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MINISTRY OF
AGRICULTURE AND
FARMERS WELFARE

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National Centre for Cold-chain Development

ENGINEERING GUIDELINES & MINIMUM SYSTEM STANDARDS FOR IMPLEMENTATION IN COLD CHAIN COMPONENTS

FOR SCHEMES SUPPORTED
BY CENTRAL
GOVERNMENT



NATIONAL CENTRE FOR COLD CHAIN DEVELOPMENT

ENGINEERING GUIDELINES & MINIMUM SYSTEM STANDARDS FOR IMPLEMENTATION IN COLD CHAIN COMPONENTS

2025 Edition

NCCD

National Centre for Cold-chain Development

2025



National Centre for Cold-chain Development

DEVESH CHATURVEDI
SECRETARY



भारत सरकार
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Government of India
Ministry of Agriculture & Farmers Welfare
Department of Agriculture & Farmers Welfare



MESSAGE

It is with great pride and anticipation that I present to you the revised edition of the "ENGINEERING GUIDELINES & MINIMUM SYSTEM STANDARDS FOR IMPLEMENTATION IN COLD CHAIN COMPONENTS," published by the National Centre for Cold Chain Development (NCCD).

In our ongoing mission to enhance the efficiency and effectiveness of India's cold chain infrastructure, this revised edition stands as a testament to our unwavering commitment to the agricultural sector and the welfare of our farmers. The cold chain is a critical component in preserving the quality and extending the shelf life of our perishable produce, thus ensuring food security and reducing post-harvest losses.

This comprehensive guide has been meticulously updated to reflect the latest technological advancements, best practices, and regulatory standards. It serves as an essential resource for all stakeholders involved in the cold chain ecosystem. By adhering to these guidelines, we can ensure that our cold chain infrastructure remains robust, reliable, and resilient.

I extend my heartfelt gratitude to the team at NCCD for their dedication and hard work in compiling this vital document. I am confident that these guidelines will play a pivotal role in advancing our agricultural sector and empowering our farmers with the tools they need to thrive in an ever-evolving market.

Together, let us strive to build a more sustainable, efficient, and equitable cold chain system that benefits not only our farmers but also the entire nation.

[Devesh Chaturvedi]

New Delhi
03 January 2025

PRIYA RANJAN
Joint Secretary



भारत सरकार
कृषि एवं किसान कल्याण मंत्रालय
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PREFACE

It is with great pleasure that I present the revised edition of the "ENGINEERING GUIDELINES & MINIMUM SYSTEM STANDARDS FOR IMPLEMENTATION IN COLD CHAIN COMPONENTS," a pivotal publication by the National Centre for Cold Chain Development (NCCD).

The dynamic nature of the agricultural sector necessitates continuous advancements and updates in our approach to handle the perishable produce. The cold chain plays an indispensable role in preserving the integrity of our horticultural products from farm to fork, thereby safeguarding the interests of our farmers and ensuring the availability of fresh produce to consumers. This revised edition encapsulates the latest technological innovations, industry best practices, and updated regulatory standards. It has been designed to serve as a comprehensive reference for all stakeholders involved in the cold chain sector.

I extend my deepest appreciation to the dedicated team at NCCD and all contributors who have worked tirelessly to compile this edition. Their expertise and commitment have been instrumental in ensuring that these guidelines are both thorough and practical. As we move forward, it is our hope that this document will serve as a cornerstone for further advancements in our cold chain systems. By adhering to these standards, we can collectively work towards minimizing post-harvest losses, improving food security, and ultimately, enhancing the livelihoods of our farmers.

I also invite all stakeholders to embrace these guidelines and collaborate in building a robust and resilient cold chain system for the future.

Sh. Priya Ranjan
Joint Secretary - Horticulture/
Director – NCCD/ MD- National Horticulture Board
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Government of India

आशीष फोतेदार
मुख्य परिचालन अधिकारी

Asheesh Fotedar
Chief Operating Officer



ABOUT THE DOCUMENT

The **Engineering Guidelines & Minimum System Standards for Implementation in Cold Chain Components** represents a cornerstone in advancing India's cold chain infrastructure. This revised edition 2025, published by the National Centre for Cold Chain Development (NCCD), embodies extensive research, expert consultations, and a deep understanding of the evolving needs of our agricultural sector.

The document has been formulated keeping in mind the present challenges in the cold chain sector and introduced where it will pave a way for our developmental goals in present and future. It covers every aspect of the cold chain, from the design and construction of cold storage facilities to the transportation and distribution of perishable goods. This document aims to maintain produce quality, minimize post-harvest losses, and support the economic viability of farmers/growers/FPOs etc.

The guidelines and standards in this edition encompass cutting-edge technological advancements and best practices, ensuring that India's cold chain infrastructure remains both **Efficient and Sustainable**. The revised edition of engineering guidelines & minimum system standards focusses on integrating cold chain components at all levels—from primary production to end distribution—ensuring **Technological Advancements, Modernization, Energy Efficiency**.

We have introduced innovative elements at the primary level of the cold chain and strengthened their integration across the overall supply chain. Automation and modern technologies along with components such as small vehicles at primary and mid-level of the cold supply chain will ensure cross linkages and thereby pushing a new era in the sustainable development of robust cold chain and ensuring unhindered supply chain for movement of perishable goods, produce and products. These advancements are expected to enhance utilization and foster new growth opportunities.

Use of **Greener Refrigerants** thereby reducing carbon footprints, not only empower farmers and growers with diversified storage and marketing options but also significantly mitigate post-harvest losses, unlocking new opportunities for growth while contributing to the **Nation's Climate and Environmental Goals**.

I extend my heartfelt gratitude to the entire NCCD team and all contributors/stakeholders who played a pivotal role in shaping this document. Their expertise and dedication have been instrumental in making this publication a reality.

Sh. Asheesh Fotedar

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ABOUT NCCD

The National Centre for Cold Chain Development (NCCD) is an autonomous, not-for-profit organization established to spearhead the development of a robust and integrated cold chain infrastructure in India. Recognizing the critical role of cold chain in reducing post-harvest losses of perishable agricultural produce, enhancing farmers' incomes, and ensuring consumers' access to fresh and nutritious food, the NCCD was conceived as a Think Tank to address these challenges.

Genesis and Mandate:

The NCCD's inception can be traced back to the recommendations of the Task Force on Cold Chain Development in India. Recognizing the need for a dedicated body to promote and develop the cold chain sector, the Task Force proposed the establishment of an autonomous centre to work collaboratively with industry and stakeholders.

Established as a registered society in 2011, with subsequent government approval in 2012, the NCCD represents a diverse range of stakeholders including government departments, industries, associations, service providers, and farmer groups. This inclusive approach ensures that the centre's activities are aligned with the needs of the entire cold chain ecosystem.

Core Functions and Objectives:

The NCCD's primary objectives are to:

- I. To recommend standards and protocols for cold chain infrastructure/building including post harvest management so as to harmonize with international standards and best practices and suggest mechanism for benchmarking and certification of infrastructure/building, process and services provided by cold chain industry.*
- II. To suggest indicative guidelines for preparation of project reports for potential investors/entrepreneurs.*
- III. To assess and develop appropriate IT-based management information system for the cold chain infrastructure*
- IV. To undertake and coordinate Research and Development (R&D) work required for development of cold chain industry in consultation with stakeholders.*
- V. To undertake and coordinate the task of Human Resource Development (HRD) and capacity building. It may also conduct in-house training, short-term/long courses relevant for cold chain development.*
- VI. To launch publicity campaign to educate the stakeholders including awareness building about the benefits of integrated cold chain.*
- VII. To recommend appropriate policy framework relating to development of cold chain.*
- VIII. To facilitate and foster the development of multi-modal transportation facilities for perishable agricultural, horticultural and allied commodities and establishment of National Green Grid Perishable Commodities.*

The NCCD envisions an India where perishable agricultural produce is handled, stored, and transported efficiently, minimizing losses and maximizing value. By creating a robust and resilient cold chain infrastructure, the centre aims to contribute to food security, economic growth, and improved livelihoods for farmers and consumers alike.

A key milestone in achieving this vision is the NCCD's revision of minimum technical standards and guidelines for cold chain components. These standards provide a roadmap for the industry, ensuring that cold chain facilities meet the highest quality and efficiency benchmarks. By setting clear guidelines, the NCCD is facilitating the development of a standardized and reliable cold chain network across India.

Through its unwavering commitment to excellence, the NCCD is poised to play a pivotal role in transforming India's cold chain landscape and securing a sustainable future for the agriculture sector.



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1. BASIC ENGINEERING PRINCIPLES

Units and Conversion Factor:

Quantity	From	To	Multiply by*
Length	inch (in.)	meter	0.0254
	foot (ft)	meter	0.3048
Area (A)	ft ²	m ²	0.0929
	in. ²	cm ²	6.4516
Volume (V)	ft ³	m ³	0.0283
	gallon (U.S.)	m ³	0.003785
	gallon (U.S.)	L	3.785
Volume flow rate (V)	ft ³ /min (cfm)	m ³ /s	0.000472
	gpm	m ³ /s	0.00006309
	gpm	L/s	0.06309
Mass (m)	lb	kg	0.45359
Mass flow rate (m)	lb/min	g/s	7.55987
Specific Volume(v)	ft ³ /lb	m ³ /kg	0.062428
	ft ³ /lb	cm ³ /g	62.428
Density (ρ)	lb/ft ³	kg/m ³	16.0185
Velocity (v)	ft/min (fpm)	m/s	0.00508
	ft/sec (fps)	m/s	0.3048
	mph	m/s	0.447040
Pressure (p)	psi	Pa (N/m ²)	6894.76
	psf	Pa	47.8803
	mm Hg	Pa	133.322
	in. Hg (0°C)	Pa	3386.38
	in. H ₂ O (4°C)	Pa	249.082
	ft H ₂ O (4°C)	Pa	2988.98
	m H ₂ O (4°C)	Pa	9806.65
	kPa	m H ₂ O	0.102
	bar	Pa	100,000
	1 atmosphere	Pa	101,325
	kgf/cm ²	kPa	98.067
Force (F)	lb	N	4.44822
Work and Energy (w)	ft-lb	J	1.355818
	Btu	J	1055.06
	Btu	ft-lb	778

Power (<i>P</i>)	hp Btu/hr ton (ref)	W (J/s) W W	745.6999 0.293067 3516.8
Specific heat (<i>c</i>) or Entropy (<i>s</i>)	Btu/lb R	J/g K	4.18682
Enthalpy (<i>h</i>)	Btu/lb	J/g	2.3244
Conductivity (<i>k</i>)	(Btu)(in.)/(hr)(ft ²)(R)	W/(m)(K)	0.1442285
Conductance (<i>C</i>) or coefficient of heat (<i>U</i>)	Btu/(hr)(ft ²)(R)	W/(m ²)(K)	5.678286

* To convert in the opposite direction, *divide* by the factor in this column.

Phases and Phase Change:

1. States of Matter:

Matter exhibits three distinct phases or states of aggregation: solid, liquid, and vapor or gas. A prime illustration is water, which manifests as a liquid, ice as a solid, and steam as vapor or gas.

- a) **Solid Phase:** In the solid phase, a material possesses a relatively low amount of internal potential energy. The molecules within the material are tightly bound together by attractive forces and the force of gravity. The molecular structure of a solid is characterized by rigidity, with each molecule having a more or less fixed position. The movement of molecules is confined to vibratory motion, which can be either slow or rapid depending on the internal kinetic energy.

Due to its rigid molecular arrangement, a solid maintains both its size and shape. Solids are practically incompressible and exhibit significant resistance to any attempt to alter their shape.

- b) **Liquid Phase:** In the liquid phase, molecules within a material possess higher energy compared to those in the solid phase, and they are not tightly bound together. This increased energy enables them to overcome attractive forces to some extent, granting them greater freedom of movement. The molecules can move freely over and around each other, allowing the material to exhibit a "flowing" characteristic. While liquids are nearly incompressible and maintain their size, their fluid molecular structure means they do not retain a fixed shape and will conform to the shape of their container.

- c) **Vapor or Gas Phase:** In the gaseous phase, molecules within a material exhibit even higher energy levels than those in the liquid phase. This elevated energy enables them to overcome all restraining forces, freeing them from both mutual attractive forces and the force of gravity. As a result, these molecules move at high velocities, engaging in continuous collisions with each other and with the container walls. Consequently, a gas does not maintain a fixed size or shape. It is highly compressible and effortlessly occupies any containing vessel. Moreover, when not stored in a sealed container, the gas will escape and disperse into the surrounding air.

Energy:

Energy is defined as the capacity to perform work. When a body can engage in work, it is considered to possess energy. The quantity of energy needed to accomplish a specific amount of work is consistently equivalent to the work performed. Similarly, the amount of energy a body possesses is always equal to the amount of work the body can do in passing from one position or condition to another.

a) Kinetic Energy:

A body can possess energy in one or both of two forms: kinetic energy and potential energy. Kinetic energy is the energy a body possesses by virtue of its motion or velocity. Examples of kinetic energy include a falling object, a flowing fluid, and the moving components of machinery, all deriving their energy from motion. The quantity of kinetic energy (KE) a body holds is determined by its mass (m) and velocity (v), as expressed in the following relationship:

$$KE = \frac{(m)(v^2)}{(2)}$$

Where, KE = Kinetic Energy
 m = Mass
 v = Velocity

b) Potential Energy:

Potential energy arises from a body's position or configuration. The work that a body can perform when transitioning from a specific position or state to a reference position or state is a measure of its potential energy. For instance, the elevated driving head of a pile driver holds potential energy based on its position above the top of a piling. Upon release, this driving head can accomplish the work of driving the piling into place. Similarly, a compressed steel spring or a stretched rubber band possesses potential energy due to their configurations, and both have the capability to perform work as they have the tendency to return to their normal states.

The gravitational potential energy associated with a body's position can be determined using the following equation:

$$PE = (m)(z)$$

Where, PE = Potential Energy
 m = Mass
 z = Distance in feet above some datum or arbitrarily selected reference point

c) Law of Conservation of Energy:

The first law of thermodynamics asserts that the total energy within any thermodynamic system remains constant. No energy is created or lost; instead, it undergoes conversion from one form to another.

Energy can be viewed as stored work. Before a body possesses energy, work must be applied to it. The work invested in giving the body motion, position, or configuration is stored within the body as energy. In all instances, the stored energy is equal to the work performed. While energy can be categorized as kinetic or potential, it can manifest in various forms, including mechanical energy, electrical energy, chemical energy, and heat energy. These forms are easily interchangeable. For example, electrical energy is converted into heat in an electric toaster or heater, as well as into mechanical energy in electric motors and solenoids. Conversely, mechanical energy, chemical energy, and heat energy can be transformed into electrical energy in generators, batteries, and thermocouples, respectively. Chemical energy undergoes conversion into heat energy through processes like combustion and oxidation. These are just a few examples illustrating the diverse ways in which energy transformations occur.

d) Solar Energy:

Solar energy refers to the radiant energy emitted by the Sun, which is harnessed and utilized for various applications on Earth. This energy can be captured and converted into electricity or used directly for heating, lighting, and other purposes. Solar energy is a renewable and sustainable source, as the Sun continuously emits vast amounts of energy that can be harvested through technologies like solar panels or solar thermal systems. It plays a crucial role in providing clean and environmentally friendly alternatives to conventional fossil fuel-based energy sources.

e) Heat:

Heat is a form of energy. This implies that the heat can be converted into other forms of energy and that other forms of energy can be converted into heat. Thermodynamically, heat is *defined as energy in transit from one body to another as the result of a temperature difference between the two bodies.*

f) Temperature:

Temperature is the property of matter. It is a measure of the level of the thermal pressure of a body. A high temperature indicates a high level of thermal pressure, and the body is said to be hot. Similarly, a low temperature indicates a low level of thermal pressure, and the body is said to be cold. The temperature is a function of the internal kinetic energy and, as such, is an index of the average molecular velocity.

g) Thermometers:

The most frequently used instrument for measuring temperature is the thermometer. The operation of most thermometers depends upon the property of a liquid to expand or contract as its temperature is increased or decreased, respectively. Alcohol and mercury are the two most frequently used liquids, out of which mercury thermometers is more accurate because

its coefficient of expansion is more constant through a greater temperature range than is that of alcohol.

Temperature readings on Fahrenheit scale can be converted into readings on the Celsius scale and vice-versa by using the equations:

$$^{\circ}\text{F} = \frac{9}{5}^{\circ}\text{C} + 32$$

$$^{\circ}\text{C} = \frac{5}{9} (^{\circ}\text{F} - 32)$$

Basic Thermodynamics and Heat Transfer:

A. Specific Heat:

The specific heat (c) of any substance is the amount of heat required to increase the temperature of unit mass of that particular substance by one degree Celsius.

The quantity of heat energy supplied to, or given up by, any given mass of material to bring about a specified temperature change can be determined from the following relationship:

$$Q = (m)(c)(T_2 - T_1)$$

Where, Q = The quantity of heat energy

m = Mass

c = Specific Heat

T_1 = Initial Temperature

T_2 = Final Temperature

B. Sensible Heat and Latent Heat:

Sensible heat is the quantity of heat or energy needed to alter the temperature of a substance without causing a change in its phase. Conversely, during a phase transition at a constant temperature, the heat absorbed or released is referred to as *latent heat*.

C. Latent Heat of Fusion:

The *latent heat of fusion* is the quantity of energy required per unit mass to bring about the change of phase between the liquid and solid phases.

The quantity of energy required to bring about the change can be determined from the following equation:

$$Q = (m)(c)(h_{if})$$

Where, Q = The quantity of latent heat

m = Mass

h_{if} = Latent heat of fusion

D. Latent Heat of Vaporization:

The latent heat of vaporization is the amount of heat energy required to transform a substance from its liquid phase to its gaseous phase at a constant temperature and pressure. The quantity of energy required to vaporize or condense any given mass of fluid at saturation temperature can be determined from the following equation:

$$Q = (m)(c)(h_{fg})$$

Where, Q = The quantity of latent heat

m = Mass

h_{fg} = Latent heat of vaporization

E. Saturation Temperature:

The temperature at which a fluid will change from the liquid phase to the vapor phase or conversely from the vapor phase to the liquid phase, is called the *saturation temperature*. The liquid and vapor at saturation temperature is called *saturated liquid* and *saturated vapor* respectively.

F. Superheat:

Superheat refers to the temperature increase of a vapor or gas above its saturation or boiling point at a given pressure, without undergoing a phase change. In other words, it is the excess temperature added to a substance in its gaseous state beyond the temperature corresponding to its current pressure and state of saturation.

G. Critical Temperature:

The critical temperature of a substance is the maximum temperature at which the substance can exist in a liquid state. Once the temperature surpasses the critical temperature for a specific gaseous substance, it becomes impossible to liquefy the substance, regardless of the applied pressure.

H. Critical Pressure:

Critical Pressure is the lowest pressure at which a substance can exist in the liquid state at its critical temperature; that is, it is the saturation pressure at the critical temperature.

I. Enthalpy (H):

Enthalpy serves as a measure of energy within a thermodynamic system, encompassing the total heat content of the system. It is determined by combining the system's internal energy with the product of its volume and pressure.

$$H = U + pv$$

Where, H = Enthalpy

U = Internal Energy

p = Pressure

v = Volume

J. Entropy (S):

Entropy is a thermodynamic property that quantifies the degree of disorder or randomness in a system. It is a measure of the system's thermal energy per unit temperature that is not available for doing work. In simpler terms, entropy reflects the level of uncertainty within a system, with higher entropy indicating greater disorder.

$$\Delta s = \frac{\Delta Q}{T_m}$$

Where, Δs = Change in Entropy

ΔQ = Change in heat Energy

T_m = Average absolute temperature

K. Methods of Heat Transfer:

The energy transfer as heat takes place by three distinct modes: *Conduction*, *Convection* and *Radiation*.

➤ Conduction:

According to Fourier's law for heat transfer by *conduction*, the rate of heat conduction is proportional to the area measured normal to the direction of heat flow, and to the temperature gradient in that direction.

$$Q = -kA \frac{\partial T}{\partial x} \quad (\text{or}) \quad q = -k \frac{\partial T}{\partial x}$$

Where, k = Coefficient of thermal conductivity

➤ Convection:

According to Newton's Law of Cooling, the rate of heat transfer between a solid object and a fluid (liquid or gas) is proportional to the temperature difference between the object and the fluid. Mathematically, it can be expressed as:

$$Q = hA\Delta T$$

Where, Q = Rate of heat transfer.

h = Heat transfer coefficient

A = Surface Area through which heat is transferred

ΔT = Temperature difference between the surface of the object and the fluid.

➤ Radiation:

According to the Stefan-Boltzmann law, the radiation energy emitted by a body is proportional to the *fourth power* of its absolute temperature.

$$Q = \sigma AT_1^4$$

Where, σ = Stefan-Boltzmann constant ($5.6697 \times 10^{-8} \text{ W/m}^2 \cdot \text{K}^4$)

T_1 = Surface Temperature in degree Kelvin

L. Insulation and K - Values:

i. Thermal conductivity and density values at 0 °C of polystyrene insulation

Type	Density	Thermal conductivity
	(kg/m ³)	(W m ⁻¹ °C ⁻¹) / (kcal h ⁻¹ m ⁻¹ °C ⁻¹)
Expanded foam Type I	10	0.057/0.049
Expanded foam Type II	12	0.044/0.038
Expanded foam Type III	15	0.037/0.032
Expanded foam Type IV	20	0.034/0.029
Expanded foam Type V	25	0.033/0.028
Rigid extruded foam	33	0.033/0.028

ii. Density values and thermal conductivity at 20-25 °C of polyurethane insulation

Type	Density	Thermal conductivity
	(kg/m ³)	(W m ⁻¹ °C ⁻¹) / (kcal h ⁻¹ m ⁻¹ °C ⁻¹)
Foam	30	0.026/0.0224
Rigid expanded board	30	0.02-0.025/0.0172-0.0215 average: 0.0225/0.0193
Rigid expanded board	40	0.023/0.02
Rigid expanded board	80	0.04/0.34
Foamed in place	24-40	0.023-0.026/0.0198-0.0224 average: 0.0245/0.0211

iii. Thermal conductivity and density values at 0 °C of fibreglass insulation

Type	Density	Thermal conductivity
	(kg/m ³)	(W m ⁻¹ °C ⁻¹) / (kcal h ⁻¹ m ⁻¹ °C ⁻¹)
Type I	10-18	0.044/0.038
Type II	19-30	0.037/0.032
Type III	31-45	0.034/0.029
Type IV	46-65	0.033/0.028
Type V	66-90	0.033/0.028
Type VI	91	0.036/0.031
Glass fibre, resin bonded	64-144	0.036/0.031

iv. Thermal conductivity and density values at 20-25 °C of cork insulation

Type	Density	Thermal conductivity
	(kg/m ³)	(W m ⁻¹ °C ⁻¹) / (kcal h ⁻¹ m ⁻¹ °C ⁻¹)
Granulated loose, dry	115	0.052/0.0447
Granulated	86	0.048/0.041
Expanded cork slab	130	0.04/0.344

Expanded cork board	150	0.043/0.037
Expanded bonded with resins/bitumen	100-150	0.043/0.037
Expanded bonded with resins/bitumen	150-250	0.048/0.041

*Source: ASHRAE Handbook

Psychometric Properties of Air:

i. Composition of Air:

Air constitutes a mechanical mixture of gases and water vapor. When devoid of water vapor, termed "dry air," it primarily consists of approximately 78% nitrogen and 21% oxygen, with the remaining 1% comprised of trace gases like carbon dioxide, as well as minimal amounts of hydrogen, helium, neon, and argon. The composition of these dry air components remains virtually consistent globally. However, the water vapor content in the air exhibits considerable variability based on location and weather conditions, typically ranging from 1% to 3% by mass.

ii. Dew Point Temperature:

The temperature at which the water vapor in the air is saturated is known as the dew point (DP) temperature of the air. The DP temperature of the air is always the saturation temperature corresponding to the partial pressure exerted by the water vapor.

iii. Absolute humidity:

Humidity designates the water vapor present in the air. The absolute humidity under specific conditions represents the mass of water vapor per unit volume of air, essentially serving as an expression of vapor density at that particular state.

iv. Relative Humidity:

Relative humidity (RH), expressed in percentage, is the ratio of the actual partial pressure exerted by the water vapor in any volume of air to the partial pressure that would be exerted by the water vapor if the water vapor in the air is saturated at the temperature of the air; that is,

$$RH = \frac{\text{actual partial pressure}}{\text{partial pressure at saturation}} \times 100$$

v. Humidity Ratio:

The *humidity ratio* or *specific humidity* is the weight of water vapor per unit weight of dry air. The retention capacity of moisture by air is a function of the temperature: the warmer the air, the more moisture it can hold.

$$\omega = \frac{\text{mass of water vapor}}{\text{mass of air}} = \frac{m_v}{m_a}$$

vi. Saturation Ratio:

Saturation ratio refers to the ratio of the actual water vapor pressure in the air to the saturation water vapor pressure at the same temperature. It is often expressed as a percentage. When the air is saturated, meaning it contains the maximum amount of water vapor it can hold at a given temperature, the saturation ratio is 100%.

$$\text{Saturation ratio} = \frac{\omega}{\omega_s}$$

Where, ω = Actual humidity ratio

ω_s = Humidity ratio at saturation for same air

vii. Dry Bulb and Wet Bulb Temperature:

Dry-bulb temperature refers to the air temperature measured with a standard thermometer without accounting for the influence of moisture or humidity. It represents the actual temperature of the air.

The temperature measured by the thermometer when its bulb is covered with wet cloth and is exposed to a current of moving air is known as wet bulb temperature. The difference between the dry-bulb and wet-bulb temperature is known as wet-bulb-depression. Wet bulb depression becomes zero the air is fully saturated.

