Technical Standards and Protocol for the Fruit Ripening Chamber in India

(Technical Standards Number NHB-CS-Type 04-2011)

राष्ट्रीय बागवानी बोर्ड
NATIONAL HORTICULTURE BOARD

Published by

Cold Chain Development Cell

National Horticulture Board

(Department of Agriculture & Cooperation,
Ministry of Agriculture, Govt. of India)
85, Institutional Area, Sector18, Gurgaon-122 015 (Haryana)

Technical Standards and Protocol for the Fruit Ripening Chamber in India

(Technical Standards Number NHB-CS-Type 04-2011)

Printed in February-2011 by NHB

For Free Distribution in Public Interest

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

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

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

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

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

Indian Cold Chain Industry is going through transformation, to fall in harmony with the international standards, and improve the overall economics. The entrepreneurs and end users are seeking information on appropriate technologies & specifications for other related components of cold chain like ripening units, reefer trucks & pack houses etc. It was felt necessary by the Board to define appropriate technical standards in respect of other components of cold chain intending to maintain product quality from the field to the consumer. TSC has now finalized the Technical Standards for Scientific Fruit Ripening Units

Work was initiated on the basis of some technical details downloaded from web sites of some leading manufacturers of ethylene generators and ripening chambers, by Shri Brajendra Singh- Deputy Director, NHB and inputs received from CII. The same was further improved during the committee meeting held on 13.08.2010 in SFAC, New Delhi. The draft standards so attempted was displayed on NHB website followed by a public notice (8th September 2010) inviting suggestions/ objections from stake-holders within a period of 30 days. Separate communications were also been sent to

ICAR, BIS, BEE, NHM, TMNE, CII etc. In order to develop broader view, a stakeholders' workshop was convened on 23rd October 2010 at National Academy of Agriculture Sciences, New Delhi involving TSC members, experts who have offered comments, and industry representatives. Inputs received from experts from M/s RINAC India Ltd and M/s Blue Star and also from NRC Banana, Horticulture Commissioner (DAC) and a number of private consultants have been of immense use in giving final shape to this document.

These Standards on Scientific Fruit Ripening Units contain four sections *viz. Section 1- Technical Standards; Section 2- Basic Design Data Sheet; Section 3- Guidelines for Stacking & Typical Construction Features; Section 4- Protocol for Implementation of the Prescribed Technical Standards.* While firming up its recommendations, 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.

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 "G*ood Manufacturing Practices*" put forth by various applicable Codes and Standards listed in this document and shall fully certify the equipment, plant and machinery supplied / installed in compliance to the relevant codes and standards.

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

We acknowledge the valuable contribution made by technical experts in firming up its recommendations mentioned in **Annexure-I** to the report. In the end, **Annexure II** lists relevant BIS and other standards furnished by CII suggesting that investors, contractors and suppliers may refer to comply with the requirements for designing and installing various components. **Annexure III** provides for extracts from International (EU) Health and Safety Rules for Ripening Rules for the purpose of making reference in appropriate context.

I gratefully acknowledge the basic draft from Shri Brajendra Singh- Deputy Director, NHB; several members of industry and CII Technical committee and immense contribution made by Dr. R. K. Sharma-Senior Deputy Director, NHB who has functioned as Member-Secretary to the Committee.

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

Dated: February 21, 2011

CONTENTS

SECTION - 1

TECHNICAL STANDARDS

1. Background Facts

Ripening is the process by which fruits attain their desirable flavour, quality, colour and other textural properties. On the basis of ripening behaviour, fruits are classified as:

(i) **Climacteric:** Climacteric fruits are defined as fruits that enter 'climacteric phase' after harvest i.e. they continue to ripen. During the ripening process the fruits emit ethylene along with increased rate of respiration. Ripe fruits are soft and delicate and generally cannot withstand rigors of transport and repeated handing. These fruits are, therefore, harvested hard and green but near full maturity and are ripened near consumption areas by using ripening aid. Even fully mature fruits of this category may be ripened by using ripening aid to get uniform ripening in large lots for bulk transport and marketing. Small dose of ethylene is used to induce ripening process under controlled conditions of temperature and humidity. Climacteric fruits are mango, banana, papaya, guava, sapota, kiwi, persimmon, fig, apple, passion fruit, apricot, plum and pear.

(ii) **Non-Climacteric**: Non-climacteric fruits once harvested do not ripen further. Non-climacteric fruits produce very small amount of ethylene and do not respond to ethylene treatment. There is no characteristic increased rate of respiration or production of carbon dioxide.

Non-climacteric fruits are citrus, pineapple, grape, strawberry, pomegranate, lichi, watermelon and cherry.

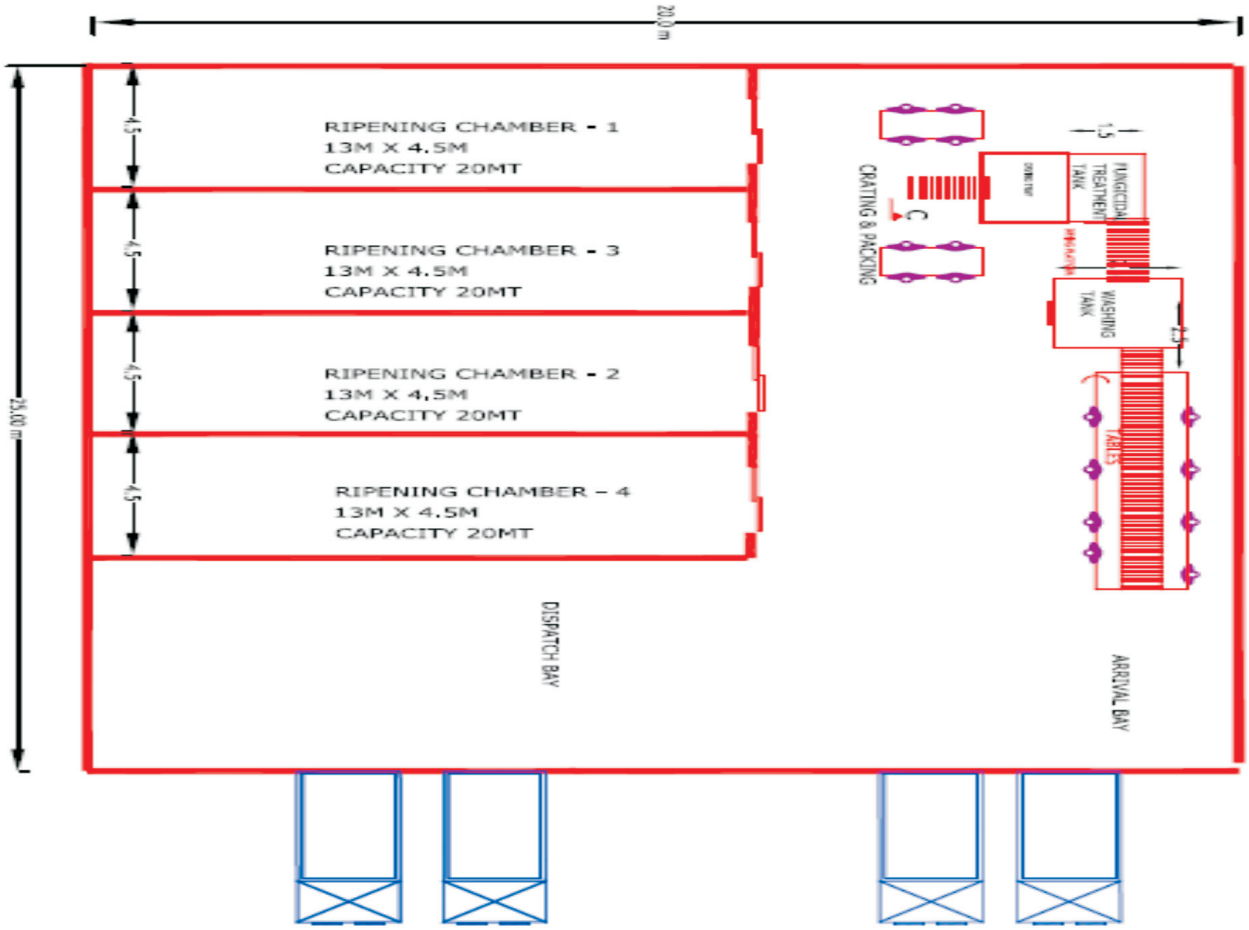
The essential requirements of an ethylene ripening system are:

- A reasonably air tight room with insulation
- A temperature control system for cooling and/ or heating
- An air circulation and ventilation system
- Humidity control
- An ethylene gas injection system and
- An electric control system

2. A Typical Layout and Types of Ripening Unit

A Typical Lay out of a Fruit Ripening Unit may have a number of chambers and a pack house. Number of chambers will depend on ripening cycle in terms of number of days for which system has been designed. Pack house may not be necessarily an integral part of ripening unit and may be at a different site also.

Figure-1
Typical Layout of a Fruit Ripening Unit



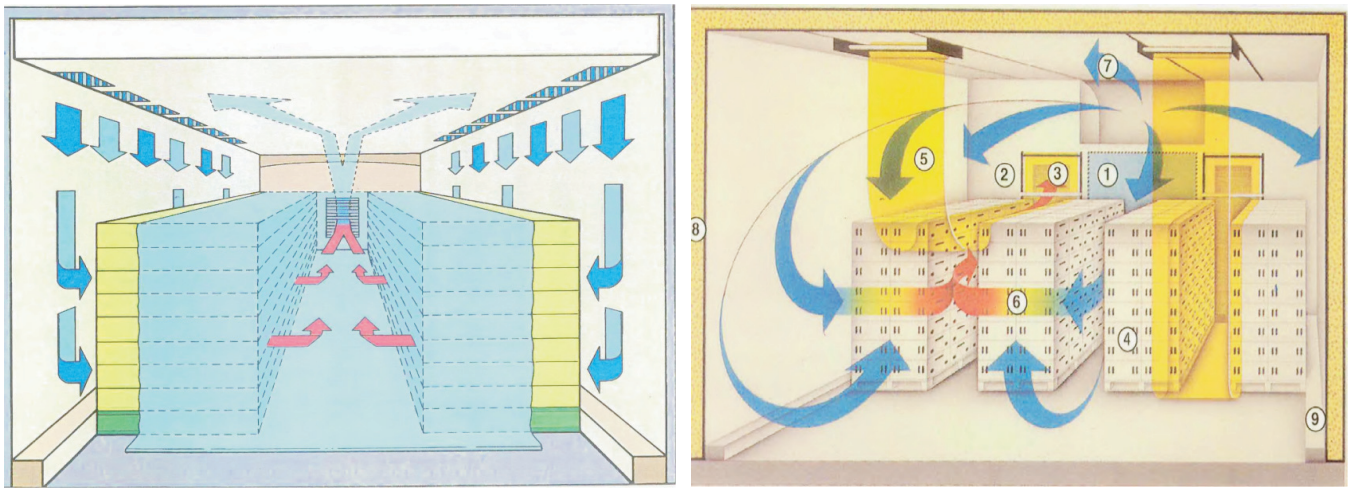
a. Ripening Room Type-1

This type of ripening room has insulated cold room with addition of ethylene equipment. For maintain desired level of low temperature and humidity, ceiling mounted Fin Coil Evaporator (close to wall panel, leaving some gap for suction) will be connected to the Condensing Unit Outside. Fruits with perforated plastic crates will be placed in the room. The air is allowed through the plastic crates by modifying its flow by simple arrangements like tarp etc, thus ensuring uniform air circulation, uniform ethylene distribution and fruits ripening. A simple ventilation system is provided, to provide automatic or manual vent control to keep CO_2 within the limits. In an Automatic Ventilation system a dual inlet/discharge damper operates in parallel with the fan to allow fresh air

from outside to replace the air within the room when venting is required. In contrast to it, in a Manual Ventilation System, ventilating effect in ripening rooms in achieved by opening the doors for about 20 minutes every 12 hours after the first 24 hours of ripening. Stacking will be done in floor (single tier) only, up to a reasonable height, which will facilitate for inspecting ripening status of fruits. Since, single tier system is generally considered; Mechanized Material handling equipments (Forklifts) need not be required. Simple Hand pallet trucks are more than sufficient to handle the produce.

