Technical Standards Committee
on
Technical Standards and Protocol for the Cold Chain in India

Cold Storage
For
Fresh Horticulture Produce Not Requiring Pre-cooling Before Storage
(Technical Standards Number NHB-CS-Type 01-2010)

25 Years
राष्ट्रीय बागवानी बोर्ड
NATIONAL
HORTICULTURE BOARD

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CONTENTS

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 (Annexure-I). *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 has been duly granted thereafter.

The TSC *has classified cold storages for fruits & vegetables in following three main categories as listed below.*

(i) Cold storages for storage of fresh horticulture products which do not require pre-cooling (Technical Standards Number NHB-CS-Type 01-2010)

(ii) Multi-commodity Cold storages for short term and long-term storage of fresh horticulture products, which require pre-cooling and varying storage requirements. Technical Standards Number NHB-CS-Type 02-2010)

(iii) Control Atmosphere (CA) *Storages. Technical Standards Number NHB-CS-Type 03-2010).*

This volume of Standards covers Cold Storage of Type 01 *mentioned above and has four sections viz. Technical Standards, Basic Data Sheet, Protocol for Implementation of the Prescribed Technical Standards and Type Designs. 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, except for potato, 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 of performance from energy efficiency point of view. **Section 3** *deals with the* **Protocol for Implementation of Technical Standards** *through system analysis of civil structure, thermal insulation and refrigeration at the stage of issuing letter of intent and through site inspection at later stages.*

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.

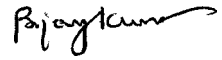
It is recommended that the suppliers / manufacturers shall furnish to the owner copies of instructions / manual which shall include operation & maintenance instruction, built drawings, wiring diagrams, recommended spare parts and replacement part list etc as recommended. It is also envisaged that the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

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 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 *had invited comments to the draft standards by issuing public notice and has examined the comments received from various stakeholders which are in respect of air-cooled ammonia compressors, Bunker-fin Coils, Electro Galvanisation and Hot Spray Galvanisation of MS cooling coils and Paddy Husk type thermal insulation, but in absence of authentic data, TSC recommends undertaking further investigation in to the claims and representations received, before their incorporation in prescribed technical standards.*

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)

SECTION - I

TECHNICAL STANDARDS

Section-I

Technical Standard No. NHB-Cold Storage-Type 01-2009

1. Cold Storage Type :

For fresh fruits and vegetables and other horticulture products which do not require pre-cooling but there is crop specific rate of pull down and storage conditions,

a. Fresh Potato Tubers for following purposes

i. Early Crop (pre mature)

ii. Seed Potato

iii. Table Potato

iv. Process Potato

- French Fries
- Chipping

b. *Onion, garlic, tamarind etc.*

2. Critical Storage Conditions :

i. Quality of produce - Curing & pre-conditioning for about 7 to 10 days in the fields for skin set/ proper handling/ Application of CIPC.

For example- it is recommended that potatoes are harvested at temps not lower than 8° C and not higher than 20° C and harvested potatoes are cured by keeping at 15° C to 20° C and 90% to 95 % RH for 5 to 10 days before placing them into cold storage, allowing the surface wounds to heal, thereby preventing water loss and protection from decay.

ii. 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* in absence of research data from Indian Institutions. Example - Design conditions for Irish Potatoes which are adopted, in absence of data for Indian potatoes are as given below.

a. Temperature, storage period, relative humidity etc.

Fresh Potato	Temperature	Storage Period	Relative Humidity
Early Crop	4 – 10°C	0 – 3 months *	95%
Seed Potato	3°C @	5 – 10 months	90 – 95%
Table Potato	4°C	5 – 10 months	90 – 95%
For French Fries	7.2 – 10°C	1 – 10 months **	90 – 95%
For Chipping	7.2–10°C #	1 – 8 months **	90 – 95%

(*) If cured / wounds healed before storage.

(**) Sprout suppressors must be used for long-term storage.

(#) Generally stored between 9 - 13°C as per WFLO manual whereas CPRI recommends 11°C

@ Based on expert advice of CPRI, which is firmed up by TSC after analysis of the same, critical storage temperature for seed potato is taken as 3°C ±1° C. Moreover, one of the following two critical storage conditions for table potatoes may be taken into account after evaluating their implications on consumer preference for stored potatoes and cost of storage; firstly as critical storage conditions of potatoes for processing purposes and secondly, the critical storage conditions recommended for seed potatoes.

a. 24 hours cooling to 15°C followed by pull down rate of 0.5°C per day till holding temperature of 11°C ± 1°C with CIPC application after first 30 days of storage; in this case stored potatoes may not turn sweet due to separation of sugar, however, storage cost will be higher due to CIPC application.

b. 24 hours cooling to 10°C, pull down to holding temperature of 3°C ± 1°C within 8 to days; in which case, starch accumulation will take place but storage cost may be lower,

c. **Temperature and humidity range:** +/- 1°C for temperature and humidity range as given.

d. **CO_2 level:** Not more than 4000 ppm during loading and 2000 ppm during holding (source: industry).

e. **Loading Rate:** 4% (at 25°C) to 5% (at 20°C) of the total storage capacity (equally split into chambers) per day so that total loading period is about 20 days. Temperature during loading to be maintained at 15° C which should be brought down to holding temperature @ 2° to 3° C per week; subject to choice of adopting CPRI recommendations as mentioned above.

f. **Pull-down time:** 24 hours for pull down to 15° C and @ 20 - 30 C per week for pull down to holding temperature. CPRI recommends that seed potatoes should be cooled to 10° C within 24 hours of arrival at cold store and its temperature should be further pulled down to holding temperature of 3° C ±1° C within 8 to 10 days as sugar separation due to rapid cooling is not a matter of concern for seed potatoes.

g. **Air Circulation:** Minimum 50 CFM/MT of Potato (85 CMH/ MT of Potato) during the loading and pull-down period. However, during the holding period fan power is optimized by fan speed reduced to almost 70% by VFD control (which will reduce fan motor power consumption to 34%) and thereafter automatic control will maintain temperature variation within each chamber at less than +/- 1 °C throughout the storage period.

h. **Ventilation requirements in cold storage:** it may range between 2 to 6 air changes per day to maintain CO_2 less than 4000 ppm. It is recommended to opt for mechanical CO_2 extractor with energy recovery system. It is a much better option than the present practice of opening the cold stores doors & hatch windows to ventilate and remove the CO_2 build-up as the later practice results in loss of energy, inability to maintain temperature variation range of ± 1°C, wetting of product leading to product loss.

i. **Lighting Condition: Dark**

j. **CIPC application:** For processing potatoes in general and for table potatoes if critical storage conditions equivalent to processing potatoes are adopted. CPRI recommends that due to slow pull down of temperature (0.5° C per day) in these situations, high holding temperature is built up which in turn accelerates germination of potatoes immediately after its dormancy period; therefore, CIPC application is recommended immediately after first 30 days of arrival of potatoes in cold storage. He further cautioned that rapid cooling should not be carried out for potatoes for processing purposes.

