3 Axial Flow Fans with Cast Aluminium OR S.S impellers, complete with TEFC Sq. cage motors, Class F insulation & IP-55 protection
Water sump tank	S.S.304 or 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 capacityat 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 / HCFC.

Capacity	*To be configured in kW*
Size	To be furnished

iii. **H.P. Receiver**

Horizontal Ammonia 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 no's 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

iv. **Air Cooling Units**

a) Finned cooling coil	Coil design to be suitable for gravity feed / pump circulation for ammonia & DX operation for HCFC / HFC as per design
M.O.C	Hot dip galvanised coil with M.S. pipes CDW Boiler quality tubes – ASTM A 214 with MS finsor S.S.304 tubes & Aluminium fins OR Aluminium tubes & Aluminium fins with proper bonding system with bullet drawn expansion / equivalent expansion for AmmoniaFor HFC / HCFC coils with copper tubes & aluminium fins or aluminium tubes with aluminium fins.
Fin spacing	*(4-6) FPI for rooms with coil temperature above 0°C and for all other conditions fin pitch should be (3-4) FPI*[1]
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
d) Defrosting arrangement	Water
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 each	To be configured

[1] Design Essentials for Refrigerated Storage Facilities (2005). ASHRAE

v. 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. For HFC / HCFC, hard Copper piping type LPiping as per. ANSI guidelines and pressure vessels as per BIS Code IS 2825). Reference to ASHRAE B-31.5 recommended.

vi. Water Piping, Fittings & Valves

Piping shall be used fora. Condenser water circulationb. Compressor coolingc. Defrostingd. 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.

vii. Water Pump sets

Water flow capacity to take care of condenser water flow & compressor head/ jacket cooling	2 nos. (one standby)
Capacity	To be configured

viii. Thermal insulation for refrigerant piping etc.

Material for insulation for refrigerant suction line, accumulators etc.	a. EPS pipe section b. PUF pipe sectionWith 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

ix. Duct Mouth pieces

To be provided on each fan outlet for uniform distribution of air at the topmost level	G.S. sheet ducting as per IS 655

x. Ventilation for cold chambers

System to be designed for providing adequate air changes / day	Axial flow / Inline duct fans with cleanable inlet filters, G.S sheets / Aluminium / PVC ducting up to cold chambers and ducting for exhaust from cold chambers to outside
	Heat exchanger with energy recovery wheel or heat pipe can be used for cooling the incoming air from the exhaust air. Typical efficiencies of heat exchangers are 70% or higher and recommended for achieving higher CoP.

xi. **Humidification**

External humidification for 90 to 95 % RH	Fogger type external humidification system with 2 to 10 micron particles with automatic regulation

xii. **Controls-** One sensor per 100 ton of storage is suggested as good (Univ. of Idaho study).

Temperature control	Temp Indicators cum controllers for individual chambers. Temperature scanners and a centralized temperature indication in machine room
RH control	RH indicator & controller
CO_2 control	CO_2 sensors for regulation of ventilation system
Refrigerant flow controls	Liquid level controls, solenoid valves etc.
PLC control systems	For overall control of various parameters

xiii. Installation, Testing & Commissioning

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

General Notes:

a. The above design recommendations are based on Ammonia as refrigerant & the system designed for gravity feed for air cooling units. It is also possible to use pump circulation system (overfeed system) requiring following components :

b. Centralised ammonia L.P receiver

c. Ammonia pumps – 2 nos.

d. Refrigerant flow & safety controls

e. Interconnecting piping – both supply & return lines shall be insulated. In this case the individual accumulators for AC units & level controls etc. are not required.

8. ELECTRICAL INSTALLATIONS

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

ELECTRICAL INSTALLATION

i. Substation

Substation with a rating of about 200kW	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 requiremente. 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.*

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 conductors for main power lines & equipment lines & copper conductors for lighting, control wiring etc.

vi. Lighting

Lighting in a. cold stores, ante room b. other areas c. outside areas	The light fittings (with non glass covering) should be energy efficient eg. CFL (with vapour proof casing) fittings for cold chambers. A central switch should be provided outside each chamber. Typical installations for lights may be 2 to 3 W / m^2 of floor area. **(IS 15111)**

9. Safety:

SAFETY MEASURES

Provision for handling accidental leakage of ammonia	Ammonia sensors in cold chambers near ACU's & machine roomEmergency ventilation for machine roomSafety release of refrigerant to water sumpAmmonia masks First aid kitInstructions for handling emergencies
Fire protection	Fire sensors in cold chambers & machine room. Dry & water based fire fighting systems as per specs below. Sprinklers for high 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	

i. Fire Fighting

a. Dry Type

Fire fighting equipment necessary fore xtinguishing 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 Bucketsiv) M.S. Stand for Fire Buckets

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

10. Coefficient of Performance (CoP)

Optimum energy efficiency should be determining criteria for CoP.