Figure-2

Illustrations of Ripening Units Type- 1



a. Ripening Units Type-2

This type of Ripening Units has special air flow system which generates desired static pressure in ripening chamber. The insulated cold rooms have a system of false ceiling, separated and sealed annular space between wall and palletised crates / CFB boxes with or without air-inlet locking system to isolate designated pallets etc. Cool air is routed through false ceiling in to boxes with perforated holes of Crates / CFB boxes for air circulation) which, in turn are stacked in single / multi-tier system. In case of multi-tier stacking, fork lift operation is necessary to handle the produce.

Figure-3

Illustrations of Ripening Units Type -2

3. A Guide for Fruit Ripening

Fruits are ripened with ethylene exposure at certain prescribed Temperature and Relative Humidity level of 90-95%. Following is broad guide for fruit ripening condition.

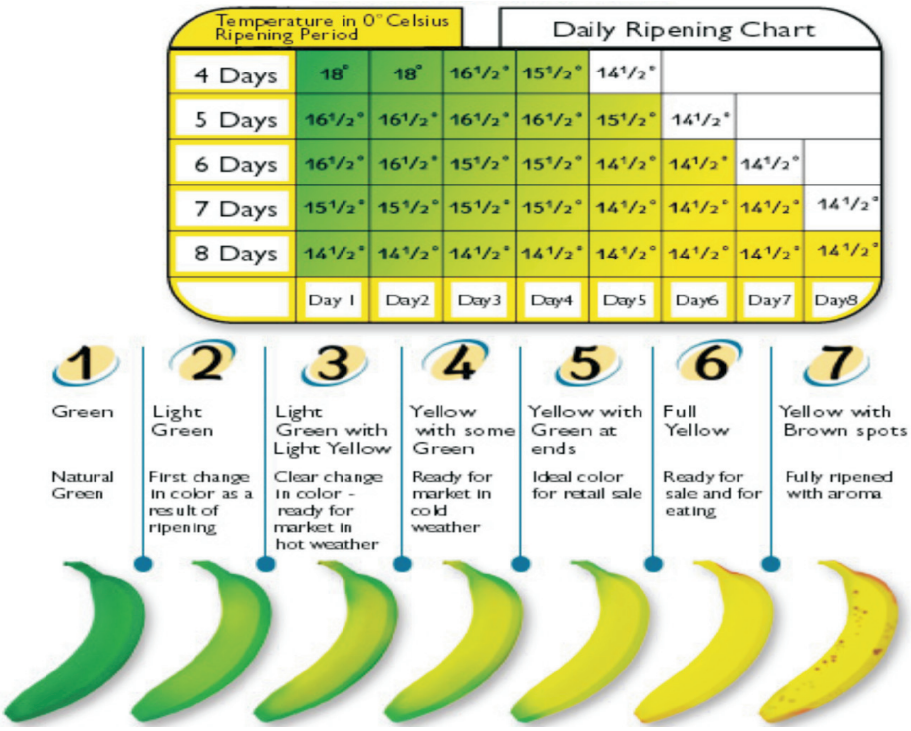
Table-1

S. No.	Produce Details	Ethylene Concentration (ppm)	Ethylene Exposure Time (hours)	Ripening Temperature (°C)	Storage Temperature after ripening (°C)
1	Banana	100-150	24-48	15-18	13-14
2	Mango	100	24	20-22	10-13
3	Papaya	100	24-48	20-25	About at 7
4	Pears	100-150	24-72	18-22	About at 0° C
5	Tomato	100-150	24-48	18-20	12.5

Source: Adel A. Kader, Department of Plant Sciences, University of California, Davis, CA. http://post-harvest.ucdavis.edu/produce/producefacts/fruits, http://fruit-ripening.com

Figure-4

Banana Ripening Chart



4. Technical Standards for Ripening Chambers/ Units

I. Background Facts

It is also noticed that ripening chambers which are being set up under various schemes of horticulture development, do not adhere to appropriate technical standards. Main shortcomings noticed are as follows-

- Inadequate building design;
- Use of inadequate / unreliable insulation material with insufficient K value
- Use of obsolete and energy inefficient refrigeration units
- Lack of uniform air flow circulation system
- Lack of controlled conditions and technology for ethylene, temperature and relative humidity
- Lack of proper ventilation systems and exhaust fans for Co_2 emission
- Lack of monitoring and control system and display devices;
- Use of unsafe electrical devices

It is therefore, necessary to prescribe appropriate technical standards in respect of modern, pressurised fruit ripening units which are given in following chapter.

II. Technical Parameters for Pressurised Ripening Chamber

Unless specifically otherwise mentioned, all the applicable latest codes and standards published by the Bureau of Indian Standards and all other standards, shall govern in all respects of design, workmanship, quality, properties of materials, method of testing and method of measurements. Generally relevant 'IS specification' and 'Code of Practices' shall be used for all electrical, mechanical and civil works / installation, however, 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. Even for Ripening of Fruits and Vegetables' the process as recommended by IS Standards (e.g. IS 11977 of 1987 for ripening of green banana) or as per International Standards should be followed. For further guidance, following technical parameters may be followed:

Storage capacity of ripening chamber may depend on fruits to be ripened and stacking and air-flow system. In this context, banana may be taken as reference crop for calculation of storage capacity for a given volume of storage space.

Table-2

S. No.	Items / Particular	Minimum Technical Specifications
1	**Civil Structure- building design**	**Civil Structure** a. Structural Safety – Structural design as per BIS Code b. Adherence to local Building Regulations c. Concrete floor with sufficient load bearing capacity. d. Chamber size is not smaller than 50 Cu M for preventing building up of high concentration of ethylene.
2	**Ripening Room Dimensions**	a. Ripening Room dimensions will depend on number of tiers and number of pallets to be stored. On an average 11M^3 per MT of banana fruits in ripening units for 10 MT or larger capacity and 12 M^3/MT for ripening units of less than 10 MT capacity. For this purpose, volume of one chamber is taken in to account. b. Number of chambers may vary from four to eight depending on ripening cycle in terms of number of days. Chambers will be generally identical in dimension. In low cost solution, one ethylene exposure chamber may be accompanied by single storage hall of, say, four times the size of the former. However, in such low cost solutions, lots of different ripening stages being stacked together, it may not be possible to provide temperature conditions recommended for each of them. c. Further Increase in number of chambers in multiple of ripening cycle may be undertaken but situation in which mechanised handling is possible, multi tier ripening chamber is an alternative option available. Number of tiers may go up to three.
3	**Ripening Room Construction**	**Construction Features** a. Ripening Room Chambers should be designed and constructed to hermetically seal with appropriate closures / doors. The key feature of ripening rooms is that conditioned air is forced through the product rather than the product just being stored in a temperature controlled room. The system passes air though each pallet or series of pallets before returning to the evaporator. Therefore, any “air-stacking” or “cross-stacking” of boxes is not necessary, and the result is less space requirement, lesser handling of the fruit and improved product quality. It is for this reason that they are recommended even for ripening of fruits in crates and are mandatory for fruits in CFB boxes and single or multi-tier stacking system. b. The airflow within the ripening rooms is to be designed to

S. No.	Items / Particular	Minimum Technical Specifications
		penetrate all boxes of fruit with an even airflow throughout the room resulting in all fruit being ripened uniformly. Recommend air flow is 0.3 cfm per pound of bananas or 2000 m3/ per hour / per metric ton of product. If the pulp temperature difference between the warmest and coolest fruit is less than 1°F or 0.55°C then there is adequate airflow. Plenum chamber is recommended so as to equalise pressure through the product for uniform distribution/flow of air and ethylene through the product. c. Ripening rooms may be constructed of PUF panels or by application of suitable thermal insulation with vapour barrier and cladding on walls, floor and ceiling of civil structure. Panels are prefabricated building components filled with insulation, clad on both sides with facing materials and arranged with a jointing means to connect panels and may be preferred. In any case, inner chamber surface should be of food grade cladding. d. The insulation envelope shall be designed to ensure that air pressure created by fans does not affect the integrity of the cold store structure or the panel joints. e. The height of wall panels is often such that care must be taken to ensure that adequate stability of the wall panels is maintained. If ceiling support are provided, the Ceiling support system shall be connected to the main structure in a manner which takes into account: i. The method of supporting the insulating ceiling panels, ii. The position of the supports to avoid local over stress within the supports, the suspended ceiling or the main structure, iii. The expansion and contraction of the main structure.
4	**Ripening Room Doors**	Ripening doors should be designed for minimal gas leakage. In general. i. For single tier loading, hinged doors, and in some cases, sliding doors are used. The doors should be designed for rugged operation and easy access for incoming and outgoing fruits on pallets. ii. When stacking is multi-tier and handling of pallets is mechanised, wider openings of doors are required. iii. Care should be taken when positioning doors adjacent to fans to avoid ingress or egress of air as significant changes in store pressure can occur when such doors are opened.iv.