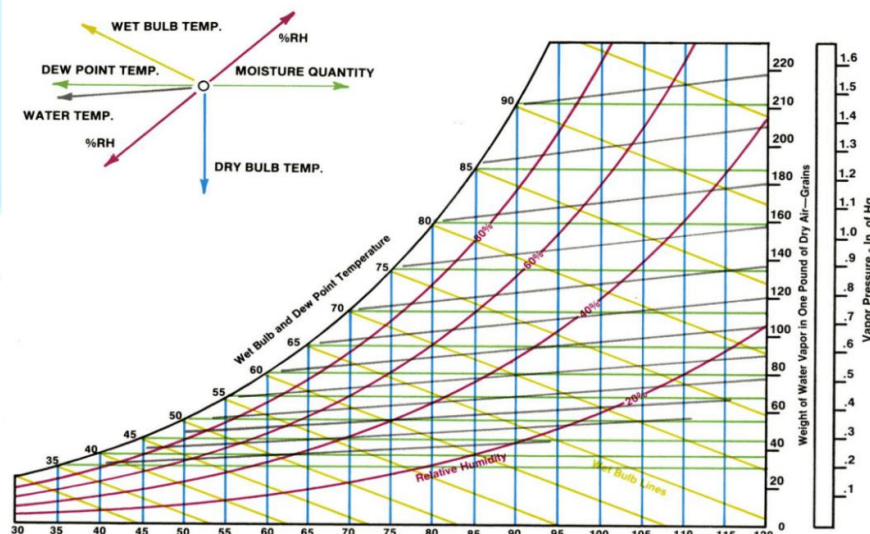


Fig 1: Dry Bulb and Wet Bulb Temperature

viii. Coil Bypass Factor:

The portion of the air that passes through the coil without contacting the coil surface is known as the *bypass air* and, when expressed as a ratio to the total air quantity, is called the *bypass factor* of the coil. Bypass factor (BPF) of any coil is primarily a function of coil design.

$$BPF = \frac{T_m - T_b}{T_m - T_a}$$

Where, T_a = DB temperature of the air entering the coil
 T_b = DB temperature of the air leaving the coil
 T_m = Mean Effective temperature of the coil surface

It is important to understand that the BPF of any heating or cooling coil must always be found by dividing the *difference between the DB temperature of the leaving air and the coil surface temperature* by the *difference between the DB temperature of the entering air and the coil surface temperature*.

ix. Psychrometric Chart:

Psychrometric charts are graphic presentations of the psychrometric properties of air. The use of such charts permits the graphic analysis of psychrometric data and processes and thereby facilitates the solution of many practical problems dealing with air that otherwise would require more tedious mathematical solutions. (refer Fig. 2)

x. Sensible Heating:

Sensible heating occurs when air is directed over a heated surface (dry), such as a steam or hot water coil, with a temperature surpassing the air's dry bulb (DB) temperature. As the air traverses this heating surface, it absorbs heat (sensible) from the warmer source, causing an elevation in the air's DB temperature, which tends to align with the surface temperature. Notably, since there is no addition or removal of moisture during this heating process, specific humidity, dew point (DP) temperature, and latent heat content remain unchanged. Sensible heating (or cooling) processes consistently follow a linear trajectory along a line of constant DP temperature, often termed constant humidity ratio processes. Throughout this process, the total heat of the air increases by an amount equivalent to the rise in sensible heat, resulting in an increase in wet bulb (WB) temperature. (refer Fig. 3)

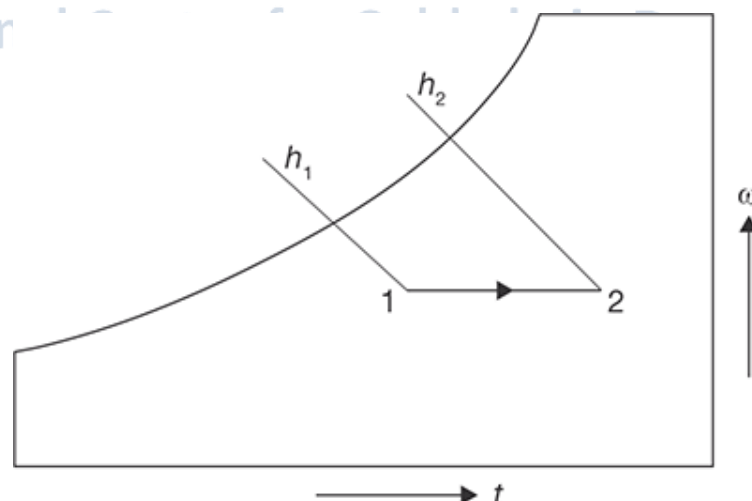


Fig 3: Sensible Heating Process 1-2 on Psychrometric Chart

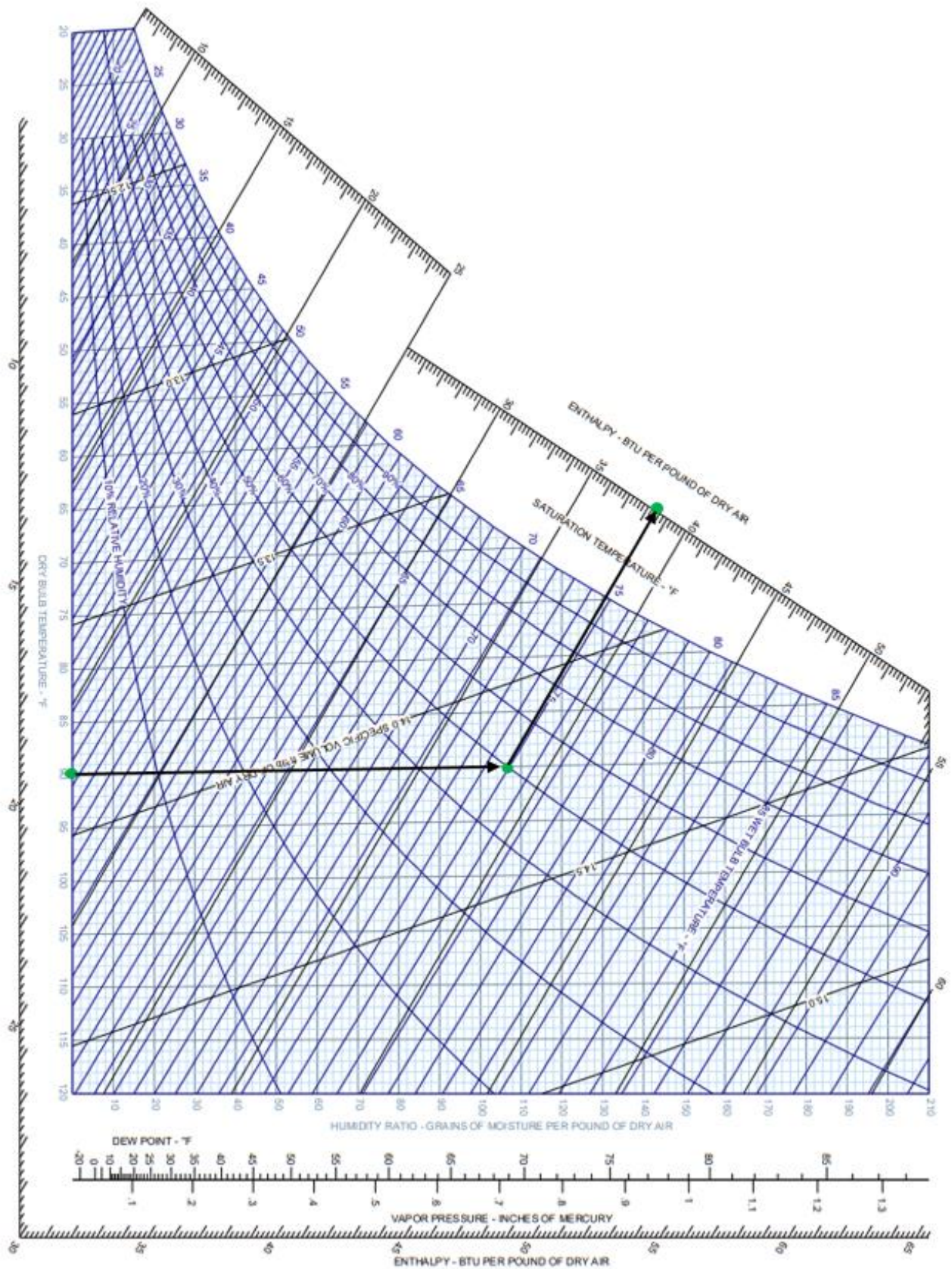


Fig 2: Psychrometric Chart

xi. Sensible Cooling Processes:

Sensible cooling of the air is accomplished by passing the air across a dry cooling surface whose temperature is below the DB temperature of the air but above the air DP temperature. The sensible cooling process is similar to the sensible heating process in a sense that no moisture is added or removed, and therefore, the specific humidity, DP temperature, and latent heat content of the air remain the same or constant throughout the process. In addition, as in the case of sensible heating, the change in the total heat of the air is equal to the change in the sensible heat of the air.

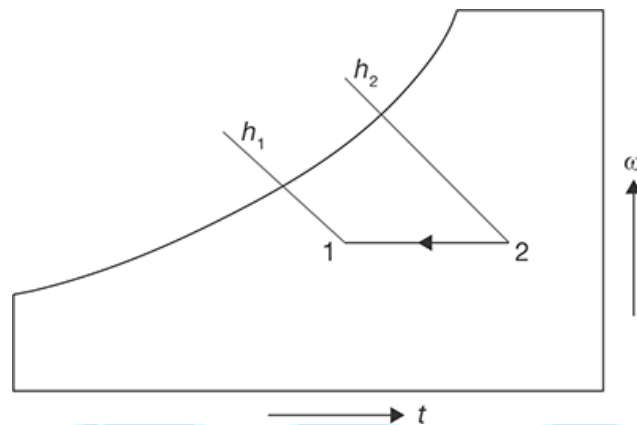


Fig 4: Sensible Cooling Process 2-1 on Psychrometric Chart

xii. Cooling and Dehumidification:

In refrigeration, cooling and dehumidification involve the removal of heat and moisture from the air to achieve a desired temperature and humidity level. This process typically begins with the air passing over an evaporator coil, where a refrigerant absorbs heat from the air, causing the air temperature to decrease. As the air cools, moisture in the air condenses into liquid water on the evaporator coil, effectively reducing humidity. The cooled and dehumidified air is then circulated back into the space being conditioned. Meanwhile, the absorbed heat and moisture by the refrigerant are expelled from the system through the condenser coil, completing the refrigeration cycle.

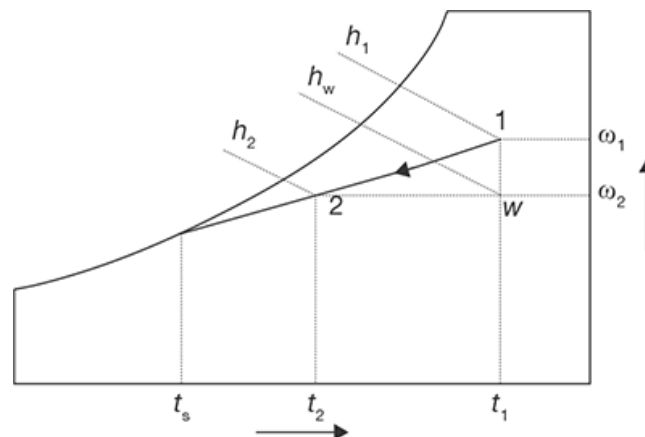


Fig 5: Cooling and Dehumidification Process

xiii. Coil Sensible Heat Factor:

In any cooling and dehumidifying process, both sensible and latent heat are removed at the cooling coil, the sum of the two being the total heat transferred. The ratio of sensible heat to total heat transferred is known as the *coil sensible heat factor* (CSHF), written as,

$$CSHF = \frac{Q_s}{Q_t}$$

Refrigeration system and cycles:

A. Refrigeration:

Refrigeration is the branch of science that deals with the removal of heat from a space at a temperature lower than the surrounding temperature. The amount of heat removed will create a cavity and as heat has a natural tendency to flow from higher to lower temperature; it will be filled by the surrounding air with high temperature. To limit this transfer of heat, it is necessary to isolate the space using insulation or insulating material.

B. Unit of Refrigeration:

The unit of refrigeration is termed as *Ton of refrigeration*. A Ton of refrigeration is defined as the quantity of heat required to be removed from one ton of ice within 24 hours when the initial condition of water is zero degree centigrade, because same cooling effect will be given by melting the same ice.

In S.I. Unit, a ton of refrigeration is defined as **3.5 kJ/sec** or **3.5 kW**.

C. Refrigeration Load:

The rate at which heat must be removed from the refrigerated space or material in order to produce and maintain the desire temperature conditions is called the *refrigeration load*, the *cooling load*, or the *heat load*.

D. Vapor Compression Refrigeration Cycle:

The Vapor Compression Cycle is a thermodynamic cycle that forms the basis of most refrigeration and air conditioning systems. It involves four main stages: compression, condensation, expansion, and evaporation.

- a. **Compression:** The cycle begins with the refrigerant entering the compressor as a low-pressure vapor. The compressor increases the pressure and temperature of the vapor, converting it into a high-pressure, high-temperature vapor. This compression stage requires energy input, usually from an electric motor.
- b. **Condensation:** The high-pressure vapor then flows into the condenser, where it releases heat to the surrounding environment. This causes the vapor to condense into a high-pressure liquid. Heat transfer occurs between the hot refrigerant and a cooler medium, such as air or water, in the condenser coils. As the refrigerant loses heat, it undergoes a phase change from vapor to liquid.

- c. **Expansion:** The high-pressure liquid refrigerant then passes through an expansion valve or throttle, where its pressure and temperature drop significantly. This sudden expansion causes a portion of the liquid to evaporate into a low-pressure vapor. The refrigerant now exists as a mixture of liquid and vapor at a lower temperature and pressure.
- d. **Evaporation:** The low-pressure vapor enters the evaporator, where it absorbs heat from the desired space, such as the interior of a refrigerator or the air inside a building. As the refrigerant absorbs heat, it undergoes further vaporization, completing the cycle. The refrigerant vapor then returns to the compressor to restart the process.

E. Vapor Absorption Refrigeration Cycle:

The Vapor Absorption Refrigeration Cycle is an alternative to the Vapor Compression Refrigeration Cycle, particularly notable for its ability to use heat, rather than mechanical work, to drive the refrigeration process. It's commonly employed in large-scale applications where waste heat or other low-grade heat sources are available, such as industrial processes or solar energy utilization. The vapor absorption refrigeration cycle works as follows:

- a. **Evaporator:** Evaporators are essential components in cooling systems, serving the primary function of removing heat from the surrounding area. When a cooled liquid enters the evaporator, it absorbs heat from its surroundings, leading to its vaporization. This vapor, typically at low pressure, exits the evaporator and moves towards the absorber in the case of ammonia-based systems.
- b. **Absorbers:** Absorbers play a critical role in the absorption of refrigerants. Within the absorber, a mixture of water and ammonia known as a weak solution is present. Ammonia vapor from the evaporator enters the absorber and is absorbed by the water, forming a strong solution containing both ammonia and water. As the water absorbs ammonia, it releases heat. This heat release reduces the water's capacity to absorb more ammonia. To maintain a high absorptive capacity and prevent the presence of ammonia vapor, cold water is continuously supplied to the absorber. This keeps the water temperature low, allowing it to efficiently absorb incoming ammonia vapor.
- c. **Pump:** The pump is responsible for moving a concentrated solution of ammonia and water from the absorber to the generator.
- d. **Generator:** In this system, ammonia and water solutions are employed, with ammonia serving as the refrigerant and water as the absorbent. Within the absorber, a blend of water and ammonia solutions exists due to water's strong affinity for ammonia. To convert the solution of ammonia and water into vapor, the generator is supplied with additional heat from external sources. These heat sources may include steam, hot water, or any type of heater. The primary aim of this heat input is to facilitate the transformation of the ammonia and water solution into vapor.
- e. **Analyzer:** On top of the generator, analyzers are positioned to monitor the system. Throughout the process, ammonia vaporizes prior to water, yet some water particles

may also vaporize alongside ammonia. The analyzer's role is to separate water particles from the ammonia vapor.

Permitting water particles to bypass the generator could detrimentally affect system efficiency. In substantial quantities, water particles might even induce system damage. To mitigate this risk, the analyzer condenses water particles while enabling the passage of ammonia vapor to proceed through the system. Although some ammonia may condense in the vapor analyzer, the majority is anticipated to successfully traverse the analyzer.

- f. **Pressure-Reducing Valve:** After the ammonia vapor has traversed the analyzers, the weak solution within the generator is directed through a pressure reducing valve, subsequently reentering the absorber. This finalizes the cycle, as the solution is now primed to absorb additional ammonia vapor, perpetuating the refrigeration process.
- g. **Expansion Valve:** The primary role of the expansion valve is to transform liquid ammonia into a cold liquid and guide it towards the evaporator. As the liquid ammonia passes through the expansion valve, its temperature and pressure experience a substantial decrease. This change causes the liquid ammonia to become exceptionally cold, laying the foundation for effective cooling within the evaporator.



National Centre for Cold-chain Development

2. COLD CHAIN THE DRIVING FORCE

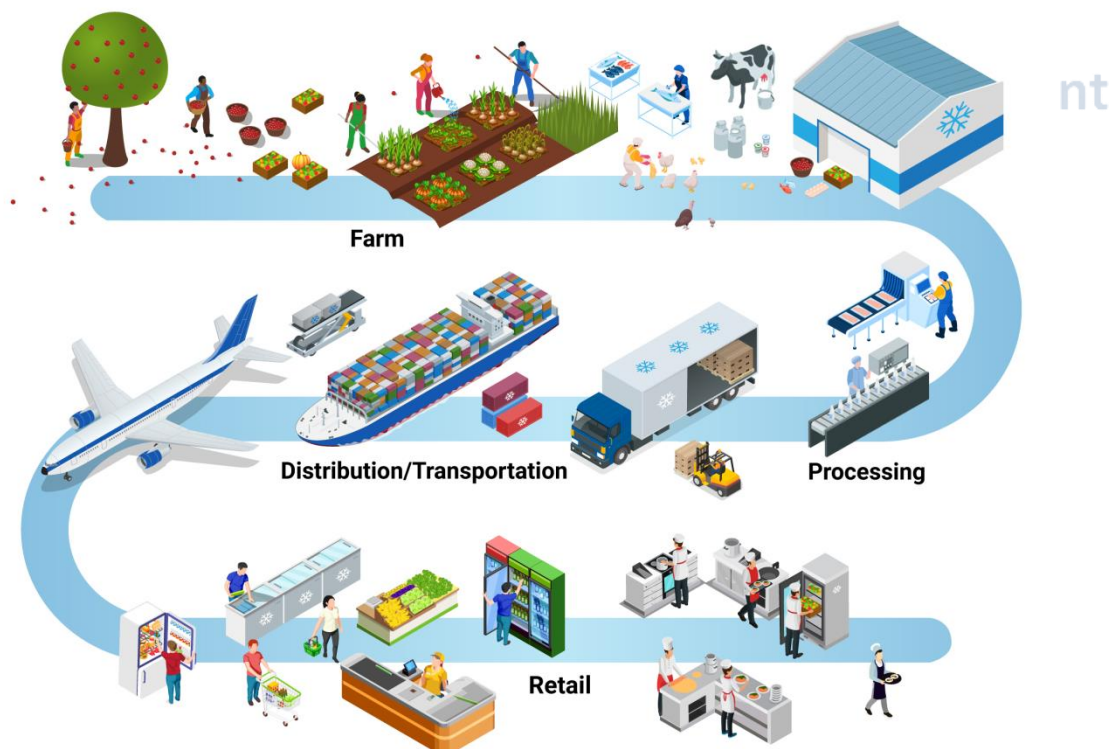
Introduction

Welcome to the world of cold-chain management, where the preservation of agriculture, Horticulture, Pharmaceutical, Dairies, Sea food, processed food, beverages, etc. takes centre stage. This book is your comprehensive guide to the guidelines and minimum system standards for implementation in cold chain components necessary in the context of schemes supported by central govt. Department of Agriculture, Ministry of Agriculture & farmers' Welfare, Govt. of India.

As we embark on this journey through the intricate landscape of cold-chain development, this document may be referred by other various ministries, stakeholders, Industry, State Government and other allied sector working in the development of cold chain. These guidelines have been derived and designed while exploring the core principles, regulations, and practices that ensure the safe and efficient handling of fresh fruits, vegetables, dairy, and other perishable farm produce.

The Significance of Cold-Chain Management in Agriculture

In the realm of agriculture, the efficient management of the cold-chain is paramount to ensuring that the fruits of the land and dairy products remain farm-fresh and nutritious, even when they travel long distances to reach consumers. Cold-chain management in agriculture goes beyond temperature control; it involves a holistic approach that encompasses humidity, air composition, packaging, and reliable transportation. The significance of cold-chain management in agriculture lies in its ability to extend the life of perishable agricultural products and maintain their freshness, whether they are destined for local markets or distant corners of the world.



Navigating the Two Aspects:

Cold-chain management in agriculture revolves around two fundamental aspects:

- ✓ **Preserving Agricultural Product Quality:** In cases where the cold-chain is primarily a shield against environmental conditions, it acts as a preservative. Fresh fruits, vegetables, dairy products, and other farm produce fall into this category. The cold-chain's role is to preserve these products by maintaining predefined ambient conditions from the point it enters into the cold storage and ensuring their quality remains unaltered during transportation and until it reaches the plate of the consumers. These product types can be fruits and vegetables, ice creams and milks, meats and processed food, vaccines and various chemicals, etc. These products have a clear cut defined post harvest/expiry periods after they are produced and stored as per the designed conditions thereby preserving their product quality. In case of processed food, the shelf life presumably remains very minimum even though if stored in favourable conditions like temp, humidity etc. Thereby, processed as per requirement, packaged in suitable packs with respect to weight, transportation etc. and ascertaining their expiry and best before dates. Prices are pre-determined, and each package is labelled accordingly. The cold-chain originates at the farm or manufacturing facility, preserving the value created there for eventual market realization.
- ✓ **Enhancing Produce/Product Shelf Life and life cycle:** When we consider fresh, living agricultural produce, the cold-chain extends the life of these farm-fresh flowers, fruits & vegetables. When managed effectively, it slows down the natural aging process of these products, offering off-season delivery to consumers. The life of these products depends not only on temperature control but also on various biological factors. Handling various type of horticulture produce in storages and to enhance the product lifecycle precise control over humidity, microbial conditions, oxygen levels, and temperature is required. Even slight fluctuations can impact both the product's longevity and pricing, which can vary based on demand and market access depending upon the various products where cold chain acts as a driving force to limit the food loss in case of food, efficacy in case of pharmaceutical products the cold chain becomes necessary to store and thereby driving benefit from the enhancement of the life cycle, quality, off-season deliveries to the consumers. The Cold Chain also by preserving quality and enhancing product life serves the farmer/grower who is essentially the fulcrum in the whole process. It allows the farmer/grower to realize it's value and propelling a multi dimensional advantage in terms of financial sustainability of the grower and simultaneously enhancing the food basket/food surplus.

A Complex and Ever-Evolving Landscape

The world of cold-chain management in agriculture is complex and ever-evolving. It demands a deep understanding of the produce being transported, the dynamic nature of market demand, and the unpredictable influence of environmental factors. With precision and care, cold-chain management serves as a critical link in the chain that connects agricultural producers to consumers, ensuring that the farm-fresh quality of produce remains intact.

In the chapters that follow, we will delve into the intricate and essential components of cold-chain management in agriculture. We will explore the regulations, standards, and best practices that underpin this industry, offering a roadmap to effective agricultural produce handling.

Whether you are a seasoned farmer or a newcomer to the world of cold-chain management in agriculture, this book is your invaluable resource for mastering the art of preserving product quality and enhancing the shelf life of farm-fresh produce.

In summary, this book aims to be an indispensable resource for anyone with an interest in agricultural produce, cold-chain management, and the complex network of components and services that ensure the safe and efficient handling of temperature-sensitive goods. Whether you are a seasoned professional or a newcomer to this field, our goal is to empower you with the knowledge and insights required to excel in the world of cold-chain logistics.

In the chapters that follow, we will begin our exploration of the core elements of cold-chain management, offering practical guidance, best practices, and standards to help you establish and operate a successful cold-chain system.

Cold Chain Components

The cold chain is a system of transporting and storing temperature-sensitive products such as vaccines, pharmaceuticals, food, fruits, vegetables, flowers and other perishable items within a specific temperature and humidity range to maintain their quality and enhance their shelf life. The components of the cold chain include:

1. **Temperature-Controlled Storage Facilities:** These are warehouses, refrigerated trucks, and storage units that are equipped to maintain the required temperature range for the products they store. They may include refrigerators, Walk-in cold rooms, multi-purpose cold storages, packhouses, ripening chambers, refrigerated transport, refrigerated retail shelves and display cabinets, freezers, and climate-controlled rooms and growing chambers, etc.
2. **Monitoring Systems:** These systems include temperature sensors, data loggers, and monitoring equipment to track and record temperature, humidity Ethylene levels, CO₂ conc., O₂ levels, refrigerant leak detection systems etc. within the storage facilities and during transportation. These systems ensure that products remain within the specified Controlled conditions as prescribed for enhancing the quality, shelf life and longevity of the produce/product.
3. **Packaging:** Specially designed packaging materials and containers are used to insulate and protect products from temperature variations. Insulated boxes, thermal blankets, and temperature-sensitive labels are some examples of packaging components. (Refer chapter 27)
4. **Refrigeration and Cooling Equipment:** Refrigeration units and cooling systems in storage facilities and transportation vehicles are essential to regulate and maintain the required temperature levels. These systems may include compressors, evaporators, and condensers.
5. **Transportation:** Refrigerated trucks, vans, and electric reefer containers are used to transport temperature-sensitive products. These vehicles are equipped with cooling and heating systems to maintain the temperature as per the required norms during the transit. (Refer chapter 22)
6. **Cold Store Management Protocols:** These are standard operating procedures and guidelines for handling and transporting temperature-sensitive products. They specify the temperature range, handling procedures, and quality assurance practices that must be followed throughout the cold chain.
7. **Training and Certification:** Personnel involved in handling and transporting temperature-sensitive products should receive training and be trained professional to ensure they

understand the importance of maintaining the cold chain. Regular trainings on operation safety and maintenance should be provided to the staffs to enhance their skill development.

8. **Regulatory Compliance:** Adherence to local & national regulations and standards is essential to ensure the safety and effectiveness of temperature-sensitive products. It is essential to follow guidelines and regulations where India is signatory and thorough compliance to be adhered on parameters related to energy, climate, Global Warming, Direct & In-direct emissions pertaining to the cold chain sector. Different industries may have specific regulatory requirements. Renewal of licenses from time to time and conducting energy audits.
9. **Emergency Response Plan:** In case of unexpected events or equipment failures, a well-defined emergency response plan is necessary to mitigate risks and minimize the impact on the cold chain.

Maintaining the integrity of the cold chain is critical for the safety and effectiveness of products that are sensitive to temperature variations, such as vaccines, pharmaceuticals, and food. Any break in the cold chain can lead to the degradation or spoilage of these products, which can have serious consequences for public health and the economy.



3. GOVERNMENT POLICIES

A. MIDH

Mission for Integrated Development of Horticulture (MIDH) is a Centrally Sponsored Scheme for the holistic growth of the horticulture sector covering fruits, vegetables, root & tuber crops, mushrooms, spices, flowers, aromatic plants, coconut, cashew, cocoa and bamboo. While Government of India (GOI) contributes 85% of total outlay for developmental programs in all the states except the states in North East and Himalayas, 15% share is contributed by State Governments. In the case of North Eastern States and Himalayan States, GOI contribution is 100%. Similarly, for development of bamboo and programs of National Horticulture Board (NHB), Coconut Development Board (CDB), Central Institute for Horticulture (CIH), Nagaland and the National Level Agencies (NLA), GOI contribution will be 100%. Guidelines regarding implementation of the scheme are described hereunder.

MIDH will have the following sub-schemes and area of operation:

Sl. No.	Sub Scheme	Target group / area of operation
1.	NHM	All states & UTs except states in NE and Himalayan Region.
2.	HMNEH	All states in NE and Himalayan Region.
3.	NBM	All states & UTs
4.	NHB	All states & UTs focusing on commercial horticulture
5.	CDB	All States and UTs where coconut is grown.
6.	CIH	NE states, focusing on HRD and capacity building.

MIDH will also provide technical advice and administrative support to State Governments/ State Horticulture Missions (SHMs) for the Saffron Mission and other horticulture related activities like Vegetable Initiative for Urban Clusters (VIUC), funded by Rashtriya Krishi Vikas Yojana (RKVY)/NMSA.

COLD CHAIN INFRASTRUCTURE

- Insulation 60 mm to 200 mm with other components (Description at Annexure -A). Cold storages (Long term storage and distribution hubs) up to 5000 MT capacity will be promoted under NHM/HMNEH sub schemes (Annexure V- Cost Norms & Pattern of Assistance under MIDH during XII Plan for NHM & HMNEH sub-schemes), capacity above 5000 MT up to 20000 MT-will be promoted under NHB sub scheme. (Annexure VII- Cost Norms & Pattern of Assistance under MIDH for NHB related activities during XII Plan). In this context for cold storages- for positive temperature application and above 3.4 cubic meter (CUM) or 120 cubic feet (CFT) of internal chamber volume shall be equivalent to one MT of storage capacity with stacking system like mezzanine, boxes, crates. For Cold storages irrespective of the product 5.4 cubic meter (CUM) or 190 cubic feet (CFT) of internal chamber volume shall be equivalent to one MT of storage capacity with stacking system like racks, shuttle racks, double deep racks, palletization. Similarly for ripening chambers 11 Cum of internal chamber space shall be equivalent to one MT of storage capacity for ripening chambers and 4.5 Cum of space would be equivalent to one MT of internal storage capacity for Apple storage. Refrigerated transport, 3Cum (106 Ft) of chamber volume shall be equivalent to one MT of internal Storage capacity. Assistance of Precooling will

be linked to pack house and cold room (Transit) Relevant details pertaining to these are available under relevant chapters.

- Extant specifications standards and protocols on cold storage and cold-chain components will be adhered to while approving cold storage projects. Revisions to technical standards and adherence protocols shall be updated by National Centre for Cold-chain Development (NCCD) as necessary when improved technologies and efficiencies are introduced/understood/approved.
- Assistance can also be availed for a combination of PHM infrastructure components by a beneficiary, within the prescribed norms of individual items. Assistance will be available to individuals, Group of farmers/growers/ consumers, Partnership/ Proprietary firms, Self Help Groups (SHGs), Farmers Producer Organization (FPOs), Companies, Corporations, Cooperatives, Cooperative Marketing Federations, Local bodies, Agricultural Produce Market Committees (APMC) & Marketing Boards and State Governments.
- Assistance will also be available for taking up cold chain components so as to integrate the activities into a single project, as a new component during XII Plan.
- Proposals on long distance transport solutions on project basis shall be supported under NHB sub-scheme.

For further details refer to: <https://www.midh.gov.in/>

B. NHB

The National Horticulture Board (NHB) was established by the Government of India in 1984 as an autonomous organization under the administrative control of the Ministry of Agriculture and Farmers Welfare. It is registered as a society under the Societies Registration Act and has its headquarters in Gurugram. Currently, NHB operates 29 field offices across the country. The primary aims and objectives of the Board are to develop production clusters/hubs for integrated hi-tech commercial horticulture, advance post-harvest and cold chain infrastructure, ensure the availability of quality planting material, and promote the adoption of new technologies, tools, and techniques for hi-tech commercial horticulture.

Aims & Objectives of NHB Schemes

The main objectives of NHB are to enhance the integrated development of the horticulture industry and to coordinate and sustain the production and processing of fruits and vegetables. The detailed objectives of the Board include:

- i. Developing hi-tech commercial horticulture in designated belts, making these areas vibrant with horticultural activity and acting as hubs for horticulture development.
- ii. Establishing modern post-harvest management infrastructure as part of area expansion projects or as common facilities for project clusters.
- iii. Creating integrated, energy-efficient cold chain infrastructure for fresh horticulture produces.
- iv. Promoting the adoption and commercialization of identified new technologies, tools, and techniques after conducting technology and need assessments.

- v. Ensuring the availability of quality planting material by promoting the establishment of scion and rootstock banks, mother plant nurseries, and accrediting/rating horticulture nurseries, as well as facilitating the import of planting material as needed.
- vi. Promoting and developing markets for fresh horticulture produce.
- vii. Encouraging field trials of newly developed/imported planting materials and other farm inputs, production technologies, post-harvest management (PHM) protocols, integrated nutrient management (INM), and integrated pest management (IPM) protocols, along with promoting applied R&D programs for the commercialization of proven technologies.
- viii. Promoting farm mechanization in horticulture through demonstrations and usage at the farmer level to reduce labor costs and increase productivity.
- ix. Advancing applied R&D for standardizing PHM protocols, prescribing critical storage conditions for fresh horticulture produce, and benchmarking technical standards for cold chain infrastructure.
- x. Facilitating the transfer of technology to producers, farmers, service providers, and workforce involved in post-harvest management, including cold storage operators and processing of fresh horticulture produce, as well as master trainers.
- xi. Promoting the consumption of horticulture produce and products.
- xii. Encouraging long-distance transport solutions for the bulk movement of horticulture produce through rail and other means.
- xiii. Conducting studies and surveys to identify constraints and develop short and long-term strategies for the systematic development of horticulture, and providing technical services including advisory and consultancy services.

For further details refer to: <https://www.nhb.gov.in/>

C. APEDA:

APEDA has been instrumental in developing cold chain infrastructure for horticultural produce, enhancing quality, value addition, and extending shelf life, thereby boosting the export quality of Indian agricultural products. Recently, the focus has expanded to include establishing processing units for horticultural and agricultural produce and reinforcing infrastructure at seaports. Additionally, the Prime Minister's Office has identified the creation and management of cold chain infrastructure for agricultural products as a priority, setting targets for various government agencies, including APEDA, to develop cold storage capacities for agro-export products.