11. Operation & Maintenance

Cold storage design must be accompanied by Operation & Maintenance Manual for cold storage 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

12. 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.

SECTION - II

BASIC DATA SHEET

Basic Data Sheet

NHB/TSC/Multi Commodity/Draft

Data Sheet for Multi Commodity Cold Stores for Long Term & Short Term Storage of Horticulture Produce that requires Pre Cooling (Rapid cooling)

A. Identification

Name of Cold Storage			
Location of Cold Storage	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	

B. Multi Commodity Cold Store Design Considerations

i) Commodity Storage Requirements

- Multi Commodity Horticulture Produce) *Reference to Annexure I*
- More than two Commodity Groups are storable at any given time
- *Use separate sheets for additional commodities*

Type of Commodities/Produce	
Ideal / Recommended Storage Conditions – Temperature (DB in ^{O}C) – Humidity RH (%) Range – CO_2 Percentage – O_2 Percentage (Optional in case of MA storage) – Rapid Cooling Rate (Product Temp Pull Down duration in hrs) – Air Circulation (CMH/MT of Produce) – Produce Freezing Point ^{O}C – Others	
Chamber Dry bulb (DB in ^{O}C)	
Chamber RH (%)	
Max Storage period (months)	
Max product temp (^{O}C) – at the time of loading	
Daily loading rate (MT/day) – in each cold chamber	
Loading Period (months)	
Temperature Pull down rate (^{O}C / day)	
Unloading Period (months)	
Daily unloading rate (MT/day) – from each cold chamber	
Ante Room Conditions (T ^{O}C & RH %)	
Sorting & Grading Area (T ^{O}C & RH %)	

ii) Storage System (Racks, Bins, Crates with/without Pallet Racking)

Brief Description of Storage System	
Bins/ Crates/Palletization in Racks	
Size of Bin/Crates	
Material of Construction	Wood/Plastic
Type of Packing of Produce	Boxes/Bags
Storage Capacity (Kg/Bin/Pallet)	
Stack ability (Bins/Pallet High)	

iii) Fresh Air / Ventilation System (if Applicable)

Brief Description of CO_2 Extraction / Ventilation System	
CO_2 Concentration Control Range (PPM)	
Monitoring & Control Instrument – Type – Accuracy	
Ventilation Capacity (Max Air Changes/Day)	
Design Considerations for Energy Recovery and Preventing Wetting of Produce	

iv) Cold Store Chamber Sizing and Capacity

- No. of chambers: *(based on Commodity Groups- Annexure I)*
- Type : Bins/Crates/Palletized
- Max Height of Building

Details	**CSC 1**	**CSC 2**	**Precooling - 1**	**Precooling - 2**
Total Capacity of Each Cold Store Chamber (MT)				
Internal Chamber Dimensions L x B x H (m)				
No. of mezzanine floors for non pre-cooled storageX Height (m) per floor				
Size & Weight of Bins/Pallets being stored				
Total number of Bins/Pallets stored in each Cold Store Chamber				

Note: Use extra sheet for additional chambers

v) Ante Room & Process Areas

Details	Length (m)	Width (m)	Height (m)
Ante Room			
Sorting & Grading Area			
Loading / Unloading dock			

vi) Machine Room & Utility Areas

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

vii) Building & Construction Details

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

Type of External walls of cold chambers	
Type of Internal / Partition walls	
Type of Roof / Ceiling	
Type of Flooring for forklift/stacker movement	
Types of Lighting fixtures in cold Chambers	
Types of Lighting fixtures in Process & Other Areas	

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 m^2/h				
Water vapour transmission rate, ng/Pa.sm, Max.				
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				

ix) Cold Store Doors & Air 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 Inspection Windows & size	
Air curtains, if any	
Others type of doors for ante room and process area	

x) Material Handling

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

Procedure	Brief Description
Material Handling Procedures & Equipments	
Any other device	

xi) Grading, Sorting Washing & Packing Line (optional)

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

Procedure	Brief Description
Process Line	
Total Connected Load (kW)	

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.