S. No.	Items / Particular	Minimum Technical Specifications
		Where possible the door should be located on the external (warm side) of the cold store insulation. v. Suitable gaskets shall be provided to form a seal around the door opening. vi. Large doors shall be supported by a sub-frame independent of the insulating panels. vii. Automatic doors shall open and close promptly. viii. Automatic doors shall incorporate a safety device to avoid injury to personnel or damage to product in the case of accidental closure. ix. All doors required for means of escape purposes shall be easily and immediately operable from the inside at all times. Doors, which open automatically, are not acceptable for means of escape unless they have a manual override and can be opened manually in the event of a power failure. x. In case of multi tier stacking, doors are rolling up type and therefore, following desirable safety features for doors should be ensured- a. Internal Door Release b. Bottom Edge Pressure Operated Safety Stop c. Cable Break Electrical Safety Stop d. Spring Break Mechanical Safety Stop e. Vision Panel with emergency Knock out panel f. Vertical "D" section flexible seal for effective sealing in condition of reverse airflow for uniform ripening. Seal should be strong enough to withstand impact from pallets during loading operations and flexible enough to create an adequate seal between air distribution system and product. Horizontal pallet seals should be supported continuously along the full length of room but should be easy to remove a seal for cleaning or replacement. g. Door protection by Goal Post Protection which protect door perimeters or Single Fixed Bollards doors suitable for ripening chamber.
5	**Insulation material**	**i. INSULATION MATERIAL** a. Some manufacturers recommend Rockwool or Poly-isocyanurate (PIR) core composite panels for fire proofing. However, Polyurethane (PUR) Foam / EPS / Extruded polystyrene are also used.

S. No.	Items / Particular	Minimum Technical Specifications
		b. *PUF panels are advisable for ripening chambers.* Minimum 60 mm thick up to 120mm thick (PUF) insulated sandwiched panel (minimum density of 40 Kg / M^3) depending on the design requirements; or any other insulation material having minimum R value of 2.6 M^2.K / W are recommended for easy in-situ construction and vapour barrier effect. Floor shall have PUF slab 60 mm (minimum density of 40 Kg / M^3) or any other equivalent insulating material is recommended. c. Covering floor insulation with 100mm concrete is recommended. Floor finish should be smooth with polymer coating so has to be kept clean. **ii. FACING MATERIALS-** One of the following coverings may be used; the first three are used more frequently than the others and a minimum total coated thickness of 0,5 mm is recommended. A vapour seal shall be used on the outer facing of materials, which are permeable, such as brick masonry: a. Galvanized steel sheeting b. Suitable plastic coated galvanized steel sheeting c. Polyester coated galvanized steel sheeting d. Stainless steel sheeting e. Aluminium sheeting f. Aluminium/zinc protected steel sheeting g. Glass reinforced plastics **iii. ADHESIVES** a. Certain adhesives have a combustible solvent base which can be absorbed by and remain in the panel insulation. These solvents should, therefore, be avoided. b. Certain adhesives should be stored under controlled conditions and the manufacturer's requirements should be strictly observed; many adhesives have a maximum shelf life. c. Adhesives should not have a lingering taint
6	**Temperature & Humidity levels**	Ripening is preferred at a lower temperature but above level of chilling injury. System has to be designed to achieve prescribed ripening conditions in terms of temperature and relative humidity for target fruits. Generally, RH level of 90- 95% is recommended to prevent moisture loss.

S. No.	Items / Particular	Minimum Technical Specifications
7	**Heat Load Calculation and Refrigerant**	Cooling and heating system needs to be designed based on heat load calculation. As per Kyoto Protocol standards, any eco-friendly refrigerant should be used including ammonia, R-134a and R 404a.
8	**Cooling / heating coils and plenum chamber**	a. Cooling coils are manufactured from Copper or Stainless Steel Tubes and Aluminium Fins. The coils must provide exceptionally large surface area to ensure high natural humidity levels within ripening rooms. In case of ammonia as refrigerant, copper tube shall not be used. b. In case of a plenum chamber; cooling coils and fans must be easily accessible via single access hatch located above or at the end of the plenum chamber at roof level. Ceiling voids should be fully illuminated to facilitate inspection of coils at regular intervals. c. Electric heating elements should be used for heating ripening room during lower temperature season as per design requirement and be placed in easily accessible locations. Open flame type chamber heating should never be used due to explosive nature of ethylene. d. Fixing of the cooler shall be arranged to avoid disturbance of the ceiling panel support system. Ceiling panels in the vicinity of the cooler units will be subjected to continual variations in temperature and therefore, relative movement during defrost cycles.
9	**Material to be used for ripening**	Ethylene gas with suitable detection and dosing equipment to maintain ethylene concentration within required levels depending on product (Range 10 to 200 ppm).
10	**Ethylene Generator and Dosing device**	a. Ethylene may be introduced in ripening chambers in one of the three ways- by using independent ethylene generator with regulator; ethylene cartridges and ethylene-nitrogen mixture (5% ethylene + 95% nitrogen) cylinder. Whichever method is used, the duty holder should ensure that there are adequate means of dispersing the ethylene gases throughout the ripening room on its release. b. Centralized Ethylene supply with Automation for multiple chambers for controlled and safe dosing of ethylene may be preferred for larger units. c. If a generator containing ethanol based solution requires to be moved, it should be switched off, the mains cord removed from the socket outlet, and the manufacturer's instructions closely followed.

S. No.	Items / Particular	Minimum Technical Specifications
		d. It may be borne in mind that ethylene in concentration above 27000 ppm may explode.
11	**Specification for Air circulation system**	i. Minimum air flow should be 2000 M^3 per hour, per MT of product ripened at 95%. ii. In Ripening Units type-1, air circulation is modified for uniform ripening by introduction of system of Tarp, Tarp/ Lock Sock System / Air Bag for Vertical Air Circulation or Horizontal Air Flow. iii. In case of Ripening Units type -2, air circulation fans should have adequate static pressure for uniform air/ ethylene flow through the ventilation holes provided in the CFB boxes/ Plastic Crates / Plastic Bags containing fruits. For this, large diameter, reversible axial flow fans should be installed in the false ceiling accessible via a single access hatch for *air supply under pressure.* Each fan should preferably be equipped with venturi inlet to provide maximum efficiency throughout the ripening process. In such cases, pallet isolation must be provided for energy savings in part load conditions by providing a series of isolation dampers along the length of the ripening chamber. This function is operated by making proper selection for pallet isolation on Computerised Ripening Room Management System.
12	**Ventilation System**	a. When fruits are ripening, they release carbon dioxide which will build up in a ripening room. The CO_2 production begins as the fruit ripens enters the "climacteric" phase, or the period when bananas release ethylene and have an elevated rate of respiration (along with a great deal of other physiological changes). Respiration involves the uptake of oxygen, the release of carbon dioxide, and the breakdown of starches. Carbon dioxide concentrations above 1% (10,000 ppm) will retard ripening, delay the effects of ethylene and cause quality problems. Suitable venting system consisting of fans/dampers/open – shut valves should be installed to maintain CO_2 concentration below 5000 ppm. b. In ripening rooms Type-1, ventilation may be automatic or manual. c. In case of ripening rooms type-2 with pallet isolation, ventilation may be provided by a roof mounted fan which is identical in specification to the pressure fans. d. In case of automatic forced air exhaust / ventilation system with ducting, a dual inlet / discharge damper

S. No.	Items / Particular	Minimum Technical Specifications
		operates in parallel with the fan to allow fresh air from outside to replace the air within the room when vent is required. Automatic exhaust fans (either timed or sensor-based) or "flow-though" (constant) ventilation are provided at two locations (one near ceiling of chamber and another a little above floor level) in each chamber. This also evacuates the ethylene after the desired exposure period and helps to maintain CO_2 concentration low (below 5000 ppm) during the ripening cycle for proper ripening. In such cases, opening and shutoff actuators/ valves control is affected by CO_2 sensor and timer device.
13	**Sensors and Control devices**	a. Suitable sensors and controlled devices should be used for maintaining following parameters. For this, temperature & humidity loggers and Ripening Chamber Air Analysis Kit (for Ethylene and CO2 levels) may be used. i. Temperature ii. Relative humidity iii. Ethylene concentration iv. CO2 Concentration b. PLC device also known as Ripening Room Management System –"RMS" is must in Ripening Unit Type-2. The controller provides total control of the ripening system allowing operators secure and password protected access to following functions- c. Clear real time temperature display and control d. Fan speed and energy usage e. Ventilation intervals f. Relative humidity indicator and control g. Ethylene level monitoring and regulation h. Door control i. Lighting control j. Pallet loading and isolation k. Differential Pressure DisplayDifferential Pressure Display provides the ripener with an indication of air pressure drop cross the fruit pallets. This information along with information from Temperature. Ethylene gas censors located inside chamber, within pallets and within boxes / plastic bags, is used to determine the setting of the inverter drive based on factors such as the type of product packaging and fruit, amount of pallets in the room and

S. No.	Items / Particular	Minimum Technical Specifications
		current stage of the ripening process. The RMS for multi-chamber pressure ripening system should preferably be able to be configured to allow all rooms to be viewed and controlled locally and, or remotely.
14	**Electrical plug point**	a. For operating Portable Ethylene Generator, an Electrical Plug point is required inside the room. Metal Clad Plug point in the Metal Socket housing with the independent circuit breaker system, in order to isolate the system independent with the rest of the System, is recommended. b. For centralized gas emission, no electrical connections are required inside the room.
15	**Pallet Racking and Material Handling**	a. Ripening unit with single tier stacking should have a manually operated pallet lifting and carrying device. Pallet racking system comprises of box section construction which may be designed as per BS 5950 or equivalent IS standards for strength and cleanliness, providing easy access for pallet loading at high level. b. For multi-tier stacking motorised forklift should be provided. In such cases, in order to assist loading at upper levels, fork lift guides are to be installed to form a centre aisle which are strengthened by back filling with concrete. These guides are to be tapered at the front. To facilitate loading and centralising the fork lift truck in the drive in racking, the middle and upper tiers of racking are offset from the lower tier. An access ladder is also provided to the rear wall for access to an optional grated walkway at middle and upper pallet levels. c. Typical palletisation systems are shown in **Section 3**.
16	**Some Useful Appliances and Instruments**	Weighing Scales and Fruit Inspection Instruments such as follow- a. Weighing Scale b. Firmness Tester c. Refractometer d. Sizers and Callipers e. Produce Knife
17	**Safety Certification**	I. Various fire detection and prevention systems and devices are commercially available and use of these is good practice. They include detectors for heat and smoke; fixed water-sprinkling system, inert gas snuffing systems,

S. No.	Items / Particular	Minimum Technical Specifications
		smoke release valves, flameproof barriers, fire breaks formed by the separation of chambers, etc. All devices used shall have been tested at low temperatures and shown to be satisfactory. II. Certification for safe storage of ethylene and for system for prevention of ignition and explosion from competent authority, as per statutory requirement, if any, must be taken. Similarly, safety for workers against suffocation must be ensured. Certification from following Certification Authority is necessary- a. Factory Inspector b. Fire Fighting Inspector c. Electrical Safety Inspector