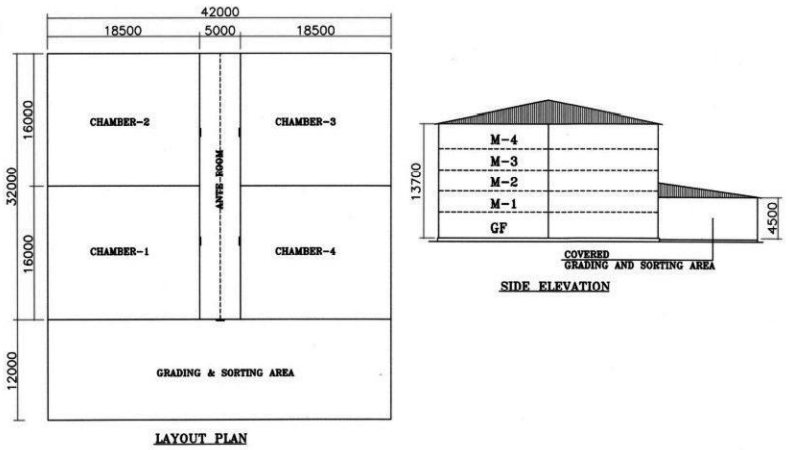
3. Layout of a Typical Cold Store for Products Identified

It is recommended to have multi commodity cold stores for better capacity utilisation. For example - a solely potato based cold storage may be designed for storage of seed potato and table potato or processing potato etc. Similarly, for energy efficiency, cold stores have to be multi chamber. It is recommended to have at least two chambers and chamber size should be of the capacity range of 1,000 MT to 1,500 MT for ensuring uniform storage condition, proper capacity utilization, and energy efficiency. This is not possible in single chamber / larger chamber cold storages. Cold stores for of this type are generally with mezzanine floors, which must be provided with anteroom of adequate dimensions. Having staircase inside the chamber may reduce storage space and restrict possibility of having elevators and fire escape. Layouts with staircase in anteroom facilitate better space utilisation; higher efficiency of workmen, providing for elevators and fire escape but construction cost may be higher due to multiple doors etc. If CIPC is to be used as sprout-suppressor for certain products, then other chambers having products to be used as seed must be adequately separated by having separate anti chamber. Two typical layouts are given below.

TYPE LAYOUT - OPTION - A

FOUR CHAMBER POTATO BASED COLD STORE

(With staircase inside chambers, common entry and exit at ground floor for all floors of a chamber, no provision for elevators and fire escape route)

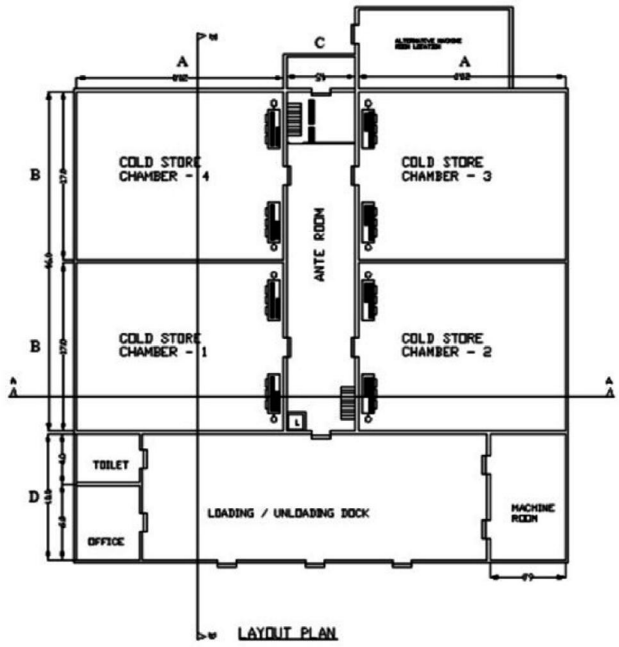


TYPE LAYOUT - OPTION - B

FOUR CHAMBER POTATO BASED COLD STORE

(With provision for staircase outside chambers, doors for each chamber at each floor, elevator and fire escape route etc)

A = 20 – 21 m
B = 15 – 18 m
C > 3 m
D = 10 – 12 m

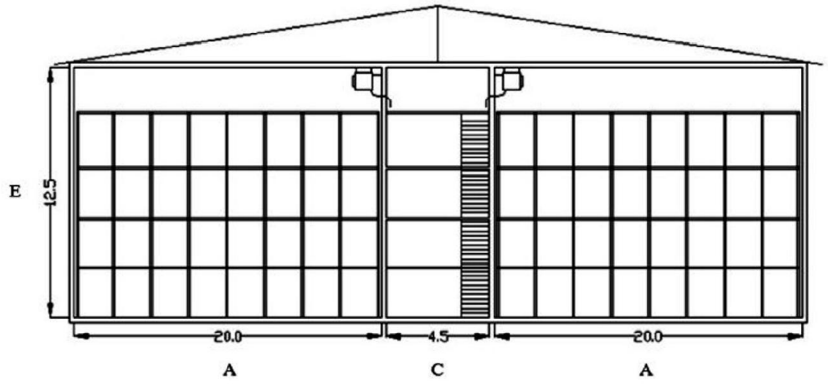


OTHER ANCILLARY WORKS

1. ELECT. SUBSTATION & METERINGROOM.
2. UNDERGROUND WATER STORAGE TANK/ FIRE FIGHTING STORAGE TANK / OVERHEAD TANK.
3. DRAINAGE LINES. STORM WATER DRAINAGE & SEPTIC TANK (IF REQUIRED).
4. FENCING & ROADS.
5. MAIN GATE & SECURITY CABIN.

NOTE -

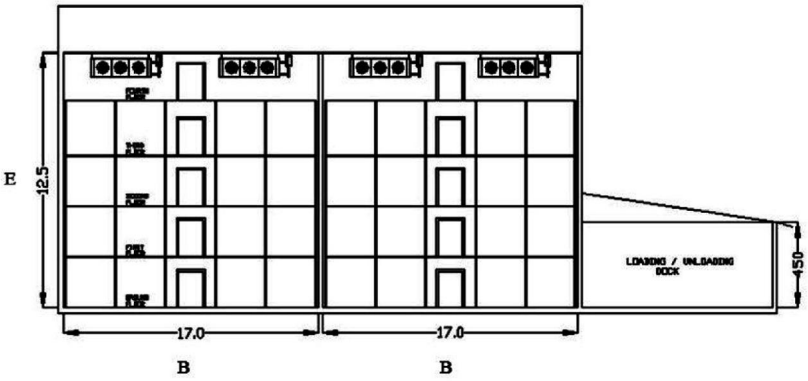
- NO OF INTER FLOORS IN COLD STORE - 5
- TOTAL HEIGHT OF COLD STORE CHAMBER - 12.5m
- P.L.S. REFER TO SECTION ON DRG NO CS GEN 09.09A & CS GEN 10.10A.
- ALL DIMENSIONS IN METERS



SECTION – AA
ALTERNATIVE – 1 (WITH TRUSS ROOF)

COLD STORAGE PLANT - SECTION FOR ALT - I

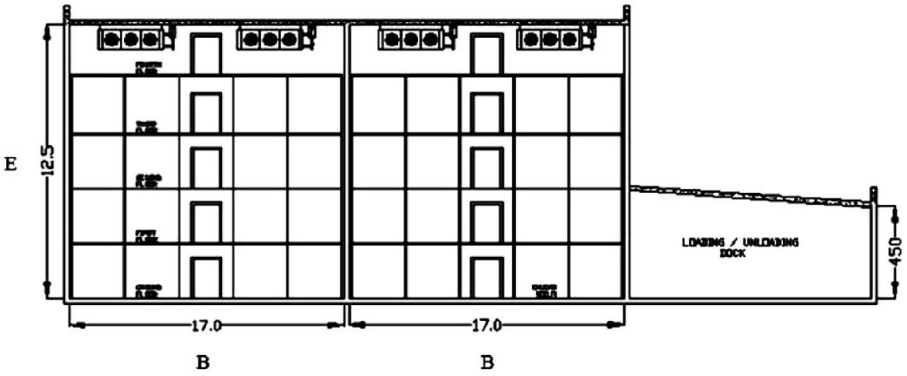
A = 20 – 21 m
C > 3 m
E = 12 – 14 m



SECTION – BB
ALTERNATIVE – 1 (WITH TRUSS ROOF)

COLD STORAGE PLANT - SECTION FOR ALT - I

B = 15 – 18 m
E = 12 – 14 m



SECTION – BB
ALTERNATIVE – 2 WITH CONVENTIONAL CONSTRUCTION WITH R.C.C SLAB ROOF

COLD STORAGE PLANT - SECTION FOR ALT - I

B = 15 – 18 m
E = 12 – 14 m

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

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

Cold Chamber:

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

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

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

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

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

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

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

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

Strip curtains for cold rooms and Air Curtains for external outlets/ inlets:

: Strip curtains are quite common for reducing infiltration of air during loading/ unloading. Air curtains need power for operation but are more effective if properly installed.