C. Heat Load Calculation of Cooling System - Summary

Ambient Conditions	Summer	Monsoon	Winter
Dry Bulb Temperature (°C)			
Wet Bulb Temperature (°C)			

Refrigeration Load		During Loading (kW)	During Pull Down (kW)	During Holding (kW)
Transmission Load				
Product Load				
Internal Load	Lighting load			
	Occupancy load			
Infiltration Load				
Ventilation/ Fresh Air Load				
Equipment Load - Fan motors etc.				
Total Load (kW/24 hrs)				

Compressor Operation Hours/Day	Pull Down Period
	Holding period

Multipliers	Safety Factor
	Defrost Period

Total Refrigeration Load	Peak Period	Holding Period	Lean Period
Total Load (kW)			

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 Qualified Engineer.

E. Cooling System Design & Equipment Selection

i) Cooling System Configuration

Type of Refrigerant	**Ammonia /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 (°C)	Refrigeration Capacity (kW)	Motor Rating. (kW)	Total Electric Power. (BkW)	Remarks Working / Standby

iii) Condenser Details - for Ammonia

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

v) Cooling Tower Details (if applicable)

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

vi) Air Cooling Units (ACU)

ACU Make & Model	Nos.	Operating Parameters Evap. (SST) & TD* (°C)	Cooling Capacity (kW)	Air Flow (CMH) & Face Velocity (M/S)	Material of Coil Tubes & Fins	Fin pitch (mm)	Total Fan Electric Power (BkW)

* TD - Temperature difference between Evap. (SST) °C and 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 Instillation

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) (proposed)	
Size of Capacitor for power factor correction & their operation	
Make & Capacity of standby D.G. Set (KVA)	

F. Safety Provisions

Details of Fire Fighting equipment	Dry	
	Water based	
Handling Refrigerants & Leaks	Leak Detection	
	Handling measures	
Safety devices - LP/HP cutouts, safety valves, shut off valves etc.		
Details of Emergency alarm system & push button system in cold chambers		
Emergency lighting in Cold chambers & other areas		
Lightening arrestors		
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 CFL/LED	
Natural Lighting for general areas	
VFD for fans / compressors	
Refrigerant Controls and Automation	
Air Purger	

Power Factor Controller	
Energy recovery heat-exchanger for Ventilation System	
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 Period	Holding Period	Lean Period
Coefficient of Performance (CoP) of the Cold Store Unit			
Power Consumption (kWH/Day)			
Total Electricity Cost (Rs/Day)			
Electricity Cost towards Storage (Rs/MT/Day)			

K. Other Information

Place
Date

Signature and
Name of Applicant with seal

SECTION - III

PROTOCOL FOR IMPLEMENTATION OF TECHNICAL STANDARDS

Section-3

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-

i. A copy of the detailed project report

ii. 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

i. Certificate of approval of the building plan by local planning authority,

ii. Certificate issued by registered civil design engineer about conformity with relevant BIS Standards and prescribed standards and safety concerns,

iii. 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**

i. 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.

ii. 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.

iii. 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.

iv. 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.

v. 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.

ANNEXURES

Annexure - I

No. 22011/5/2007-M-II
Government of India
Ministry of Agriculture
Department of Agriculture & Cooperation

Krishi Bhavan, New Delhi
Dated the 16th June, 2009

A Task Force on development of cold chain in India had been set up by Ministry of Agriculture vide its order dated 3rd May, 2007. One of the recommendations of the Task Force, which submitted its report in 2008, is a standardized infrastructure and service pertaining to the cold chain can be promoted in India.