I. Variation / amendment Clause

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

SECTION - 2

BASIC DESIGN DATA SHEET

BASIC DESIGN DATA SHEET

Sl. No.	Specifications	Units	Parameters
1	Storage Capacity (in terms of banana)	**M**T	.....
2	Room Volume	M^3	.....
3	Room Size (l x w x ht)	each in M	.....
3a)	Ripening rooms	Number	.....
4	Pallets	Type	.....
4 a)	Size of each pallet	MM x MM xMM	.....
4 b)	Pallets each chamber	Number	.....
4 c)	Crates / box layers on a Pallet	Number	.....
4 d)	Stacks in case of multi tier stacking	Number	.....
4 e)	Pallet lifting system		.....
5	Design Ambient Temperature	DEG.C	.....
6	Target Fruits	Names	.....
7.	Ripening Room Temperature	DEG.C	.....
8	SST	DEG.C	.....
9	Design RH in ripening room	%	.....
10	Product Incoming Temperature	DEG.C	.....
11	Pull down Period	HOURS	.....
12	Wall / Ceiling / Floor Insulation	Type	
13	Values of Thermal Insulation	(a) Density.....	(b) U value.....
14	Insulation Thickness		
14a)	Wall Insulation Thickness	MM	.....
14b)	Ceiling Insulation Thickness	MM	.....
14c)	Floor Insulation Thickness	MM	.....
14d)	Type and thickness of cladding on insulation on walls		.....
16	Door Size (w x ht x Thick) each in	MM	.....
16a)	Hinged Door Size		.....
16b)	Sliding Door Size		.....
16c)	Other Type		.....
17	Tube Light Fittings	W x Nos.	.....
18	Design Ripening Period	No of Days	.....
19	**Refrigeration Load**	**KW / Tr**	.....
20	Suggested Refrigeration Units	Tr and No.	.....
21	Indicative Power Input Data for Refrigeration System	KW	.....
22	**Humidification Load**	**Kg / Hr**	.....
23	Ethylene Application System	Detail	.....
24	Sensors	Detail	.....
25	Control System	Detail	.....
26	Electric System for chamber		.....
27	Humidifier	Detail	.....
28	Measures to ensure proper quality of water for humidifier		.....
29	CoP		.....