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

Rooms for machines, Electricals etc.

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

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).**Though fresh F & V are 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 / grove joints
3. Sheet metal flashing to be provided on all concrete and 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).
- **Radiant barrier.** This could be an option which the promoters can use for energy saving. However, the minimum thickness of insulation and the method of fixing will remain as specified in the standards.

5. 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. However, average value may be taken as shown in Typical Designs enclosed.

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

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

6. 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**

  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 and Plate Heat Exchanger (PHE) with cooling tower arrangement in case of HFC / HCFC / Ammonia plant or of evaporative / atmospheric type in case of ammonia plant. Capacity of condenser shall be confirmed by data-sheet of manufacturer.

- **Air Cooling Unit - ceiling / wall mounted- for cold stores**

  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. Coils with Aluminium tubes and Aluminium fins can also be used.

- **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.

- **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.

- **Equipment derating at higher ambient**

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

7. GENERAL SPECIFICATIONS FOR REFRIGERATION SYSTEM

(May refer to the Type Designs given in Section 4)

Brief Specifications for Equipment / Materials / Services

i. Refrigeration Compressors & Motors

Quantity	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 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 capacity at 38 deg C condensing & and applicable WB temp	*To be configured in kW*
Suggested Standard	ARI Std 490

Air-cooled / water-cooled condenser for HFC / HCFC.

Capacity	To be configured in kW
Size	To be furnished

iii. H.P. Receiver for Ammonia:-

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 re-circulation/overfeed system 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 fins OR, S.S.304 tubes &Aluminium fins OR, Aluminium Tubes & Aluminium fins with proper bonding system with bullet drawn expansion/ equivalent expansion for Ammonia; For HFC / HCFC coils with copper tubes & aluminium fins or aluminium tubes with aluminium fins with bullet drawn expansion may be used.
Fin spacing	*6.25 to 8.5 mm (3 to 4 FPI)*
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

For Fruits & Vegetables requiring higher humidity, lower delta T, higher flow rates of air and higher coil surface areas need to be used.

For F & V cold store	One or more nos. per chamber depending on chamber size and capacity; generally 3 to 4 nos. to ensure uniform air distribution, as per configuration
Estimated capacity each at critical operating condition	*To be configured*
Estimated coil surface area	*To be configured*
Estimated air flow capacity each	*To be configured*
Suggested Standard	ARI Std. 420

Notes:

a) Number of ACUs may vary from 2 to 4 per chamber, in which case the capacity parameters shall be increased or decreased proportionally

b) The ranges in capacities have been mentioned considering the possibility of higher cooling capacity requirement if incoming product temperatures are around 30 deg C, mostly in western & southern zones

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 in case of ammonia plants. For HFC / HCFC, hard Copper piping type L Piping as per. ANSI guidelines and pressure vessels as per BIS Code IS 2825). Reference to ASHRAE B-31.5 recommended.

vi. Water Piping, Fittings & Valves

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

vii. Water Pump sets

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

viii. Thermal insulation for refrigerant piping etc.

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

ix. Duct Mouthpieces

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 for achieving desired 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

Note: Location for installing the sensors will depend on site conditions and stacking pattern etc. However, facility for recording temperatures and RH at various locations on hourly basis and displayed in the plant room is desirable. Therefore Programmable Logic Controllers (PLC) is recommended for large cold stores (3,000 MT and above) with the display point in the manager's cabin.

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.

f. In case of palletized cold store, it is recommended that in order to prevent damages to the walls from the pallet movement etc., strong GI Pipe/tubing should be laid out to create a barrier.

g. The docks should ensure that dimensions of the dock should commensurate with the dimensions of the containers to avoid hot air entering the inside of the bay. Further, dock cushioning and shock absorber should be installed to avoid damage by the impact of container adjustment on the docking bay.

h. All cold store doors should be constructed to be airtight and weather-proof, to suitable to the cold store specific applications.

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 requirement e. Switchyard fencing with gates as per Electrical Board requirements

ii. D.G. Set for standby power

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

iii. Main power distribution panel

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

iv. Electric panels

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

v. Power & Control cabling etc

Power and Control cabling, earthing etc for various electrical circuits	Aluminium armoured 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)**

vii. Electrical hoist

Electric hoist	With wire ropes, steel fabricated cage with guides & openable doors for material movement, product lifting
Capacity	2 MT of product

9. SAFETY

Safety Measures

Provision for handling accidental leakage of ammonia	Ammonia sensors in cold chambers near ACUs & machine room Emergency ventilation for machine room Safety release of refrigerant to water sump Ammonia masks First aid kit Instructions for handling emergencies

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

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

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

- Provision of lifts/ material handling equipments - no. of doors (one on GF or on each floor)

Improper handling may cause injury to the potatoes. As labour is cheap in India and power is not reliable, lifts/ mechanized handling is not common but may be useful in some cases. Palletization; wherever feasible and economical would maintain the quality of potato.

10. Coefficient of Performance (CoP)

Optimum energy efficiency should be determining criteria for CoP. However, for the instant type of cold storage CoP of minimum 3.6 at peak load condition, 3.3 for holding period and about 2.5 during lean period is recommended.

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.

BASIC DATA SHEET

SECTION - II

Basic Data Sheet

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. Basic Cold Store Design Considerations

i) Commodity Storage Requirements

Type of Commodities/Produce Ideal / Recommended Storage Conditions - Temperature (DB in ^{O}C) - Humidity RH (%) Range - Air Circulation (CMH/MT of Produce) - Ventilation (Air Changes/Day) - CO_2 Range (PPM) - Produce Cooling Rate (^{O}C/day) - Freezing Point ^{O}C - Others	
Cold Chamber Dry bulb (DB in ^{O}C)	
Cold 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)	
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 %)	
Special Provisions - CIPC treatment for Process Potatoes	
Special Provisions - MA / Ethylene Control / Fumigation/ Fresh Air etc	

ii) Fresh Air / Ventilation System

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	

iii) Cold Store Chamber Sizing and Capacity

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

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

iv) Ante Room & Process Areas

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

v) Machine Room & Utility Areas

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

vi) Building & Construction Details

- Type of construction : Civil/ Pre-engineered Building

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

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				

viii) 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 Strip curtains - nos. & overlap %	
Air curtains, if any	
Others	

ix) Material Handling

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

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

x) 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	Loading Period
	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.

D. 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

iv) 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

v) 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 & Return Air (at coil inlet).