Now it has been decided with the approval of the competent authority to constitute a Technical Standards Committee for recommending the technical standards and protocols for the cold chain in India with the following composition:-

1.	Managing Director, National Horticulture Board, DAC	Chairman
2.	Shri Daljit Mirchandani, Chairman CII Cold Chain Initiative	Member
3.	A representative of Secretary, Ministry of Food Processing Industries (not below the rank of Dy. Sec.)	Member
4.	A representative of Secretary, Department of AHD & F (not below the rank of Dy. Sec)	Member
5.	A representative of Chairman Railway Board	Member
6.	Joint Secretary and Mission Director (NHM), DAC or his representative	Member
7.	A representative of Chairman, APEDA	Member
8.	A representative of DG, ICAR (not below the rank of ADG)	Member
9.	A representative of Principal Secretary (Horticulture), Govt. of Uttar Pradesh	Member
10.	A representative of Principal Secy. (Agriculture), Govt. of Maharashtra.	Member
11.	A representative of Principal Secy. (Hort.) Govt. of Himachal Pradesh	Member
12.	A representative of Vice-Chancellor, G.B. Pant University of Agriculture & Technology, Pant Nagar Uttrakhand	Member
13.	A representative of Bureau of Indian Standards - Dy. D.G. (Technical)	Member
14.	A representative of Chairman & Managing Director, Central Warehousing Corporation	Member

15. Shri Sanjay Agarwal, CMD, Dev Bhumi Cold Chain Pvt. Ltd. Member

16. Shri S.K. Sharma, MD, Global Agri System Pvt. Ltd. Member

17. Shri P.K. Swain, Director (Marketing), DAC Member-Secy.

National Horticulture Board, DAC will provide the secretarial assistance to the committee. The Technical Standards Committee shall give recommendations on the following issues:-

(i) Suitable technical standards and protocols for cold chain infrastructure in the country.

(ii) The mechanism of implementation of such standards and protocols.

(iii) Any other issue that the Committee may consider important or relevant to the subject or may be assigned to it by the Government.

The Committee will submit its recommendations within a period of two months.

16.6.07

(Rajendra Kumar Tiwari)
Joint Secretary (Marketing)

To

1. Shri S.K. Pattanayak, JS (NHM), DAC, Krishi Bhavan, New Delhi.

2. Shri Bijay Kumar, MD, NHB, 85, Institutional Area, Sector-18, Gurgaon - 122 015 (Haryana)

3. Shri B.B. Patnayak, CMD, CWC, 4/1, Sriri Institutional Area, August Kranti Marg, New Delhi

4. Shri Daljit Mirchandani, Confederation of Indian Industries (CII) Indian Habitat Centre, Core 4 A, 4th Floor, Lodi Road, New Delhi

5. Shri Gokuk Patnaik, Chairman, Global Agri System Pvt. Ltd., K-13A, Hauz Khas Enclave, New Delhi

6. Shri V.K. Dutt, Aditional Member Electrical, Railway Board, Rail Bhavan, New Delhi

7. Shri Rajiv Agarwal, MD, National Cooperative Development Corporation, 4, Siri Institutional Area, Hauz Khas, New Delhi

8. Mrs. Madhulika Prakash, DDG, Bureau f Indian Standards, Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi - 110 002

9. Joint Secretary, Ministry of Food Processing Industries, Panchsheel Bhavan, New Delhi

10. Joint Secretary, Department of Animal Husbandry, Dairying & Fisheries, Krishi Bhavan, New Delhi

11. DG, National Institute of Agricultural Marketing, Kota Raod Bambala (Near Sanganer), Jaipur - 302 033 (Rajasthan)

12. Chairman, APEDA, NCUI Auditorium, 3 Siri Institutional Area, Hauz Khas, New Delhi.

13. Director General, ICAR, Krishi Bhavan, New Delhi

14. Chairman, National Bank of Agriculture & Rural Development, (NABARD), C-24, Bandra Kurla Complex, Bandra (East), Mumbai - 400 051

15. Director, General, Bureau of Indian Standards, Manak Bhavan, 9 Bahadurshah Zafar Marg, New Delhi - 110 002

16. Principal Secretary (Agriculture), Government of Maharashtra, Mumbai

17. Principal Secretary (Horticulture), Govt. of Uttar Pradesh, Lucknow

18. Principal Secretary (Horticulture), Department of Horticulture, Government of Himachal Pradesh, Shimla

19. Vice-Chancellor, G.B. Pant University of Agriculture & Technology, Pantnagar - 263 145 (Uttarakhand)

20. Shri Sanjay Agarwal, CMD, Dev Bhumi Cold Chain Pvt. Ltd.

21. Shri S.K. Sharma, MD, Global Agri System Pvt. Ltd.

22. Shri Rajesh Menon, Sr. Director & Head, Agriculture & Food Processing, Confederation of Indian Industries (CII), India Habitat Centre, Core 4A, 4th Floor, Lodi Road, New Delhi

23. Shri P.K. Swain, Director (Marketing), Deptt. of Agri & Cooperation, New Delhi

24. PS to Additional Secretary (GCP)

25. PS to Joint Secretary (Marketing).

Annexure - II

Technical Standards Committee Experts

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2. Dr. R. Ezekiel, Head, PHT, Central Potato Research Institute, Shimla.