SECTION - 3

Guidelines for Stacking & Typical Construction Features of a Ripening Unit

Appendix I

Some Typical Pallets' Arrangements

Figure - 5
A Typical Pallet

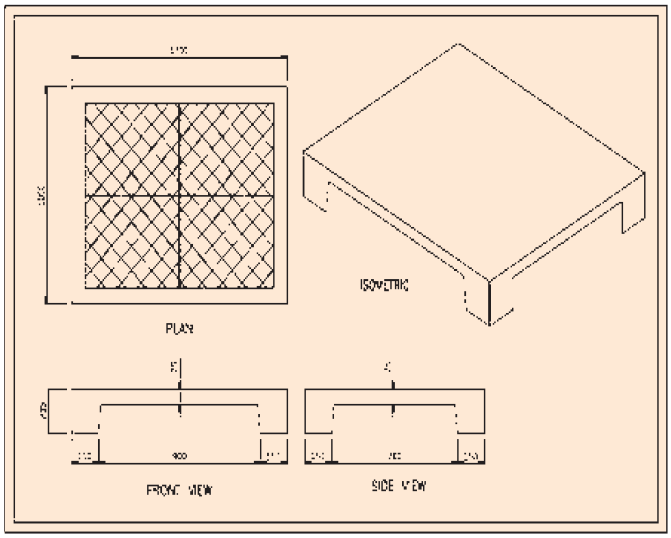


Figure - 6
A Typical Crate

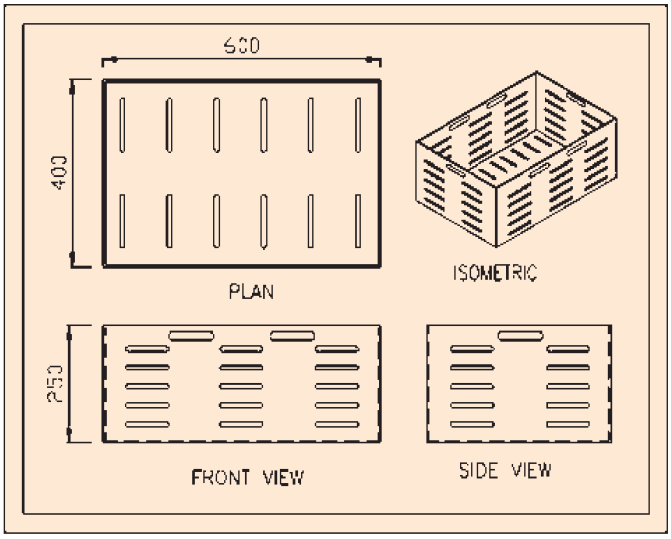


Figure - 7
A Typical Pallet – Crates Arrangement

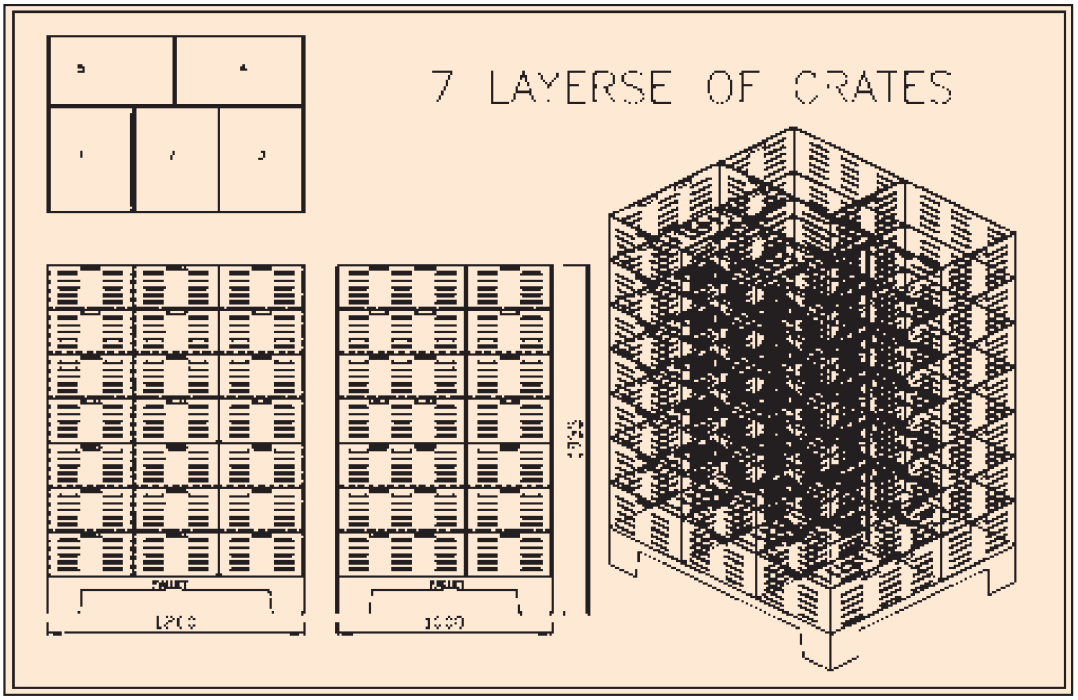


Figure - 8

5 MT Ripening Chamber - Evaporator Unit & Pallets Arrangements

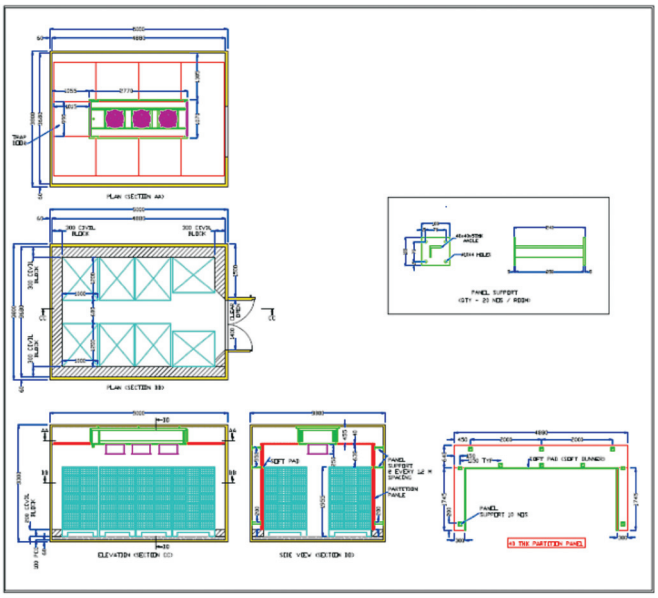


Figure - 9

10 MT Ripening Chamber - Evaporator Unit & Pallets Arrangements

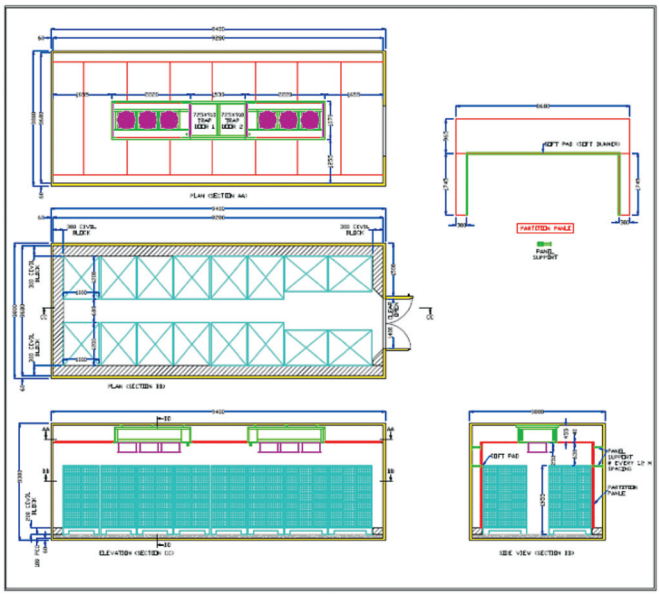


Figure - 10

20 MT Ripening Chamber - Evaporator Unit & Pallets Arrangements

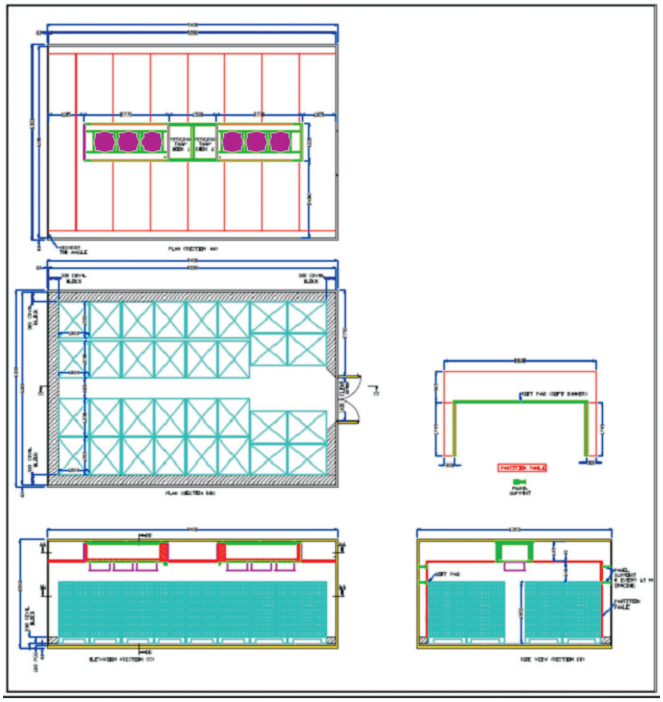


Figure - 11

30 MT Ripening Chamber - Evaporator Unit & Pallets Arrangements

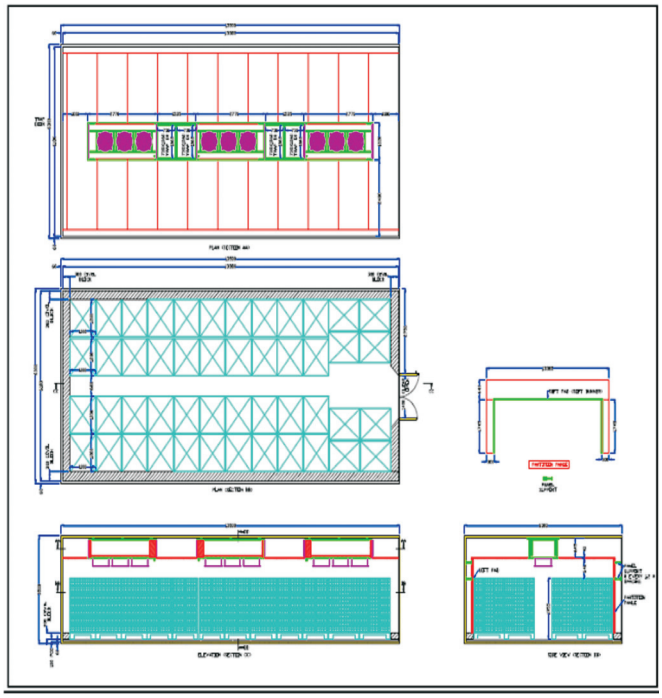


Figure - 12
Typical Air Flow Diagram for Ripening Room

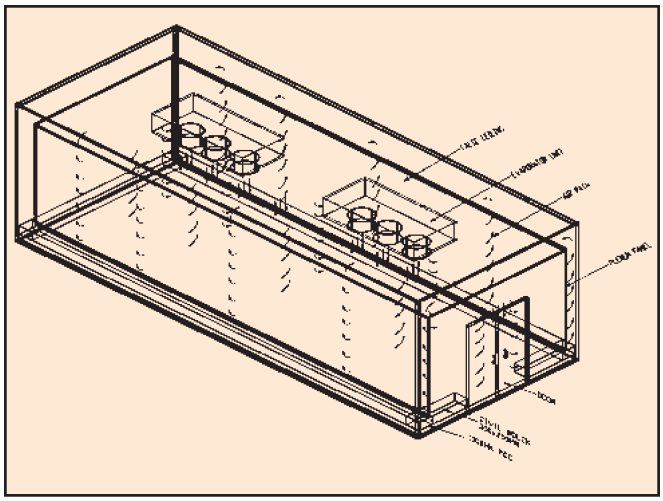


Figure - 13
Typical Air Flow Diagram for Ripening Room With Pallets

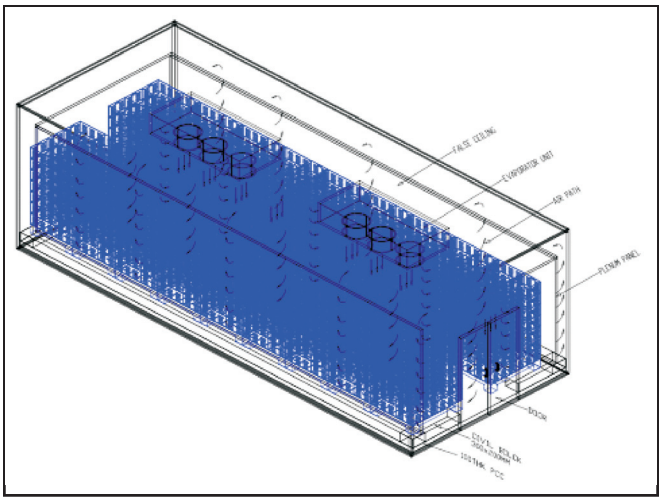
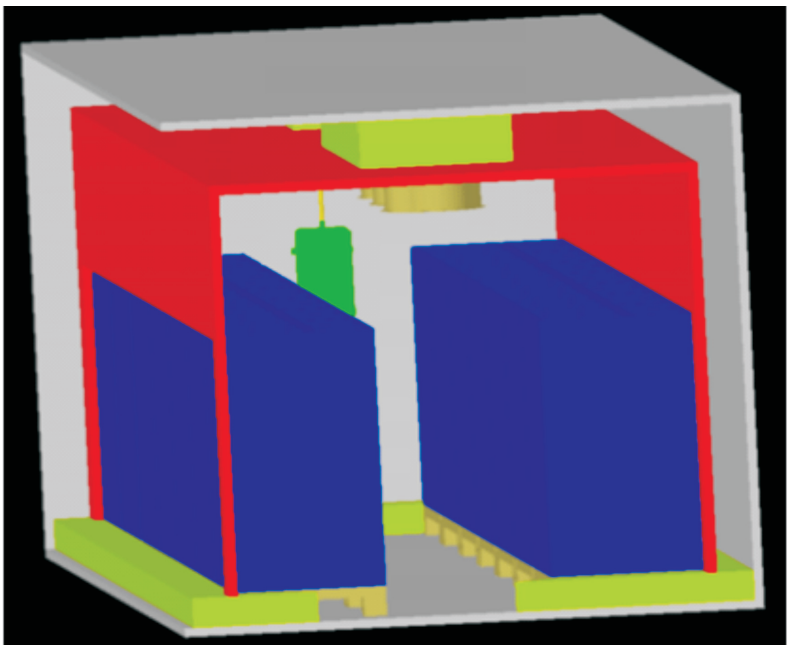