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

E. Electrical Installation

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

PROTOCOL FOR IMPLEMENTATION OF TECHNICAL STANDARDS

SECTION - III

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 Devices

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.

SECTION - IV

TYPE DESIGNS

Typical Design for Layout Option- A

(For 5000 MT Potato Storage)

1. Basic Design Data

i. Plant location: Uttar Pradesh / Major Potato production belt of India

ii. Outside dry-bulb temp: +45°C (max.)

iii. Outside wet-bulb temp: +30°C (max.)

iv. Power supply: 415 V, 3 phases, 50 Hz

v. Control Power Supply: 220 V, 1 phases, 50 Hz

vi. Product Receiving system : Open trucks

vii. Product Temperature at the time of loading: 20 °C to 25 °C

viii. Storage system : 50kg Bags

ix. Total Storage Capacity: 5000 Mt

x. No of Chambers & Capacity: 4 X 1250 Mt.

xi. Chamber Size: 21.00 m x 16.00 m x 13.70 m (L xWx H)

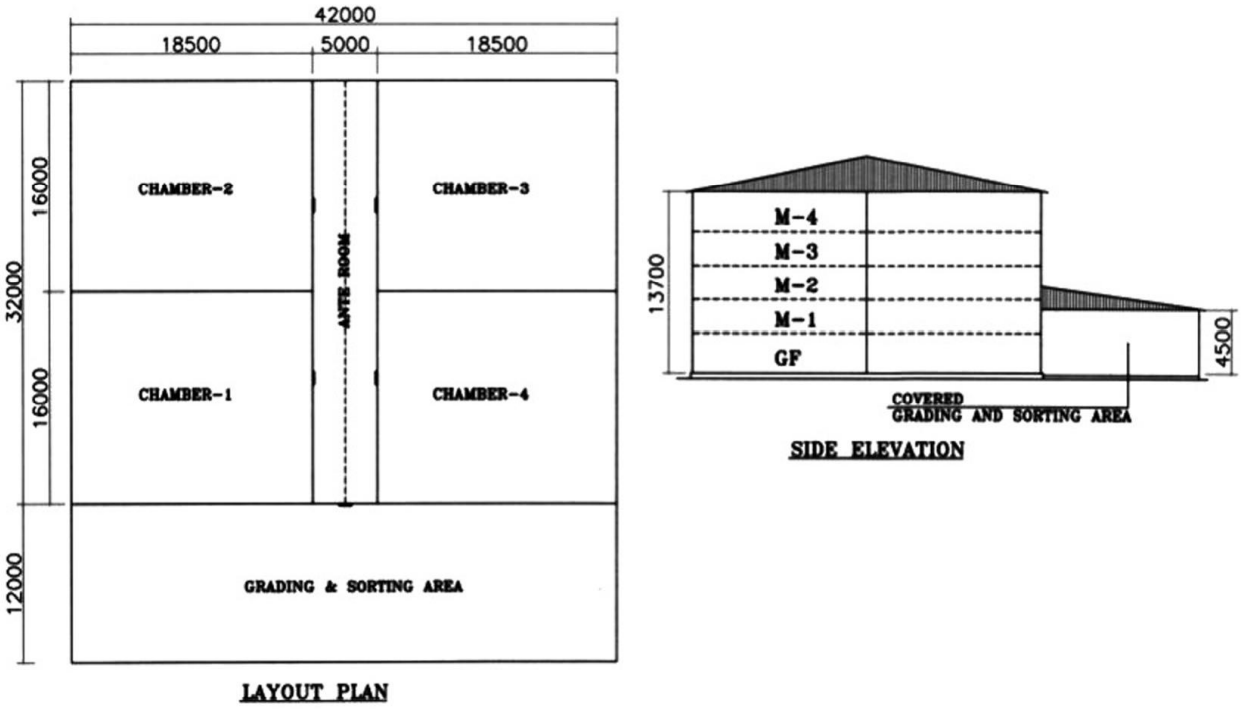
xii. Loading Rate: 4% to 5% of the total storage capacity / day (equally split into four chambers)

xiii. Pull-down time : 24 hours

xiv. Compressors running hours : During Pull Down - 20 hours/day and During Holding – 18 hours/day

xv. Duel Commodity Cold Store with mezzanine floors

1. Layout- Option A



3. Thermal Insulation: Expanded Poly Styrene (EPS)– on Civil Building applied as per IS 661:2000 for cold storage temperature range of -4°C to +2°C (Duel Commodity Storage)

Application Area	U Values ($W/m^2.K$)	R Value ($m^2.k/W$)	Thickness (mm)
Exposed Walls	0.27	3.70	150
Intermediate Walls	0.58	1.72	60
Roofs	0.24	4.17	150
Floors	0.29	3.6	125

Thermal conductivity "k" is 0.036 *W/ (m.K.) at 18 kg / m^3 (IS* 4671-1984)

4. Other Considerations

- A factor of safety of 10% on account of miscellaneous source of heat and possible discrepancies between design criteria and actual operation is considered.
- The total heat load is estimated through "hour by hour calculations" and spreading it across 24 Hrs operations per day
- Air Circulation is based on minimum 50 CFM/MT of Potato (85 CMH/ MT of Potato) during the loading

and pull-down period. However, during the holding period fan power is optimized by fan speed reduced to almost 70% by VFD control (which will reduce fan motor power consumption to 34%) and thereafter automatic control will maintain temperature variation within each chamber at less than +/- 1 °C throughout the storage period.

- The ventilation air load is estimated based on 70% energy recovery using heat exchanger between the exhaust and supply air. The ventilation requirements range between 2 to 6 air changes per day to maintain CO_2 less than 4000 ppm.
- Deal with adverse harvest conditions when the produce is wet, rotting, too cold or too warm
- Provide adequate and controlled cooling to maintain desired temperature and high humidity conditions during the storage phases.

5. Total Refrigeration Load Summary- Method of calculation as per ASHARE

A. During loading and Pull Down to 15°C (loading @ 1000 Bags/day Per Chamber)*

S. No.	Description	kW / 24 Hrs.	Percentage
1.	Transmission Load	12.12	14.20%
2.	Product Load (including respiration)	43.16	50.58%
3.	Internal Load	5.25	6.16 %
4.	Infiltration & Ventilation Air Load (with 70% recovery)	16.14	18.93%
5.	Equipment Load	8.65	10.13%
	Total	**85.32 (24.37 TR)**	**100 %**

(*) Variable on Loading Rate & Product Temperature

B. During Pull Down to 3°C @ 0.5°C per day - fully loaded (Per Chamber)*

S. No.	Description	kW / 24 Hrs.	Percentage
1.	Transmission Load	12.12	14.35%
2.	Product Load (including respiration)	54.56	64.60%
3.	Internal Load	0.0	0.00%
4.	Ventilation Air Load (70% recovery)	9.11	10.79%
5.	Equipment Load	8.66	10.26%
	Total	**84.45 (24.13 TR)**	**100 %**

(*) Fixed Load

C. During Holding Period at 3°C - fully loaded (Per Chamber)*

S. No.	Description	kW / 24 Hrs.	Percentage
1.	Transmission Load	12.12	36.80 %
2.	Product Load (including respiration)	14.80	44.94 %
3.	Internal Load	0.0	0.00 %
4.	Ventilation Air Load (with 70%recovery)	3.03	9.20 %
5.	Equipment Load (with VFD)	2.97	9.06 %
	Total	**32.93 (9.41 TR)**	**100 %**