Under its Scheme for Infrastructure Development, APEDA provides 90% financial assistance of the eligible project cost to State Government Agencies for establishing cold chain infrastructure. This includes pre-cooling units, cold stores, high-humidity cold stores, controlled atmosphere (CA) stores, and material handling plants and machinery such as sorting, grading, washing, waxing, and packing in an integrated manner. Additionally, it covers the establishment of Centers for Perishable Cargo at airports, qualitative infrastructure at seaports, processing units, and testing laboratories for common use by exporters of agricultural products.

Various State Government agencies, State Agricultural Marketing Boards, State Agriculture/Horticulture Departments, and other organizations have benefitted from APEDA's assistance in setting up such facilities, thereby strengthening their export infrastructure capabilities and capacities. Over the past 15 years, APEDA has sanctioned more than 100 projects across various states, which include setting up integrated pack houses with pre-cooling, cold storage, material handling, vapor heat treatment, and irradiation facilities. This also includes establishing Centers for Perishable Cargo at 12 major airports, flower auction centers, and upgrading laboratories for export testing.

For further details refer to: <https://apeda.gov.in/>

D. MOFPI:

The Ministry of Food Processing Industries (MoFPI) plays a pivotal role in transforming India's agricultural landscape. A robust and dynamic food processing sector is crucial for reducing the wastage of perishable agricultural produce, enhancing the shelf life of food products, ensuring value addition, and diversifying and commercializing agriculture. This sector also significantly contributes to generating employment, increasing farmers' income, and creating surplus for the export of agro and processed foods.

The "Integrated Cold Chain and Value Addition Infrastructure" scheme aims to provide seamless cold chain and preservation infrastructure facilities from the farm gate to the consumer. This includes infrastructure development throughout the supply chain, such as pre-cooling, weighing, sorting, grading, and waxing facilities at the farm level; multi-product/multi-temperature cold storage; CA storage; packing facilities; IQF; blast freezing at distribution hubs; and reefer vans and mobile cooling units for distributing non-horticultural, horticultural, fish/marine (excluding shrimp), dairy, meat, and poultry products. The scheme allows flexibility in project planning, with a particular focus on creating cold chain infrastructure at the farm level.

The integrated cold chain projects can be established by Partnership/Proprietorship Firms, Companies, Corporations, Cooperatives, Self Help Groups (SHGs), Farmer Producer Organizations (FPOs), NGOs, and Central/State PSUs, provided they meet the eligibility conditions outlined in the scheme guidelines. This scheme has been in operation since 2008.

The scheme aims to establish a robust cold chain infrastructure for agricultural, horticultural, dairy, fish & marine, poultry, and meat products, creating a seamless link from the farm gate to the consumer. This end-to-end system is designed to reduce losses through efficient storage, transportation, and minimal processing. The various components of the Cold Chain projects include:

- Minimal Processing Centres at the farm level, equipped with facilities for weighing, sorting, grading, waxing, packing, pre-cooling, Control Atmosphere (CA)/Modified Atmosphere (MA) cold storage, normal storage, and Individual Quick Freezing (IQF).
- Mobile pre-cooling vans and reefer trucks.
- Distribution hubs with multi-product and multi-Control Atmosphere (CA)/Modified Atmosphere (MA) chambers, cold storage, Variable Humidity Chambers, packing facilities, Cleaning in Process (CIP) fog treatment, Individual Quick Freezing (IQF), and blast freezing.

- Irradiation facilities.

For further details refer to : <https://www.mofpi.gov.in/>

E. Dept. Of Fisheries:

The Department of Fisheries is one of the two Departments under the Ministry of Fisheries, Animal Husbandry & Dairying. It came into existence with effect from 05.02.2019 through carving out Fishery Division from the erstwhile Department of Animal Husbandry, Dairying and Fisheries. The Department is responsible for matters relating to formulation of policy and schemes relating to Development of Inland, Marine and Coastal Fisheries and Fishery Institutes.

One of the main objectives of the Department is to implement of National Action plan for Cold Chain & Development is to strengthen the post-harvest infrastructure such as chilled storage facilities, ice plants cold chain and freezing/processing units, transportation facilities, modern and hygienic wholesale and retail market outlets etc., as the development of this sector. This would ensure higher profit margin to the producers enabling faster fisheries development. This will promote quality assurance and better food safety standard for fish food for domestic consumers and also for the export market.

For further details refer to : <https://dof.gov.in/>

OTHER DEPARTMENTS:

1. Bureau of Energy Efficiency (BEE)

The Government of India established the Bureau of Energy Efficiency (BEE) on March 1, 2002, under the provisions of the Energy Conservation Act, 2001. The Bureau's mission is to support the development of policies and strategies focused on self-regulation and market-driven principles, aiming to reduce the energy intensity of India's economy. This objective is pursued within the framework of the Energy Conservation Act, 2001, through the active involvement of all stakeholders, fostering the accelerated and sustained adoption of energy-efficient practices across all sectors.

2. Ministry of New and Renewable Energy (MNRE)

The Ministry of New and Renewable Energy (MNRE) serves as the nodal agency of the Government of India, overseeing all initiatives related to new and renewable energy. Its primary objective is to develop and implement renewable energy solutions to complement the nation's energy needs.

The Ministry envisions advancing renewable energy technologies, processes, materials, components, subsystems, products, and services to meet international standards of quality and performance. By achieving this, it aims to position India as a net foreign exchange earner in the renewable energy sector while promoting the deployment of domestically developed and manufactured solutions to strengthen the country's energy security.

3. Ministry of Environment, Forest and Climate Change (MoEFCC)

The Ministry of Environment, Forest and Climate Change (MoEFCC) serves as the central authority within the Government of India for planning, promoting, coordinating, and overseeing the implementation of the country's environmental and forestry policies and programs.

To support its commitment to the Montreal Protocol, the Ministry has established an Ozone Cell, functioning as the National Ozone Unit (NOU). This unit facilitates the effective and timely execution of India's obligations under the protocol, including the phase-out of ozone-depleting substances (ODS).



4. THE IDEA - SHAPING THE STANDARDS & GUIDELINES

The Cold Chain journey is to essentially mitigate food losses and ensure food security by maintaining the quality and safety of perishable products from farm to table. By carefully controlling temperature and humidity throughout the supply chain, cold chains minimize spoilage, extend shelf life, and reduce waste. This not only preserves the nutritional value of food but also enhances its availability, helping to meet the growing demands of a global population. Additionally, a robust cold chain infrastructure supports economic growth by reducing the financial impact of food loss on farmers, distributors, and retailers, while contributing to environmental sustainability by decreasing the carbon footprint associated with food wastage.

Initially cold stores were majorly used for storing potatoes and they used Bunker-Coil system for storing them. But this system was not very energy efficient, resulting which NCCD eliminated the method in its 2015 published Guidelines and Minimum technical standards. In 2024, while revising these Guidelines and Minimum Technical standards, it was noted that India has signed several international treaties, and have set net zero targets. Considering all the present conditions, NCCD has started the revision.

For a small farmer, A Farm Operation, Management, and Produce Handling Unit or **FARM GATE PACKHOUSE** is introduced as a facility designed to efficiently manage and handle farm produce from the point of harvest to storage or further processing. This unit ensures that agricultural products are handled in a hygienic and organized manner, minimizing damage and maintaining quality. Now, if the farmer is left with unsold produces or want to store produces overnight, he is now provided with the option to avail a small cold room at farm level known as **Farm Gate Standalone Cold Storage** which can be setup using technology like solar, thermal storage, bio-mass & conventional grid power based.

For farmers or growers producing and harvesting in large amount have the option to build **INTEGRATED PACKHOUSE**, which is a place/structure where harvested produce is brought in from the nearby farms and prepared for transport and distribution to markets. Integrated Packhouse operations include cleaning, washing, weighing, precooling (if required), sorting & grading, treatments, packing, cooling, storage and dispatch to market.

To cater to medium and semi-large volumes, **COLLECTION AGGREGATION CENTRES** would act as linkages for group of farmers, FPOs and organisations working in Agri sector. To bridge rural areas with urban markets, Aggregation Centers equipped with facilities such as a receiving area, weighbridge, washing section, and enclosed spaces for weight and size sorting and grading. These centers include an automated sorting, grading, and waxing line with a capacity of 2 MT/hr, along with specialized packaging systems featuring automatic strapping, conveyors, and other equipment for the efficient movement of packaged produce. These would also include Cold Rooms on new technologies which would ensure storing of leftover produce as well as new arrivals to be stored in favorable temperature and humidity conditions thereby enabling users to extend shelf life of their produce which otherwise would get wasted.

For storing produces in bulk and long term, **COLD STORAGE (CS-1, CS-1- Onion, CS-2, CS-2-CA, CS-3 OR CS-4)** have been remodeled enabling use of modern energy efficient technologies, low GWP refrigerants, energy efficient buildings as per the requirement. These types of storages are discussed in details along with minimum guidelines to follow in the subsequent chapters. Largely the

focus has been to simplify things but at the same time promote and ensure development of all cold chain components with 8 major aspects-

- Modernisation
- Technology
- Energy Efficiency
- Refrigerants
- Climate
- Indigenous Manufacturing
- Cold Supply Chain
- Integrating the cold chain components

These large facilities are intended to cater to storing capacities upto 20000 MT which would allow cold chain sector to move into the next phase of growth and new cycle of sustainable growth. This allows developers to achieve our agenda of food safety and food security. These are generally connected to the markets or distribution centres by means of **Refrigerated Transport**, which is temperature and humidity controlled containers mounted on vehicles to keep the cold chain intact. These Reefer vehicles may be small, medium or large and can be powered by Internal Combustion Engines or electrically powered.

For ease of operation in the facilities emphasis has been laid on following:

- i. **Docking and Dockyard:** The docking area is the platform where trucks or other vehicles can be loaded or unloaded. The dockyard is the entire area surrounding the docking area, including ramps, shelters, and other facilities for the efficient handling of goods.
- ii. **Material Storing and Stacking:** Material storing and stacking refer to the methods and procedures used to arrange products within the cold store. Proper stacking and storage practices are essential to optimize space utilization, prevent damage, and maintain product quality.
- iii. **Mechanisation:** Mechanization in cold stores involves the use of machinery and equipment to automate various tasks, such as material handling, loading, unloading, and temperature control. This can improve efficiency, reduce labour costs, and enhance productivity.
- iv. **Grading and Sorting:** Advanced graders are machines used in packhouses to automatically sort and grade products based on size, quality, and other criteria, enhancing efficiency and consistency in product handling.
- v. **Material Handling:** Material handling encompasses the movement, storage, and control of materials within a cold store. It includes activities like receiving, storing, picking, packing, and shipping products. Efficient material handling is crucial for maintaining product quality and preventing damage.
- vi. **Packaging:** Packaging is the process of enclosing temperature-sensitive products in suitable containers and relevant packaging materials designed to insulate and protect the goods from temperature fluctuations and physical damage.
- vii. **Retail Shelf:** Retail shelves are refrigerated display units in grocery stores and supermarkets. They are designed to showcase temperature-sensitive products to consumers while maintaining their freshness.
- viii. **PLC (Programmed Logic Controller):** PLC is an industrial computer used for automation in cold storage facilities. It controls and monitors various components, ensuring precise temperature and humidity management.

- ix. **IoT (Internet of Things):** IoT refers to the network of interconnected devices and sensors that collect and transmit data in real-time. In the cold chain, IoT technology is used for remote monitoring, control, and data analysis.
- x. The heart of a cold store facility is the **Refrigeration System** of the facility, which keeps the temperature and humidity of the produces inside the facility at desired level. Cooling can be achieved in multiple ways and will be discussed in details later on.

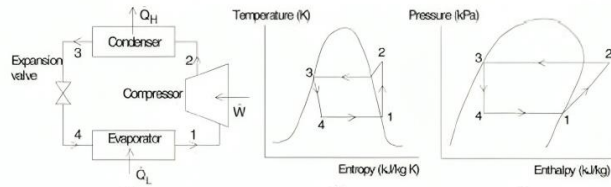


Fig 1. Vapour Compression Refrigeration System

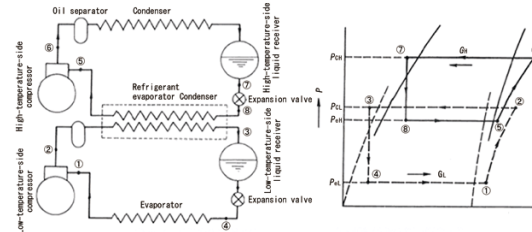


Fig 2. Cascade Refrigeration

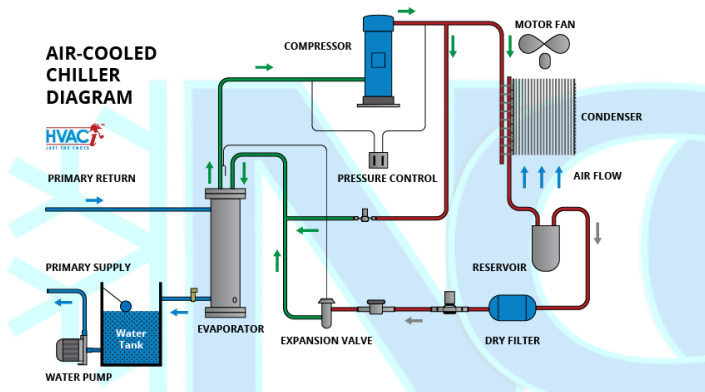


Fig 3. Refrigeration System of Chiller Plant

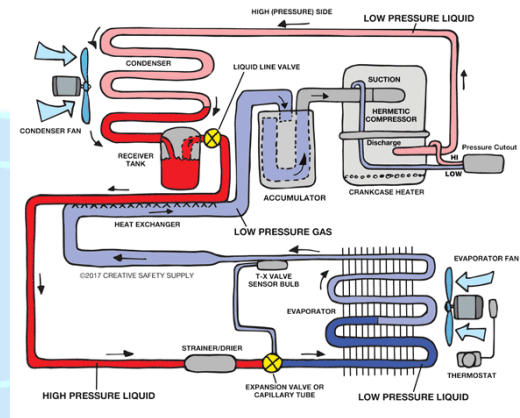


Fig 4. Ammonia based Refrigeration System

SPECIALISED APPLICATIONS:

Apart from usual applications, Cold Chain also provides other benefits and has special applications, like:

1. **Ripening Chambers:** Ripening chambers are controlled environments by which certain fruits attain their desirable flavour, quality, colour and other textural properties. They facilitate the controlled ripening of fruits like bananas, mangoes, Papaya, guava, sapota, kiwi, persimmon, fig, passion fruit, apricot, plum, and pear ensuring uniform ripeness.
2. **CA Rooms (Controlled Atmosphere Rooms):** CA rooms are Positive pressure gas tight chambers in facilities with precise control over temperature, humidity, Oxygen and CO₂ concentrations. These stores are mostly designed and installed in the growing areas to prevent ripening process and storage disorders mostly in apples. They are mostly helpful in maintaining the desirable flavour, quality, colour and other textural properties for a longer period of time which can extend upto 6 months and more.

- **Insulation:** Thermal barrier preventing heat transfer into or out of the cold store, maintaining desired temperature.
- **Gas Tightening:** Sealing the cold store to prevent air exchange, allowing precise control of oxygen and carbon dioxide levels. Refer chapter
- **CA Generator:** Equipment that produces and controls the desired atmosphere within the cold store by adjusting oxygen and carbon dioxide levels. Refer chapter
- **Automation:** Use of technology to control temperature, humidity, gas levels, and other parameters, minimizing manual intervention. Refer chapter
- **Material Handling:** Systems and equipment for efficient movement of products within the cold store, including pallets, conveyors, and forklifts. Refer chapter
- **Docking and dockyards:** Loading and unloading areas for trucks, equipped with ramps and shelters to maintain temperature control during product transfer. Refer chapter
- **CA Doors (Controlled Atmosphere Doors):** CA doors are specialized Gas tight doors designed for controlled atmosphere rooms. They assist in maintaining the desired controlled atmospheric conditions of oxygen and CO₂ along with temp., humidity etc.

Introduction of various new components and use of renewable energy:

It is very encouraging to see that new technologies based on Renewable Energy, Bio-mass, Thermal Storages have been developed to promote the policies of sustainability and also simultaneously address climate and environmental issues. To promote these technologies special mention of these technologies has been addressed in this book. Especially Farm handling Unit, Integrated Packhouse and Aggregation Centres have been designed and crafted in such a way that it promotes use of **DRE, Hybrid and Bio-Mass based technologies**. These alternate energy options in the cold chain refer to using renewable energy sources such as solar or bio-mass to reduce energy consumption and environmental impact. These energy sources can be used on-grid, off-grid or hybrid mode. Any other technology developed in future can also be considered if it saves energy and is environment friendly.

BASIC DATA SHEETS have been modified to catch details of a project. This document provides essential information about a product, including its specifications, handling guidelines, and safety considerations within the cold chain. These sheets should be studied well and filled with:

- I. **All relevant details related to the project.**
- II. **Safety:** Clearly defined and established safety standards are must while implementing cold chain components. These details are required to be filled in Basic Data Sheet.
- III. **Energy Efficiency:** Considering the alarming need to save energy, separate sheet to check energy consumption and utilisation is added. This sheet will provide information about the energy consumption pattern and scope of improvement.
- IV. Any other details which are necessary to identify the need and base of the project.
- V. Basis of Design
- VI. Building layouts
- VII. Following up of BIS, IS and other relevant codes while designing the buildings.

To sum up, these minimum system standards and guidelines have been redesigned in such a way so as to promote the development of cold chain keeping in mind the vision of long term sustainable development, food security addressing manufacturing issues as well as promoting storage and

simultaneously ensuring reduced post harvest losses, thereby, enabling financial growth of our farmers, growers, FPOs, etc.

DISTRICT COOLING SYSTEM:

District Cooling (DC) involves using a central chiller plant to cool water or other similar media, which is then circulated to multiple buildings to provide cooling. District Energy systems have existed since ancient Rome and are prevalent in the Middle East, Europe, and Scandinavian countries. The Middle East, in particular, favours District Cooling systems due to significant reductions in CO₂ emissions, less harmful chemical usage, and lower energy consumption. The region, where Smart Cities, mega projects, and urbanization are highly prevalent, is an especially good location for the use of these unique and effective systems.

In cities around the world, district cooling is integral energy infrastructure to reduce strain on the electric grid caused by increasing demands for air conditioning, which typically create 50%-70% of peak electricity demand. By aggregating the cooling need of a network of buildings, district cooling creates an economy of scale that drives efficiency, balances electric loads, and reduces fuel costs.

Aggregated cooling loads also make feasible creative technologies such as sustainable lake- or ocean water cooling, grey water recovery, treated sewage effluent, and thermal energy storage which reduce costs and environmental impact associated with air conditioning. Additionally, central plants eliminates the sunk costs of oversized, individual chiller plants and the capital costs of installing chillers and cooling towers, freeing up valuable rooftop and building space.

Components of a District Cooling system:

DC systems involve many different components to make it work, including a chiller plant to cool water to around 4-5°C. It **offers a centralized use of refrigerants and heat rejection methods, such as seawater, river water, or even treated sewage effluent.** In addition to a chiller, the central plant also houses a water filtration and treatment system, to help to keep the water recirculated through the network conditioned and prevent the fouling of equipment. Finally, the plant contains equipment to control and monitor the entire system, ensuring optimal temperatures and functioning of pumps and automated valves

5. FARM GATE PACKHOUSE

The cold chain starts right at the moment of harvest. It is crucial for the farmer or grower to quickly reduce the temperature of the freshly harvested produce to maintain its quality and shelf life. To achieve this, the farmer has the option to install cooling facilities at the farm gate level. If setting up such a facility on the farm is not feasible, the farmer must explore alternative options, such as sending the harvested produce to the nearest cold storage, packhouse, or aggregation center. The most fundamental facility designed for these purposes is known as a **Farm Gate Packhouse**.

A Farm Gate Packhouse Unit refers to a facility designed to efficiently manage and handle farm produce from the point of harvest to storage or further processing. This unit ensures that agricultural products are handled in a hygienic and organized manner, minimizing damage and maintaining quality.

Key components of such a unit include:

1. **Shed with Finished Concrete Floor:** The unit typically includes a well-constructed shed with a durable, smooth concrete floor. The finished floor aids in maintaining cleanliness, provides a stable surface for handling equipment, and reduces contamination risks by ensuring easy cleaning and drainage.
2. **Movable Handling Trolley:** A critical feature of the unit is the use of movable trolleys designed to carry crates or boxes filled with produce. These trolleys facilitate the smooth transportation of goods from the farm fields to the handling unit, reducing manual labor and minimizing the risk of bruising or damaging the produce.
3. **Minimal Equipment:** Basic equipment such as **electrical ceiling fans** for ventilation and **lighting** to ensure adequate visibility are essential for maintaining a comfortable and functional working environment. These tools improve working conditions, especially in climates where excessive heat can degrade produce quality or affect worker productivity.
4. **Sorting Table:** These are normal table situated inside the farm gate packhouse for manual sorting and grading of produces by workers/growers. 3 sorting table of size 3' x 2' to be installed.

This setup optimizes efficiency, preserves product integrity, and supports streamlined farm management practices for handling and post-harvest operations at the farm gate.

A farm-gate standalone cold room may be installed to enhance farm operations, management, and produce handling. However, its installation is optional and can be undertaken based on specific individual requirements. For detailed guidance, please refer to Chapter 9, under the category "Farm Gate Standalone Cold Room."

An individual farmer can also develop an INTEGRATED PACKHOUSE. As area productivity and business expands and FPO's, Grower Associations or individual farmers equip themselves with skill development they can establish a Centre which are defined as COLLECTION & AGGREGATION CENTER, which is discussed in next chapter.

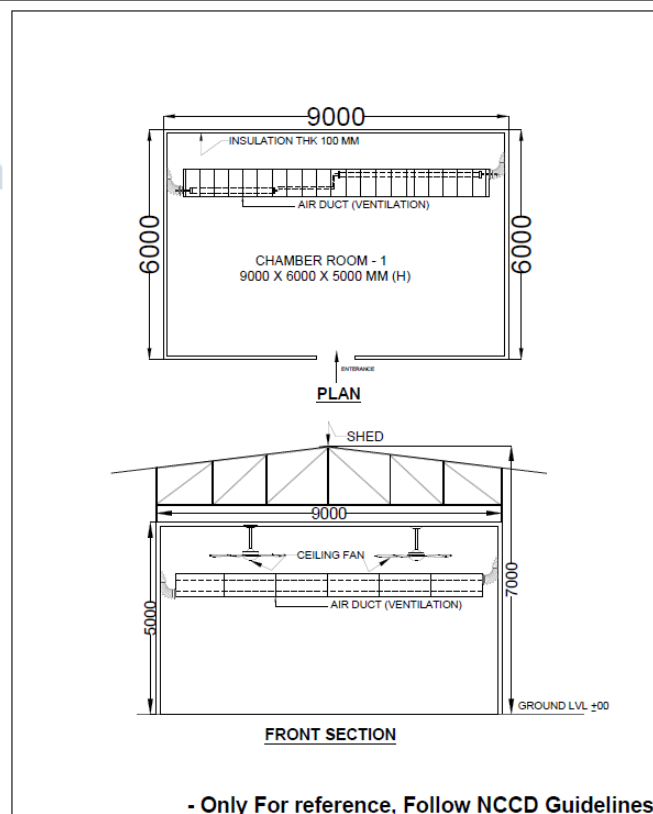
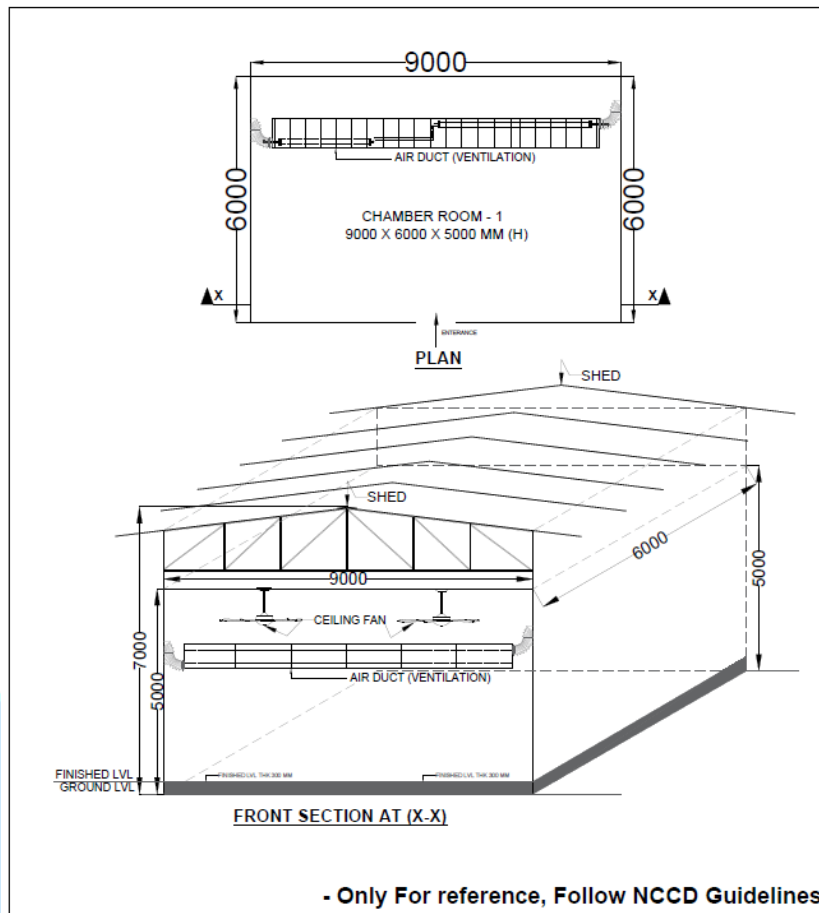




Fig 1.- Farm Gate Packhouse
(For reference)



Fig 2.- Movable handling Trolleys



MANDATORY SUBSIDY COMPONENTS:

For Both NHM/NHB

COMPONENT NO.	DESCRIPTION & NAME	Max. ALLOWABLE QTY.	COST
C-1	Farm Gate Packhouse Shed with finished concrete floor, Movable Handling trolley which can carry crates or boxes from the farm up to the unit. Min. Equipment like electrical ceiling fans, lighting, ventilation etc.	Size of 6m x 9m per project	Rs. 4.8 lakh / project
	Movable Handling Trolley: A critical feature of the unit is the use of movable trolleys designed to carry crates or boxes filled with produce. These trolleys facilitate the smooth transportation of goods from the farm fields to the handling unit, reducing manual labour and minimizing the risk of bruising or damaging the produce.	Max 5 units	
	Sorting Table: Tables of size 3' x 2' installed inside the facility to manually sort/grade produces by workers/growers.	Max. 3 units	
*Add-on:	Farm Gate Standalone Cold Storage The rationale is to provide short term storage which is able to help the farmer etc. in terms of curtailing the economic loss. In this case, in either of the three options only one can be chosen with capacity maximum upto 10MT/project- Option I: Solar Photo Voltaic based system with battery and thermal storage Option II: Thermal Storage type (PCM, water) with auxiliary batteries, cold room running on grid where minimum 8-10 hrs of electricity is available (DG Set not allowed)		Rs. 20 lakh/ project Rs. 8 lakh/ project

	Option III: Cold Storage running on Bio-mass with either vapour absorption or adsorption technologies.		Rs. 12 lakh/ project
	Option IV: Conventional Cold Store running on grid electricity.		Rs. 5 lakh/ project

Technical Evaluation while Claiming Subsidy: The following details need to be submitted for Technical Evaluation while availing subsidy for government.

1. Nomenclature: S-1/ I F/II F/III F/IV F/I Vg/II Vg/III Vg/IV Vg/F/H/C/S/TS/B/SREF/NREF-PCM

- a) S-1 stands for storage upto 10 MT
- b) I F/II F/III F/IV F/I Vg/II Vg/III Vg/IV Vg- choose the type of commodity to be kept (refer to chapter no.31- COMMODITIES SPECIFICATION)
- c) F stands for Farm Gate Packhouse
- d) H/C/S/TS/B – choose the type of technology used
- e) SREF/NREF- choose Synthetic Refrigerant or Natural Refrigerant used
- f) -PCM – write only if PCM is used.

2. Basic Data Sheet: Refer to Annexure I at the end of this book.

3. Drawings: Enclose sketch with Plan layout and sections showing storage chambers and floor heights clearly.

*** Add-on:** The **Farm Gate Standalone Cold Storage** can be either taken as an add-on with Farm Gate Packhouse or can be taken as a standalone unit at the farm gate level for the purpose of storage for a period of 2 to 3 days before dispatch to either market or to a collection aggregation centre or to a cold storage.

NOTE/ESSENTIALS:

- i. This component can be availed through both NHM & NHB.
- ii. All mandatory rules and regulations (BIS, ISO, IS, MNRE, etc.) relevant to the item must be complied with.
- iii. In conventional storage, Refrigerants having potential for Ozone Depletion[#] and GWP ranging more than 1500 (like R22, R404A etc.) are not allowed for temperature range 0° C and above.
- iv. Use of inverter compressor / Digital compressor/ compressors with capacity control with choice of refrigerants as described above should also be considered to promote energy efficiency and sustainable development.

ODP is Ozone Depletion and GWP signifies Global Warming Potential

6. INTEGRATED PACKHOUSE

An Integrated packhouse (IP) is a place structure where harvested produce is brought in from the nearby farms and prepared for transport and distribution to markets. Integrated Packhouse (IP) operations include cleaning, washing, weighing, precooling (if required), sorting & grading, treatments, packing, cooling, storage and dispatch to market.

Integrated Packhouse (IP) is the first link in the Cold chain and enables a farmer, producer etc to bring in his harvest for essential treatment ensure product quality and quantity. It enables assessment of market requirement by the farmer and thereby potentially reducing its losses during logistics of the produce to markets, distribution centres, hubs etc

An Integrated packhouse (IP) can serve as a hub for coordination and governance of a farm-packhouse (IP)-market organization in which market demand dictates production and packhouse (IP) activities (Figure 1).