Figure - 14
Typical Pallet-crates Arrangements in A Ripening Room



APPENDIX-2

Typical Construction Features of a Ripening Unit

Figure - 15
Typical General Items Arrangements in A Ripening Room

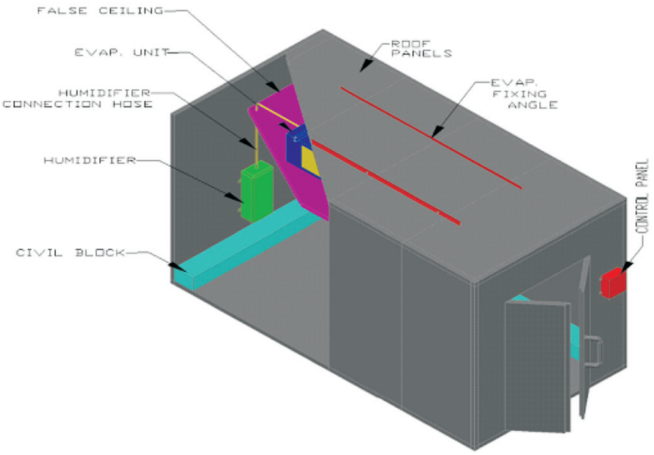


Figure - 16
Typical Evaporator Fixing Arrangements

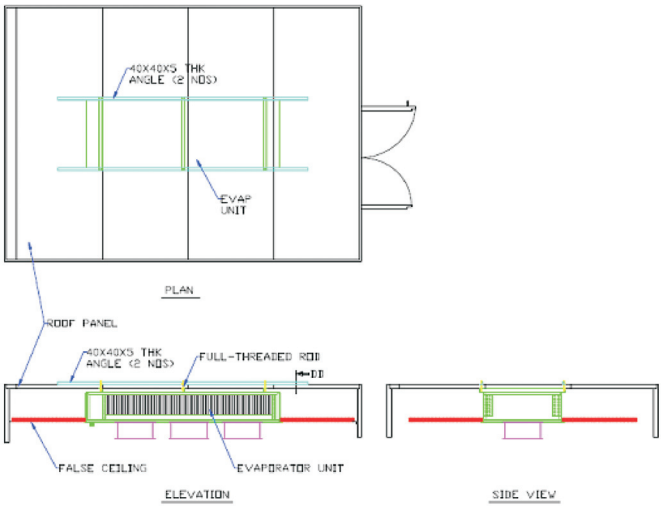


Figure - 17
Typical Control Panel & Sensor Locations

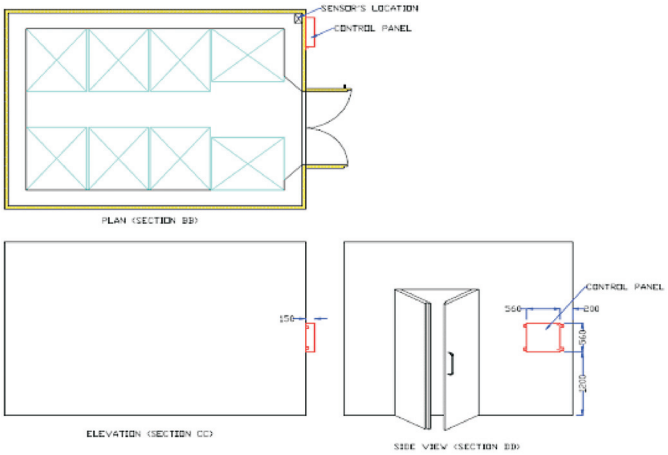


Figure - 18
Humidifier Location

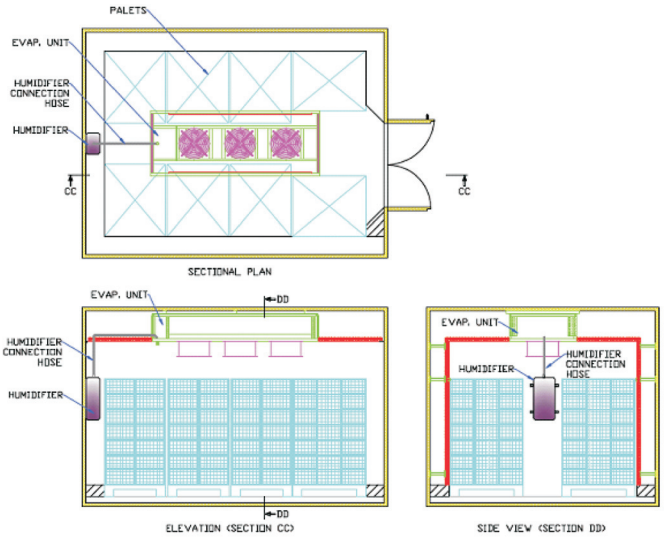


Figure - 19

Typical Fresh Air Entry & Exhaust System

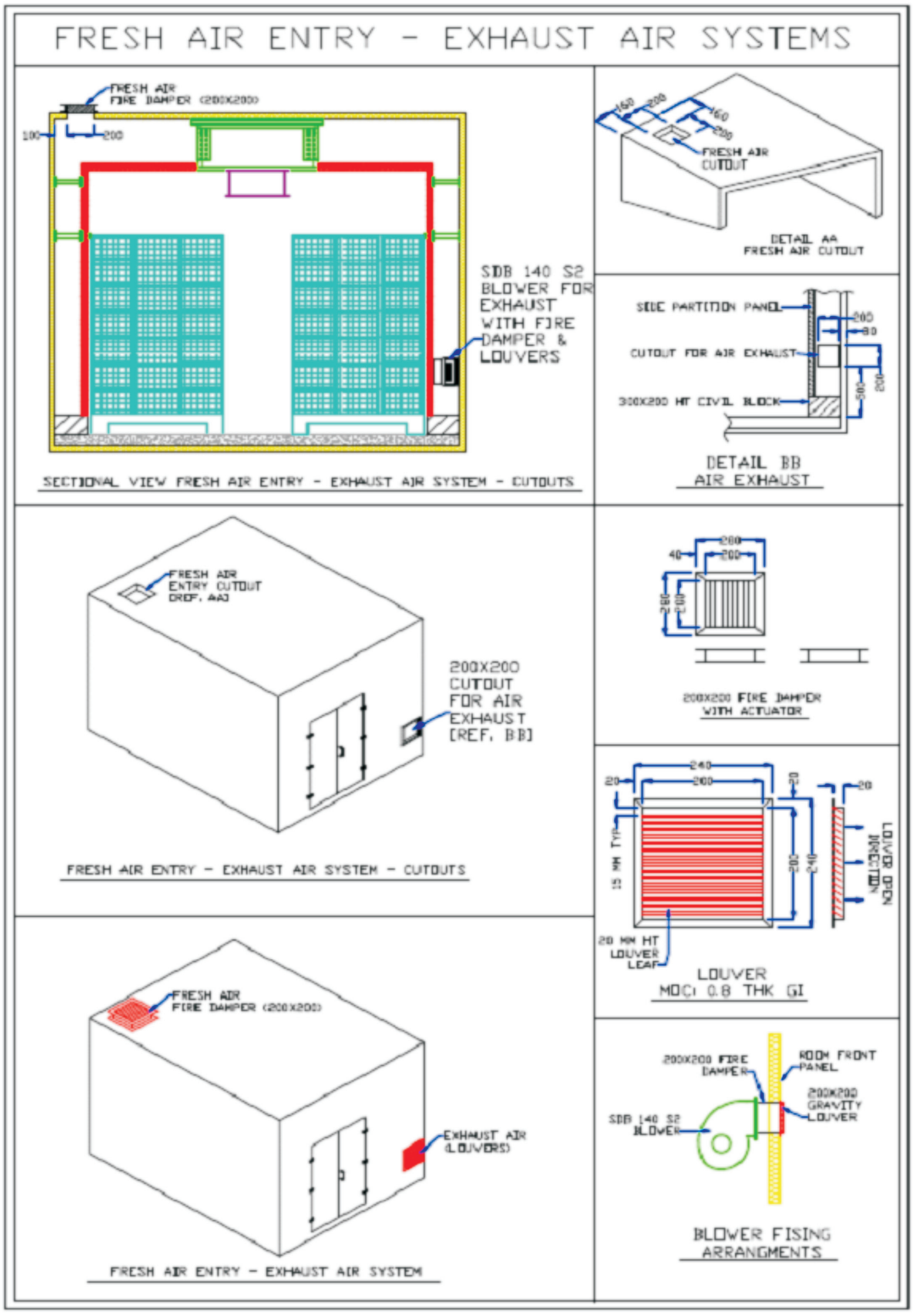


Figure - 20
Air Bags (Vertical Air Circulation)

Figure - 21
Lock Sock System

Figure - 22
Lock Sock System

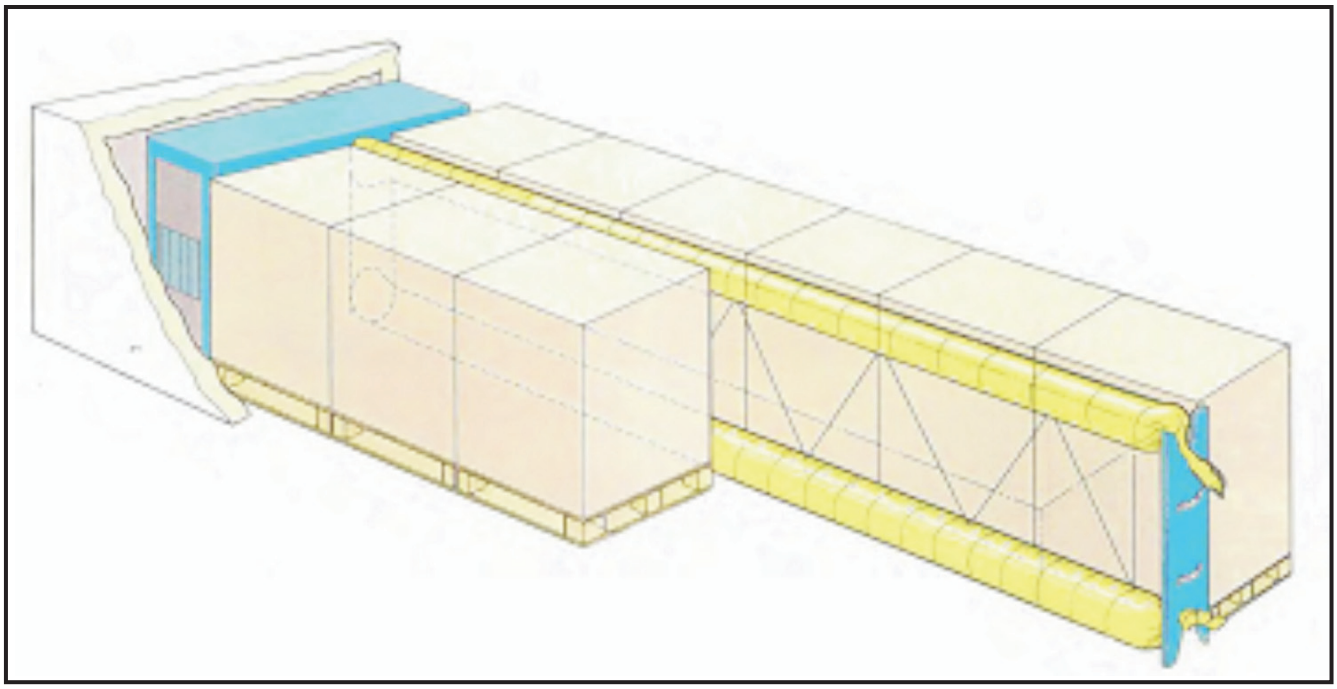


Figure - 23
Horizontal Air Circulation

Figure - 24
Racks and Pallet Isolation

SECTION - 4

Protocol for Implementation of Technical Standards

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 Design 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,

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

ii. 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.

Annexure – I

List of Members / Experts in Technical Committee of NHB

1. Shri Bijay Kumar, Managing Director, National Horticulture Board, Gurgaon (Haryana)
2. Shri I.C. Chadha, DY. General Manager (Tech.), Central Planning Housing Corporation. New Delhi
3 Shri Naresh Kumar Jawa, Chief Executive Officer, Fresh & Healthy Enterprises Ltd., CONCOR HSIIDC Industrial Estate, Rai, Sonepat-131029 (Haryana)
4 Shri R.S.Rathore, Department of Horticulture & Food Processing, Govt. of Uttar Pradesh, Lucknow
5 Shri Suneeth Toteje, Scientist - C, Food & Agri Bureau of Indian Standards
6 Shri R.K.Boyal, General Manager (F&R), Agriculture & Processed Food Product Expert Development Authority(APEDA), 3rd Floor, NCUI Building, 3 Siri Institutional Area, August Kranti Marg, New Delhi
7 Shri Vinod Kaul, Dy. General Manager (F&R), Agriculture & Processed food Product Expert Development, Authority (APEDA), 3rd Floor, NCUI Building, 3 Siri Institutional Area, August Kranti Marg, New Delhi
8 Shri S.D.Sharma, AGM (Project) CWC, CO, New Delhi
9 Dr. S.K. Chauhan, Deptt. Of Horticulture & Food Processing, Lucknow (UP)
10 Dr. M.M.Mustaffa, Director, National Research Center of Banana, Trichi
11 Shri P. Saxena, Advisor, National Cooperative Development Corporation, New Delhi
12 Dr. D.K. Tandon, Scientist, Central Institute for subtropical Horticulture, Lucknow (UP)
13 Shri A.K. Verma, Central Institute for subtropical Horticulture, Lucknow (UP)
14 Dr. R. K. Sharma, Sr. Deputy Director, National Horticulture Board, Gurgaon
15 Shri Brijendra Singh, Deputy Director, National Horticulture Board, Gurgaon
16 Shri K. Vijay Singh, Rinac India Pvt. Ltd, 101-C, Ist Floor, Kudan House, Hari Nagar, Ashram Chowk, New Delhi – 110 014.
17 Shri Mr. T.N. Jayaram, Head (Technical Training & Support) Rinac India Pvt.Ltd.,101-C, Ist Floor, Kudan House, Hari Nagar, Ashram Chowk, New Delhi.
18 Shri Ekanath Gajare, At & Po-Chinawal, Tehsil- Raver, Dist- Jalgaon (MS)
19 Shri Ashish Srivatava, Chemtron Science Lab Pvt. Ltd., Lucknow (UP)
20 Shri V.S. Sunjay, Yes Bank Ltd., DLF-Phase II, Gurgaon (Haryana)
21 Shri Umesh C. Agrawal, Isopan Insulation Pvt. Ltd., T-11/90, Vipul Green, Sohana Road, Gurgaon (Haryana)
22 Shri Suresh Kumar, Blue Star Ltd., Block 2A, DLF Corporate Park, Gurgoan

23 Shri B. Thiagarajan, Blue Star Ltd, 9 Bazullah Road, T. Nagar, Cheenai-600017

24 Shri R M Iyengar, Blue Star Ltd.

25 Shri Dnyandeo Ganpati Mahajan, At & Po- Chinawal, Tehsil- Raver, Dist- Jalgaon (M.S)

26 Shri S.K.Sharma, Managing Director, Global Agri System Pvt. Ltd., K-13, Hauz Khas, Enclave, New Delhi

27 Shri M.S. Manjunath, Vice President (Business Development), Ingersoll Rand International (India), Bangalore

28 Shri M. Venkanna, Ranersonrand International India Ltd., Bangalore

29 Shri Sanjay Gupta, Infracool, 42-76, Sector 23 A, Gurgaon

30 Shri R. Anish Sinha, Rinac India Ltd., Bangalore

31 Shri Rajesh Kumar, Chemtron Science Lab Pvt. Ltd., EI-47, MSDC Mahape, Navi Mumbai.

32 Shri Dinesh Goswasy, Agritech Equipment & Services Pvt. Ltd., New Delhi

33 Shri A.K. Choudhary, Dev Bhumi Cold Chain Ltd.,17-18, Sabji Mandi, Azadpur, Delhi

34 Shri Subhash Kankan, Dev Bhumi Cold Chain Ltd., 17-18, Sabji Mandi, Azadpur, Delhi

35 Shri Sanjay Aggarwal, Dev Bhumi Cold Chain Ltd., 17-18, Sabji Mandi, Azadpur, Delhi

36 Shri S.K. Sharma, Bajaj Processor Machine Pvt. Ltd., 7/27, Jailaxmi Industrial, Estate site-4, Sahabad, Industrial Area, Gaziabad (UP)