(*) Fixed Load

D. Total Refrigeration Load Summary with 10% safety factor

Total Refrigeration Load	Peak Period	Holding Period	Lean Period with 2 chambers
Total Load (kW/24 Hrs.)	371.58 (106.17 TR)	144.90 (41.40 TR)	72.45 (20.70 TR)

6. A Typical Configuration of Cooling System & Equipment Selection

Type of Refrigerant	Ammonia
Type of System	Overfeed
Type of compressor	Multi Cylinder - Reciprocating
Type of capacity control	Automatic In steps
Type of condenser	Atmospheric
Type of cooling coil	Ceiling/Wall Suspended - High Efficiency Finned Coil with carbon steel tubes and fins, hot dip galvanized, 6 rows deep, 8mm fin Pitch
Type of defrosting	Air / Water
Humidification System & Control	Micro Mist Generator of Capacity 20 lit/hrs/chamber with controller, operational during pull down period (30 days only)

ii. Compressor Operating Parameter

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
Investor's Selection	1	880	+2 °C / 38 °C 52 psig/ 197.5psig	234.85 kW	55kW	45.5 BkW	Pull-down
Investor's Selection	1	880	- 2 °C / 38 °C 43psig/ 197.5psig	200.90 kW	55kW	45.3 BkW	Holding

iii. Atmospheric Condenser Operating Parameter

Condenser Make & Model	Nos. of stands	Operating Parameters & flow (lps) (max)	Condenser Capacity (kW)	Pump Motor Rating (kW)	Total Electric Power (BkW)	Remarks Working / Standby
Atmospheric 2" Dia. Pipe	24	38 °C/ 197.5 psig/ 38.4 lps	560 kW (2 Comp)	3.7 kW x 2	6.29 BkW	50% During Holding

iv. Air Cooling Units (ACU) Operating Parameters

ACU Make & Model	Nos.	Operating Parameters Evap. (SST) & TD (°C)	Cooling Capacity (kW) per Coil	Air Flow (CMH)/ Coil	Material of Coil tubes & Fins	Fin pitch (mm)	Total Fan Electric Power (BkW)
Investor's Selection	12	- 2 °C SST & + 3 °C Return During holding	28 kW	35700 CMH	Hot Dip Galvanized	8mm	1.78
Investor's Selection	12	+ 2 °C SST & + 9 °C Return *During Pull Down*	38 kW	35700 CMH	Hot Dip Galvanized	8mm	1.78

(*) TD Refrigerant Temperature and Delta T (TD) across the Coil (i.e., difference between return air and saturated suction temperature of refrigerant) is a critical factor determining the size and heat transfer capacity of the cooling coil.

- For low humidity Delta T can be selected between 11°C to 17°C.
- For High humidity Delta T can be selected between 2.2°C to 4.4°C. (Ref..Stoecker, W.F. 1998)

7. Summary of Estimated Electrical Operating Load

Equipment	Peak Period BkW	Holding Period BkW	Lean Period BkW
Compressors	91	45.3	27.18
Condenser Pumps	6.29	3.145	3.145
Air Cooling Units	21.36	7.32	3.66
Over Feed System	4.7	4.7	4.7
Internal Lighting/Misc.	2	0	0
Total Operating Load (BkW)	**125.35**	**60.47**	**38.68**

8. Estimated Performance Parameters of the Proposed 5000 MT Cold Store

Parameters	Peak Period* Two Compressors Operating & Two Condenser Pumps	Holding Period* One Compressor Operating, One Condenser Pump & VFD Control	Lean Period* One Compressor Operating at 50% One Condenser Pump & VFD Control
Coefficient of Performance (CoP=kW Cooling/BkW Power) of the Proposed MT Cold Store Unit	469.70 /125.35 =3.747	200.90/60.47 =3.322	100.45/38.68 =2.596
Power Consumption (kWH/Day) considering diversity factor of 0.8	125.35 x 0.8x 20 hrs =2005.6	60.47 x 0.8x18 hrs =870.78	38.68x 0.8x 18 hrs =557.11

(*) Peak Period: 15th Feb. to 15th March and Subsequent Holding Period: till end October

TYPICAL DESIGN-FOR LAYOUT OPTION- B
For a 5000 MT Potato Cold Store

1. Commodity Storage Conditions

a. Design conditions for Irish Potatoes

Fresh Potato	Temperature	Storage Period	Relative Humidity
Early Crop	4 - 10°C	0 - 3 months *	95%
Seed Potato	3°C	5 - 10 months	90 - 95%
Table Potato	4°C	5 - 10 months	90 - 95%
For French Frying	7.2 - 10°C	1 - 10 months **	90 - 95%
For Chipping	7.2 - 10°C#	1 - 8 months **	90 - 95%

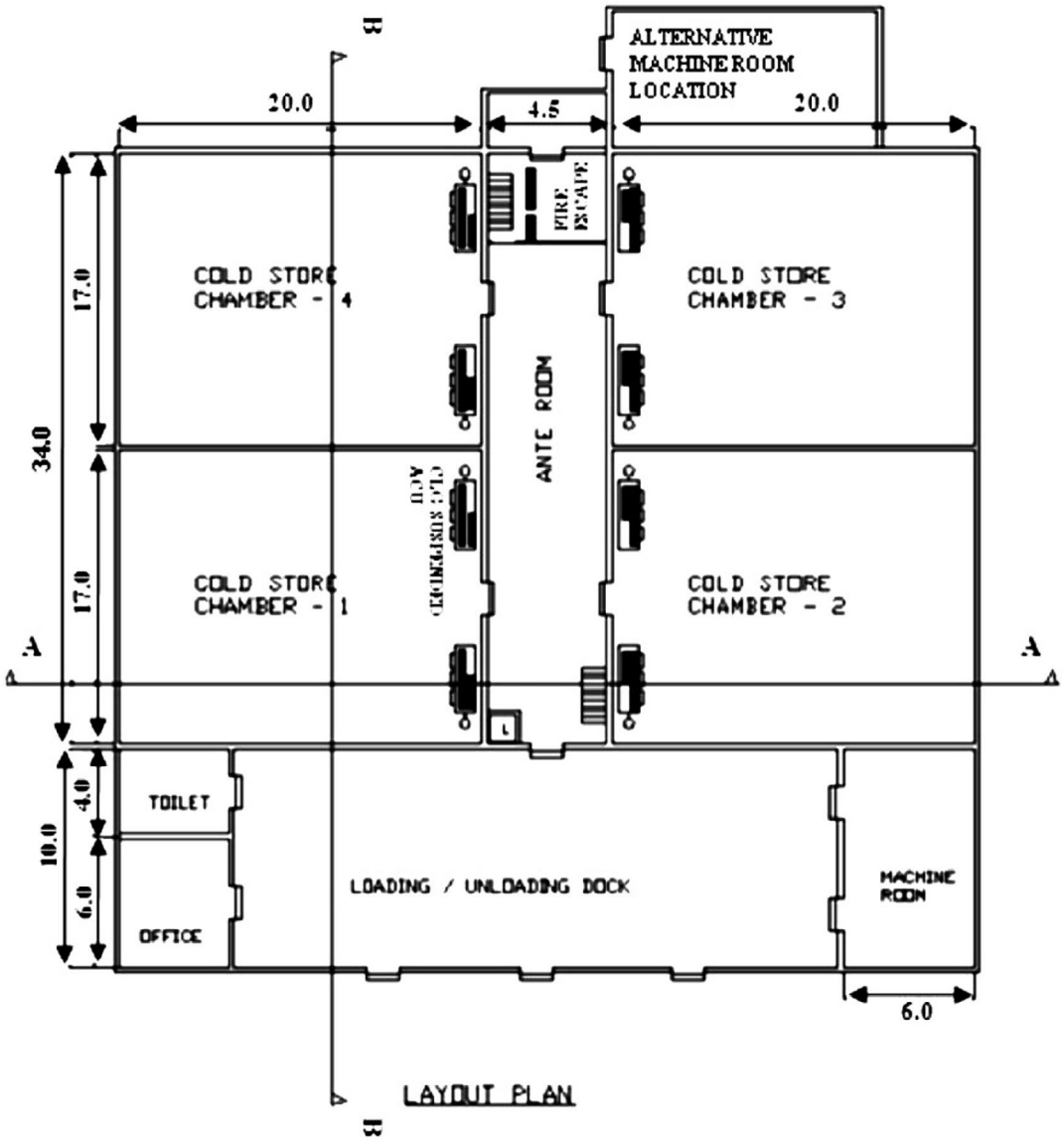
(*) If cured / wounds healed before storage
(**) Sprout suppressors must be used for long term storage.
(#) Generally stored between 9-13°C as per WFLO manual