3. Sh. Awadhesh Kumar, Director, Ministry of Food Processing Industries, Panchsheel Bhawan, New Delhi

4. Sh. P. Saxena, Executive Director, National Cooperative Development Corporation (NCDC), 4, Siri Institutional Area, August Kranti Marg, Hauz Khas, New Delhi-110016

5. Sh. L. Shivatania Reedy, Deputy Commissioner, National Horticulture Mission, DAC, Krishi Bhawan, New Delhi -110019

6. Sh. R. K. Boyal, GM, Agricultural and Processed Food Products Export Development Authority (APEDA), 3rd Floor, NCUI Building, 3 Siri Institutional Area, August Kranti Marg, New Delhi-110016

7. Sh. Vinod Pandey, Agricultural and Processed Food Products Export Development Authority (APEDA), 3rd Floor, NCUI Building, 3 Siri Institutional Area, August Kranti Marg, New Delhi-110016

8. Sh. O. P. Bharti, General Manager (Commercial), Central Warehousing Corporation, 4/1, Siri Institutional Area, August Kranti Marg, New Delhi-110016

9. Sh. I. S. Teotia, Sr. Assistant Manager, Central Warehousing Corporation, 4/1, Siri Institutional Area, August Kranti Marg, New Delhi-110016

10. Sh. 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).

11. Mr. Suresh Kumar, General Manager, Confederation of Indian Industry (CII),(Blue Star), India Habitat Centre, Core 4A, 4th Floor, Lodi Road, New Delhi - 110 003 (INDIA)

12. Sh. N.K. Jawa, CEO, Fresh & Healthy Enterprises Ltd., HSIIDC Industrial Estate, Rai, Sonepat-131029 (HR)

13. Sh. Arvind Surange, ACR-Project Consultant, H.O. Vijay Apts., 39/35 Erandavana, Pune-411 004 (Maharashtra)

14. Sh. Sanjay Aggarwal, Dev Bhumi Cold Chain Pvt. Ltd., 17 & 18, Azadpur, New Subzi Mandi Delhi-110 033

15. Sh. A.K. Choudhary, Dev Bhumi Cold Chain Pvt. Ltd., 17 & 18, Azadpur, New Subzi Mandi, Delhi-110 033

16. Sh. Anil Dwivedi, Dev Bhumi Cold Chain Pvt. Ltd., 17 & 18, Azadpur, New Subzi Mandi, Delhi-110 033

17. Sh. M.Verma, Vice President, International Coil Ltd., A-21/24, Naraina Industrial Area, Phase-II, New Delhi-110 028

18. Sh. Amit Garg, Head (Agrifresh & New Initiative), Adani Agrifresh Ltd. Adani House, 83, Sec-32, Institutional Area, Gurgaon- 122 001

19. Sh. Sanjay Gupta, INFRA Cool, AD-95 A, Pitam Pura, Delhi - 110 088

20. Sh. Naresh Kohli, harshna Group of Companies, C-76, New Fruit Market, Azad Pur, New Delhi

21. Sanjeev Jain, Prof., IIT, Houz Khas, New Delhi

22. Sh. S.K. Sharma, Global Agri Systems Pvt. Ltd. K-13A, Hauz Khas Enclave, New Delhi-110 016

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25. Sh. Arvind Agarwal, Chief Technical Advisor, Cold Storage Association, U.P., 40E/2-3, Lal Bahadur Shastri Marg, opp. A.H. Wheelers, Civil Lines, Allahabad

26. Sh. M.K. Chourasia, Head, Deptt. Food Corpn., Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia - 741 252, West Bengal

27. Sh. N.S. Ranawat, Deputy Director, National Institute of Agricultural Marketing, (Ministry of Agriculture, Government of India), Kota Road, Bambala, Sanganer, Jaipur – 303906

28. Sh. Gubba Nagendev Rao, Federation of Cold Storage (A.P)

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33. Sh. Vijay Singh, RINAC India Ltd. 101, Kundan House (1st Floor), Harinagar, Ashram, New Delhi-110014

34. Sh. Rajesh Goyal, National Coordinator, Federation of Cold Storage Association of India.

35. Sh. Atul Khanna, Director, GCCA India Chapter, 10, Sunder Nagar, New Delhi

36. Sh. Zafer Ansari, Dow Chemical International Pvt. Ltd. Corporate Park, Unit No. 1, V.N. Purav Marg, Chembur, Mumbai – 400 071

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39. Sh.. Amit Srivastava, Kirloskar Pneumatic Co. Ltd., 208, Meghdoot 94, Nehru Place, New Delhi.