37 Shri Girish Bajaj, Bajaj Processor Machine Pvt. Ltd., 7/27, Jailaxmi Industrial, Estate site-4, Sahabad, Industrial Area, Gaziabad (UP)

38 Shri J.M. Gupta, MD, APC Polycoat (India) Pvt. Ltd. A1/296, Janakpuri, Pankha Road, New Delhi

39 Shri Mahavir Verma, Vice President, International Coil Company, A 21-24, Naraina, Industrial Area, Phase-II, New Delhi- 110028

40 Shri Mukesh Puri, President, ISHRAE, HQ, , 502, 5th Floor, DDA Building District Centre, Laxmi Nagar, Delhi – 110092

41 Shri Girish Sachar, Executive Secretary, ISHRAE, HQ, 502, 5th Floor, DDA Building District Centre, Laxmi Nagar, Delhi – 110092

42 Shri S. S. Malik, B 5 &6/4299, Vasant Kunj, New Delhi-110070

43 Shri Ashutosh C. Mali, Jain Irrigation System Ltd., Jalgaon (M.S)

44 NHB Officers from its HQ and different States.

Annexure – II

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	IS 2274-1963
	(system voltage exceeding 650 V)	
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

S. No.	Title	Reference
21.	Flexible Steel conduits for electric wiring	IS 3480
22.	Air-Break Switches	IS 4064
23.	Motor Starters for voltage not exceeding 1000 Volts	IS 8544
24.	Conduits for electrical installation	IS 9537
25.	Selection, installation & maintenance of Transformers	IS 10028
26.	Selection, installation & maintenance of switch gear and control gear	IS 10118
27.	National Electrical Codes	SP: 30

B. Mechanical
Bureau of Indian Standards (BIS)

S. No.	Title	Reference
1.	Safety cods for Mechanical Refrigeration	IS 660
2.	Code of practice for thermal insulation of cold storages	IS 661
3.	Code of practice for application of polyurethane insulation by in-situ pouring method	IS 13205
4.	Rigid phenolic foams for thermal insulation	IS 13204
5.	Application for spray applied insulation code of practice – Polyurethane / Poly-isocyanurate	IS 12432 Part-III
6.	Specifications for preformed rigid polyurethane (Pur) and poly isocyanurate (Pir) foams for thermal insulation	IS 12436
7.	Expanded polystyrene for thermal insulation	IS 4671
8.	Code for practice for fire safety of industrial buildings: General Storage and warehousing including cold storage	IS 3594
9.	Anhydrous ammonia	IS 662
10.	Industrial Bitumen	IS 702
11.	Gunmetal gate, globe and check valve for general purpose	IS 778
12.	Ball Valves including floats for water supply purposes	IS 1703
13.	Mild Steel Tubes, tubular and other wrought steel pipes fittings	IS 1239
14.	Steel Plates for pressure vessels used at moderate and low temperature	IS 2041
15.	Color code for identification of pipe lines	IS 2379
16.	V-belts for industrial purposes	IS 2494
17.	Hot dip galvanizing of iron and steel	IS 2629

S. No.	Title	Reference
18.	Code for unfired pressure vessels	IS 2825
19.	Glossary of terms for safety and relief valves	IS 3233
20	Steel for pressure vessels and welded structures	IS 3503
21.	Steel tubes for mechanical and general engineering purposes	IS 3601
22.	Steel for general structural purposes	IS 2062
23.	Steel tubes for structural purposes	IS 1161
24.	Specifications for steel doors, windows and ventilators	IS 1038
25.	Code of practice for design loads (other than earthquake) For building and structures	IS 875 Part I to V
26.	Criteria for earthquake resistant design of Structures	IS 1893
27.	Specifications for cold formed light gauge structural steel sections	IS 811
28.	Code of practice for use of Steel Tubes in general building construction	IS 806
29.	Code of practice for use of cold form light gauge steel structural members in general building construction	IS 801
30.	Code of practice for general construction in steel	IS 800
31.	Glossary of terms used in refrigeration and air-conditioning	IS 3615
32.	Pressure and vacuum gauges	IS 3624
33.	Safety Codes for scaffolds and ladders	IS 3696
34.	Formed ends for tanks and pressure vessels	IS 4049
35.	Shell an tube type heat exchangers	IS 4503
36.	Code of safety for ammonia	IS 4544
37.	Expanded polystyrene for thermal insulation purposes	IS 4671
38.	Hot-dip Zinc coating on steel tubes	IS 4736
39.	Units and symbol for refrigeration	IS 4831
40.	HDPE pipes for potable water supplies, sewage and industrial effluents	IS 4984
41.	Gauge glasses	IS 5428
42.	Specification for sprayed aluminum and zinc coating on iron and steel surfaces	IS 5905
43.	Steel Pipe flanges	IS 6392
44.	Injection molded HDPE fittings for portable water supplies	IS 8008
45.	Vertical steel ladders	IS 8172

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

C. Publication by International Societies and Associations
Pre Engineered Building

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

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 its building.	ETAG 021

merican Society of Heating, Refrigeration and Air Condition Engineers, Inc ASHRAE

Refer to REFRIGERATION - Systems and Applications, Handbook

Chapter - 51 Codes and Standards,

International Standard (ISO)

Standard and/or project
ISO 873:1980 Peaches — Guide to cold storage
ISO 874:1980 Fresh fruits and vegetables — Sampling
ISO 931:1980 Green bananas — Guide to storage and transport
ISO 949:1987 Cauliflowers — Guide to cold storage and refrigerated transport
ISO 1134:1993 Pears — Cold storage
ISO 1212:1995 Apples — Cold storage
ISO 1673:1991 Onions — Guide to storage
ISO 1838:1993 Fresh pineapples — Storage and transport
ISO 1956-1:1982 Fruits and vegetables — Morphological and structural terminology
ISO 1956-2:1989 Fruits and vegetables — Morphological and structural terminology

Standard and/or project
ISO 1990-1:1982 Fruits — Nomenclature — First list
ISO 1990-2:1985 Fruits — Nomenclature — Second list
ISO 1991-1:1982 Vegetables — Nomenclature — First list
ISO 1991-2:1995 Vegetables — Nomenclature — Part 2: Second list
ISO 2165:1974 Ware potatoes — Guide to storage
ISO 2166:1981 Carrots — Guide to storage
ISO 2167:1991 Round-headed cabbage — Guide to cold storage and refrigerated transport
ISO 2168:1974 Table grapes — Guide to cold storage
ISO 2169:1981 Fruits and vegetables — Physical conditions in cold stores — Definitions and measurement
ISO 2295:1974 Avocados — Guide for storage and transport
ISO 2826:1974 Apricots — Guide to cold storage
ISO 3631:1978 Citrus fruits — Guide to storage
ISO 3659:1977 Fruits and vegetables — Ripening after cold storage
ISO 3959:1977 Green bananas — Ripening conditions
ISO 4125:1991 Dry fruits and dried fruits — Definitions and nomenclature
ISO 4186:1980 Asparagus — Guide to storage
ISO 4187:1980 Horse-radish — Guide to storage

Standard and/or project
ISO 5524:1991 Tomatoes — Guide to cold storage and refrigerated transport
ISO 5525:1986 Potatoes — Storage in the open (in clamps)
ISO 6000:1981 Round-headed cabbage — Storage in the open
ISO 6477:1988 Cashew kernels — Specification
ISO 6478:1990 Peanuts – Specification
ISO 6479:1984 Shelled sweet kernels of apricots — Specification
ISO 6479:1984/Cor 1:1999
ISO 6659:1981 Sweet pepper — Guide to refrigerated storage and transport
ISO 6660:1993 Mangoes — Cold storage
ISO 6661:1983 Fresh fruits and vegetables — Arrangement of parallelepipedic packages in land transport vehicles
ISO 6662:1983 Plums — Guide to cold storage
ISO 6663:1995 Garlic — Cold storage
ISO 6664:1983 Bilberries and blueberries — Guide to cold storage
ISO 6665:1983 Strawberries — Guide to cold storage
ISO 6755:2001 Dried sour cherries — Specification
ISO 6756:1984 Decorticated stone pine nuts — Specification
ISO 6757:1984 Decorticated kernels of mahaleb cherries — Specification

Standard and/or project
ISO 6822:1984 Potatoes, root vegetables and round-headed cabbages — Guide to storage in silos using forced ventilation
ISO 6882:1981 Asparagus — Guide to refrigerated transport
ISO 6949:1988 Fruits and vegetables — Principles and techniques of the controlled atmosphere method of storage
ISO 7558:1988 Guide to the pre packing of fruits and vegetables
ISO 7560:1995 Cucumbers — Storage and refrigerated transport
ISO 7561:1984 Cultivated mushrooms — Guide to cold storage and refrigerated transport
ISO 7562:1990 Potatoes — Guidelines for storage in artificially ventilated stores
ISO 7563:1998 Fresh fruits and vegetables — Vocabulary
ISO 7701:1994 Dried apples — Specification and test methods
ISO 7702:1995 Dried pears — Specification and test methods
ISO 7702:1995/Cor 1:2001
ISO 7703:1995 Dried peaches — Specification and test methods
ISO 7703:1995/Cor 1:2001
ISO 7907:1987 Carob — Specification
ISO 7908:1991 Dried sweet cherries — Specification
ISO 7910:1991 Dried mulberries — Specification
ISO 7911:1991 Unshelled pine nuts — Specification

Standard and/or project
ISO 7920:1984 Sweet cherries and sour cherries — Guide to cold storage and refrigerated transport
ISO 7922:1985 Leeks — Guide to cold storage and refrigerated transport
ISO 8682:1987 Apples — Storage in controlled atmospheres
ISO 8683:1988 Lettuce — Guide to pre-cooling and refrigerated transport
ISO 9376:1988 Early potatoes — Guide to cooling and refrigerated transport
ISO 9719:1995 Root vegetables — Cold storage and refrigerated transport
ISO 9833:1993 Melons — Cold storage and refrigerated transport
ISO 9930:1993 Green beans — Storage and refrigerated transport
ISO 23391:2006 Dried rosehips — Specification and test methods
ISO 23392:2006 Fresh and quick-frozen maize and peas — Determination of alcohol-insoluble solids content
ISO 23393:2006 Pomegranate fruit — Specification and test methods
ISO 23394:2006 Dried oleaster — Specification and test methods----------

Other Standards and References

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

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

   a) Commodity Storage Manual

b) Crisis Management Manual

c) Guide to Effective Ware House Operations

d) Maintenance and Modernization Manual

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

a) REFRIGERATION – Systems & Applications

b) FUNDAMENTALS

c) HVAC Systems and Equipment

d) HVAC Applications

3. The International Institute of Refrigeration (IIR),

4. International Institute of Ammonia Refrigeration (IIAR),

5. United States Department of Agriculture (USDA),

6. Post-harvest Technology-Research & Information Center UC DAVIC

Appendix - III

Extracts From International (EU) Health and Safty Rules for Ripening Room

INTRODUCTION

1 There are large number of fruit Ripening Plants in the EU enforcement area. Bananas are the most common fruit but other exotic fruits are ripened by the same process.