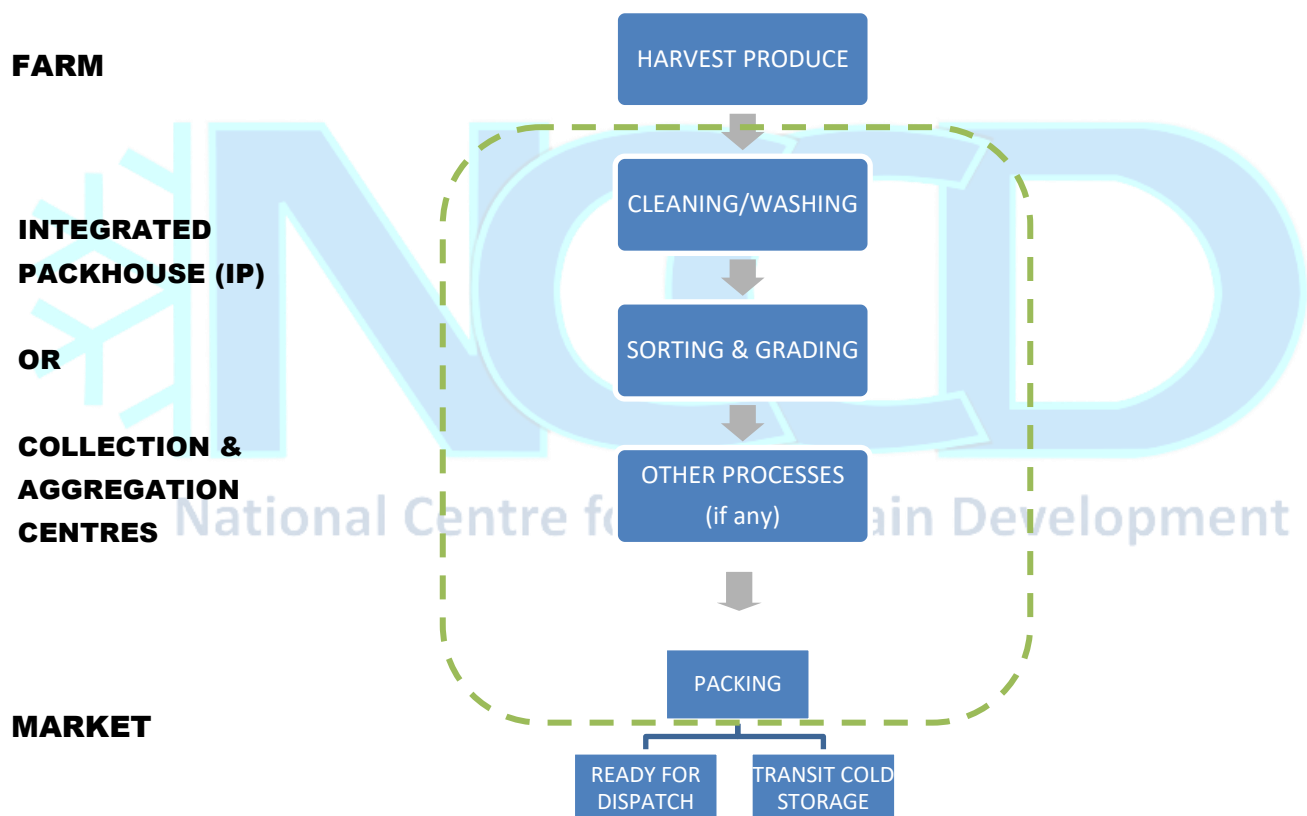


FIG-1

A farm-packhouse (IP)-market (FPM) maximizes technical and business development interventions. It helps to organize the produce into a suitable manner and therefore leads to economy of scale & new market access. Overall, the packhouse (IP) is the first point of farm after the produce is harvested and ready to be shipped to the market.

ESSENTIALS OF INTEGRATED PACKHOUSE (IP) SETUP & OPERATION:

- i. To identify the packhouse (IP) location for the produce i.e. coming in to the packhouse (IP).
- ii. Relevant data and information on the production area, type of produce, quality of produce, and connectivity of farm to the packhouse (IP) and target market or hubs should be properly recorded and known for utmost utilisation of the facility.
- iii. A packhouse (IP) should be located close to the farm, should provide services to local farmers and should have facilities for pick and drop of produce by way of small or medium size reefer vehicles.
- iv. A packhouse (IP) should be connected to good roads and should be covered properly to prevent from sun, rain and other contaminants from environment.
- v. A packhouse (IP) should be designed well with sufficient areas for loading and unloading bays. It should have adequate water and electricity supplies and the drainage system should be done in a very well manner and necessary water treatment plant should be used wherever applicable.
- vi. A packhouse (IP) should have all the necessary arrangements for safety and other desirables for the comfort of workers and other skilled professionals.
- vii. A packhouse (IP) can have both straight line and L shaped or U shaped packhouse (IP) operations.
- viii. A packhouse (IP) should also have a weigh scale at the receiving side of the packhouse (IP).
- ix. It may be connected to various numbers of collection centres of a farmer produce organisations or any other help groups which allows seamless connectivity of the produce to the packhouse (IP) in the shortest possible time thereby reducing post harvest losses.

A packhouse (IP) generally have adequate no. of crates, bins & other types of MHE's, sorting grading tables, cold rooms, trimming machines (as per requirement), sorting, grading, weighing machines & packaging machines, drying machines (as per requirement), sizing machines (as per requirement) and sufficient ventilated space cooled to temperatures and humidity for human comfort to prevent produce from contamination and diseases.

COMPONENTS OF INTEGRATED PACKHOUSE (IP):

- A. **Receiving Area (Covered):** It is essential that while produce undergoes different operations the produce should be protected from physical damages, contamination and should be protected from direct sunlight, rain, dust, etc. The receiving area should have the facility to examine the damaged produce or any other type of disease etc. which can result in incurring both financial as well as post harvest losses. Loading and un-loading docks shall be designed with RCC slab, roof or sheet roofing. The dock area to accommodate suitable sized office and toilet for staffs and workers.
- B. **Weighing Scale:** Suitable capacity at the inward of packhouse (IP) compound should be installed to weigh the incoming and outgoing produce.

- C. **Enclosed Sorting and Grading Area:** Sorting and grading is very vital part of the packhouse (IP) operation and helps in reduce post harvest losses. Sorting and Grading area generally is the area where the produce is received after un-loading on the dock for further process. This area should be enclosed with preferably civil construction with RCC slab roof or pre-fabricated shed where adequate care is taken to ensure that no contamination happens from the roof through insects and birds excreta. It may be covered with some kind of false ceiling with sufficient energy efficient light, ventilation seamless movement of produce on the washing, sorting, packaging, line upto the transit cold storage or direct dispatch as the case may be. Sorting helps to remove damaged produce and meeting requirements which are essential for acceptable quality. It is usually the first step in the packhouse (IP).
- D. **Precooling:** the precooling method is the technique where farm heat is removed to reduce the metabolic activity and thereby increasing the shelf life of the produce. It can be of various types like- hydro-cooling, ice-cooling, evaporative cooling, etc. Depending upon the type and requirement of the produce. (Check from the chapter NO. 8- PRE-COOLING UNIT)
- E. **Transit Cold Room:** refrigeration allows maintenance of required temperature and humidity levels inside the cold storages thereby enabling protection of both quality and against losses. The desired temperature and relative humidity are achieved through refrigeration equipments. These refrigeration equipments are operational both on non-renewable source of energy and as well as renewable (solar) sources of energy. While designing these packhouse (IP)s the focus Should be on energy efficiency, the use of refrigerants which have low GWP and are also climate friendly. Essential efforts should be put on mechanisation, Automation of the facility which allows sustainable development.
- F. **Reefer Vehicle:** to promote the cold supply chain for connecting farms and produce handling units to integrated packhouse (IP)s and further distribution of the sorted, graded/ cold produce or direct deliveries of the finished produce as the case may be through an unbreakable cold chain into the market.
- G. **Material Handling Equipment (MHE):** to enhance productivity and reduce contamination through human touch and to further modernize the operations for handling more number of horticulture produce in shorter period of times in an efficient and timely manner.
- H. **Receiving & Dispatching:** To facilitate receiving and dispatching on the docks suitable dock leveller systems are required to integrate the incoming and outgoing vehicles scientifically to the packhouse (IP). Essential care should be taken in handling the packed produce during the loading on to the reefer trucks. Material handling equipment should be used for easy and convenient method of loading the freshly sorted graded produce into the vehicle for market area. The docking dispatch area should be appx. 1.06 m from the road level and docking equipment should be used in the docks and differentiated from the packhouse (IP) area by means doors and walls. Suitable arrangement to be made for placing docking doors on the dock and connected to the packhouse (IP) through a insulated panels forming a kind of closed passage between dock door and entry of packhouse (IP).

Each pack-house, appraised under this component, should be equipped with the necessary equipment to facilitate mechanised sorting and grading conveyor system. Additionally, washing and weighing equipment can be added to prepare the product for packaging in special cases.

The list of commodities and their storage parameters can be found at **List: I** at the end of this book.

MINIMUM STANDARDS TO BE FOLLOWED:

- 1) The indicative dimensions are **18m x 22m** with corner height of 5m and center height of 7m. These dimensions are exclusive of docking area and needs to be surrounded by covered dock area for loading un-loading on at least 2 sides. The inside of the packhouse (IP) needs to be maintained within comfort conditions of temperature and humidity and suitable Industrial air washers should be installed for this purpose.
- 2) Docking area to be kept on two sides of the packhouse (IP) with a minimum width of 2m x 1.06 m (width x height). At the places of placing dock leveller system appropriate width to be considered for seamless installation of dock leveller system and movement of MHEs from inside the Packhouse (IP) through the dock into the reefer truck for loading-unloading.
- 3) In case dock leveller systems are installed on one side then proper space should be maintained between the two dock leveller system to maintain uninterrupted movement of produce for loading and unloading. In that case the width of the other side of the dock can be reduced to 1 m with provision of ramp and staircase arrangement with access shutter doors/ any other type of suitable door providing access into the enclosed sorting and grading area.
- 4) Civil works involve the construction of 1.06 Mtr finish floor level raised platform. The finished floor should be kota stone/ epoxy or any other finished floor type. A proper level needs to be maintained inside the packhouse (IP) with drainage system for dispensing water.
- 5) Superstructure and the foundation to be designed by licensed structural/civil engineer. And the design shall meet the BIS standards and relevant seismic zone norms for earthquake proof design.
- 6) The Integrated Packhouse should have throughput a capacity of minimum 15 MT upto 30 MT and is equipped with facilities of a mechanised conveyor belt, sorting, grading units, washing, drying, and weighing. **(Min. one no. 15MT chamber to be installed mandatorily)**. It would be preferred to run these transit cold stores on DRE technology (De-centralized Renewable Energy) or Hybrid mode or thermal storage type or conventional cold rooms.

NOTE: - **For further details and guidelines Refer chapter no. 9- COLD ROOM TRANSIT**

- 7) A Pre-Cooling Unit is required, though it's only needed for certain produce. **20 m³** will be considered per one MT to pre-cool the produce. Pre-coolers would not be allowed on DRE technology. (Refer to chapter no. 8- PRE-COOLING UNIT). *



- 8) The floor in the transit cold rooms should be of base concrete, with kota stone/ epoxy or any other finished floor type inside the floor chambers. Floor insulation slab preferably XPS (EPS not allowed) laid in two layers. The Floor should be cleaned, painted with black Japan paint and then laid with 1st layer of vapour barrier which can be either 250 microns tarfelt sheet or polythene sheet of suitable thickness. The vapour barrier should be covered with 1st layer of insulation and overlaid with 2nd layer of insulation in a manner to cut the gaps in the first layer of insulation. The joints can be filled with suitable hot grade bitumen (80:25). The 2nd layer of insulation is then covered with 2nd layer of vapour barrier which would be upto 1 mm thick tar felt or poly felt sheets with 5 mm overlap on the walls.
- 9) The laying of Trimix should be 75 MM to 100 MM thickness with any suitable finish like kota stone, epoxy etc. and anti-skid tapping. The floor level of the cold storage should match the floor level of the Integrated packhouse (IP) for easy movement of material as well as MHEs. In case of raised floor levels, a suitable graded ramp to be either fixed or made outside the door for mechanised movement of the goods.
- 10) The Cold Room should be installed in such a way that small HPTs/BOPTs can be used to load/un-load the material mechanically.

INSULATION & DOORS

- 11) The cold room insulation should be PUF/PIR or any other new environment friendly insulating material of thickness min 100 mm. sandwiched in either pre-painted GI(0.45 mm Min. thickness) or SS(food grade SS-306) sheets.
- 12) The insulated door should be either overlap or inline or sliding but of the same thickness as that of the panel with a view window on the door properly fitted along with heater for anti-condensation on the glass. The door should be fitted with strip curtains form inside with 0.5 mm overlap from SS hooks or hangers.

SUPPLY CHAIN

- 13) One (1) no. Refrigerated transport vehicles of minimum load carrying capacity 1 MT and max. upto 2 MT (either ICE or EV). The load carrying capacity of container is determined after subtracting the sum of (kerb weight of the chassis + container weight + weight of Reefer unit) from the Gross Vehicle Weight (GVW) of the chassis. This component is added to ensure seamless connectivity at primary level.

NOTE: - **For further details and guidelines Refer chapter no. 22- REFRIGERATED TRANSPORT**

- 14) The place for refrigeration machines, DG set (need base as per individual requirement), etc should be adjacent to the proposed enclosed packhouse (IP) with sufficient space for small vehicles to move in and out. D G Sets to be installed as per the norms and guidelines of respective Pollution Control Boards or as notified from time to time by Govt. Of India. The changes in the rules for any such components which may be listed under the polluting norms including DG Sets would be applicable as per revised norms issued by relevant regulatory authority state and central both as well as by NCCD.

15) At least three storage pits for vegetable waste with proper methodology.

Design Guidelines:

- Utilize Cam Lock Joints and Continued PUF (Polyurethane Foam) Panel insulation for Integrated Pack Houses. These panels should have a density of 40kg $\pm$ 2kg and a thickness of minimum 100 mm. (Refer chapter no. 24– INSULATING MATERIALS)
- Proper sanitation and safety measures to be taken for the welfare of the workers/staffs working.
- Prioritize a design that emphasizes low energy consumption.
- Consider the possibility of prefabricated and modular construction, eliminating the need for extensive civil work.

MANDATORY SUBSIDY COMPONENTS:

For Both NHM/NHB

COMPONENT NO.	DESCRIPTION & NAME	MAX. ALLOWABLE QTY	CAPACITY/UNITS/SIZES
C-2	Integrated Packhouse (IP) Integrated Packhouse (IP) of size 18m x 22m with facilities of Receiving Area, weighing bridge, Washing, Enclosed Sorting and Grading Area with mechanised sorting/grading conveyor-based system. (refer point 1, and other relevant points)	Size of 18m x 22m per project	Rs. 60 lakh / project
	Material Handling Equipment (MHE): Above 1 ton HPT	Max. 2 unit/ project	Rs. 20000/unit
	Crates/Bins	Max. 50 MT/ project	Rs.2000/MT (max. 50 MT allowed)
	Dock Leveller System(DLS)	Max. 2 units/ project	Rs. 8.4 lakh/unit
	Precooling (if required)* (Based on requirement, not exceeding more than 3 MT as cumulative capacity) Refer Chapter No. 8 for details	Max. 3 MT/ project	Rs. 5 lakh/MT

Refer to Chapter no. 9 (COLD ROOM TRANSIT) for technical details.	Cold Room Transit (Option I) Decentralised cold storages based on solar technologies or hybrid running on batteries, solar PV panels, microcontrollers, etc. along with ante rooms, Thermal storages(all kinds), insulation, doors, necessary civil work and refrigeration systems. (refer point no. 6) Refer Chapter No. 10 for details	Max. 30 MT (2 chambers of 15 MT)	Rs. 26 lakh/chamber
	Cold Room Transit (Option II) In case of cold rooms based on Thermal storage type where electric energy is available for 8 hrs/day(No DG Sets are allowed) (refer point no. 6)	Max. 30 MT (2 chambers of 15 MT)	Rs. 15 lakh/chamber
	Cold Room Transit (Option III) The cold room transit are conventional cold rooms working on conventional refrigerants with ante rooms, insulation, doors necessary inside civil work and refrigeration systems. (Refer Chapter No. 9 for details)	Max. 30 MT (2 chambers of 15 MT)	Rs. 7.5 lakh/chamber
	Reefer Vehicle of load carrying capacity of min. 1 MT upto 2 MT (EV or ICE) The load carrying capacity of container is determined after subtracting the sum of (kerb weight of the chassis + container weight + weight of Reefer unit) from the Gross Vehicle Weight (GVW) of the chassis. Refer Chapter No. 22 for details	1 no. Vehicle of min. 1 MT upto 2MT (Either 1 ICE based OR 1 EV based)	Rs. 12 lakh/vehicle Rs. 14 lakh/vehicle

Remarks / Recommendations: These pack-houses are the initial step in organized post-harvest management for horticulture and serve as the first-mile production units for this sector. In conjunction with the pack-house, a pre-cooler with a transit cold room should be available. If not already in place, these two components must be created. Integrated pack-houses with pre-cooling and dispatch cold rooms can be designed to handle multiple types of produce. The typical workflow in such pack-houses involves receiving harvested goods, preliminary pruning/trimming/de-handing (some of which

can occur at the farm level), sorting for market channels and quality assessment, grading by size and colour, packaging and labelling as the first level of pre-conditioning, unitizing the load for pre-cooling, and transient storage in a cold room in preparation for onward transport.

An integrated pack-house aims to open multiple market channels for produce, allowing for:

- I. Direct access to local markets, whether packaged or non-packaged.
- II. Localized storage of selected produce for off-season supply.
- III. Integration into the cold supply chain for distant markets or cold storage.
- IV. Routing selected produce to food processing units.
- V. Managing waste by directing it to non-food processing.

Technical Evaluation while Claiming Subsidy: The following details need to be submitted for Technical Evaluation while availing subsidy for government.

1. Nomenclature: S-1/ I F/II F/III F/IV F/I Vg/II Vg/III Vg/IV Vg/IP/H/C/S/TS/B/SREF/NREF-PCM

- a) S-1 stands for storage upto 30 MT
- b) I F/II F/III F/IV F/I Vg/II Vg/III Vg/IV Vg- choose the type of commodity to be kept (refer to chapter no.31- COMMODITIES SPECIFICATION)
- c) IP stands for Integrated Pack House
- d) H/C/S/TS/B – choose the type of technology used
- e) SREF/NREF- choose Synthetic Refrigerant or Natural Refrigerant used
- f) -PCM – write only if PCM is used.

2. Basic Data Sheet: Refer to Annexure II at the end of this book. (Basic Data Sheet for Integrated Packhouse)

3. Heat Load Calculation Sheet: Enclose basis of heat load calculation. (Preferably)

4. Drawings: Enclose sketch with Plan layout and sections showing storage chambers and floor heights clearly.

5. Data Sheets of all Refrigeration Equipments to be installed duly certified by respective equipment manufacturer. (For the purpose of understanding technology)

NOTE/ESSENTIALS:

- i. This component can be availed through both NHM & NHB.
- ii. All mandatory rules and regulations (BIS, ISO, IS, MNRE, etc.) relevant to the item must be complied with.
- iii. In conventional storage, Refrigerants having potential for Ozone Depletion# and GWP ranging more than 1500 (like R22, R404A etc.) are not allowed for temperature range 0° C and above.
- iv. Use of inverter compressor / Digital compressor/ compressors with capacity control with choice of refrigerants as described above should also be considered to promote energy efficiency and sustainable development.
- v. Ensure structural stability of the packhouse considering loads etc. (refer point no. 5 under Minimum Standards to be Followed)
- vi. Applicant who intends to setup Integrated Packhouse/Collection Aggregation centre can design a bigger facility as per their requirement however, no additional subsidy

would be given beyond the mentioned sizes, capacities, quantities, etc. under the table “Mandatory Subsidy Components”. Additionally, the applicant needs to fulfil all the requirements necessitated by the appraising agency for the overall facility and inspection would be conducted of the overall facility installed fulfilling all the requirements of minimum standards and guidelines 2025.

* The dimensions of the Integrated Packhouse including Dock Area (2m X 2m) on two sides of Integrated Packhouse of size 18m x 22m would be 20m x 24m. Therefore, Total Platform size of the Integrated Packhouse would be 20m x 24m.

ODP is Ozone Depletion and GWP signifies Global Warming Potential

*Pre-cooling is a specialized process and can be availed as per the list of produce attached in the chapter no. 8 PRECOOLING UNIT. The applicant needs to justify how they intend to use the pre-cooler and why is it necessary to use a precooler for produce specified.



7. COLLECTION AGGREGATION CENTRE

To bridge rural areas with urban markets, Collection & Aggregation Centers are setup, equipped with facilities such as a receiving area, weighbridge, washing section, and enclosed spaces for weight and size sorting and grading. These centers include an automated sorting, grading, and waxing line with a capacity of 2 MT/hr, along with specialized packaging systems featuring automatic strapping, conveyors, and other equipment for the efficient movement of packaged produce.

The Collection & Aggregation centre is generally setup to cater larger/medium volumes. This aggregation centre would provide details of backward linkage, name of the farmer associated, aadhaar card of the farmers in that area and common agreement between the farmers and working group to allow smooth operation of the Collection & Aggregation centre. This can be also taken by group of individual farmers with providing list of details of name of farmers address, aadhaar card details and their produce and further market linkage or methodology in terms of storing of the produce.

This Collection & Aggregation centre can also act as a Distribution centre for **farmgate packhouse** which can be created by the FPOs, Group of individuals, Grower Associations, Corporate, and thereby, increasing the throughput capacity of the facility. These facilities should be placed at locations which are closer to Urban Centres, National Highways, Super expressways, etc.

ESSENTIALS OF COLLECTION AGGREGATION CENTRE SETUP & OPERATION:

- i. Relevant data and information on the production area, type of produce, quality of produce, and connectivity of farm to the Collection & Aggregation Centre and target market or hubs should be properly recorded and known for utmost utilisation of the facility.
- ii. A Collection & Aggregation Centre should be connected by good roads and should be covered properly to prevent from sun, rain and other contaminants from environment.
- iii. These facilities should be well connected to the packhouses or farm handling units and should have reefer vehicles for both forward and backward linkages within the cold chain.
- iv. A Collection & Aggregation Centre should be designed well with sufficient areas for loading and unloading bays. It should have adequate water and electricity supplies and the drainage system should be done in a very well manner and necessary water treatment plant should be used wherever applicable.
- v. A Collection & Aggregation Centre should have all the necessary arrangements for safety and other desirables for the comfort of workers and other skilled professionals.
- vi. A Collection & Aggregation Centre should also have a weigh scale at the receiving side of the centre.
- vii. It may be connected to various numbers of farm handling units of a farmer, FPO or any other help groups which allows seamless connectivity of the produce to the Collection & Aggregation Centre in the shortest possible time thereby reducing post harvest losses.

A Collection & Aggregation Centre generally have adequate no. of crates, bins & other types of MHE's, sorting grading tables, cold rooms, trimming machines(as per requirement), sorting, grading (automatic conveyors), weighing machines, packaging machines, drying machines(as per requirement), sizing machines (as per requirement).

Sufficient ventilated space also cooled to temperatures and humidity for human comfort to prevent produce from contamination and diseases. (Atleast industrial air washers can be installed for this purpose).

Also, the centre should have installed automated system for generating QR code/Bar code labelling, farmers details, date of arrival, variety of the crop, etc.

COMPONENTS OF COLLECTION AGGREGATION CENTRE:

- A. **Receiving Area (Covered):** The produce after arrival should be identified-farm source, weighed and same should be recorded for the purpose of expanding to bigger markets that may require a traceability system. It is essential that while produce undergoes different operations the produce should be protected from physical damages, contamination and should be protected from direct sunlight, rain, dust, etc. The receiving area should have the facility to examine the damaged produce or any other type of disease etc. which can result in incurring both financial as well as post harvest losses. Loading and un-loading docks shall be designed with RCC slab, roof or sheet roofing. The dock area to accommodate suitable sized office and toilet for staffs and labors.
- B. **Automated computerised system:** The produce after arrival should be identified-farm source, weighed and same should be recorded for the purpose of expanding to bigger markets that may require a **traceability system**.
- C. **Weighing Bridge:** Suitable capacity at the inward of Collection & Aggregation Centre should be installed to weigh the incoming and outgoing produce.
- D. **Enclosed Sorting and Grading Area:** Sorting and grading is very vital part of the Collection & Aggregation centre operation and helps in reduce post harvest losses. Sorting and Grading area generally is the area where the produce is received after un-loading on the dock for further process. This area should be enclosed with preferably civil construction with RCC slab roof or pre-fabricated shed where adequate care is taken to ensure that no contamination happens from the roof through insects and birds excreta. It may be covered with some kind of false ceiling with sufficient energy efficient light, ventilation seamless movement of produce on the washing, sorting, packaging, line upto the transit cold storage or direct dispatch as the case may be. Sorting helps to remove damaged produce and meeting requirements which are essential for acceptable quality. It is usually the first step in the Collection & Aggregation Centre.
- E. **Sorting, Grading Machines:** This refers to Sorting, Grading, Conveyor including washing treatment for fruits/vegetables with packing tables, etc. Refer to chapter no. 26 – (WASHING, SORTING & GRADING LINES)
- F. **Precooling:** the precooling method is the technique where farm heat is removed to reduce the metabolic activity and thereby increasing the shelf life of the produce. It can be of various types

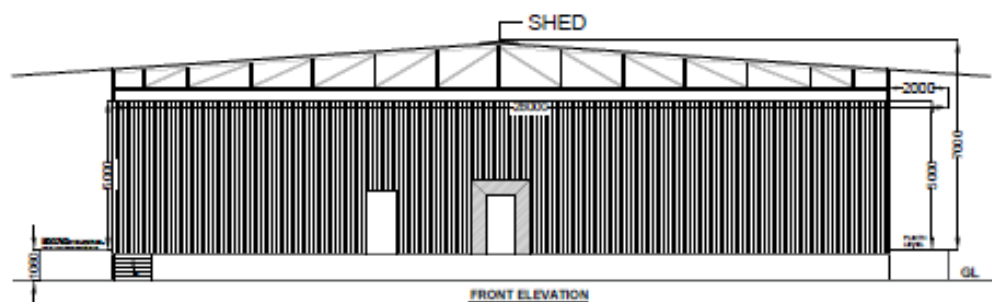
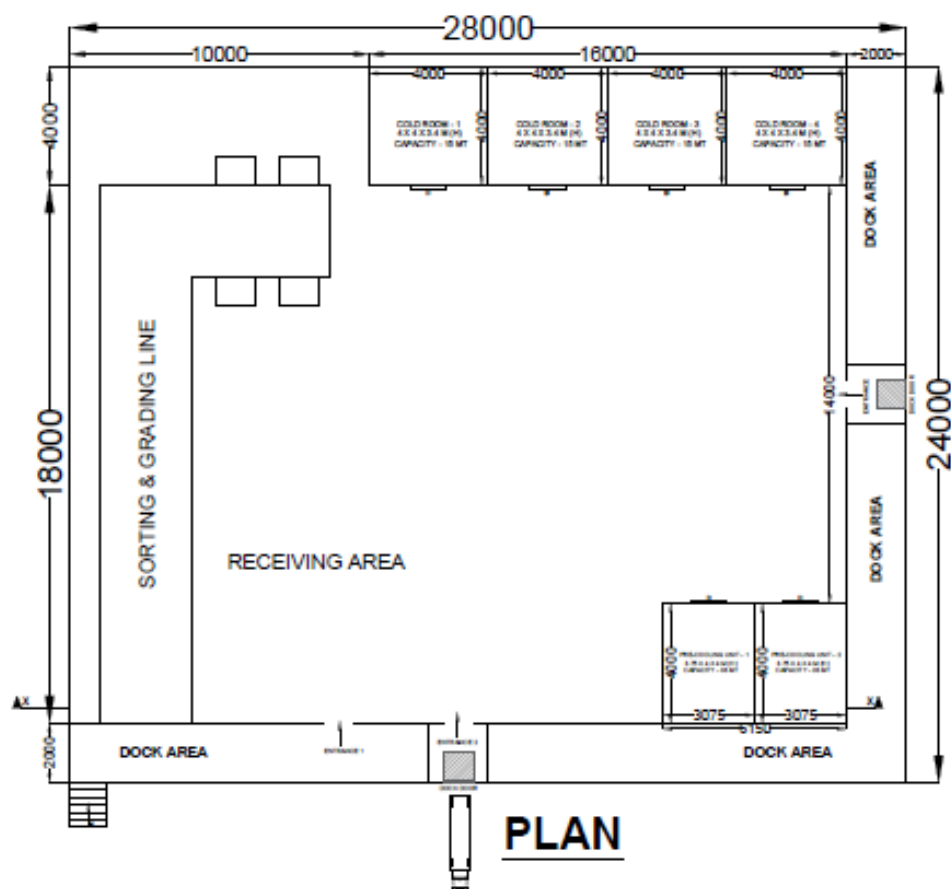
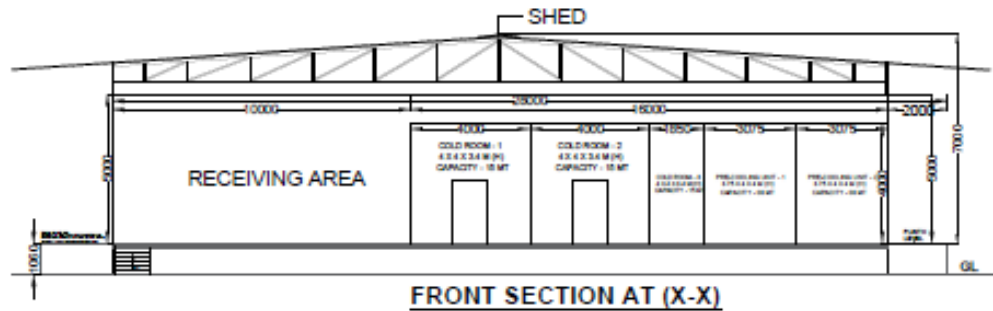
like- hydro-cooling, ice-cooling, evaporative cooling, etc. Depending upon the type and requirement of the produce. (refer to chapter no. 8- PRECOOLING UNIT)

- G. **Transit Cold Room:** refrigeration allows maintenance of required temperature and humidity levels inside the cold storages thereby enabling protection of both quality and against losses. The desired temperature and relative humidity are achieved through refrigeration equipments. These refrigeration equipments are operational both on non-renewable source of energy and as well as renewable (solar) sources of energy. While designing these Collection & Aggregation Centres the focus should be on energy efficiency, the use of refrigerants which have low GWP and are also climate friendly. Essential efforts should be put on mechanisation, Automation of the facility which allows sustainable development. (Refer Chapter no. 9- COLD ROOM TRANSIT)
- H. **Reefer Vehicle:** to promote the cold supply chain for connecting farms and produce handling units of integrated packhouses to Collection & Aggregation Centre and further distribution of the sorted, graded/ cold produce or direct deliveries of the finished produce as the case may be through an unbreakable cold chain into the market.
- I. **Material Handling Equipment (MHE):** to enhance productivity and reduce contamination through human touch and to further modernize the operations for handling more number of horticulture produce in shorter period of times in an efficient and timely manner.
- J. **Receiving & Dispatching:** To facilitate receiving and dispatching on the docks suitable dock leveller systems are required to integrate the incoming and outgoing vehicles scientifically to the Collection & Aggregation Centre. Essential care should be taken in handling the packed produce during the loading on to the reefer trucks. Material handling equipment should be used for easy and convenient method of loading the freshly sorted graded produce into the vehicle for market area. The docking dispatch area should be appx. 1.06 m from the road level and docking equipment should be used in the docks and differentiated from the Collection & Aggregation Centre area by means doors and walls. Suitable arrangement to be made for placing docking doors on the dock and connected to the Collection & Aggregation Centre through a insulated panels forming a kind of closed passage between dock door and entry of Collection & Aggregation Centre.