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41. Mrs. Megha Sanjeev Borse, President Flower Growers Association Maharastra , 20/4, Kulkarni Bagh. Opp. Natural Synergies Ltd., 20 (Old 156) Santheme High Road, Chennai-603004

42. Shri Sopan Kanchan, President, E-15, Nisrag, Market Yards, Gultekdi, Pune-37 (Maharashtra)

43. Shri K. Natrajan, President, M/s Natural Synergies Limited, 20 (Old 156) Santhome High Road, Chennai-603 004

44. Dr. R. S. Minhas, Himalayan Plant Health Clinic & Leaf Analysis Laboratory Khaneri Rampur Bushahar, Distt- Shimla (H.P)- 172001

45. Sh. Shri Ram Gadhave Shivneri Krushi Gram Vikas, Pratishthan, A/P Naryanagaon, Nimbarkar Market, Tah. Junnar, Distt. Pune- 410504

46. Sh. Ravinder Chauhan, President, Lal Bhwan, VPO Kiari, Teh. Kotkhai, Distt. Shimla (HP) – 171204

47. Sh. D.K. Sharma, Vice President Mango Growers Association of India, 166-Acivil line 11, Bijnor - (UP)

48. Dr. R.K. Sharma, Sr. Deputy Director, National Horticulture Board, Ministry of Agriculture, Govt. of India, Plot No. 85, Institutional Area, Sector-18, Gurgaon-122 015 (Haryana)

49. Sh. P. K. Swain, Director (Marketing), Department of Agriculture, Ministry of Agriculture, Govt. of India, Krishi Bhawan, New Delhi

Annexure – III

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

B. Mechanical

Bureau of Indian Standards (BIS)

S. No.	Title	Reference
1.	Safety cods 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 12432Part-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 875Part 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
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 Relevant	IS specification
62.	Food Hygiene – General Principle – Code of Practice	IS 2491-1998
63.	Self blasted lamps for general lighting service	IS 15111 Part 1 and 2

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,

International Standard (ISO)

Standard and/or project

ISO 873:1980 Peaches -- Guide to cold storage
ISO 874:1980 Fresh fruits and vegetables -- Sampling
ISO 931:1980 Green bananas -- Guide to storage and transport
ISO 949:1987 Cauliflowers -- Guide to cold storage and refrigerated transport
ISO 1134:1993 Pears -- Cold storage
ISO 1212:1995 Apples -- Cold storage
ISO 1673:1991 Onions -- Guide to storage
ISO 1838:1993 Fresh pineapples -- Storage and transport
ISO 1956-1:1982 Fruits and vegetables -- Morphological and structural terminology
ISO 1956-2:1989 Fruits and vegetables -- Morphological and structural terminology
ISO 1990-1:1982 Fruits -- Nomenclature -- First list
ISO 1990-2:1985 Fruits -- Nomenclature -- Second list
ISO 1991-1:1982 Vegetables -- Nomenclature -- First list
ISO 1991-2:1995 Vegetables -- Nomenclature -- Part 2: Second list

ISO 2165:1974 Ware potatoes -- Guide to storage
ISO 2166:1981 Carrots -- Guide to storage
ISO 2167:1991 Round-headed cabbage -- Guide to cold storage and refrigerated transport
ISO 2168:1974 Table grapes -- Guide to cold storage
ISO 2169:1981 Fruits and vegetables -- Physical conditions in cold stores -- Definitions and measurement
ISO 2295:1974 Avocados -- Guide for storage and transport
ISO 2826:1974 Apricots -- Guide to cold storage
ISO 3631:1978 Citrus fruits -- Guide to storage
ISO 3659:1977 Fruits and vegetables -- Ripening after cold storage
ISO 3959:1977 Green bananas -- Ripening conditions
ISO 4125:1991 Dry fruits and dried fruits -- Definitions and nomenclature
ISO 4186:1980 Asparagus -- Guide to storage
ISO 4187:1980 Horse-radish -- Guide to storage
ISO 5524:1991 Tomatoes -- Guide to cold storage and refrigerated transport
ISO 5525:1986 Potatoes -- Storage in the open (in clamps)
ISO 6000:1981 Round-headed cabbage -- Storage in the open
ISO 6477:1988 Cashew kernels -- Specification
ISO 6478:1990 Peanuts -- Specification