Ref. : Commodity Storage Manual - WFLO for Irish Potatoes

- To control shrinkage in potatoes, desired RH > 95%.
- Ethylene sensitivity is moderate for potatoes.
- Processing and see potatoes should be stored in dark while fresh potatoes can be stored in diffuse light.
- Ventilation air to be provided such that the carbon dioxide levels may be maintained below the desired level (generally considered to be 4000ppm). For processing potatoes the values are more critical.
- Loading period : 20-30 days
- Pull down rate : 2-3°C/ week
- Intake product temperature : 20°C (Northern India) - 30°C (Southern & Western India)

2. Cold Store Capacity & Typical Layout Of A Four Chamber Design

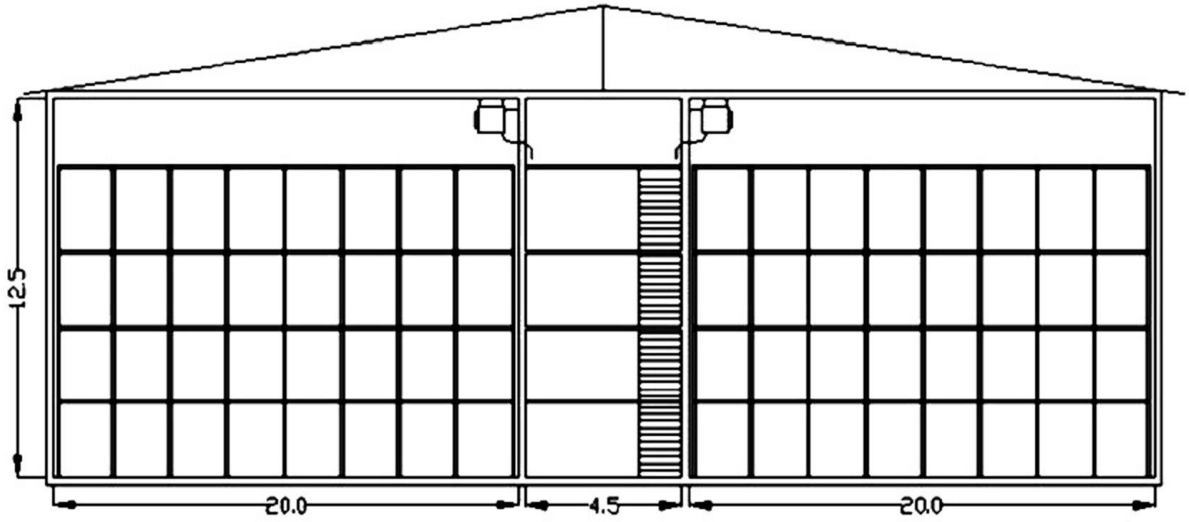
- Each chamber of 20 x 17 x 12.5
- Capacity of each chamber - 1250 MT based on 3.4 m^3/ MT
- Each bag of 50kg
- Ante room and other areas as marked on the layout



All dimensions in meters.

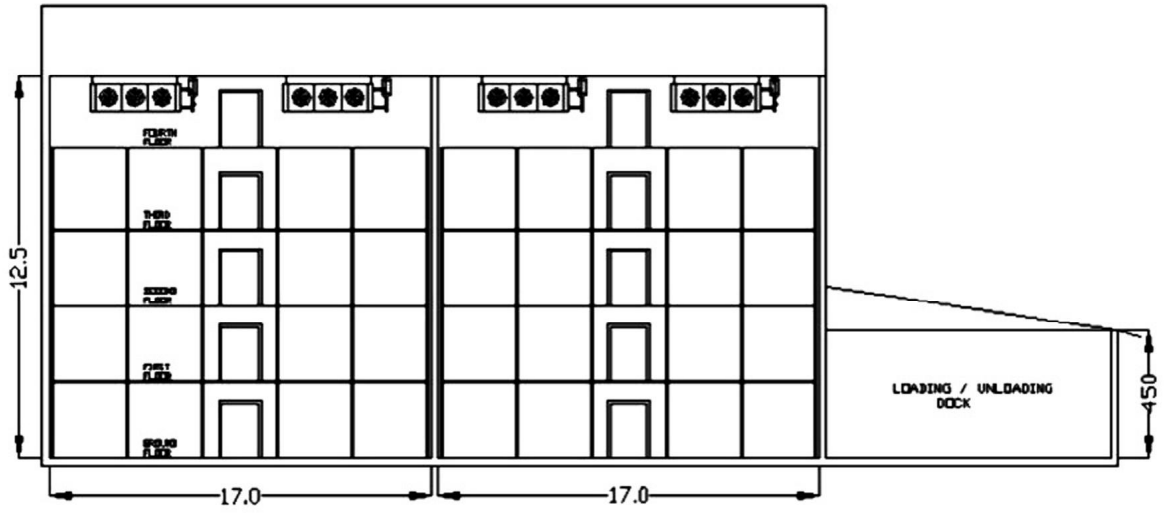
Other ancillary works

1. Electrical substation & metering room.
2. Underground water storage tank / fire fighting storage tank / overhead tank.
3. Drainage lines, storm water drainage & septic tank (if required).
4. Fencing & roads.
5. Main gate & security cabin.



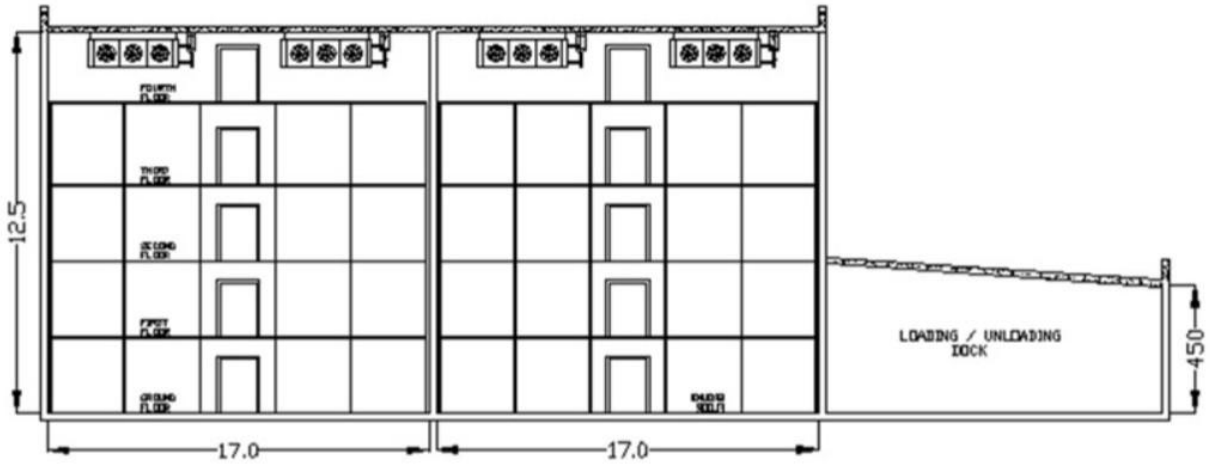
SECTION - AA
ALTERNATIVE - 1 (WITH TRUSS ROOF)