Each Centre, appraised under this component, should be equipped with the necessary equipment to facilitate automated sorting and grading conveyor system. Additionally, washing and weighing equipment can be added to prepare the product for packaging in special cases.

The list of commodities and their storage parameters can be found at **List: I** at the end of this book.

AGGREGATION CENTER



- Only For reference & calculation, Follow NCCD Guidelines.

MINIMUM STANDARDS TO BE FOLLOWED:

- 1) To avail this component applicant should incorporate atleast **5 to 10 farmers/growers** etc. and can apply through **state missions NHM/MIDH/NHB**.
- 2) To avail this component by organisations which are into distribution/self farming/retailing of fresh produce by sourcing it from farmers, FPOs, etc. can apply through National Horticulture Board (NHB)*
- 3) The Collection & Aggregation Centre has to be located within **5-10 km radius** of nearby **Urban Centres, National Highways, Super expressways**, etc. The purpose is to connect farm and its produce to distribution centres and thereby connecting the cold chain.
- 4) The indicative dimensions are **22m x 26m** with corner height of 5m and center height of 7m. These dimensions are exclusive of docking area and needs to be surrounded by covered dock area for loading un-loading on atleast 2 sides. The inside of the Collection & Aggregation Centre needs to be maintained within comfort conditions of temperature and humidity and suitable Industrial air washers should be installed for this purpose. The dimensions are indicative and applicant may increase the dimensions as per suitability but not less than 18m x 18m.
- 5) Docking area to be kept on two sides of the Centre with a minimum width of 2m x 1.06 m (width x height). At the places of placing dock leveler system appropriate width to be considered for seamless installation of dock leveler system and movement of MHEs from inside the Collection & Aggregation Centre through the dock into the reefer truck for loading-unloading. Provision of ramp and stairs providing access into the enclosed sorting and grading area.
- 6) In case dock leveller systems are installed on one side then proper space should be maintained between the two dock leveller system to maintain uninterrupted movement of produce for loading and unloading. In that case the width of the other side of the dock can be reduced to 1 m with provision of ramp and staircase arrangement with access shutter doors/ any other type of suitable door providing access into the enclosed sorting and grading area.
- 7) Civil works involve the construction of a 1.06 meter finish floor level raised platform. The finished floor should be kota stone/epoxy or any other finish floor type. A proper level inside the Collection & Aggregation Centre, drainage system for dispensing water.
- 8) Superstructure and the foundation to be designed by licensed structural/civil engineer. The design shall meet the BIS standards and relevant seismic zone norms for earthquake proof design.

*Private retailing organizations involved in collection, distribution & retailing of fresh horticulture produce can also apply and avail this component with details of collection, distribution & retailing but only through NHB.

Any group/ farmer group/ FPO etc. (5-10) involved in or intending in collection, distribution & retailing of fresh horticulture produce can also apply and avail this component with details of collection, distribution & retailing, through both NHM & NHB.

- 9) The Collection & Aggregation centre should have throughput a capacity of minimum 45 MT upto 60 MT and is equipped with facilities of a mechanised conveyor belt, sorting, grading units, washing, drying, and weighing. **(Min. three no. 15MT chambers to be installed mandatorily equivalent to 45 MT)**. It would be preferred to run these transit cold stores on DRE technology (De-centralised Renewable Energy) or Hybrid mode or thermal storage type or conventional cold rooms.

NOTE: - **For further details and guidelines on Cold Room Transit refer chapter no. 9- COLD ROOM TRANSIT**

- 10) A Pre-Cooling Unit (if required) with a maximum capacity of 6 MT precooling. Though it's only needed for certain produce. (Refer to chapter no. 8- PRE-COOLING UNIT TABLE NO.1).
- 11) 20 cu. mtr. may be considered per one MT to pre-cool the produce. Indicatively, the pre-cooling capacity should not be less than 3 MT per batch in Collection & Aggregation centre and subsidy as per the prevalent norms can be claimed on pro rata basis of specified cost norm. Pre-coolers would not be allowed on DRE technology.
- 12) The floor in the transit cold rooms should be of base concrete, with kota stone/ epoxy or any other finished floor type inside the floor chambers. Floor insulation slab preferably XPS (EPS not allowed) laid in two layers. The Floor should be cleaned, painted with black Japan paint and then laid with 1st layer of vapour barrier which can be either 250 microns tarfelt sheet or polythene sheet of suitable thickness. The vapour barrier should be covered with 1st layer of insulation and overlaid with 2nd layer of insulation in a manner to cut the gaps in the first layer of insulation. The joints can be filled with suitable hot grade bitumen (80:25). The 2nd layer of insulation is then covered with 2nd layer of vapour barrier which would be upto 1 mm thick tar felt or poly felt sheets with 5 mm overlap on the walls.
- 13) The laying of Trimix should be 75 MM to 100 MM thickness with any suitable finish like kota stone, epoxy etc. and anti skid tapping. The floor level of the cold storage should match the floor level of the Integrated packhouse (IP) for easy movement of material as well as MHEs. In case of raised floor levels a suitable graded ramp to be either fixed or made outside the door for mechanised movement of the goods.
- 14) The Cold Room should be installed in such a way that small HPTs/BOPTs can be used to load/un-load the material mechanically.

INSULATION & DOOR:

- 15) The cold room insulation should be PUF/PIR or any other new environment friendly insulating material of thickness min 100 mm. sandwiched in either pre-painted GI(0.45 mm Min. thickness) or SS(food grade SS-306) sheets.
- 16) The insulated door should be either overlap or inline or sliding but of the same thickness as that of the panel with a view window on the door properly fitted along with heater for anti-condensation on the glass. The door should be fitted with strip curtains form inside with 0.5 mm overlap from SS hooks or hangers.

SUPPLY CHAIN:

- 17) Two (2) no. s Refrigerated transport vehicles of minimum load carrying capacity 1 MT and max. upto 2 MT (either ICE or EV). The load carrying capacity of container is determined after subtracting the sum of (kerb weight of the chassis + container weight + weight of Reefer unit) from the Gross Vehicle Weight (GVW) of the chassis. This component is added to ensure seamless connectivity at primary level.

NOTE: - **For further details and guidelines Refer chapter no. 22- REFRIGERATED TRANSPORT**

- 18) The place for refrigeration machines, DG set (need base as per individual requirement), etc should be adjacent to the proposed enclosed packhouse (IP) with sufficient space for small vehicles to move in and out. D G Sets to be installed as per the norms and guidelines of respective Pollution Control Boards or as notified from time to time by Govt. Of India. The changes in the rules for any such components which may be listed under the polluting norms including DG Sets would be applicable as per revised norms issued by relevant regulatory authority state and central both as well as by NCCD.

- 19) At least three storage pits for vegetable waste with proper methodology.

Design Guidelines:

- Utilize Cam Lock Joints and Continued PUF (Polyurethane Foam) Panel insulation for Integrated Pack Houses. These panels should have a density of 40kg $\pm$ 2kg and a thickness of minimum 100 mm. (Refer chapter no. 24– INSULATING MATERIALS)
- Proper sanitation and safety measures to be taken for the welfare of the workers/staffs working.
- Prioritize a design that emphasizes low energy consumption.
- Consider the possibility of prefabricated and modular construction, eliminating the need for extensive civil work.

MANDATORY SUBSIDY COMPONENTS:

For Both NHM & NHB

COMPONENT NO.	DESCRIPTION & NAME	MAX. ALLOWABLE QTY.	CAPACITY/UNITS/SIZES
C-3	To connect rural areas with urban markets Collection & Aggregation Centre of size 22m x 26m with facility of receiving area, weighing bridge, Washing, with Enclosed weight, size Sorting and Grading Areas with automatic/ mechanised sorting, grading, waxing line of 1MT~2MT/hr,	Size of 22m x 26m per project	Rs. 120 lakh / project

	with packing system consisting of strap packing machines, etc.		
Refer to chapter no. 9 (COLD ROOM TRANSIT) for technical details	Automated computerised system with software for generating QR/bar code labelling, farmers details, date of arrival, variety of the crop at the arrival of Collection & aggregation center	One system/ project	Rs. 3.5 lakh / project
	Material Handling Equipment (MHE) Above 1 Ton HPT	Max. 4 units	Rs. 20000/ unit
	Above 1 Ton BOPT	Max. 2 units	Rs. 1.5 lakh/ unit
	Crates/Bins	Max. 100 MT	Rs. 2000/MT
	Dock Leveller System	Max. 3 units	Rs. 8.4 lakh/unit
	Precooling (if required)* (Based on requirement, not exceeding more than 6 MT as cumulative capacity and min 3MT)	Min 3 MT up to Max. 6 MT	Rs. 5 lakh/MT
	Cold Room Transit (Option I) Decentralised cold storages based on solar technologies or hybrid running on batteries, solar PV panels, microcontrollers,etc. alongwith ante rooms, Thermal storages(all kinds), insulation, doors, necessary civil work and refrigeration systems. (refer point no. 9)	Max. 60 MT (4 chambers of 15 MT)	RS. 26 lakh/chamber for Capacity allowed in multiples of 15 MT
	Cold Room Transit (Option II) In case of cold rooms based on Thermal storage type where electric energy is available for 8 hrs/day(No DG Sets are allowed) . (refer point no. 9)	Max. 60 MT (4 chambers of 15 MT)	Rs. 15 lakh/chamber for Capacities allowed in multiples of 15 MT
	Cold Room Transit (Option III) The cold room transit are conventional cold rooms working on conventional refrigerants with ante rooms, insulation, doors necessary inside civil work and refrigeration systems. . (refer point no. 9)	Max. 60 MT (4 chambers of 15 MT)	Rs. 7.5 lakh/chamber for Capacity allowed in multiples of 15 MT

	Reefer Vehicle of load carrying capacity min. 1 MT (EV or ICE) upto 2 MT. ADD-ON: Reefer Vehicle of load carrying capacity min. 9 MT. upto 14 MT (for NHM) And 15 MT and above (for NHB) The load carrying capacity of container is determined after subtracting the sum of (kerb weight of the chassis + container weight + weight of Reefer unit) from the Gross Vehicle Weight (GVW) of the chassis. Collection & Aggregation centres should be set up near urban areas, market yards, distribution centres, consumer centres, National Highways and should integrate with farm handling units for forward linkage and with rural retail markets for backward linkage.	Max 2 no. vehicle of capacity min. 1MT upto 2 MT (Either ICE based or EV based)	Rs. 12 lakh / ICE vehicle Rs. 14 lakh/ EV This can be availed as an Add-on component on need basis as per applicable norms defined in component C-13 (Refrigerated transport vehicle)
Weigh Bridge	Weigh Bridge of capacity min 25 MT	Max. 1 unit / project	Rs. 4 lakh/unit

Remarks / Recommendations: This component is introduced with the aim to help larger group of farmers or growers. This facility can be set up in such a way that neighbouring villages or small towns can accumulate their harvest and process together. The Collection & Aggregation Centre should ideally equip with all the modern amenities and technologies for improved efficiency and productivity. These centres in times can also cater as training centres for farmers, growers, entrepreneurs, etc.

A Collection & Aggregation Centre aims to open multiple market channels for produce, allowing for:

- I. Direct access to local markets, whether packaged or non-packaged.
- II. Localized storage of selected produce for off-season supply.
- III. Integration into the cold supply chain for distant markets or packhouses.
- IV. Routing selected produce to food processing units.
- V. Managing waste by directing it to non-food processing.

Technical Evaluation while Claiming Subsidy: The following details need to be submitted for Technical Evaluation while availing subsidy for government.

1. Nomenclature: S-2/ I F/II F/III F/IV F/I Vg/II Vg/III Vg/IV Vg/AC/H/C/S/TS/B/SREF/NREF-PCM

- a) S-2 stands for storage upto 45 MT
- b) I F/II F/III F/IV F/I Vg/II Vg/III Vg/IV Vg- choose the type of commodity to be kept (refer to chapter no.31- COMMODITIES SPECIFICATION)
- c) AC stands for Collection & Aggregation Centre
- d) H/C/S/TS/B – choose the type of technology used
- e) SREF/NREF- choose Synthetic Refrigerant or Natural Refrigerant used
- f) -PCM – write only if PCM is used.

2. Basic Data Sheet: Refer to Annexure II at the end of this book. (Basic Data Sheet of Integrated Packhouse / Collection & Aggregation Centre)

3. Heat Load Calculation Sheet: Enclose detail basis of heat load calculation.

4. Drawings: Enclose sketch with Plan layout and sections showing storage chambers and floor heights clearly.

5. Technical Performance Data Sheets of Refrigeration Equipments to be installed duly certified by respective equipment manufacturer.

6. Energy Efficiency Sheet: Refer to Annexure VI at the end of this book.

NOTE/ESSENTIALS:

- i. This component can be availed through both NHM & NHB.
- ii. All mandatory rules and regulations (BIS, ISO, IS, MNRE, etc.) relevant to the item must be complied with.
- iii. In conventional storage, Refrigerants having potential for Ozone Depletion[#] and GWP ranging more than 1500 (like R22, R404A etc.) are not allowed for temperature range 0° C and above.
- iv. Use of inverter compressor / Digital compressor/ compressors with capacity control with choice of refrigerants as described above should also be considered to promote energy efficiency and sustainable development.
- v. Applicant who intends to setup Integrated Packhouse/Collection Aggregation centre can design a bigger facility as per their requirement however, no additional subsidy would be given beyond the mentioned sizes, capacities, quantities, etc. under the table “Mandatory Subsidy Components”. Additionally, the applicant needs to fulfill all the requirements necessitated by the appraising agency for the overall facility and inspection would be conducted of the overall facility installed fulfilling all the requirements of minimum standards and guidelines 2025.

* The dimensions of the Collection Aggregation Centre including Dock Area (2m X 2m) on two sides of Integrated Packhouse of size 22m x 26m would be 24m x 28m. Therefore, Total Platform size of the Integrated Packhouse would be 24m x 28m.

ODP is Ozone Depletion and GWP signifies Global Warming Potential

*Pre-cooling is a specialized process and can be availed as per the list of produce attached in the chapter no. 8 PRECOOLING UNIT. The applicant needs to justify how they intend to use the pre-cooler and why is it necessary to use a pre-cooler for produce specified.

8. PRE-COOLING UNIT

Pre-cooling is the most essential process soon after the harvest to maintain optimal quality and endure shelf life. Maintaining optimal temperature, humidity, etc. control throughout the post-harvest life of Fruits & vegetables is crucial for preserving quality and minimizing losses. Cold storage facilities play a vital role in this process, but pre-cooling units act as the first line of defense. It is the process of rapidly reducing field heat from freshly harvested produce in order to slow down the various biological processes before the produce is stored or prepared for transportation to various markets and consumption centers. Pre-cooling units are generally designed as batch type rapid cooling rooms.

Their significance and usage is generally in the packhouses & Collection & aggregation centre (refer chapter no.6- INTEGRATED PACKHOUSE, chapter no.7 - COLLECTION & AGGREGATION CENTRE) or near the farm gates. At various places mobile precoolers are also used which are mounted on trucks and can be moved easily from place to place where there is requirement. Precooling is done as a rapid cooling process which allows rapidly cooling and reducing the temperature & maintaining humidity of the produce harvested in order to control the metabolic activity and thereby preventing losses and wastage.

The normal precooling units range from 3 MT to 6 MT maximum in an integrated packhouse and Collection & aggregation centre respectively with designed pull down time of 4-6 hrs max. The desired temperature and necessary humidity levels in a precooler where forced air is circulated in the chamber.

The required air flow should be between 2-3 CFM/kg of the produce and bins & packaging units must of openings to allow cold moist air to pass over individual piece of produce. A tunnel type cooling is the most common design/method for forced air cooling where produce are placed in two lanes parallel on either side of each other. A tarp or any other suitable material is placed over the produce covering the produce and the tunnel.

The forced air coolers fan equipped with all the controls and capability to maintain humidity levels upto 95% (as required) is situated at the end opposite to the door to suck cold air through the tunnel and synchronize with the refrigeration system which allows to reach desired temp conditions and also simultaneously maintains relative humidity by way of design.

The precoolers approximately are designed to reduce 80-85% of the desired storage temp of the produce and to prevent transpiration. There are various types of precooling types used depending upon the type of produce that is to be precooled if required. This chapter delves into the technical aspects of pre-cooling unit integration within cold storage facilities.

Pre-Cooling Unit Technologies:

Cold storage facilities can utilize various pre-cooling techniques depending on product characteristics and facility requirements. Here's a closer look at common pre-cooling unit technologies:

- i. **Room Cooling:**
- ii. **Forced Air Cooling (FAC):**
- iii. **Hydro-Cooling (HC):**

- iv. **Top Icing:**
- v. **Vacuum Cooling (VC):**
- vi. **Evaporative Cooling (EC):**

i. **Room Cooling**

Room cooling operates by slowly transferring heat from the mass of the produce through convection to the cold air circulated around stacked containers. This method is widely employed, particularly for products with longer storage life intended for immediate marketing post-harvest. Cold air, cooled by the evaporator, enters the room, moves horizontally through the produce containers, and returns to the evaporator. One advantage of room air-cooling is its economic feasibility, as produce can be cooled and stored within the same room without requiring transfer.

ii. **Forced Air Cooling (FAC):**

Forced air cooling, alternatively known as pressure cooling, involves the passage of cold air by force from one side to the other using large fans. Unlike room cooling, where air circulates around containers, in forced air cooling, air moves through the containers themselves. This results in a cooling rate approximately 4 to 10 times faster than room cooling, contingent upon airflow and individual produce volume. However, the high velocity of air circulation may lead to desiccation of crops. To mitigate this in some techniques the air is directed through cold water troughs which is placed at the bottom of the unit and allows picking up of moisture while returning to the plenum or the throwing side of the air handling unit.

Technical Considerations:

- Selection of appropriate fan types (axial, centrifugal) based on desired airflow velocity and static pressure.
- Careful evaporator coil design to optimize heat transfer efficiency and minimize moisture loss.
- Implementation of air distribution systems (baffles, ducts) to achieve uniform air circulation throughout the product load.
- Use of tarps to cover the produce.
- Air flow management through the bins, crates from sides and bottom is essential.

MINIMUM STANDARDS TO BE FOLLOWED FOR FORCED AIR PRECOOLERS:

1. A Pre-Cooling Unit with a capacity of 3 metric tons (MT) may be installed as a component in an Integrated packhouse.
2. A Pre-Cooling Unit with a capacity of minimum 3 metric tons (MT) and maximum upto 6 MT may be installed as a component in a Collection & Aggregation Centre.
3. 20 Cu. Mtr. should be considered per one MT to pre-cool the produce since in a precooler the stacking pattern is normally either near to the fan or lined up to create an air tunnel of cold and humid air for rapid cooling inside the chamber where produce is stored as a batch of MT.

4. Pre-coolers would not be allowed on DRE technology, since it requires sufficient amount of refrigeration capacity to cool a relevant batch of produce (MT) upto the desired precooling temperatures (normally between 4-6°C and 80% of the desired temperature condition) in prescribed time limit of 4-6 hrs.
5. Maintaining of required RH levels is necessary and should be part of the design conditions while designing a pre-cooler. Additional humidifiers may be installed to maintain the requisite humidity.
6. The height of the precooler should not exceed 4 mtr. Less than 4 m is allowed as per the design and required condition of the applicant.
7. It is important to maintain a minimum free space of appx. 1.5 m between the door and the last part of the stack. In pre-cooler the stacking is done from the point where the fans are installed.
8. The place of precooler should be chosen in such a way that it allows movement of produce into the transit cold storage in a seamless manner.
9. The precooler insulation should be PUF/PIR (excluding EPS) or any other new environment friendly insulating material of min thickness 100 mm. sandwiched in either pre-painted GI(0.45 mm Min. thickness) or SS(food grade SS-306) sheets.
10. The insulated door should be either overlap or inline or sliding but of the same thickness as that of the insulated panel.
11. The precooler door should be fitted with strip curtains form inside with 0.5 mm overlap from SS hooks or hangers. The door sizes should be chosen appropriately for easy access to goods and movement of either Battery operated MHEs, or HPTs as the case may be.
12. Minimum door size recommended is 1mtr x 2 mtr ($\pm 5\%$ variation would be accepted on the min recommended size, however the upper size can be selected as per requirement).
13. (The insulation density and U- values to be referred from chapter no.24- INSULATING MATERIALS)
14. The floor level of the precooler should match the floor level of the packhouse for easy movement of material as well as MHEs. In case of raised floor levels a suitable graded ramp to be either fixed or made outside the door for mechanised movement of the goods.
15. The internal height of the precooler (not more than 4m) should be designed in such a way that it should easily accommodate floor mounted precooling refrigeration units to maintain temp and humidity inside the chamber.
16. The floor in the precooler should be of base concrete, with kota stone/ epoxy or any other finished floor type inside the floor chambers. Floor insulation slab preferably XPS (EPS not allowed) laid in two layers. The Floor should be cleaned, painted with black japan paint and then laid with 1st layer of vapour barrier which can be either 250 microns tarfelt sheet or polythene sheet of suitable thickness. The vapour barrier should be covered with 1st layer of insulation and overlaid with 2nd layer of insulation in a manner to cut the gaps in the first layer of insulation. The joints can be filled with suitable hot grade bitumen (80:25). The 2nd

layer of insulation is then covered with 2nd layer of vapour barrier which would be upto 1 mm thick tar felt or poly felt sheets with 5 mm overlap on the walls.

17. The laying of Trimix should be 75 MM to 100 MM thickness with any suitable finish like kota stone, epoxy etc. and anti skid tapping. The floor level of the cold storage should match the floor level of the Precooler for easy movement of material as well as MHEs. In case of raised floor levels a suitable graded ramp to be either fixed or made outside the door for mechanised movement of the goods.
18. The precooler should be installed in such a way that small HPTs/BOPTs can be used to load/un-load the material mechanically.

Pre-Cooler Unit:

19. The air flow should be maintained between 2-3 CFM/kg of produce. Sufficient Air velocity should be considered to ensure throw upto the length of the room.
20. This is the core component responsible for removing heat from the product. The precooling unit normally is a floor mounted unit which allows movement of cold moist air within the stacked produce uniformly and rapidly. Ceiling mounted systems can be also used with certain amount of modification and should meet the required conditions.
21. The condensing unit should be designed with the proper refrigeration capacity. Keeping in view the sustainable development the selection of refrigerant should be done carefully and importantly.
22. In conventional storage, Refrigerants having potential for Ozone Depletion[#] and GWP ranging more than 1500 (like R22, R404A etc.) are not allowed for temperature range 0° C and above. Wherever possible and depending upon the wet bulb approach either water cooled condensers or air cooled condensers with adiabatic cooling should be used to help in reducing the energy costs thereby promoting sustainable development in the cold chain sector.
23. The selection of the type of the compressor should be done with care depending upon the capacity of the compressor at the desired conditions; its working envelope serviceability should be kept in mind while choosing the desired unit.
24. Inverter compressors / digital compressors /semi-hermetic compressors/screw compressors with capacity control which allows optimization of capacity as required thereby lowering the energy cycle cost are encouraged and preferred.

List of Commodity recommended for Forced Air Cooling:

Sl. No.	Commodity	Temperature (°C)	Relative Humidity (%)	Ethylene Sensitive
1	Grapes	0	85-95	N
2	Beans, snap	4-7	95	Y
3	Blackberries	(-0.5)-0	90-95	N
4	Blueberries	(-0.5)-0	90-95	N
5	Cantaloupe	2-5	95	Y
6	Cherries, sweet	(-1)-(-0.5)	90-95	N

7	Cucumbers	10-13	95	Y
8	Citrus	1-3	95	Y
9	Nectarines	(-0.5)-0	95	Y
10	Peaches	(-0.5)-0	90-95	Y
11	Pears	0	90-95	Y
12	Peppers, bell	7-13	90-95	Y
13	Plums	0	90-95	Y
14	Raspberries	0	90-95	Y
15	Strawberries	0	90-95	N
16	Tomatoes	16-20	90-95	Y

Table no.1

(Source: ASHRAE Handbook/Scientific papers)

iii. **Hydro-Cooling (HC):**

This technique involves submerging the product in chilled water or water-ice slurry. The high thermal conductivity of water facilitates rapid heat transfer, making it suitable for leafy greens and vegetables with high water content.

➤ **Technical Considerations:**

- Design of efficient water chilling systems using refrigeration compressors or ice builders.
- Sanitation protocols to minimize the risk of microbial contamination during the hydro-cooling process.
- Drying mechanisms to remove excess surface moisture after hydro-cooling to prevent product decay.

Types of Hydro Coolers:

a) Shower/Batch Type:

In the shower or batch type hydro cooler, water is showered over the commodity, which may be contained in bins, boxes, or conveyed on a perforated conveyor belt. Typically, the crop is transported on the conveyor belt at a speed adjusted to the required cooling time, while cold water is pumped from a tank and allowed to fall onto the produce in a sprinkled manner. The water then drains through the perforations into a tank below, where it is filtered, recycled, and re-cooled. Efficient cooling relies on ensuring adequate water flow over the product surface. For products in bins or boxes, water flow rates of 75-100 liters per minute per square foot (400-600 liters per minute per square meter) of surface area are commonly used.

b) Immersion Type:

The immersion type hydro cooler is the simplest form, where produce is immersed in cold water. This method is most suitable for bulk products that do not float, as they come into direct contact with the cold water while moving through a long tank. Immersion hydro coolers convey the product against the direction of water flow and often include a system for agitating the water to enhance cooling efficiency. The depth of the water tank should be at least 30 centimeters, and water tends to penetrate inside fruits, particularly hollow ones such as peppers. Water temperature also plays a

role in infiltration, with it being recommended that the fruit temperature is at least 5°C lower than the liquid. Examples of products suited for immersion hydro cooling include radishes, asparagus, artichokes, green onions, capsicum, and leafy vegetables.

iv. Top Icing:

Top icing, an age-old method for reducing field temperature, is commonly employed by placing a layer of crushed ice directly on top of produce boxes. Alternatively, an "ice slurry" composed of 60% finely crushed ice, 40% water, and 0.1% sodium chloride can be utilized to lower the ice's melting point. Ice slurry, offering greater contact between the produce and ice compared to traditional top icing, results in faster cooling. Primarily utilized for road transport, top icing can be applied shortly after harvest. When applying top ice on loads, it's advisable to do so in rows rather than forming a solid mass to prevent blocking air circulation within the transport vehicle. Ratios of water to ice may vary from 1:1 to 1:4. Initially, direct contact between the produce and ice facilitates rapid conduction cooling. However, as the ice melts, an air space forms between the ice and produce, halting conduction cooling. Subsequent cooling occurs through slower processes of radiation and convection.

v. Vacuum Cooling:

Vacuum cooling is a method used in precooling units to rapidly reduce the temperature of fresh produce, extending its shelf life and preserving quality. This process involves placing the produce in a sealed chamber and lowering the air pressure, causing water inside the produce to evaporate quickly. The evaporation process absorbs heat from the produce, leading to rapid cooling. This method is particularly effective for leafy vegetables and other high-moisture content items. Vacuum cooling is valued for its efficiency and ability to uniformly cool large quantities of produce without the need for direct contact with cooling agents, reducing the risk of contamination and maintaining the produce's structural integrity.

vi. Evaporative Cooling (EC):

This technique combines FAC with water evaporation. Air is passed over moistened pads, causing evaporative cooling that reduces air temperature while maintaining a higher humidity level. EC is suitable for products sensitive to drying.