ISO 6479:1984 Shelled sweet kernels of apricots -- Specification
ISO 6479:1984/Cor 1:1999
ISO 6659:1981 Sweet pepper -- Guide to refrigerated storage and transport
ISO 6660:1993 Mangoes -- Cold storage
ISO 6661:1983 Fresh fruits and vegetab.les -- Arrangement of parallelepipedic packages in land transport vehicles
ISO 6662:1983 Plums -- Guide to cold storage
ISO 6663:1995 Garlic -- Cold storage
ISO 6664:1983 Bilberries and blueberries -- Guide to cold storage
ISO 6665:1983 Strawberries -- Guide to cold storage
ISO 6755:2001 Dried sour cherries -- Specification
ISO 6756:1984 Decorticated stone pine nuts -- Specification
ISO 6757:1984 Decorticated kernels of mahaleb cherries -- Specification
ISO 6822:1984 Potatoes, root vegetables and round-headed cabbages -- Guide to storage in silos using forced ventilation
ISO 6882:1981 Asparagus -- Guide to refrigerated transport
ISO 6949:1988 Fruits and vegetables -- Principles and techniques of the controlled atmosphere method of storage
ISO 7558:1988 Guide to the pre packing of fruits and vegetables
ISO 7560:1995 Cucumbers -- Storage and refrigerated transport
ISO 7561:1984 Cultivated mushrooms -- Guide to cold storage and refrigerated transport

ISO 7562:1990 Potatoes -- Guidelines for storage in artificially ventilated stores
ISO 7563:1998 Fresh fruits and vegetables -- Vocabulary
ISO 7701:1994 Dried apples -- Specification and test methods
ISO 7702:1995 Dried pears -- Specification and test methods
ISO 7702:1995/Cor 1:2001
ISO 7703:1995 Dried peaches -- Specification and test methods
ISO 7703:1995/Cor 1:2001
ISO 7907:1987 Carob -- Specification
ISO 7908:1991 Dried sweet cherries -- Specification
ISO 7910:1991 Dried mulberries -- Specification
ISO 7911:1991 Unshelled pine nuts -- Specification
ISO 7920:1984 Sweet cherries and sour cherries -- Guide to cold storage and refrigerated transport
ISO 7922:1985 Leeks -- Guide to cold storage and refrigerated transport
ISO 8682:1987 Apples -- Storage in controlled atmospheres
ISO 8683:1988 Lettuce -- Guide to pre-cooling and refrigerated transport
ISO 9376:1988 Early potatoes -- Guide to cooling and refrigerated transport
ISO 9719:1995 Root vegetables -- Cold storage and refrigerated transport
ISO 9833:1993 Melons -- Cold storage and refrigerated transport

ISO 9930:1993 Green beans -- Storage and refrigerated transport
ISO 23391:2006 Dried rosehips -- Specification and test methods
ISO 23392:2006 Fresh and quick-frozen maize and peas -- Determination of alcohol-insoluble solids content
ISO 23393:2006 Pomegranate fruit -- Specification and test methods
ISO 23394:2006 Dried oleaster -- Specification and test methods

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,
    a) Commodity Storage Manual
    b) Crisis Management Manual
    c) Guide to Effective Ware House Operations
    d) Maintenance and Modernization Manual
2. American Society of Heating, Refrigeration and Air Condition Engineers, Inc -ASHRAE Handbooks
    a) REFRIGERATION – Systems & Applications
    b) FUNDAMENTALS
    c) HVAC Systems and Equipment
    d) 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

F.No. 45-64/2010-Hort.
Government of India
Department of Agriculture & Cooperation
(Horticulture Division)

Krishi Bhavan, New Delhi
Dated : 25th February, 2010

Subject : Technical Standards for Cold Storages - Reg.