BACKGROUND

2 Bananas imported green into the EU are ripened in specially constructed rooms by exposure to controlled atmosphere containing ethylene gas at a concentration of typically 0.1% by volume in air. Some rooms are heated by gas or electricity, when ambient temperature is low. The ethylene is introduced from pressured cylinders, cartridges or a catalytic generator. If the introduction of ethylene is uncontrolled there is a risk that the ethylene may reach or exceed the Lower Explosive limit (LEL) and be ignited by unprotected electrical apparatus or gas heating systems. The LEL for ethylene is 3.1 %.Therefore it is highly recommended that use of Ethylene cylinders be vigorously discouraged.

THE PROCESS

3 a. Green bananas in cartons and at an ambient fruit pulp temperature are loaded into the ripening rooms. If the pulp temperature is higher, the ripening rooms will pre-cool to 15-17° C in about 16 hours. The Green bananas must be washed to remove latex and skin should be cleaned.

b. The room is closed, cooled for 12 to 16 hours until the pulp temperature reaches 15 to 17oC. The heating is then switched off.

c. Ethylene is discharged into the room at a concentration of 0.1%. The room is then kept closed for 24 hours. The ethylene acts as a catalyst initiating the hormonal process of ripening.

d. At the end of this time the room is ventilated to clear the ethylene.

e. The room is then closed again and the atmosphere controlled at a temperature of 15 to 17°C for three to four days. The fruit pulp may reach a temperature of 32°C during this process and gases, including carbon dioxide, are evolved in substantial quantities.

f. The room is finally ventilated and the ripe fruit removed. A common way of ventilating involves opening the doors for at least 5, usually 15 minutes before entry is made Extractor fans may also be used.

NB: The amount of ethylene gas required for a ripening room is normally calculated on the free air space after

the bananas have been loaded (i.e. if bananas take up to 35% of the room size. Calculate the amount of ethylene required for remaining 65% free air space

METHODS OF INTRODUCING ETHYLENE GAS

'ETHY-GEN' Catalytic Generators

4. A method by which a liquid concentrate 'Ethy-Gen' is decomposed in an electrically powered catalytic generator, to produce ethylene gas. The 'Ethy-Gen' concentrate is supplied in containers which produce about 12ft3 (0.33 m3) of ethylene gas, the amount of liquid put in the generator depends on size of ripening room.

Ethylene Cartridges

5. Each ethylene cartridges contains approximately 51g of pure ethylene and the ethylene Concentration in the room may be controlled simply and accurately by using the appropriate number of cartridges. Ethylene is released by piercing the cartridges with a tool which is supplied.

Ethylene and Ethylene/Nitrogen Cylinders

6. The explosion risk from ethylene can be eliminated by the use of a mixture of gas consisting of 5% ethylene in nitrogen. Pure ethylene and the mixture can be obtained from British Oxygen Company Limited and Air Products Limited.

Pure Ethylene Cylinders

7. Pure ethylene can be obtained in cylinders, but fire and explosion hazards being high, must be avoided.

HAZARDS

8. The hazards arising from this process fall into two main categories.

Fire/Explosion

a. Introduction of pure ethylene from cartridges may result in localized and short-lived flammable gas/air mixtures.

b. Extensive flammable gas/air mixture may result from the uncontrolled addition of Ethylene from a large cylinder or from a multiple discharge of small cartridges of the use of the catalytic generator in too small a room.

c. Where gas-fired heating equipment/electrical points are used, flame failure may result in quantities of unburnt gas entering the room and creating a flammable atmosphere.

BANANA (AND OTHER FRUIT) RIPENING ROOMS-ETHYLENE-GAS

a. excess addition of ethylene/nitrogen mixture from cylinders.

b. the evolution of carbon dioxide during the ripening process.

c. The combustion of fuel gas toxic combustion products (chiefly CO) will be produced if there is not sufficient oxygen present at the burner for complete combustion.

9. Incidents to date show that the main hazard to arise from this process is the combustion and explosion of excess quantities of pure ethylene resulting from uncontrolled discharge from large capacity cylinders. There may be a further hazard from asphyxiating gases in the ripening room, e.g. carbon dioxide and nitrogen if entry is made before ventilation is complete.

Ethanol

10. Ethy-Gen concentrates Ethanol. It is a mild irritant avoid contact with skin or eyes. It can be fatal if taken internally. It is also a highly flammable liquid.

PRECAUTIONS

11. a. Flammable or asphyxiating atmospheres can be created by admitting excess ethylene gas. The use therefore of cylinders of pure ethylene should be vigorously discouraged Enforcement officers should press for a change to ethylene cartridges or Ethylene cartridges or Ethy-Gen generators.

b. A notice showing the quantity of ethylene cartridges or Ethy-Gen concentrate required for ripening in each room given different volumes of fruit etc, be conspicuously displayed in that room. This is particularly important where there are rooms of different sizes in the same premises.

c. It is impossible to form a flammable concentration with air using ethylene/nitrogen cylinders but, advice should be given on the asphyxiation hazard to ensure awareness.

d. The ripening room should be thoroughly ventilated between loads. Preferably by mechanical means.

e. The introduction of ethylene into a room should be undertaken only by a competent person who understands the hazards involved.

f. The catalytic generator must never be used in a room less 1,150ft3 (32.56m3),it must never be moved while it still contains concentrate is used. It is virtually impossible to create an explosive or asphyxiating atmosphere using this system.

g. It is also advised that any gas-fired equipment installed in ripening rooms should be fitted with suitable safeguards, in the event of flame failure, which are properly maintained.

PREVENTION OF IGNITION SOURCES

12. a. No naked lights should be allowed in the after introduction of ethylene until through ventilation has take place.

b. Gas- fired heating systems should be turned off before ethylene is introduced.

a. Where small ethylene cartridges and ethylene generators are used the dilution of gas is very rapid. It is suggested that no flammable atmospheres need to be provided for electrical equipment. However, ethylene should not be discharged within 2m of fixed electrical installations. In order to prevent layering it should not be discharged less than 1m from the floor.

STORAGE OF ETHYLANE CARTRIDGES AND ETH-GEN CONCENTRATE

13 a. Quantities stored on site should be as small as is reasonably practicable.

b. Cartridges and Ethy-Gen concentrate must be under the control of a competent person.

c. Quantities of cartridges may be stored indoors within a suitably ventilated area as detailed in Guidance Note CS4 “The keeping of LPG in Cylinders and similar containers.

d. Ethy-Gen concentrate (a highly flammable liquid) may be stored in a suitable bin or cupboard indoors in quantities of up to 50 litres. Greater quantities require special storage facilities as detailed in Guidance Note CS2 “The Storage of Highly Flammable Liquids” No naked or smoking should be permitted in these storage areas.

FACTS ABOUT PERISHABLES WHILE IN TRANSIT

Perishable produce are those, which are easily destroyed ,rot, decay, if not handled properly postharvest or during transit from one place to another and these include fruits, vegetables, horticultural produce such as flowering bulbs, and flowers etc. to be of value to consumers and retailers, these must reach them suitable for consumption or the intended use. The factors and characteristics of perishables affecting their shelf life should be paid careful attention.

Perishables have unique characteristics when it comes to transportation from one place to another. The factors affecting the perishables during transport include temperature, air exchange, humidity, ethylene sensitivity, water loss, respiration rate, packaging and maturation of produce.

Respiration is a major factor in determining requirement of refrigeration, because fruits and vegetables are living organisms, even after they are separated from their plants, tree. They generate heat and release gases and moisture. This process is respiration and during this process oxygen in the air combines with carbon in the plant tissue to form various decompositions, products, carbon dioxide and water.

Some products have respiration rate and require more refrigeration than others. *Green peas for example require 10 times faster cooling than tomatoes.* Heat evolution rates for various commodities are different and charts for relative respirations are available with western handlers of transport.

Respiration rate is a function of temperature. For every 18° F rise in temperature, respiration is doubled or tripled. Head Lettuce for example respires two to three times faster at 68oF than at 50°F and apples three times faster at 50°F than at 32°F. The faster a product respires, the greater the quantity of heat it generates.

Water loss after harvest varies with commodities. Leafy vegetables like Lettuce lose moisture more rapidly than like Melons.

Ethylene spells doom for some products. Ethylene is self generating gas in fruits and vegetables and is fruit ripening regulator. It is produced by all plants, fruits, vegetables and even by some fungi. When used in moderate quantity and at right temperature, ethylene is beneficial to speed up ripening. By ripening in some products ethylene can hasten their senescence, decay, rottening. Therefore products like mangoes, bananas, all of which are sensitive to ethylene should never be held in same areas as produce like apples, avocados, which emit ethylene. They should not be transported in same refrigerated lorry.

Product condition at shipment or transport determines its condition at destination.

For every perishable there is a time for transportation. The products to be transported should neither be immature nor overly mature.

Pre-cooling and maintaining temperature are essential before and during transit.

Maintaining Ethylene level at threshold during transit is a very important factor reach products to designation safe.

Portable temperature, humidity, ethylene monitor are must in containers or refrigerated lorries. Relative humidity also determines product quality of perishables at destination.

Modifying atmosphere of a refrigerated lorry can extend product life of perishables

Difference among fruits and vegetables call for special attention during transit in refrigerated lorries or containers.

Temperature compatibility is important factor when mixing commodities in transport.

Refrigerated Lorries should not only be designed for maintaining temperature and humidity but all these factors should be given due weight.

***

National Horticulture Board, Gurgaon

An Organisation with a Vision for Appropriate Technology In Post Harvest Management Infrastructure

- Technical Standards for Cold Storages for Horticulture Produce not requiring Pre-Cooling
- Technical Standards for Cold Storages for Horticulture Produce requiring Pre-Cooling
- Technical Standards for Control Atmosphere Storages for Horticulture Produce
- Technical Standards for Specialised Transport Vehicles including Refrigerated Vans
- Technical Standards for Scientific Fruit Ripening Chambers
- Technology Solutions for Long Distance Bulk Transport of fresh Horticulture Produce

Website : www.nhb.gov.in