COLD STORAGE PLANT - SECTION FOR ALT - 1



SECTION - BB
ALTERNATIVE - 1 (WITH TRUSS ROOF)

COLD STORAGE PLANT - SECTION FOR ALT - 1



SECTION - BB
ALTERNATIVE - 2 WITH CONVENTIONAL
CONSTRUCTION WITH R.C.C. SLAB ROOF

COLD STORAGE PLANT - SECTION FOR ALT - 2

3. CONSTRUCTION FEATURES

The general norms for conventional construction are as follows:

Foundation: Conventional Foundation / Pile Foundation / Raft Foundation - to be designed by qualified & licensed structural / civil engineer. The design shall meet the relevant seismic zone norms for earthquake proof designs.

Cold Chamber:

Walls — 230 mm Brick walls / solid concrete blocks with sand- cement plaster

Roof — RCC slabs or Truss Roof with GI / Pre-coated GI 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.

Floor	The floor comprises of base concrete, in cold stores with suitably lower levels in cold chambers. The level difference between cold chambers and ante room to be equal to the thickness of floor insulation plus the layer of PCC or tremix finish.
Inter-floors	The basic structure can be RCC columns & beams or steel columns & steel beams
Grating	Wooden batten grating or steel grating using flats / square tubes etc. The interfloors have to be designed for a product loading of 900 kg/m^2 min. Where AC units are located on top floor, the structure has to be suitable for the unit static & dynamic loads.
Ante Room	This shall be designed to accommodate staircase, electrical hoist cage and have wider doors. Provision for fire escape stair & exits to be made as per local norms. The interfloors in ante room to have doors to each cold room on each floor.

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.
Strip Curtains	To be provided to reduce infiltration during loading/ unloading. Air curtains can also be used although they consume energy.
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 land scaping with benches for labourers.

4. THERMAL INSULATION

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 insulation materials are:

a) Expanded polystyrene

b) Rigid Polyurethane foam

c) Rigid phenolic foam

d) Mineral wool / glass wool

e) Extruded polystrene

The ancillary materials to be used include:

a) Vapour barrier eg. 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 / Fiberglass sheets of suitable thickness

For Conventional Insulation

Walls & Ceiling

1. Primer Coat followed by two layers of bitumen
2. Fixing aluminums 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 & precoated 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 tarfelt
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 camlock or tongue / grove joints
3. Sheetmetal 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

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		
	ρ Density Kg/m³	K (at 10 °C) W/mK	Thickness m m	Thickness m m	Thickness m m	Thickness m m
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 at 10 °C for all insulation materials except XPS
- K value# in case of XPS is as per ISO/FDIS 4898:2008(E) at 10°C mean/28days minimum
- 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)

9. Cooling Load Calculations

Chamber size: 20x17x12.5

Basic Assumptions:

Ambient Conditions	:	0.4% annual for Delhi - 42°C/ 22.1°C
(ASHRAE data)	:	0.4% for March in Delhi (for loading period only) - 34.9°C/ 19.9°C
Loading period	:	20 days

Specific heat of the potato	:	3.433kJ/kg
Ventilation air	:	4 air changes/ day
Heat of respiration at 3°	:	0.018W/kg (Ref. - Ashrae Refrigeration handbook 2006)
(California potato) at 15°	:	0.027W/kg.
Occupancy	:	4 people working for 12 hours during loading
Lighting load	:	1.85 kW for 12 hours during loading period for 4 chambers
Enthalpy wheel for ventilation	:	70% energy recovery
Fan load	:	Estimated based on refrigeration capacity of each chamber, (Ref. : W.F . Stoecker, Industrial refrigeration handbook) Front face(40x12.5) orientation of the building assumed to be 60 degree west of south

Insulation U values as per IS 661 : 2000

Transmission load calculated on the basis of ASHRAE RTS method.

Pull down period : 24 hrs

As the loads shown in the tables below are the estimated peak loads based on the above assumptions suitable diversity and safety factors can be used which may change the load values by few kW.

Loading and pull down to 15° C (per chamber)

Load type	**Value**	**Units**
	Maximum load value	
Transmission	8.49	kW
Ventilation	1.76	kW
Product cooling load	37.25	kW
Respiration	33.75	kW
Occupational load	0.13	kW
Lighting	0.22	kW
Fan motor	9.00	kW
Total	**90.59**	**kW**

Pull down to 3° C (0.5° C per day) (per chamber)

Load type	Max load value	Units
Transmission	12.35	kW
Ventilation	3.58	kW
Product cooling load	24.84	kW
Respiration	33.75	kW
Occupational load	0.00	kW
Lighting	0.00	kW
Fan motor	9.00	kW
Total	**83.51**	**kW**

Hold on at 3° C (per chamber load)

Load type	Load value	Units
Transmission	12.35	kW
Ventillation	3.58	kW
Product cooling load	0.00	kW
Respiration	22.50	kW
Occupational load	0.00	kW
Lighting	0.00	kW
Fan motor	3.38	kW
Total	**41.80**	**kW**

Loading and pull down to 15° C

(Assuming March conditions instead of annual design conditions)

Load type	Value	Units
	Maximum load value	
Transmission	6.30	kW
Ventilation	1.22	kW
Product cooling load	37.25	kW
Respiration	33.75	kW
Occupational load	0.13	kW
Lighting	0.22	kW
Fan motor	9.00	kW
Total	**87.86**	**kW**

10. TYPICAL SPECIFICATIONS OF REFRIGERATION SYSTEM

- Products that can be stored: Potatoes, Apples, pears for storage above 1^0C.
- Estimated refrigeration capacity : 340 - 370 kW
- Refrigerant : Anhydrous Ammonia
- Gravity feed system

Refrigeration Compressors & Motors

Quantity	3 Nos each of 50% capacity (One standby)
Type	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
Capacity at (-) 3 deg C Evaporating & 38 deg C Condensing	185 to 190 kW
Estimated Motor rating	55 kW x 1450 RPM, TEFC Sq.cage, class F insulation, suitable for 415 V, 3 ph, 50 c/s. AC supply

Evaporative Condenser

Coil section	Hot dip galvanized M.S. pipes CDW Boiler quality tubes 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 capacity at 38 deg C condensing & and applicable WB temp	480 to 500 kW

H.P. Receiver

Horizontal Ammonia receiver complete	With necessary connections, reflex type level gauge etc.
Capacity	1500 liters (min)
Material of Construction	Boiler quality steel plates
Quantity	2 Nos. (Two nos are suggested since some states regulations call for Pressure testing of high pressure vessels on a periodic basis)

Air Cooling Units

a) Finned cooling coil	Coil design to be suitable for gravity feed / pump circulation as per design
M.O.C	Hot dip galvanised M.S. pipes CDW Boiler quality tubes or S.S.304 tubes & Aluminium fins with proper bonding system
Fin spacing	6.25 to 8.5 mm (3-4 FPI)
b) Axial Flow fans	With cast aluminum / 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)
d) Unit casing	G.S. sheet duly painted, drain pan of G.S / M.S with epoxy paint
d) Defrosting arrangement	Water
Unit capacities	3 nos per chamber
Estimated capacity each at (-) 3 deg C Evaporating & 5 deg C T.D (between evap temp & air entering temp)	34.5 to 38.3 kW
Estimated coil surface area	270 to 330m^2
Estimated air flow capacity each	9 to 10 m^3 / s

For fruits & Vegetables requiring higher humidities, lower delta T, higher flow rates of air and higher coil surface areas need to be used.