The undersigned is directed to convey the approval for Competent Authority for setting up of following cold storages as per the technical standards submitted by the Technical Standards Committee (TSC) on Cold Storages constituted by the Task Force on Cold Chain Development.

1. Fresh horticulture produce not requiring pre-cooling before storage (Technical Standards Number NHB-CS-Type 01-2010)
2. Fresh horticulture produce requiring pre-cooling before storage (Technical Standards Number NHB-CS-Type 02-2010)
3. Control atmosphere cold stores (Technical Standards Number NHB-CS-Type 03-2010)

In this regard, it is informed that all the project proposals received under various schemes of this Department viz, NHM, TMNE, NHB etc., for setting up of Cold Chain Projects of above categories should invariably comply to the said prescribed technical standards w.e.f. 01.04.2010. The details of technical standards, specifications etc. of the above cold storages are enclosed. Alternatively, details are also available on websites of this Department, http://agricoop.nic.in; www.nhm.nic.in; http://nhb.gov.in

Enclosed : Reports of Technical Standards for Type 01,02 and 03 - 3 Nos.

(L. Shivarama Reddy)
Dy. Commissioner (Hort.)

To

1. Mission Director, State Horticulture Mission - all NHM States
2. Director (Horticulture/Agriculture) - all TMNE States
3. Chairman, NABARD, Mumbai
4. Managing Director, National Horticulture Board, Gurgaon
5. Managing Director, NCDC, New Delhi
6. Managing Director, NAFED, New Delhi
7. Managing Director, NHRDF, Nasik
8. Managing Director, SFAC, New Delhi
9. Deputy Director General (Horticulture), ICAR, New Delhi
10. Chairman, APEDA, New Delhi
11. Chairman, Coconut Development Board, Kochi
12. Joint Secretary, RKVY, Krishi Bhavan, New Delhi
13. Joint Secretary (Marketing), Krishi Bhavan, New Delhi
14. Joint Secretary, Ministry of Food Processing Industries, August Kranti Marg, New Delhi
15. Horticulture Commissioner, DAC, New Delhi

Copy to:

1. PPS to Secretary (A&C)/PPS to Special Secretary
2. PPS to AS (AB)/PPS to AS (GCP)
3. PS to JS (NHM)

of performance from energy efficiency point of view. Section 3 deals with the Protocol for Implementation of Technical Standards, probably through Letter of Intent (LoI), and system analysis of civil structure, thermal insulation and refrigeration.

These standards and recommendations 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 ISO / ASME / ASHRAE / IIAR or other International Codes have been followed. The responsibility for deciding whether other requirements additional to the ones listed in the technical standard 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.

It is recommended that the suppliers / manufacturers shall furnish to the owner copies of instructions / manual which shall include operation & maintenance instruction, built drawings, wiring diagrams, recommended spare parts and replacement part list etc as recommended. It is also envisaged that 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.

Nonetheless, these also have provision for scope of variation, through a Variation and Amendment Clause, to take care of new concepts, innovations, and R&D in building design etc. so that improvements coming along the way are not stopped but analysed and incorporated in the design.

The Notification Constituting Technical Standard Committee is given in Annexure-I.

The Committee acknowledges the valuable contribution made by experts in firming up its recommendations whose particulars are listed in Annexure-II to the report; the list has special mention of non-member experts who have volunteered and spared their valuable time in giving their inputs from time to time. In the end, Annexure-III lists relevant BIS and other standards to which investors, contractors and suppliers may refer to comply with the requirements for designing and installing various components.

TSC gratefully acknowledges USDA Office of Transportation, Agricultural for referring to grouping of fresh fruits & vegetables prescribed by its Hand Book in the prescribed Technical Standards (Source: McGregor, B.M. 1989. Tropical Products Transport Handbook- USDA Office of Transportation, Agricultural Handbook 668).

Last but not the least, contribution made by Dr. R. K. Sharma - Senior Deputy Director NHB has been of immense value as he for all practical purposes functioned as Member- Secretary to the Committee.

Bijay Kumar
Chairman, TSC and Managing Director
National Horticulture Board
(Ministry of Agriculture, Govt. of India)

NHB's Mission in Silver Jubilee Year 2009-10

- Energy efficient Cold Chain Infrastructure
- Human Resource Development for Cold Chain Operation and Commodity Storage
- Accreditation and Rating of Horticulture Nurseries
- NHB-APEDA joint initiative for Export Quality Production
- "From Market Information to Market Intelligence"

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