Physiological Effects of Temperature on Perishables:

The metabolic rate of fruits, vegetables, and meats is highly temperature-dependent. Higher temperatures accelerate respiration, a series of biochemical reactions that convert sugars to energy. This process leads to several detrimental effects:

- **Enhanced Enzymatic Activity:** Enzymes responsible for ripening and senescence processes become more active at elevated temperatures. This results in faster softening, discoloration, and loss of flavor and texture.
- **Increased Moisture Loss:** Higher temperatures elevate the vapor pressure deficit, causing increased transpiration and weight loss through wilting.
- **Microbial Growth:** Warm environments promote the proliferation of bacteria, mold, and fungi, accelerating spoilage.

Pre-cooling rapidly reduces product temperature, thereby:

- **Decreasing Respiration Rate:** Slower respiration translates to reduced enzymatic activity, preserving product quality and extending shelf life.
- **Minimizing Moisture Loss:** Lower temperatures decrease the vapor pressure deficit, reducing transpiration and maintaining product weight.
- **Inhibiting Microbial Growth:** Cold temperatures create an unfavorable environment for microbial activity, minimizing spoilage.

SUBSIDY COMPONENTS DETAIL:

COMPONENT NO.	DESCRIPTION & NAME	CAPACITY/ UNITS/ SIZES	COST NORM
C-4	Pre-cooling unit: Integrated Packhouse	Max. 3 MT	Rs. 5 lakh/ MT
	Collection & Aggregation Centre	Max. 6 MT Min. 3 MT	
	Cold Stores (<3000 MT)	Max. 6 MT	
	Cold Stores(>3000 MT)	Max. 12 MT (2 x 6MT)	

Table no. 2

***Precoolers (Forced Air Cooling)** are subject to requirement and depending upon the produce which require precooling. It would be allowed after thorough justification in case where pre-coolers are asked as a component along with cold storages/integrated packhouse/collection & aggregation centre.

Any research-based govt. organization/centres working on post-harvest losses and to study effect of pre-coolers on fruits and vegetables can avail benefit of Precoolers upto max. 3 MT/ Project.

VACUUM COOLING

To promote technology interventions, precooling by the method of vacuum cooling of horticultural produce can be availed upto max. 6 MT for private organizations in Integrated Packhouse/ Collection & Aggregation Centre under the component pre-cooling unit.

To promote technology interventions, precooling by the method of vacuum cooling of horticultural produce can be availed upto max. of 3 MT capacity by Govt./Autonomous Research Organization per Project. However, proper detailed justification of horticulture produce where vacuum cooling is desired needs to be submitted.

Applicant can opt either vacuum cooling or Forced Air Cooling while availing benefit for pre-cooling unit under Integrated Packhouse or Collection & Aggregation Centre. The applicable cost norm and conditions remain same.

The applicant needs to fill the annexure VII at the end of the book in case they are opting for Vacuum Cooling instead of Forced Air Cooling.

Remarks/Recommendation:

Pre-cooling units are a critical technology within packhouse facilities, playing a vital role in preserving the quality and extending the shelf life of perishable goods. By understanding the physiological effects of temperature on perishables and the technical aspects of various pre-cooling technologies, cold storage operators can make informed decisions about selecting and integrating the most suitable pre-cooling unit for their specific needs.

Precoolers when not in use can be used as normal cold storages with augmented storage capacity. For e.g. 1 MT of precooling capacity, can store appx. 6 MT of produce when being used as a cold store. It is important that these modifications should be used with automation like compressor capacity control, microprocessors, etc. controlling air flows, as required to ensure energy efficiency.

Additionally following points may be considered:

- **Energy Efficiency:** Pre-cooling units can consume significant amounts of energy. Optimizing system design, utilizing energy-efficient components, and implementing proper control strategies can minimize energy consumption.
- **Maintenance:** Regular maintenance of pre-cooling units is crucial for ensuring optimal performance and longevity. This includes cleaning coils, maintaining water quality in hydro-cooling systems, and servicing refrigeration equipment.
- **Emerging Technologies:** New pre-cooling technologies are constantly being developed. Facilities should stay updated on advancements and the use of natural refrigerants to improve efficiency and sustainability.
- **Use of Energy efficient and low GWP refrigerants is important.**

By implementing effective pre-cooling strategies and continuously optimizing their systems, Farmers, FPOs, Growers, etc. can ensure the freshness and quality of perishable products throughout the supply chain, minimizing losses and maximizing profits.

NOTE/ESSENTIALS:

- i. **This component can be availed through both NHM & NHB.**
- ii. **All mandatory rules and regulations (BIS, ISO, IS, MNRE, etc.) relevant to the item must be complied with.**
- iii. **In conventional storage, Refrigerants having potential for Ozone Depletion# and GWP ranging more than 1500 (like R22, R404A etc.) are not allowed for temperature range 0° C and above.**

- iv. **Use of inverter compressor / Digital compressor/ compressors with capacity control with choice of refrigerants as described above should also be considered to promote energy efficiency and sustainable development.**

ODP is Ozone Depletion and GWP signifies Global Warming Potential

*Pre-cooling is a specialized process and can be availed as per the list of produce attached in this. The applicant needs to justify how they intend to use the pre-cooler and why is it necessary to use a pre-cooler for produce specified.

*For precooling where vacuum cooling is availed instead of forced air cooling Annexure VII needs to be submitted along with the application/Project report.



9. COLD ROOM TRANSIT

The transit cold room (previously known as Cold Room Staging) is used for storage of produce with required temperature and humidity conditions either in a packhouse, Collection & aggregation centre or along with Farm Gate Packhouse. These cold storages are the initial points in the cold chain used to enhance shelf life, protect the quality, etc. and vitally form the arrangement before transit to markets, or distribution centres or to retail, etc. These cold rooms are defined as transit cold rooms since they play role very immediately after the harvest and before the transit actually begins. These are used as short term storages.

Rationale: In order to promote the integration of various post harvest components, augment the supply chain of fruits and vegetables and other produces etc. which require cold chain from the point of harvest upto consumption. To enhance shelf life, quality and to reduce post harvest losses in the initial phase the scheme of things have been formulated to encourage cold chain from the farm point and simultaneously to integrate the whole system with the consumers, markets, etc. The stop over points like integrated packhouse, aggregation centres, are also introduced to allow farmers, growers, FPOs, etc. to channelize their produce through these setups maintaining cold chain throughout till it reaches the end point of distribution.

The idea is to enhance linkages both forward and backward as well as promote multi directional output through these setups. To further promote sustainability, climate, use of refrigerants which are environment friendly, energy reduction and energy efficiency, modernization various types of options have been incorporated under the transit cold storages which can be chosen as per requirement.

Minimum Standards to follow and details:

- **Nomenclature:** The applicant needs to understand the nomenclature and choose the right nomenclature to allow identification of the produce, technology, type, etc. This allows NCCD and various other departments to map various technologies that are being employed.

Nomenclature:

- **S-1/S-2/S-3** defines the Capacity and Type of Transit Cold Storage
- **I F/II F/III F/IV F/I Vg/ II Vg/III Vg/IV Vg** defines type of commodity
- **F/IP/AC/R** define Farm Gate Packhouse/ Integrated Pack house/ Collection & Aggregation Centre/Ripening chamber
- **H/C/S/TS/B** defines Hybrid/Conventional/Solar based system/Thermal Storage/Bio-mass
- **SREF/NREF** defines Synthetic refrigerant or Natural refrigerant used
- **-PCM** if PCM material is used

e.g.- S-1/I Vg/P/H-PCM

Classification:

1. **Type S-1:** 10 MT to 30 MT Capacity

Type S-2: 30 MT to 100 MT Capacity

Type S-3: Ripening Chambers- In the multiples of 10MT or 15 MT (Max. capacity as per MIDH /NHB norms) This nomenclature is applicable when Ripening chambers are installed with solar based photovoltaic system/ bio-mass/ thermal storage system.

(Refer guidelines under chapter no.20- Ripening Chambers)

- F/IP/AC/R/T defines Farm Handling Unit/ Integrated Pack house/ Collection & Aggregation Centre/Ripening chamber/Transit cold room at Farm gate
- S/H/C/TS/B defines Solar based system /Hybrid/Conventional /Thermal Storage/Bio-mass

S stands for Solar based system: A thermally insulated environmental chamber of suitable capacity with appropriate control electronics used for long-term storing agriculture produces powered by Solar Energy. Solar Photo Voltaic Module Array consists of suitable number of same type/ identical, model and almost equal capacity PV Modules connected in series and parallel to generates the required DC electrical energy. It also consists of controllers, microcontrollers, auxiliary batteries, and necessary software.

H stands for hybrid: These kinds of cold stores have both the option to run on available solar based power and on grid electricity when solar power is unavailable.

C stands for Conventional: These cold storages are usual conventional storages running solely on grid electricity.

TS stands for Thermal Storage: The electrical energy from the grid powers the compressor to generate cooling. The cooling generated from the refrigeration system is stored in the thermal energy storage in phase change material (PCM). The thermal energy storage can simultaneously charge and provide cooling in the cold room. During a power cut the thermal energy storage can provide cooling inside the cold storage to maintain the temperature. There is a small battery bank to run the auxiliary components of the system such as system controls, evaporator fans, pumps, etc.

B stands for Bio-mass: The system uses agricultural waste (biomass) to power the refrigeration process, making it an eco-friendly and cost-effective solution for post-harvest storage. Unlike the vapour compression cycle, no compressor is used. The compressor is replaced by a three-step process achieved by the adsorber/absorption, and the desorber. The operation of vapour adsorption cycle is based on the ability of porous solids (the adsorbent) to adsorb vapour (refrigerant) when at low temperature, and to desorb it when heated. The hot water that drives the adsorption cycle is produced by the combustion of biomass in the hot water generator or utilizing other heat generating sources.

- **PCM/SREF/NREF defines PCM, Synthetic refrigerant, Natural refrigerant:** This refers to use of medium like Phase Change Materials, Synthetic refrigerants or Natural Refrigerants as heat transfer medium to achieve desired cooling effect.

2. Capacity: These “Cold Room Transit” are of capacities as shown in the table below:

S. No.	Description	Max. allowed capacity
1	Farmgate Standalone cold room in multiple of 10 MT (available as add-on with Farm Gate Packhouse)	10 MT
2	Cold Room Transit in Integrated Packhouse in multiple of 15 MT	30 MT
3	Cold Room Transit in Collection & Aggregation center in multiple of 15 MT	60 MT

4	Standalone Cold Room Transit in multiples of 15 MT	30 MT

Under S. No. 4 (above) can be availed as a Standalone Cold Room as per following norms:

COMPONENT NO.	AVAILABLE OPTIONS	CAPACITY	COST NORM
C-6	Cold Room Transit (Option I) Decentralised cold storages based on solar technologies or hybrid running on batteries, solar PV panels, microcontrollers, etc. along with ante rooms, Thermal storages(all kinds), insulation, doors, necessary civil work and refrigeration systems. Refer Chapter No. 10 for details	Max. 30 MT (2 chambers of 15 MT)	Rs. 26 lakh/chamber
	Cold Room Transit (Option II) In case of cold rooms based on Thermal storage type where electric energy is available for 8 hrs/day(No DG Sets are allowed)	Max. 30 MT (2 chambers of 15 MT)	Rs. 15 lakh/chamber
	Cold Room Transit (Option III) The cold room transit are conventional cold rooms working on conventional refrigerants with ante rooms, insulation, doors necessary inside civil work and refrigeration systems. Refer Chapter No. 9 for details	Max. 30 MT (2 chambers of 15 MT)	Rs. 7.5 lakh/chamber

It would be preferred to run these transit cold stores either on DRE technology (De-centralised Renewable Energy) or Hybrid mode or thermal storage type or conventional cold rooms. The subsidy applicable would be as per prevalent norms. This chapter delves into the technical aspects of a transit cold room, outlining its components, considerations, and dependencies.

Farmgate Standalone Cold Room:

- The nomenclature defined above needs to be filled for the purpose of classification.
- The Farmgate Standalone cold room are storage room installed on farms alongwith Farm Handling Unit.
- Calculation of the room sizes in both the cases would be 3.4 cu. m/MT.
- The maximum allowable height is appx. 3 m.

- v. The standalone cold room needs to be installed on a raised platform which does not allow rainwater, etc. to enter the cold room when installed in open. Ensure factors like wind, storms, lightning, thunderstorms, hail, heavy rains, snow, etc. in your safety designs and optimum care has to be taken on these factors to protect the standalone cold room from these hazards. Earthing pits, Earthing, Lighting arrestors need to be installed to ensure safety from electric hazards and protection against fire, etc. Help of licensed structural/civil engineer should be taken and the design shall meet the BIS standards and relevant seismic zone norms for earthquake proof design.
- vi. The maximum capacity allowed is 10 MT single chamber.
- vii. **RATIONALE:** In order to optimise the cost of solar PV panels the rationale is to store appx 20-30% per day of the total capacity and maximum for 2.5 days. These stores are majorly going to store leftover produce at the farms it is suggested that since these are used for minimising farm losses and provide support to farmers so that the produce is not wasted until it reaches either the market or the integrated packhouse or aggregation centre. The temperature slide from harvest time upto the required temperature and humidity should be optimized by achieving temperature conditions upto 70-75% of the required temperature on day 1 and in case of holding it due to any reasons the remaining required temperature pull down should be attained. The humidity in all possibilities should be achieved and maintained throughout the time of storage into these farm gate cold storages. It is though advisable to not hold the produce at the farms for more than 1 day. It is also recommended that the produce should be shifted and transferred to markets and other cold chain centres through GPS enabled, temperature controlled small reefer vans to maintain the cold supply chain.

Cold Room Transit in Integrated Packhouse:

- i. The nomenclature defined above needs to be filled for the purpose of classification.
- ii. Cold Room Transit in Integrated Packhouse are storage room installed on inside Integrated Packhouse (IP).
- iii. The maximum allowable height is appx. 3.8 m from the finished inside floor of the chamber.
- iv. Calculation of the room sizes with mezzanine, boxes, crates would be 3.4 cu. m/MT.
- v. Calculation of the room sizes with racks, palletization would be 5.4 cu. m/MT.
- vi. The maximum capacity allowed is 30 MT with configuration of 15 MT single chamber or 15 MT x 2 no.s chambers
- vii. The Cold Room Transit in Integrated Packhouse needs to be installed on a raised platform which does not allow water, etc. to enter the cold room when installed in the packhouse. Ensure factors like wind, storms, lightning, thunderstorms, etc. in your safety designs and optimum care has to be taken on these factors to protect the cold room from these hazards. Earthing pits, Earthing, Lighting arrestors need to be installed to ensure safety from electric hazards and protection against fire, etc. Help of licensed structural/civil engineer should be taken in designing the packhouse building and ensure factors like wind, storms, lightning, thunderstorms, hail, heavy rains, snow, etc. in your safety designs for designing the packhouse building and the structure(PEB, etc.). The design shall meet the BIS standards and relevant seismic zone norms for earthquake proof design.
- viii. **RATIONALE:** In order to optimise the cost of solar PV panels the rationale is to store appx 20-30% per day of the total capacity and maximum for 2.5 days. These stores are majorly going to

store leftover produce at the farms it is suggested that since these are used for minimising farm losses and provide support to farmers so that the produce is not wasted until it reaches either the market or aggregation centre or distribution centre. The temperature slide from harvest time upto the required temperature and humidity should be optimized by achieving temperature conditions upto 70-75% of the required temperature on day 1 and in case of holding it due to any reasons the remaining required temperature pull down should be attained. The humidity in all possibilities should be achieved and maintained throughout the time of storage into these farm gate cold storages. It is though advisable to not hold the produce at the packhouses for more than recommended days. In case other technologies like thermal storage, conventional cold storages are used the pattern of pulldown and throughput would increase and proper care should be given to basis of design while setting up these kinds of facilities. It is also recommended that the produce should be shifted and transferred to markets and other cold chain centres through GPS enabled, temperature controlled small reefer vans to maintain the cold supply chain.

Cold Room Transit in Aggregation Centre:

- i. The nomenclature defined above needs to be filled for the purpose of classification.
- ii. Cold Room Transit in Aggregation Centre are storage room installed on inside the Aggregation Centre.
- iii. The maximum allowable height is appx. 3.8 m from the finished inside floor of the chamber.
- iv. Calculation of the room sizes with mezzanine, boxes, crates would be 3.4 cu. m/MT.
- v. Calculation of the room sizes with racks, palletization would be 5.4 cu. m/MT.
- vi. The maximum capacity allowed is 60 MT with configuration of 15 MT x 4 no.s chambers or min. Capacity of 45 MT with configuration of 15 MT x 3 no.s chambers
- vii. The Cold Room Transit in Aggregation Centre needs to be installed on a raised platform which does not allow water, etc. to enter the cold room when installed in the Aggregation Centre. Ensure factors like wind, storms, lightning, thunderstorms, etc. in your safety designs and optimum care has to be taken on these factors to protect the cold room from these hazards. Earthing pits, Earthing, Lighting arrestors need to be installed to ensure safety from electric hazards and protection against fire, etc. Help of licensed structural/civil engineer should be taken in designing the centre building and ensure factors like wind, storms, lightning, thunderstorms, hail, heavy rains, snow, etc. in your safety designs for designing the centre building and the structure(PEB, etc.). The design shall meet the BIS standards and relevant seismic zone norms for earthquake proof design.
- viii. **RATIONALE:** In order to optimise the cost of solar PV panels the rationale is to store appx 20-30% per day of the total capacity and maximum for 2.5 days. These stores are majorly going to store leftover produce at the farms it is suggested that since these are used for minimising farm losses and provide support to farmers so that the produce is not wasted until it reaches either the market or distribution centre. The temperature slide from harvest time upto the required temperature and humidity should be optimized by achieving temperature conditions upto 70-75% of the required temperature on day 1 and in case of holding it due to any reasons the remaining required temperature pull down should be attained. The humidity in all possibilities should be achieved and maintained throughout the time of storage into these farm gate cold storages. It is though advisable to not hold the produce at the Aggregation Centre for more than recommended days. In case other technologies like thermal storage, conventional cold storages are used the pattern of pulldown and throughput would increase and proper care should be given to basis of design while setting up these kinds of facilities. It is also

recommended that the produce should be shifted and transferred to markets and other cold chain centres through GPS enabled, temperature controlled small reefer vans to maintain the cold supply chain.

WHAT TO DO AND FOLLOW - Read Carefully

The component "Cold Room Transit" comprises:

- 1) **Insulated Room:** The transit cold room insulation should be PUF/PIR/VIP (excluding EPS) or any other new environment friendly insulating material of thickness min 100 mm. sandwiched in either pre-painted GI(0.45 mm Min. thickness) or SS(food grade SS-306) sheets. The height of the cold room is restricted between 3.8 m or 3 m as applicable.
- 2) Civil works involve the construction of 1.06 Mtr finish floor level raised platform. The finished floor should be kota stone/ epoxy or any other finished floor type. A proper level needs to be maintained inside the packhouse (IP) with drainage system for dispensing water.
- 3) The floor in the transit cold rooms should be of base concrete, with kota stone/ epoxy or any other finished floor type inside the floor chambers. Floor insulation slab preferably XPS (EPS not allowed) laid in two layers. The Floor should be cleaned, painted with black Japan paint and then laid with 1st layer of vapour barrier which can be either 250 microns tarfelt sheet or polythene sheet of suitable thickness. The vapour barrier should be covered with 1st layer of insulation and overlaid with 2nd layer of insulation in a manner to cut the gaps in the first layer of insulation. The joints can be filled with suitable hot grade bitumen (80:25). The 2nd layer of insulation is then covered with 2nd layer of vapour barrier which would be upto 1 mm thick tar felt or poly felt sheets with 5 mm overlap on the walls.
- 4) The laying of Trimix should be 75 MM to 100 MM thickness with any suitable finish like kota stone, epoxy etc. and anti skid tapping. The floor level of the cold storage should match the floor level of the Integrated packhouse (IP) for easy movement of material as well as MHEs. In case of raised floor levels a suitable graded ramp to be either fixed or made outside the door for mechanised movement of the goods.
- 5) The Cold Room should be installed in such a way that small HPTs/BOPTs can be used to load/un-load the material mechanically.
- 6) The insulated door should be either overlap or inline or sliding but of the same thickness as that of the panel with a view window on the door properly fitted alongwith heater for anti-condensation on the glass. The door should be fitted with strip curtains form inside with 0.5 mm overlap from SS hooks or hangers.
- 7) **Associated Refrigeration Equipment:** This includes the refrigeration system necessary to maintain the desired temperature within the transit cold storage and cold room transit (staging).

- 8) The specific equipment selection (compressors, condensers, evaporators) will depend on factors like target temperature, desired cooling rate, and ambient conditions. This is the core component responsible for removing heat from the product. The transit cold room refrigeration unit normally is a ceiling suspended which allows movement of cold moist air within the stacked produce uniformly and rapidly.
- 9) The units should be designed with good air flow (not less than 50-80 cfm per ton of storage, and air throw designed upto the length of the room, the fan grill designed in such a way that it allows air to escape in all the direction at the outlet of the fan to create uniform air movement).
- 10) Electronic expansion valves (wherever necessary) should be used to control the temp difference between the refrigerant inlet temp and the coil temperature so as to maintain optimum and required humidity inside the chamber electronically.
- 11) Keeping in view the sustainable development the selection of refrigerant should be done carefully and importantly those refrigerants with low GWP and ODP should be used.
- 12) In conventional storage, Refrigerants having potential for Ozone Depletion# and GWP ranging more than 1500 (like R22, R404A etc.) are not allowed for temperature range 0° C and above. The selection of the type of the compressor should be done with care depending upon the capacity of the compressor at the desired conditions it has to achieve, its working envelope, and serviceability should be kept in mind while choosing the desired unit.
- 13) Inverter compressors / digital compressors / compressors with capacity control which allows optimization of capacity as required thereby lowering the energy cycle cost are encouraged and preferred.
- 14) The condensing unit/ condensers/ heat exchangers should be designed with the proper refrigeration capacity with safety factors and keeping in view the ambient conditions, condensing temperature in case air cooled condensers are used.
- 15) Wherever possible and depending upon the wet bulb approach either water cooled condensers or air cooled condensers with adiabatic cooling should be used to augment the refrigeration capacity and help in reducing the energy costs thereby promoting sustainable development in the cold chain sector.
- 16) In some configurations, an additional ante-room might be incorporated before these transit cold rooms. This creates a multi-stage buffer zone, further minimizing temperature fluctuations within the main cold room. The ante rooms are basically insulated rooms- min. 60 mm PUF insulation, floor insulation to be done same way as cold rooms with insulated doors of any type- inline, overlap, sliding. The ante room should allow the door opening of the transit cold rooms within the ante room with sufficient movement within to allow goods movement through MHEs (HPT, BOPT, etc.) without hindering opening of staging cold room doors. The ante rooms can also be installed with refrigeration unit optionally to prevent thermal shock to the produce during loading and unloading.
- 17) Material handling is defined as those equipments which allow movement of product/produce within the warehouse/packhouse. These equipments are essential in terms of allowing the

produce to move rapidly and compliment the stacking elements like shelves, racks, bins, pallets to allow maximum storage capacity, faster product access, and allow scientific inventory control.

Integration and Dependencies:

While the cold room transit component is offered as a component, its functionality majorly depends upon its integration with a pre-cooling unit, modern and advanced grading, packing lines, docking areas, MHEs, markets and other consumer centres and makes it a very vital element in the integrated packhouse or aggregation centres.

Design Considerations:

The design specifications for cold room transit areas are similar to those of cold storage facilities. However, the refrigeration system design needs to be tailored to maintain specific humidity and temperature ranges suitable for storing horticultural produce.

- **Humidity Control:** Maintaining optimal humidity levels within the cold room transit is crucial to prevent moisture loss and wilting of fruits and vegetables. Humidification systems may be integrated into the refrigeration design.
- **Temperature Control:** The target temperature range for the cold room transit will depend on the specific produce being stored. However, it should generally be slightly higher than the main cold storage area to minimize temperature fluctuations upon access.

NOTE/ESSENTIALS:

- i. This component can be availed through both NHM & NHB.
- ii. All mandatory rules and regulations (BIS, ISO, IS, MNRE, etc.) relevant to the item must be complied with.
- iii. This is a reference chapter for Cold Room Transit. This chapter details the guidelines & standards for establishing Transit type cold rooms at Farmgate (either with Farmgate packhouse or standalone), Integrated Packhouse, Collection Aggregation Centre and Standalone, Cold room Transit. The details and minimum and maximum capacities to be installed have been defined at relevant places in respective chapters.
- iv. In conventional storage, Refrigerants having potential for Ozone Depletion# and GWP ranging more than 1500 (like R22, R404A etc.) are not allowed for temperature range 0° C and above.
- v. Use of inverter compressor / Digital compressor/ compressors with capacity control with choice of refrigerants as described above should also be considered to promote energy efficiency and sustainable development.
- vi. Under farm gate packhouse only 10 MT cold storage per project is allowed as an add-on component. (refer to chapter no. 5 - Farm Gate Packhouse)
- vii. Under Cold Room Staging (C-6), BIO-MASS Technology is also applicable for subsidy. Under this component Max. 30 MT capacity in multiple of 15 MT is allowed. For BIO-MASS Technology cost norm of Rs. 14 lakh per chamber of 15 MT is applicable. For BIO-MASS Refer chapter no. 11.

ODP is Ozone Depletion and GWP signifies Global Warming Potential

10. SOLAR BASED COLD STORAGE

In areas lacking grid access or facing frequent outages, maintaining a cool environment for perishables poses a significant challenge. Off-grid cold storage systems powered by solar energy offer a robust and technically sophisticated solution. This chapter delves into the intricate workings, components, and design considerations for such systems.

The Solar-Powered Advantage:

Off-grid cold storage systems leverage the photovoltaic effect. Sunlight striking the solar panels excites electrons within their semiconducting material, generating direct current (DC) electricity. This DC power needs further processing for integration with the system.

- **Energy Independence:** Unlike grid-dependent systems, off-grid solutions rely solely on the captured solar energy. This ensures uninterrupted operation even during power outages, crucial for maintaining consistent cool temperatures. This should provide autonomy for 2-3 days of full operations.
- **Sustainability:** By harnessing a renewable resource like sunlight, these systems minimize reliance on fossil fuels for electricity generation. This translates to a reduced carbon footprint and aligns with environmentally conscious practices.
- **Reduced Long-Term Costs:** While the initial investment for a solar-powered system can be higher, the long-term savings from solar energy generation are substantial. Over time, these savings offset the initial expenses, making them a cost-effective solution in the long run.



Key Components and Their Technical Specifications

A well-designed off-grid solar-powered cold storage system comprises several critical components, each playing a vital role:

1. **Solar Panels:** These panels are typically made of monocrystalline or polycrystalline silicon. They come in various wattages, with higher wattage panels offering increased energy output per unit area. The system design considers factors like solar irradiance levels in the specific location to determine the number of panels required. The Solar Cold Storages should incorporate PV (Photovoltaic) Array of 4 KWp to 12KWp.
2. **Solar Charge Controller:** This intelligent device plays a crucial role in regulating the charging process for the battery bank. It prevents overcharging, which can damage batteries and shorten their lifespan. Maximum Power Point Tracking (MPPT) controllers are preferred, as they optimize power output from the solar panels under varying weather conditions. This should work with high efficiency (above 95%)
3. **Battery Bank:** Deep-cycle batteries, typically lead-acid or lithium-ion, are used for energy storage. Their capacity (Amp-hours) determines the amount of energy they can store and for how long they can power the refrigeration unit during periods of low solar generation. Battery selection considers factors like depth of discharge (DoD) - the usable portion of the battery's capacity - and ambient temperature, which can impact battery performance. This should be designed for 2-3 days of autonomy.
4. **Inverter:** This device converts the stored DC battery power into AC electricity usable by the refrigeration unit. Selection criteria include inverter efficiency, output power rating to meet the refrigeration unit's peak demand, and pure sine wave output for compatibility with sensitive equipment.
5. **Refrigeration Unit:** High-efficiency, DC-powered refrigeration units are specifically designed for off-grid cold storage systems. They utilize technologies like variable speed compressors and efficient evaporator and condenser coils to minimize energy consumption.
6. **Thermal Mass (Optional):** In some systems, a thermal mass like large water tanks can be integrated for additional cooling storage capacity. This stored coolness can help supplement the refrigeration unit during peak cooling demand periods. The thermal mass material's specific heat capacity and the tank's size determine its effectiveness.
7. **Thermal Energy Storage:** Several thermal energy storage (TES) technologies can be integrated into off-grid cold storage systems:
 - **Phase Change Materials (PCMs):** These specialized materials absorb and release heat during phase transitions (solid to liquid or vice versa). PCMs can be incorporated into panels within the cold room walls or integrated into a separate storage tank. The selection of PCMs considers the desired operating temperature range for the cold storage.
 - **Chilled Water Storage:** Large, insulated water tanks are used to store cool water generated by the refrigeration unit during off-peak periods. This chilled water can then be

circulated through the cold room during peak cooling demand periods, reducing the load on the refrigeration unit.

- **Ice Slurry Storage:** In this method, a mixture of water and ice is stored in a tank. The ice slurry provides a high cooling capacity due to the latent heat of fusion of ice. This option is particularly suitable for applications requiring very low storage temperatures.

The optimal TES technology selection depends on factors like the desired storage temperature range, available space, and system budget.

System Design and Considerations

Designing an off-grid cold storage system requires careful consideration of various technical factors to achieve optimal performance and efficiency.

- **Storage Capacity and Cooling Load:** Off-grid cold storage systems powered by solar energy are particularly well-suited for remote locations lacking reliable grid access, the cold stores may be setup in this regard upto 10 MT running fully on solar and upto 60 MT running in hybrid mode.
- **Insulation:** The size and thermal insulation quality of the cold room significantly impact the required cooling power. Higher insulation R-values reduce heat transfer into the storage space, lowering the cooling load. Generally, PUF panels of 100 mm or equivalent is used.
- **Energy Consumption and System Sizing:** The refrigeration unit's energy consumption (measured in Watt-hours per day) needs to be balanced with the solar panel output (Watt-hours per day) and battery storage capacity. This ensures the system can maintain desired temperatures throughout the day and night.
- **Local Climate and Solar Irradiation:** The amount of solar energy available in the specific location is crucial. Solar irradiance data, typically measured in peak sun hours per day, is used to determine the optimal number of solar panels required for sufficient energy generation. Exact values to be referred as per the guidelines published by MNRE.
- **Load Profile and Battery Bank Sizing:** Understanding the anticipated usage patterns, including peak cooling demand periods, is essential. This information helps determine the appropriate battery bank capacity to ensure enough energy storage is available during periods of low solar generation.