For 1 no. F & V cold store	3 nos
Estimated capacity each at (-) 2 deg C Evaporating & 4 deg C T.D	38.3 kW
Estimated coil surface area	300 to 380 m^2
Estimated air flow capacity each	10 to 12 m^3 / s

Refrigerant Piping, Fittings & Valves

Piping Interconnecting piping between compressor, condenser, receiver and cooling units	M.S. black piping conforming to IS-1239 and other relevant Indian standards

Water Piping, Fittings & Valves

Piping shall be used for a. Condenser water circulation b. Compressor cooling c. Defrosting d. Drain lines	Piping to be G.I class B for 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.

Water Pump sets

Water flow capacity to take care of condenser water flow & compressor head / jacket cooling	2 nos. (one standby)
Capacity	13 to14 lps

Thermal insulation for refrigerant piping etc.

Material for insulation for refrigerant suction line, accumulators etc.	a. EPS pipe section b. PUF pipe section With 0.6 mm Aluminum or 0.5 mm GI precoated sheet cladding c. Nitrile Rubber / EPDM / pipe section / other acceptable materials with woven glass cloth with UV treated pigmented epoxy Coating

Duct Mouth pieces

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

Ventilation for cold chambers

System to be designed for providing adequate air changes / day	Axial flow / Inline duct fans with cleanable inlet filters, GI sheets / Aluminium / PVC ducting upto 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.

Humidification

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

Controls

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

Installation, Testing & Commissioning

Installation	The plant shall be installed, tested & commissioned as per IS 660.

Liquid Overfeed System:

- The above design recommendations are for gravity feed for air cooling units. It is also possible to use pump circulation system (overfeed system) requiring following components :

  a. Centralized ammonia L.P receiver

  b. Ammonia pumps - 2 nos

  c. Refrigerant flow & safety controls

  d. Interconnecting piping - both supply & return lines shall be insulated

In this case the individual accumulators for AC units & level controls etc. are not required. The coil surface area may be 5 - 10% lower.

11. ELECTRICAL INSTALLATION

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. Earthing station as per requirement e. Switchyard fencing with gates as per Electrical Board requirements

D.G.Set for standby power

D.G.set complete with accessories and with weather-proof and noise-proof canopy as per local pollution control norms	Estimated Rating : 160kW for single One big and one small can also be used

Main power distribution panel

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

Electric panels

Electric panels for	a. Refrigeration b. Lighting, Electric hoist, Fans c. APFC (Automatic Power Factor Correction) panel d. Water supply, fire fighting etc.

Power & Control cabling etc

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

Lighting

Lighting in a. cold stores, ante room b. other areas c. outside areas	The light fittings should be energy efficient eg. CFL fittings for cold chambers. A central switch may be provided outside each chamber.

Electrical hoist

Electric hoist	With wire ropes, steel fabricated cage with guides & openable doors for material movement, product lifting
Capacity	2 MT of product

12. SAFETY PROVISIONS

Provision for handling accidental leakage of ammonia	Ammonia sensors in cold chambers near ACUs & machine room Emergency ventilation for machine room Safety release of refrigerant to water sump Ammonia masks First aid kit Instructions for handling emergencies
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	

Fire Fighting

c. Dry Type

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

d. Water based

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

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.

16.6.09

(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

1. Sh. Bijay Kumar, Managing Director, National Horticulture Board, Ministry of Agriculture, Govt. of India, Plot No. 85, Institutional Area, Sector-18, Gurgaon-122 015 (Haryana)

2. Sh.D.L.Mirchandani, Chairman, Confederation of Indian Industry (CII) India Habitat Centre, Core 4A, 4th Floor, Lodi Road, New Delhi - 110 003 (INDIA)

3. Sh. R. Vaithiyanathan, Deputy Director, Confederation of Indian Industry (CII), India Habitat Centre, Core 4A, 4th Floor, Lodi Road, New Delhi - 110 003 (INDIA)

4. 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).

5. Sh. Zafar Ansari, Vice President Marketing & Sales, Dow Chemical International Pvt. Ltd. Corporate Park, Unit No. 1, V.N. Purav Marg, Chembur, Mumbai – 400 071

6. Mr. J. M. Gupta, Managing Director, JBM engineering Pvt. Ltd., A-1/296, 3rd Floor, Janak Puri, New Delhi -110 058

7. Sh. K.K. Mitra, Sr. General Manager Marketing & Technical, Lloyd Insulation Pvt. Ltd., Punj Star Premises, 2, Kalkaji, Industrial Area, Opposite Chandiwala Estate, New Delhi – 110 009

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

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

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

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

12. Mr.Rahul Sood, The Supreme Industries Limited, 26, Deepak Building, 13, Nehru Place, New Delhi-110019.

13. Sh. B.K. Sikka, Dean, College Of Agribusiness Management, G. B. Pant University of Agriculture and Technology, Pantnagar – 263145, Uttaranchal (India)

14. Sh. Samur Pandita, Assistant Energy Economist, Bureau of Energy Efficiency, New Delhi-110 066

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

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

17. Sh. Ajay Kumar Lal, Bureau of Indian Standards, Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi – 110002

18. Sh. A.K. Saini, Head Civil Engg. Department, Bureau of Indian Standards Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi – 110002

19. Sh. C.K. Veda, Bureau of Indian Standards Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi – 110002

20. Sh. E. Devendar, Bureau of Indian Standards, Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi – 110002

21. Sh. K.K. Paul, Sc. E.(Chemicals), Bureau of Indian Standards, Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi – 110002

22. Sh. Har Pal Singh, Deputy General Manager, Agricultural and Processed Food Products Export Development Authority (APEDA), 3rd Floor, NCUI Building, 3 Siri Institutional Area, August Kranti Marg, New Delhi-110016.

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

24. Sh. R.V. Dave, Assistant General Manager, (Investment Credit Department) ,National Bank for Agriculture and Rural Development, (NABARD), 3rd floor, A & B Wing, C-24, "G" Block, Bandra Kurla Complex, Bandra (East), Mumbai-400051.

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

26. Sh. H.P.Verma, National Cooperative Development Corporation (NCDC), 4 Siri Institutional Area, Hauz Khas, New Delhi-110016.

27. 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)

28. 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
28.	Self blasted lamps for general lighting service	IS 15111 Part 1 and 2

B. Mechanical

Bureau of Indian Standards (BIS)

S. No.	Title	Reference
1.	Safety 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

C. Publication by International Societies and Associations

Pre Engineered Building

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

D. European Organization for Technical Approvals (EOTA)

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

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

Refer to REFRIGERATION - Systems and Applications, Handbook

Chapter – 51 Codes and Standards.

Other Standards and References

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

1. International Association of Refrigerated Warehouses (IARW) and World Food Logistics Organizations,
    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)

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"

Website : www.nhb.gov.in