Sophisticated system design software can be employed to model energy consumption, battery bank behavior, and system performance under various operating conditions. Consulting with experienced solar system designers is highly recommended to ensure a system configuration tailored to your specific needs and location.

Benefits and Applications: A Real-World Impact

Off-grid solar-powered cold storage systems offer a multitude of advantages:

- **Reduced Food Spoilage:** Maintaining consistent cool temperatures extends the shelf life of fruits, vegetables and other perishables. This translates to significant economic benefits for:

- **Farmers:** Reduced post-harvest losses lead to higher profits and improved food security for local communities.
- **Retailers:** Fresher produce for a longer duration attracts customers and reduces spoilage costs.
- **Improved Efficiency and System Monitoring:** Modern off-grid cold storage systems often incorporate advanced monitoring systems. These systems track:
 - **Solar panel output:** Provides insights into energy generation and potential panel cleaning needs.
 - **Battery bank health:** Monitors battery voltage, current, and temperature, allowing for preventative maintenance and ensuring optimal performance.
 - **Refrigeration unit operation:** Tracks temperature within the cold room and alerts for any deviations, enabling prompt corrective action.
- **Remote System Management:** In some cases, these systems can be remotely managed through internet connectivity. This allows for:
 - **Real-time data access:** Enables monitoring and troubleshooting from a central location.
 - **System adjustments:** Remote control of temperature set points or configuration changes can be made if needed.

These advancements contribute to improved system efficiency, reduced maintenance costs, and faster response times to potential issues.

Conclusion

Off-grid solar-powered cold storage systems offer a reliable, sustainable, and cost-effective solution for preserving perishables in remote areas or locations with unreliable grid access. By harnessing the power of the sun and employing advanced technologies, these systems can play a significant role in:

- **Reducing Food Spoilage:** Contributing to global food security and minimizing food waste.
- **Empowering Local Communities:** Enabling farmers, businesses, and healthcare providers to operate more effectively in remote locations.
- **Promoting Environmental Sustainability:** Lowering reliance on fossil fuels and contributing to a cleaner environment.

As solar technology continues to evolve and system designs become more sophisticated, off-grid cold storage systems are poised to become an even more widespread and impactful solution for the future.

11. BIO- MASS

The efficient storage and preservation of agricultural produce is crucial for ensuring food security and reducing post-harvest losses. Traditional cold storage methods often rely on grid-connected electricity, which can be unreliable and costly, particularly in rural areas. Biomass-powered cold storage offers a sustainable and off-grid solution to address these challenges. This chapter explores the technical aspects of biomass-powered small cold stores at the farm gate level.



Biomass as a Sustainable Energy Source

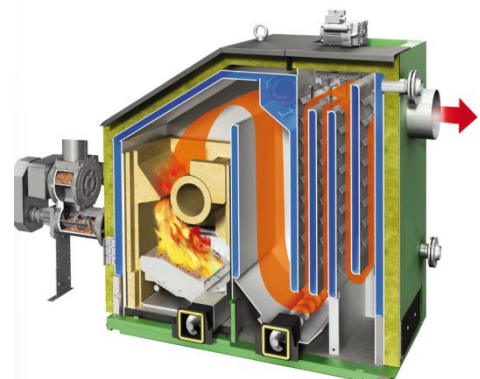
Biomass, derived from plant matter and agricultural residues, is a renewable energy source that can be converted into various forms of energy, including heat. When used to power cold storage units, biomass offers several advantages:

- **Sustainability:** Biomass is a renewable resource, reducing dependence on fossil fuels and contributing to a more sustainable energy future.
- **Carbon Neutrality:** The combustion of biomass releases carbon dioxide that was absorbed during plant growth, making it a carbon-neutral fuel source.
- **Reduced Reliance on Grid Electricity:** Biomass-powered cold stores can operate independently of the grid, providing energy security in regions with unreliable power supplies.
- **Local Resource Utilization:** Biomass can be sourced locally, reducing transportation costs and supporting local economies.

Components of a Biomass-Powered Cold Store

A typical biomass-powered cold store consists of the following components:

- **Biomass Burner:** This device converts biomass into heat energy through combustion. The burner can be designed to accommodate various types of biomass, including agricultural residues, wood chips, and pellets.
- **Heat Exchanger:** The heat generated by the burner is transferred to a heat exchanger, which heats a refrigerant.
- **Refrigeration System:** The heated refrigerant is circulated through the refrigeration system to cool the storage chamber.

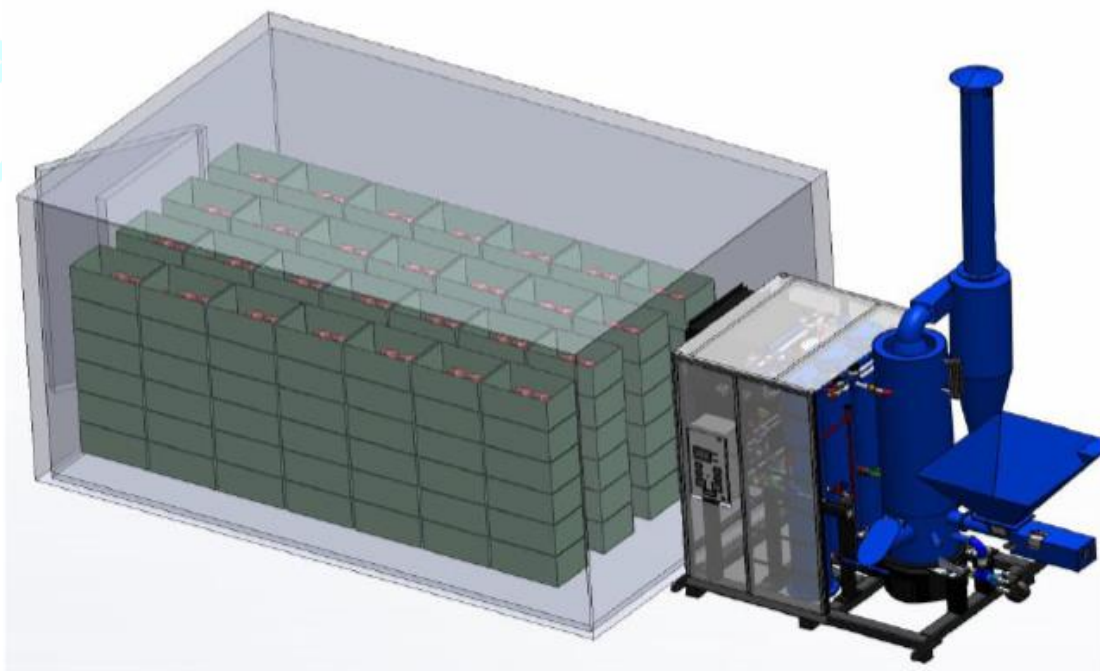


- **Cold Storage Chamber:** The insulated chamber provides a controlled environment for storing perishable products.
- **Control System:** A control system regulates the temperature and humidity within the storage chamber, ensuring optimal conditions for product preservation.

Technical Considerations

Several technical factors must be considered when designing and implementing a biomass-powered cold store:

- **Biomass Quality and Moisture Content:** The quality and moisture content of the biomass used can significantly impact the efficiency of the combustion process. High moisture content can reduce the calorific value of the biomass and increase emissions.
- **Burner Efficiency:** The efficiency of the biomass burner determines the amount of heat generated per unit of biomass consumed. Advanced burner technologies can improve efficiency and reduce emissions.
- **Refrigeration System Design:** The refrigeration system must be selected based on the desired temperature range and the specific requirements of the stored products.
- **Insulation:** Adequate insulation of the storage chamber is essential to minimize heat loss and reduce energy consumption.
- **Emission Control:** Measures should be taken to control emissions from the biomass burner, such as installing emission reduction equipment or using low-emission burner technologies.



Benefits of Biomass-Powered Cold Stores

Biomass-powered cold stores offer several benefits for farmers and communities:

- **Reduced Post-Harvest Losses:** By providing reliable cold storage facilities, biomass-powered cold stores can help reduce post-harvest losses and increase farmers' incomes.
- **Improved Product Quality:** Proper storage conditions can enhance the quality and shelf life of agricultural products.

- **Energy Independence:** Biomass-powered cold stores can reduce reliance on grid electricity, providing energy security and resilience.
- **Environmental Sustainability:** By utilizing a renewable energy source, biomass-powered cold stores contribute to a more sustainable and environmentally friendly agricultural sector.

Conclusion

Biomass-powered small cold stores at the farm gate level offer a promising solution for addressing the challenges of post-harvest losses and energy access in rural areas. By harnessing the power of biomass, these cold stores can provide a sustainable, efficient, and reliable means of preserving agricultural produce. As technology continues to advance, biomass-powered cold stores are likely to play an increasingly important role in supporting food security and rural development.



12. COLD STORAGE UNITS

Important Guidelines

Cold storage units are purpose-built facilities that utilize refrigeration systems and insulation to maintain precise temperature environments for the storage of perishable goods. These units play a critical role in minimizing spoilage and preserving the quality, safety, and freshness of a wider range of products across various industries.

A cold storage can be multi temperature and multi product storage for extending the shelf life of the harvested produce and can act as standalone storage or a distribution centre from where cold stored produce can be transported to further distribution destinations.

The Ministry of Agriculture & Farmers Welfare, Government of India, through its Missions for Integrated Development of Horticulture (MIDH) program, provides financial assistance in the form of subsidy for the construction and expansion of cold storage facilities. This program is routed through state horticulture depts. And the capacity is restricted upto 4999 MT ~ 5000 MT.

The Ministry of Agriculture & Farmers Welfare, Government of India, through its Post Harvest Management Program under National Horticulture Board (NHB), provides financial assistance in the form of back end subsidy for the construction and expansion of cold storage facilities. This program is routed through NHB and the min. capacity to apply under this scheme is above 5000 MT & is restricted upto 20000 MT.

- **National Horticulture Mission (NHM):** Approve projects with a capacity of **4,999 MT ~ 5000 MT (Metric Tons)** or less.
- **National Horticulture Board (NHB):** Approve projects from **5,000 MT** onwards capacity upto **20000 MT**.

Essentials of Cold Storage Setup and Operation: NHM

- For the purpose of guidelines under the NHM norms a beneficiary may apply for construction of new cold storage upto 4999 MT ~ 5000 MT as a new standalone project. Mission shall accept projects of capacity upto 4999 MT ~ 5000 MT and below but not less than 500 MT standalone.
- For the purpose of guidelines under the NHM norms a beneficiary may apply for construction of new Ripening Chamber upto max. 300 MT as a new standalone project. Mission shall accept projects of capacity upto 300 MT. This has been classified under CS-3. Refer chapter no. 14- RIPENING CHAMBERS.
- For the purpose of guidelines under the NHM norms a beneficiary may apply for Refrigerated Transport of load carrying capacity ranging from 4 MT to 14 MT. The details can be referred from chapter no. 22 - REFRIGERATED TRANSPORT.

Essentials of Cold Storage Setup and Operation: NHB

- For the purpose of guidelines under the NHB norms a beneficiary may apply for construction of new cold storage above 5001 MT upto 20000 MT as a new standalone project.
- For the purpose of guidelines under the NHB norms a beneficiary may apply for construction of new Ripening Chamber upto max. 300 MT as a new standalone project. Mission shall accept projects of capacity upto 300 MT. This has been classified under CS-3. Refer chapter no. 14- RIPENING CHAMBERS.
- For the purpose of guidelines under the NHB norms a beneficiary may apply for Refrigerated Transport of load carrying capacity above 15 MT. The details can be referred from chapter no. 22- REFRIGERATED TRANSPORT.

To cater to various types of produce and for the ease of application, norms and standards are to be used as mentioned below:

For standardization purposes, MIDH/NHB guidelines establish a conversion factor:

- **1 MT (Metric Ton) of storage capacity = 3.4 m³ (cubic meter) or 120 ft³ (cubic feet)** of temperature-controlled space, irrespective of the product stored when using mezzanine, boxes and crates.
- **1 MT (Metric Ton) of storage capacity = 5.0 m³ (cubic meter) or 176 ft³ (cubic feet)** of temperature-controlled space, irrespective of the product stored when using racks, shuttle racks, double deep racks & palletization.
- **1 MT (Metric Ton) of storage capacity = 4.4 m³ (cubic meter) or 155 ft³ (cubic feet)** of temperature-controlled space for storing apples. (applicable in CA stores)
- **1 MT (Metric Ton) of storage capacity = 4.0 m³ (cubic meter) or 141 ft³ (cubic feet)** of temperature-controlled space for Dry Spices/raisins.
- **1 MT (Metric Ton) of storage capacity = 11 m³ (cubic meter) or 390 ft³ (cubic feet)** of temperature-controlled space for Ripening chambers.
- **1 MT (Metric Ton) of storage capacity = 20 m³ (cubic meter) or 710 ft³ (cubic feet)** of temperature-controlled space for pre-coolers.

NOTE: The storage capacity, type of stores and other specification are to be taken from the detailed standards against each category.

- **Nomenclature:** The applications would be submitted as per the prescribed nomenclature and standards attached alongwith the basic data sheet prescribed under that nomenclature.

Cold storages types:

Nomenclature: CS-1/CS-1-Onion/CS-2/CS-2-CA/CS-3/CS-4/I F/II F/III F/IV Vg/II Vg/III Vg/IV Vg/S /N X/Y MT/MIDH/NHB- District

- CS-1/CS-1-Onion/CS-2/CS-2-CA/CS-3/CS-4 **defines the Type of Cold Storages.**
- I F/II F/III F/IV Vg/II Vg/III Vg/IV Vg/S **defines type of commodity (table follows)**
- N.. X.. where N denotes the number and X is the no. of chambers that would be installed by the applicant
- Y MT, Y is the total proposed capacity and MT is the unit of proposed capacity.
- R Z/Z-2, R is the refrigerant and Z is the type of the refrigerant used. Z-2 reflects secondary refrigerant if used.
- MIDH/NHB- District defines where the project is submitted and the District where the project is proposed to be installed.

For e.g.- CS-1/I F/N-4/4500 MT/R 717/MIDH- Gurgaon, etc.

Classification:

1. Cold Storage Unit Types and Alignment with Storage Needs

There are four primary categories of cold storage units, designed to address distinct storage requirements:

Definition: Cold Storage type –I (CS-1) are cold storages designed mostly for single product storage where bulk and long term storage is preferred. They are normally seen in brick and mortar structure, however, an applicant can also develop it under the pre-engineered building (PEB). It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas, loading docks, PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places.

Definition: Cold Storage type –I -Onion (CS-1- Onion) are cold storages designed for single product storages like Onion where bulk and long term storage is preferred. They are normally seen in brick and mortar structure, however, an applicant can also develop it under the pre-engineered building (PEB). It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas, PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places.

Definition: Cold Storage type –II (CS-2) are cold storages designed mostly for multi product storage where bulk, short and long term storage is preferred as required. They are normally seen in pre-engineered building and certain areas like docks, plant rooms, offices, convenience areas can be constructed with brick and mortar and integrated with the PEB. It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas, loading docks, PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places.

Definition: Controlled Atmosphere Storage type –II-CA (CS-2-CA) are cold storages designed for controlled atmosphere storage where bulk, short and long term storage is preferred as required. These storages should be equipped with all necessary equipments to maintain and monitor the required concentration of N₂, CO₂ and O₂ levels along with temp and humidity control. They are normally seen in pre-engineered building and certain areas like docks, plant rooms, offices, convenience areas can be constructed with brick and mortar and integrated with the PEB. It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas, loading docks, PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places.

Definition: Ripening Chamber type –III (CS-3) are cold storages designed mostly for ripening of fruits, etc. and are used for bringing in unripe produces into the chambers and ripened as per the protocol and dispatched to the further market for retail. They are normally seen in pre-engineered building (PEB), an applicant can also develop it under the brick and mortar structure with all necessary arrangement for cutting, washing, crating, docks, plant rooms/place for individual condensing units with good ventilation around, offices, convenience areas. It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits(in case the capacity exceeds 100 MT or the facility is larger one or integrated with some other cold storage of larger capacity (upto 4999 MT ~ 5000 MT and above) with use of any flammable material, refrigerant, electrical installations which are hazardous and flammable), plant room safety norms, environmental clearances, handling areas, loading docks, PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places. All the

plastic crates etc. should be handled with care and should not be stored in areas which are vulnerable to catch fire and can also cause damage to human life.

Definition: Cold Storage for Dry Spices/Raisins type –IV (CS-4) is cold storages designed mostly for dry spices, raisins and MFP. Storage where bulk and long-term storage is preferred. They are normally seen in brick and mortar structure; however, an applicant can also develop it under the pre-engineered building. It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas, loading docks, PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places.

2. The type of commodity to be selected from the following table:

FRUITS

TYPE- IF (upto 2°C)

Sl. No.	Products	Temp	Humidity	Holding Time
1	Apples	0-2° C	90-95%	1-6 months
2	Apricot	-0.5 - 0°C	90-95%	1-3 Weeks
3	Blackberry	-0.5-0°C	90-95%	3-6 days
4	Blueberry	-0.5 - 0°C	90 - 95%	10-18 days
5	Cherries(sour)	0° C	90 - 95%	3-7 days
6	Cherries(sweet)	-1-0°C	90 - 95%	2-3 weeks
7	Grapes	-0.5-0°C	90 - 95%	1- 6 months
8	Kinnow	1°C	95%	2-4 weeks
9	Kiwi	0° C	90 - 95%	3-5 months
10	Litchi	1-2°	0.95	3-5 weeks
11	Orange(FL humid areas)	1 - 2°C	85 - 90%	8-12 weeks
12	Peaches	-0.5-0°C	90 - 95%	2-4 weeks
13	Pears	-1.5-.0.5° C	90-95%	2-7 months
14	Plum	-0.5-0°C	90-95%	2-5 weeks

15	Raspberry	-0.5-0°C	90-95%	3-6 days
16	Strawberry	0-1°C	90-95%	7-10 days

TYPE- II F (2°C – 5°C)

Sl. No.	Products	Temp	Humidity	Holding Time
1	cranberry	2-5°C	90-95%	8-16 weeks
2	Tangerine	3-6°C	85 - 90%	2-4 weeks
3	Pomegrenate	5°C	90-95%	2-3 months

TYPE- III F (5°C – 10°C)

Sl. No.	Products	Temp	Humidity	Holding Time
1	Guava	5 - 10°C	90%	2 - 3 weeks
2	Melons	5-10°C	85-90%	2-3 weeks
3	Avocado	5-8° C	85-90%	2-4 weeks
4	Papaya	7-13°C	85-90%	1-3 weeks
5	Dragon Fruit	4-10°C	90-95%	2-3 weeks
6	Pineapples	7-13° C	85-90%	2-4 weeks

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TYPE- IV F (above 10°C)

Sl. No.	Products	Temp	Humidity	Holding Time
1	Passion fruit	10	85-90%	3-4 weeks
2	Rambutan	12	90-95%	1-3 weeks
3	Mango	12 - 13°C	85 - 90%	14 - 21 days
4	Banana	12 - 15°C	80 - 95%	14 - 21 days
5	Custard Apple	13°C	90-95%	2-4 weeks
6	Jackfruit	13°	85-90%	2-4 weeks

VEGETABLE

TYPE- I Vg (upto 2°C)

<i>Sl. No.</i>	<i>Products</i>	<i>Temp</i>	<i>Humidity</i>	<i>Holding Time</i>
1	carrot (Bunched)	0°C	98-100%	10-14 days
2	carrot (Topped)	0°C	98-100%	3-6 Months
3	cauliflower	0°C	95-98%	3-4 weeks
4	Corn	0°C	95-98%	5-8 days
5	Garlic	0°C	65-70%	6-7 months
6	Mint	0°C	95-100%	2-3 weeks
7	Lettuce	0°C	98-100%	2-3 weeks
8	Mushroom	0°C	90%	7-14 days
9	Radish	0°C	95-100%	1-2 months
10	Spinach	0°C	95-100%	10-14 days
11	Sprouts	0°C	95-100%	5-7 days
12	Turnip Root	0°C	95%	4-5 months
13	Beet (Bunched)	0°C	98-100%	10-14 days
14	Beet (Topped)	0°C	98-100%	4 Months
15	Broccoli	0°C	95-100%	10-14 days
16	Cabbage (early)	0°C	95-100%	3-6 weeks
17	Cabbage (late)	0°C	95-100%	5-6 months
18	Peas	0-1°C	90-98%	1-2 weeks
19	Shallot	0-2°C	65-70%	1-2 weeks
20	Water Chestnut	1-2°C	85-90%	2-4 months
21	Onion	1-3°C	60-65%	4-6 months

TYPE- II Vg (2°C – 5°C)

<i>Sl. No.</i>	<i>Products</i>	<i>Temp</i>	<i>Humidity</i>	<i>Holding Time</i>
1	Oregano	0-5°C	90-95%	1-2 weeks
2	Tamarind	2-7°C	92-95%	3-4 weeks
3	Tomato	3-4°C	85-95%	10 weeks
4	Beans	4-7°C	95%	7-10 days
5	Potato (some varieties)	2-4°C	90-95%	5-10 Months

TYPE- III Vg (5°C – 10°C)

<i>Sl. No.</i>	<i>Products</i>	<i>Temp</i>	<i>Humidity</i>	<i>Holding Time</i>
1	Potato (late)	4-12°C	90-95%	5-10 Months
2	Potato (early)	10-15°C	90-95%	10-14 days
3	Chilli	5-10°C	85-95%	2-3 weeks
4	Olives	5-10°C	85-90%	4-6 weeks
5	Okra	7-10°C	90-95%	7-10 days
6	Squash (courgette)	7-10°C	95%	1-2 weeks

National Centre for Cold-chain Development

TYPE- IV Vg (Above 10°C)

<i>Sl. No.</i>	<i>Products</i>	<i>Temp</i>	<i>Humidity</i>	<i>Holding Time</i>
1	Bitter Gourd	10-12°C	85-90%	2-3 weeks
2	Cucumber	10-12°C	85-90%	10-14 days
3	Eggplant	10-12°C	90-95%	1-2 weeks
4	Lemon	10-13°C	85-90%	1-6 months
5	Watermelon	10-15°C	90%	2-3 weeks
6	Pumpkin	12-15°C	50-70%	2-3 months
7	Squash (calabash)	12-15°C	50-70%	2-3 months

8	Ginger	13°C	65%	6 months
9	Sweet Potato	13-15°C	85-95%	4-7 months
10	Onion	25-29°C	60-65%	4-6 months

TYPE- S (4°- 10°C)

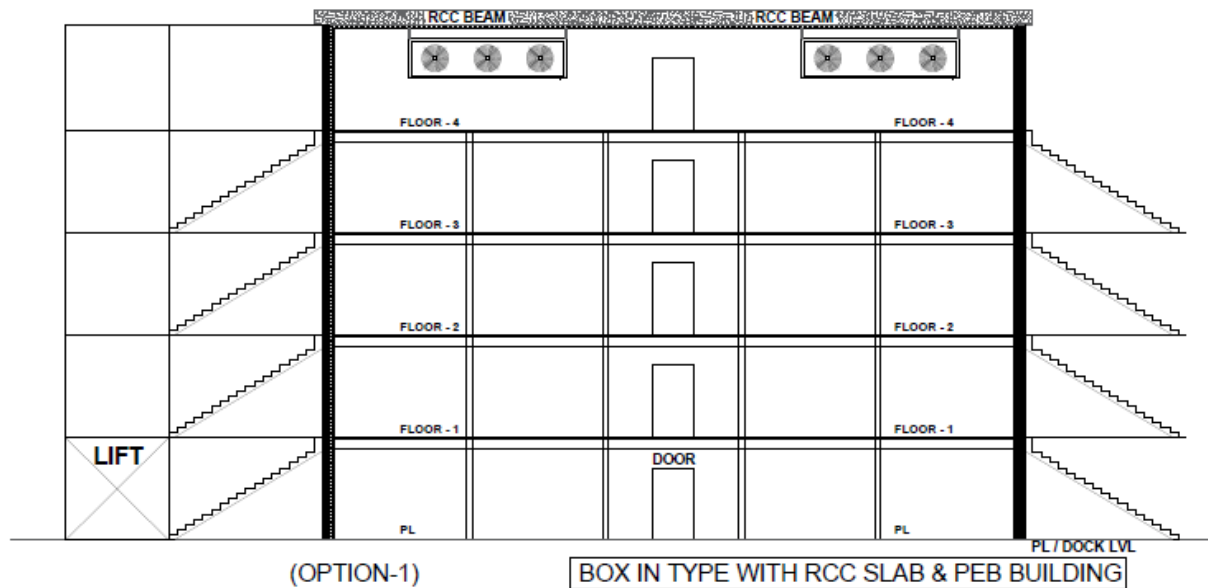
Sl. No.	Products	Temp	Humidity	Holding Time
1	Dry Spices	4-7° C	65-75%	8-9 months
2	Raisins	4-10° C	75-85%	6-12 months

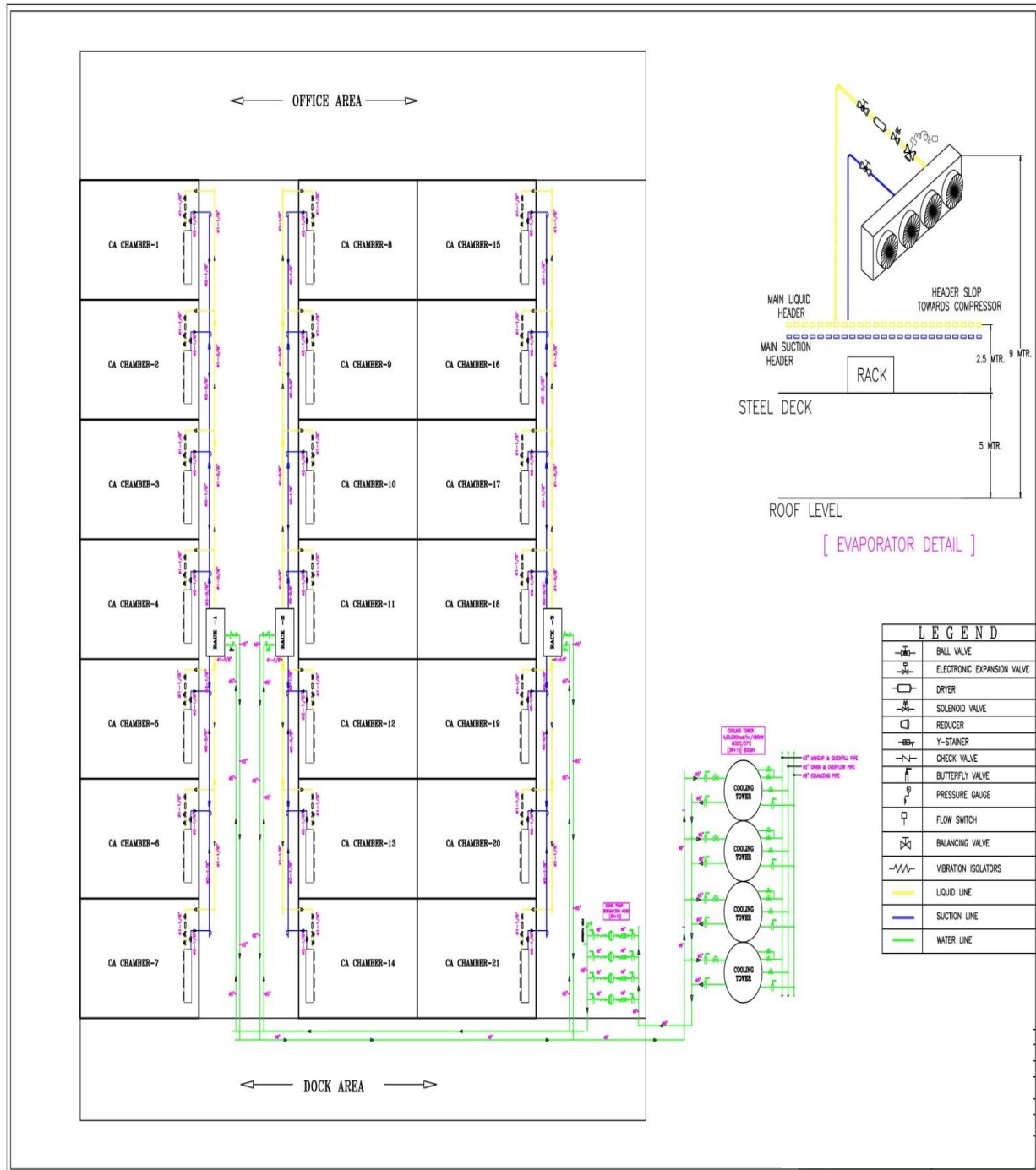
3. **N X** defines the no of chambers being proposed in new project. E.g.- 3 N, 4 N, 6 N, etc.
4. **Y MT** defines the maximum storage capacity of the facility based on the internal dimensions and suitable conversion factors as applicable. E.g.- 2500 MT, 3100 MT, 4756 MT, etc.
5. **R Z/Z-2** defines the type of refrigerant used for cooling. And in case secondary refrigerant is being used, “-2” is added. E.g.- R 134a/718-2, R 717, etc.
6. **MIDH/NHB- District** defines where the project is submitted and the District where the project is proposed to be installed. E.g.- MIDH- Gurgaon, etc.

The chamber size and allowable configuration for each type of cold storages are provided in the subsequent chapters. The applicant needs to construct cold chambers on the basis of those guidelines only.

Following are few examples of constructing Cold Storages:

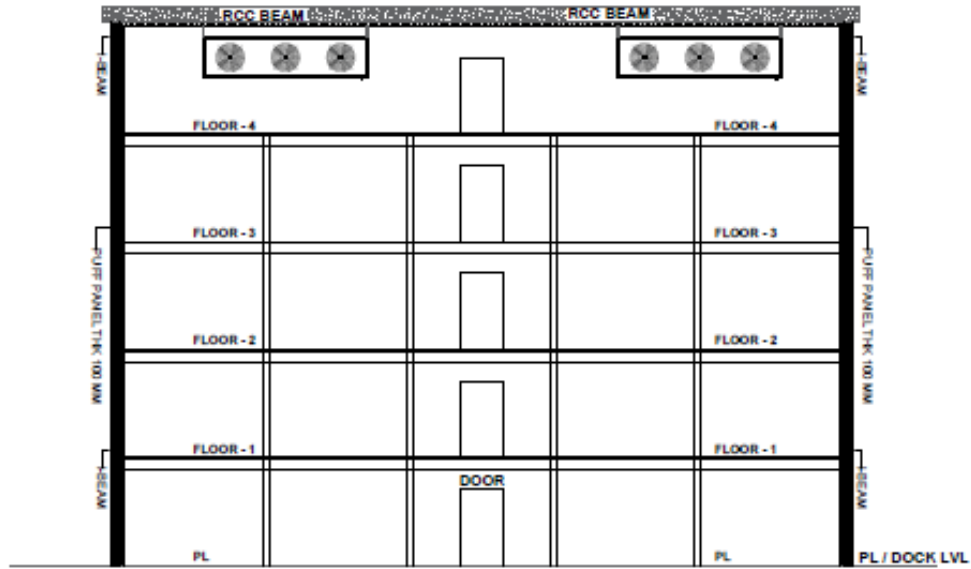
Please note these are only for reference.





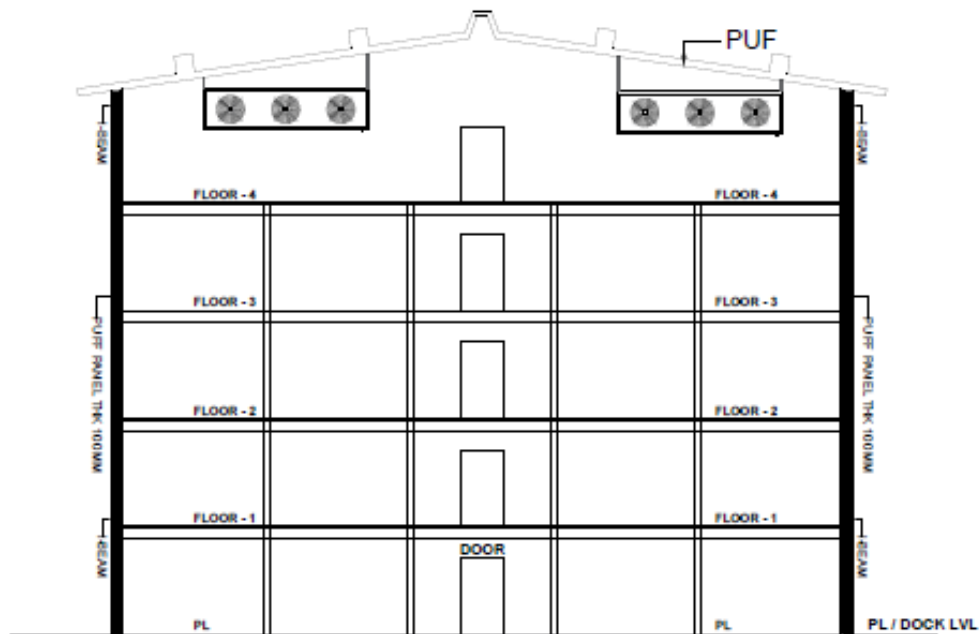
Typical P&ID for a multipurpose multi room Cold Store with centralized refrigeration plant.

*Only for reference



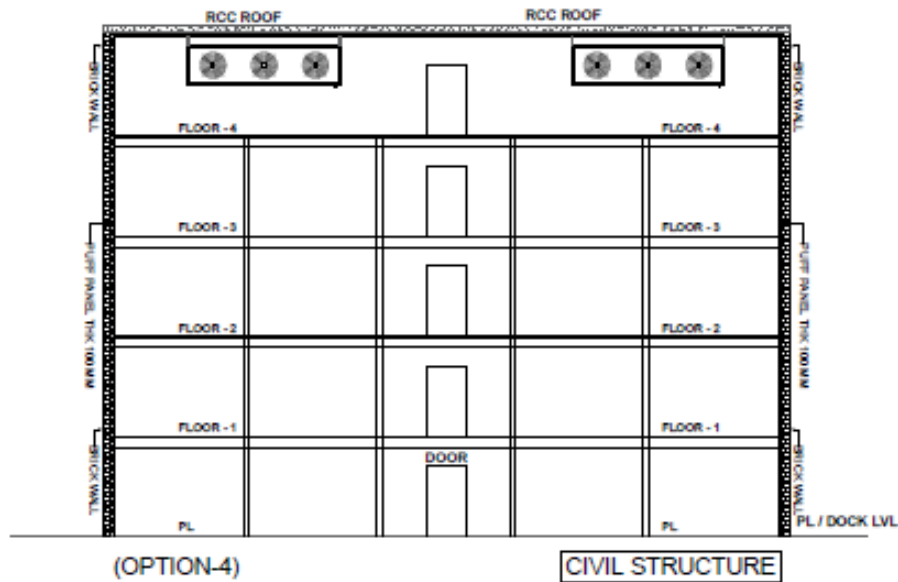
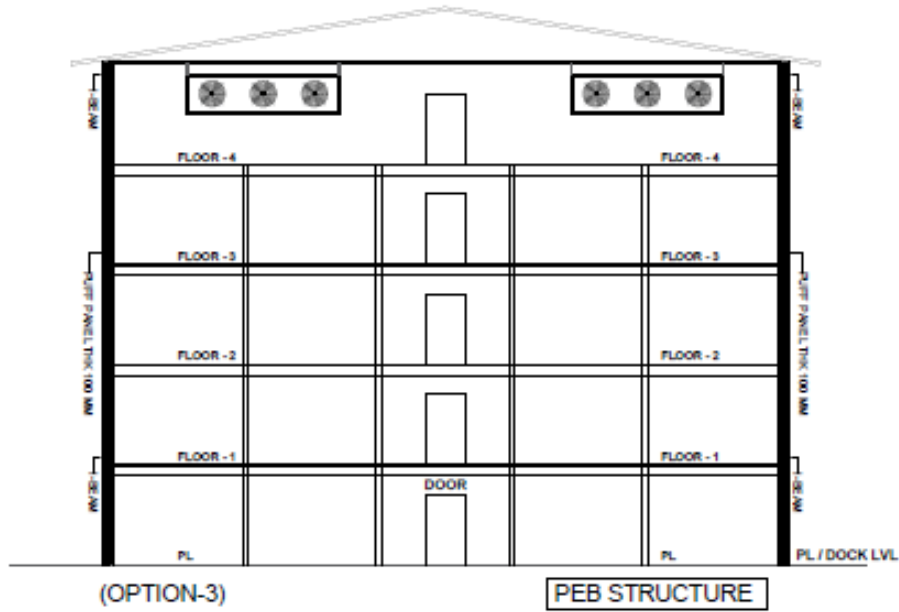
(OPTION-1)

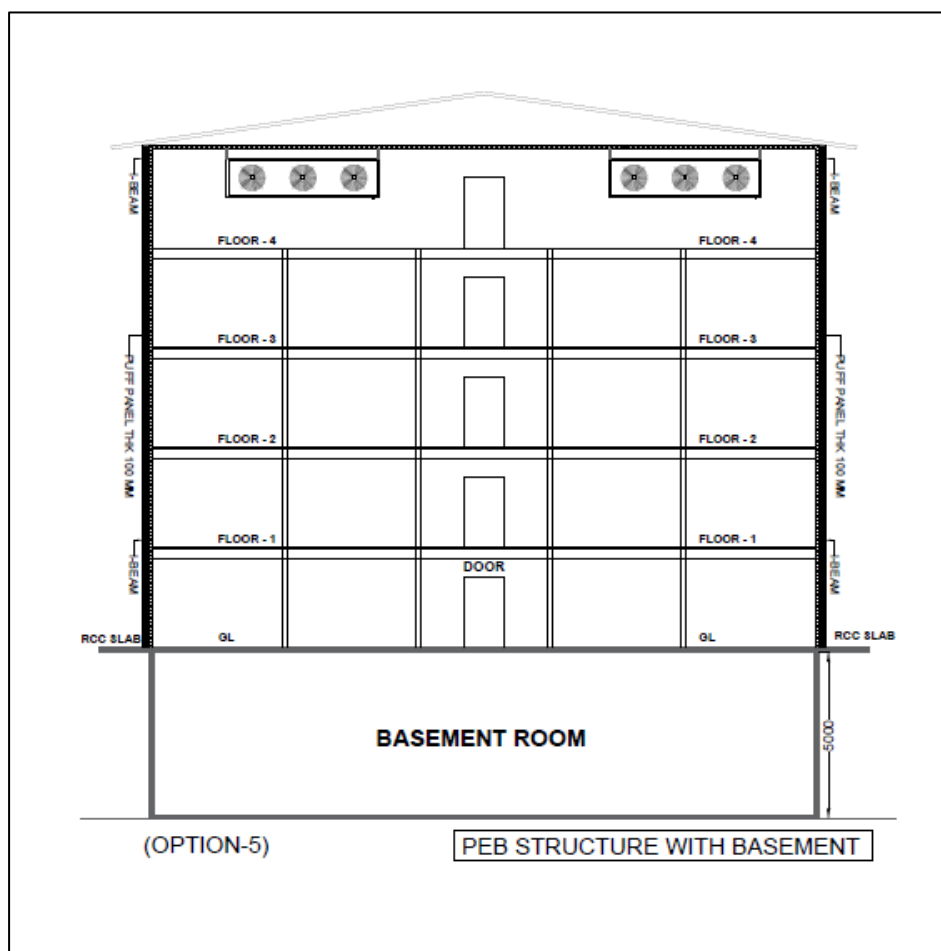
BOX IN TYPE WITH RCC SLAB & PEB BUILDING



(OPTION-2)

BOX IN TYPE WITH PUF PANEL INSULATION





Note:

- Follow relevant BIS Codes on safety and Standards
- Please provide relevant structural safety certificate from certified structural engineer, certified architects, certified agencies or certified person relevant to building norms.
- Fire safety norms to be followed as per relevant BIS codes and Standards. Clearance certificate to be provided.
- Environmental Clearance certificate to be provided as per requirement and relevant codes and standards.
- In conventional storage, Refrigerants having potential for Ozone Depletion# and GWP ranging more than 1500 (like R22, R404A etc.) are not allowed for temperature range 0° C and above.
- Use of inverter compressor / Digital compressor/ compressors with capacity control/reciprocating or screw compressors with microprocessor based controls should be used with choice of natural refrigerants/ refrigerants as described above should also be considered to promote energy efficiency and sustainable development

* **BUNKER COIL SYSTEM**: Bunker Coil System is not allowed in any Type of Cold Storage (CS-1, CS-1-Onion, CS-2, CS-2-CA, CS-3, CS-4) and no Assistance/Subsidy would be provided for any of the cold storage types with Bunker Coil System.

13. COLD STORAGE TYPE - I

A cold storage under type-1 category (CS-1) are aligned for long term bulk storage for storing of produce in bags, bulk or lots for the purpose of catering to off season demands. The produce can be brought from either packhouses or directly from farms. The produce/commodity classification is as per the attached List-1 (attached at the end of this book).

This can be developed by an individual farmer, FPO, group of farmers or any legal entity, etc. These stores act as place of storage with maintenance of temperature, relative humidity or any further requirement deemed necessary for bulk and long storage. These can be constructed either near the growing areas or at the place of consumption depending upon the requirement and maintaining the necessary chain and connectivity at the back end with either integrated packhouses, aggregation centres or directly with the farms and simultaneously used as part of the distribution network for forward linkages with the consumer centres through a well-connected temperature-controlled supply chain network.

Essentials of Cold Storage Type- I (CS-1):

- i. To identify the cold storage location for the produce that is coming into the store.
- ii. Relevant data and information on the production area, type of produce, quality of produce, and connectivity and target market or hubs should be properly recorded and known for utmost utilisation of the facility.
- iii. A Cold Store should be located close to the farm, should provide services to local farmers and should have facilities for pick and drop of produce by way of large or medium size reefer vehicles.
- iv. A Cold Store should be connected to good roads and should be covered properly to prevent from sun, rain and other contaminants from environment.
- v. A Cold Store should be designed well with sufficient areas for loading and unloading bays. It should have adequate water and electricity supplies and the drainage system should be done in a very well manner and necessary water treatment plant should be used wherever applicable.
- vi. A Cold Store should have all the necessary arrangements for safety and other desirables for the comfort of workers and other skilled professionals.
- vii. A Cold Store may also have a weigh scale at the receiving side. (Optional)
- viii. It may be connected to various numbers of aggregation centres, etc. of a farmer produce organisations or any other help groups which allows seamless connectivity of the produce to the Cold stores in the shortest possible time thereby reducing post harvest losses.

Minimum Guidelines to follow:

Cold Storage Construction Features:

- Foundation/slab/columns/pillars/ PEB structure- Civil construction/PEB
- Insulation/refrigeration - Cold Chambers (Max. capacity 4999 MT ~ 5000 MT)
- Insulation/finish floor etc. -Floor
- Mezzanine/pallets/racks/crates/bins/bags etc. - Inter-floors
- Insulated doors/strip curtains/air curtains- Doors
- Insulation- Ante room
- Compressors/condensers/pressure vessels/ heat exchangers/electrical panels/ power factor banks etc. -Machine rooms
- Dock levelers/ dock shelters/ dock doors etc.- Loading/unloading areas
- Transformers/ DG set/Earthing/Light/lightning arrestors etc. -Electrical installations
- Conveyor belts/ lifts etc. –Mechanisation
- Microprocessors/data loggers/IoT/alternate energy etc.- Automation & energy efficiency
- CCTV/ parking areas / Office block/ Convenience areas – Administrative block
- Fire fighting equipments/ fire exits/ fire doors- Safety & Hazard control

1. Civil Construction: Super structure and foundation to be designed by certified structural/ civil engineer/ architect/ certified agency. The design shall meet all BIS standards and relevant seismic zone norms for earthquake proof design. The building can be constructed either with brick walls with RCC slab at top. However, in case pre-fabricated PUF panels are used directly as a box in/out option after following necessary standards and safety protocols, brick walls can be eliminated from the civil construction after due consideration to structural stability and design & certification of the building by a certified structural/ civil engineer/ architect/ certified agency.

Note:

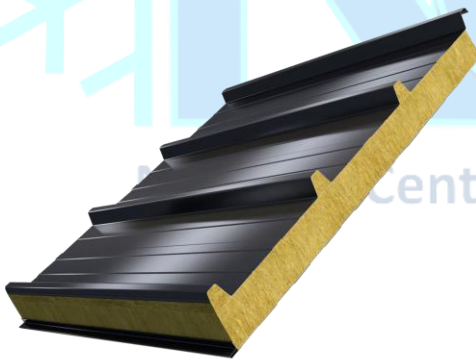
- Super structure and foundation to be designed by certified structural/ civil engineer/ architect/ certified agency.
- Certification of the building by a certified structural/ civil engineer/ architect/ certified agency should be furnished while applying for subsidy.

Special consideration with reference to hanging arrangement of unit coolers from bottom of the PUF insulated ceiling panel with RCC slab on top of it-

- Prevent condensation and water leakages through gaps into the cold storage.
- Provision of cat walks for maintenance of pipes, controls, etc. in case of pipes running around the building.
- Installation of ceiling PUF panels below the RCC slab with minimum gap between the slab and the panel.
- Provision of inverted beams in the slabs allowing plain RCC slab from the bottom.
- Provision of water proofing with chemicals, etc. to prevent water seepage from RCC slab onto the PUF insulated ceiling of the cold room.
- Special kind of runners, running alongside the building to allow holding of the PUF panels.
- Extension of RCC slab around the building to prevent rain water to hit the panel directly and causing seepage and damage.

- Sunken floors for laying and fixing of floor insulation in the areas where insulation is to be done.
- Thermal barriers to be made between all cold rooms and ante rooms
- The floor levels need to be in level at all the places for easy movement of MHEs.
- Use of material handling lifts which can accommodate both BOPTs and HPTs from basement (in case basement is done) upto the top floor.
- Each mezzanine floor inside the cold chamber to be connected through doors to the ante room at the same level of the mezzanine floor or to a landing area at the same level as that of mezzanine with easy access to fire exits as well as allowing movement of material handling equipments from lifts to the mezzanine floor.
- Two stair cases to be made at appropriate ends allowing movement of goods as well as acting as easy escape points. One staircase to be isolated with the cold storage area/ante rooms by fire rated doors which should be ISI/BIS marked for 120 minutes integrity and 30 minutes insulation.

PEB structure: The building should be constructed as per drawings and dimensions indicated. It is recommended to construct such facilities using steel construction/ Pre-Engineered construction confirming to the relevant BIS codes for live load as per IS 875 part – II, wind load as per IS 875 part-III, seismic load as per IS 1893 and other codes and standards as applicable. Also factors like wind, storms, lightning, thunderstorms, hail, heavy rains, snow, etc. should be taken in the safety designs and optimum care has to be taken on these factors to protect the cold room from these hazards. Earthing pits, Earthing, Lighting arrestors need to be installed to ensure safety from electric hazards and protection against fire, etc. The steel structure component /construction sections to be fabricated confirming to relevant codes and standards of ASTM /BIS.



In case of PEB, roof insulated panels as per BIS guidelines can be also installed with plain ribbed sheets from inside and corrugated sheets from the outside with minimum 120 mm + 30mm thickness of the insulated panel.

Care needs to be taken in ensuring that this kind of installation uses proper thickness of the panel and does not allow condensation or water dripping due to some part of the PEB structure inside the cold storage and some outside thereby causing thermal shock and allowing leakages. The building should be constructed as per drawings and dimensions indicated confirming to relevant codes and standards of BIS, IS.

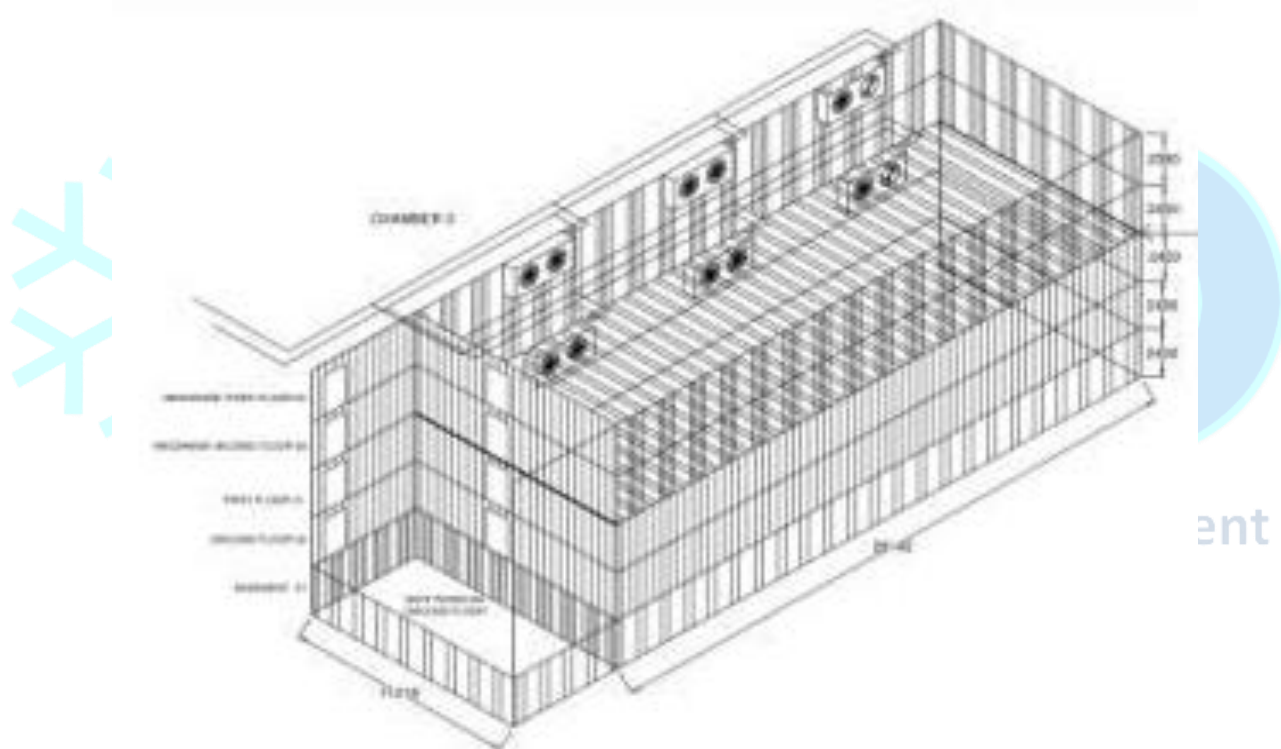
In case of truss roof, provisions to be made for fixing insulated panels to the ceiling and support of the cooling unit from the trusses in case of ceiling suspended evaporators/ unit coolers/ cooling units.

The structural certifying agency/ structural engineer etc. should pay special attention to the hanging arrangement of unit coolers from the trusses/supports to avoid condensation and prevent water leakage through gaps into the cold storage. The cold chain engineer should ensure world class installation that shall ensure that joints at the top does not leak and access areas should be sealed. Preferably, a catwalk should be designed & provided to access areas above the cold storages. These areas should preferably include ventilation fans and special under-deck insulation to lower

temperatures in these areas, reducing heat infiltration from the top and improving overall energy efficiency.

Note: Mezzanine bifurcation inside the chambers would not amount to single chamber and would be considered as 1 chamber from to bottom unless there is proper bifurcation inside the chamber and fulfilling all the criteria in terms of hard flooring, insulated flooring, dedicated refrigeration unit and access doors from the respective floor and connectivity to lifts and fire exits.

The certifying agency, person etc. relevant to the line of work giving the clearance fit for construction will provide document duly signed and stamped.



2. Cold Chambers: (QUALIFICATION FOR CS-1)

Rule no.	Minimum Storage Capacity (MT)	Maximum Storage Capacity (MT)	MIDH/NHM Configuration	NHB Configuration
1	500	4999 ~ 5000	The combination of capacity of chambers in a project can be divided between min. capacity of 500 MT and up to a max. capacity of 1500 MT (per chamber).	NA

2	5001	10000	NA	The combination of capacity of chambers in a project can be divided between min. capacity of 1500 MT and up to a max. Capacity of 2500 MT (per chamber).
3	10001	20000	NA	The combination of capacity of chambers in a project can be divided between min. capacity of 1500 MT and up to a max. capacity of 2500 MT (per chamber) from 5001 MT up to 10,000 MT. And for storage capacity above 10,000 MT up to max. 20,000 MT, the combination of capacity of chamber can be divided up to a max. Capacity of 5000 MT per chamber but not less than 1500 MT capacity in any case.

The cold chamber is a box of specific size which is constructed with the help of insulation of different thicknesses to maintain temperature, humidity, etc. inside that cold chamber referred to as a cold storage. This cold storage is meant for storing different types of fruits and vegetables and other horticulture products which may or may not require pre-cooling depending upon the requirement to preserve the freshness, quality and shelf life.

These cold storages require adequate refrigeration, air circulation, proper stacking and storage arrangements to achieve the required conditions for maintaining product temperature and other required conditions like humidity, CO₂ levels, Ethylene levels, etc. to enhance the shelf life of the produce.

Efficiency and performance in such stores is vital and depends upon various factors like appropriate storage system, optimizing space, allowing uniform air circulation through the produce, requirement of stock rotation if necessary. This is abundantly important to consider in design so as to allow the economic viability of the cold store as it allows reduction in energy bills, less wastage and maintaining the quality of the produce.

The cold storage consists of components which have been categorized for the purpose of submission in the applications for the purpose availing subsidy following the below specified minimum standards and guidelines under various components:

DETAILED SPECIFICATIONS

- Cold Store Building-** In general, under CS type-I (CS-1) both civil as well as PEB structures are allowed confirming to relevant BIS codes, fire safety guidelines as per state regulations and BIS standards applicable to buildings.

Sl. No.	Description	Remarks
1	Cold Store Building	The total height of the building including dock or foundation should not be more than 20 mtrs.
		The height of the dock should be not less than 1.06 mtr or as required from the finished road level
		In case of PEB structure holding cold rooms with boxes inside the PEB columns (Box-in type), special Z runners/support should be placed at every 3 to 4 mtr. around these structure from the dock level for holding the wall insulation panels securely and tightly. Sufficient space should be provided outside of the foundation of PEB columns in and around dock/platform.
		In case of Basements for buildings with PEB structure or civil, the total height of the basement and the building (outer) should not exceed more than 20 m. The individual height of the basement in this case should not exceed 5.2 m. with 1.06 m of the basement above the ground level with RCC slab acting as a table top/roof of the basement and floor for the cold storage above it. The basement needs to be constructed with due approval and clearances from the authorities and utmost care to be taken to prevent any water leakages/seepages inside the basement for which proper water proofing with latest methods needs to be done on the outside of the retention walls inside the basement and other necessary areas. Proper Justification should be provided whenever basements are created and due approval for use of basement in cold storages should have proper approval and clearance from all the relevant authorities like planning, fire safety, etc. In case of table top structures the floors should be insulated to prevent condensation in the basement floors. No basement floors with access from road level would be allowed in cold storages. However, the fire safety exits should go upto the basement floor and care should be taken during construction which does not allow flooding of the basement. Wherever possible use modern construction technologies, types of beams and columns suitable for setting up of cold storage should be implemented in construction.

		The design should be innovative with appropriate measures taken to ensure use of space with design of sunken floors, inverted beams, as required to allow maximum utilisation of space, minimum cutting of insulation panels, and easy installation for reducing gaps between the joints and preventing loss of cold, disallowing condensation and other problems. Appropriate care to be taken inside the cold storage flooring and use of technology, expansion joints, resins, epoxy, to create smooth floor level and prevent cracking of the floors thereby, not allowing moisture and water to travel upto insulation and creating efficiency issues as well as hazards to building. Suitable grade of concrete like M25, M28, M30, etc. with block testing should be done as per standards and guidelines.
		For all types of construction atleast 1 mandatory service lift/ conveyor material hoist system/ mechanized material handling conveyors should be operational from the basement upto the top floor alongwith 2 stair cases on two sides of the building which can be used for loading as well as fire exits. One stair case of the two needs to be placed at the end of the loading/un-loading ante rooms with closure at one end with a fire rated safety door at each floor.
		Preferably, a catwalk should be designed & provided to access areas above the cold storages. These areas should preferably include ventilation fans and special under-deck insulation to lower temperatures in these areas, reducing heat infiltration from the top and improving overall energy efficiency but not mandatory.
		While designing it should be considered to leave appropriate space for movement of fire trucks around the building, loading/unloading trucks, space for utilities like transformers, DG sets, in such a way that it does not hinder operations and possess threat to human safety and well being.

3. 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:

Rigid Polyurethane foam: Chlorofluorocarbon (CFC) free and self-extinguishing and shall conform to IS 12436: 1988.

Vacuum Insulated Panels: Conforming to BIS and IS standards

PIR PUF panels: Conforming to BIS and IS standards

Pre Painted Galvanized Iron (PPGI): The PPGI sheet shall have adequate thickness to withstand load and shall have zinc coating of min. 90 Gsm.

Flashing/Accessories: Made of PPGI sheet conforming to IS 14246:2013

Walls & Ceiling: Rigid PUF panels/PIR/VIP

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 / trimix 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

Minimum insulation thickness for various insulation materials

Type of insulation	Material		Wall		Ceiling/ roof U value = 0.24 W/m ² K	Floor U value = 0.29W/m ² K
			External U value = 0.27W/m ² K	Partition U value = 0.58W/m ² K		
	ρ Density Kg/m ³	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

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)

4. FLOOR:

- 1) The floor in the cold rooms should be of base concrete, with kota stone/ epoxy or any other finished floor type inside the floor chambers. Floor insulation slab preferably XPS (EPS not allowed) laid in two layers. The Floor should be cleaned, painted with black japan paint and then laid with 1st layer of vapour barrier which can be either 250 microns tarfelt sheet or polythene sheet of suitable thickness. The vapour barrier should be covered with 1st layer of insulation and overlaid with 2nd layer of insulation in a manner to cut the gaps in the first layer of insulation. The joints can be filled with suitable hot grade bitumen (80:25). The 2nd layer of insulation is then covered with 2nd layer of vapour barrier which would be upto 1 mm thick tar felt or poly felt sheets with 5 mm overlap on the walls.

- 2) The laying of Trimix should be 75 MM to 100 MM thickness with any suitable finish like kota stone, epoxy etc. or any other finish floor. The floor level of the cold storage should match the floor level of the cold store for easy movement of material as well as MHEs. In case of raised floor levels a suitable graded ramp to be either fixed or made outside the door for mechanised movement of the goods.
- 3) The Cold Room should be installed in such a way that small HPTs/BOPTs can be used to load/un-load the material mechanically.

INSULATION & DOORS:

- 4) The cold room insulation should be PUF/PIR or any other new environment friendly insulating material of thickness min 100 mm. sandwiched in either pre-painted GI(0.45 mm Min. thickness) or SS(food grade SS-306) sheets.
- 5) The insulated door should be either overlap or inline or sliding but of the same thickness as that of the panel with a view window on the door properly fitted alongwith heater for anti-condensation on the glass. The door should be fitted with strip curtains form inside with 0.5 mm overlap from SS hooks or hangers. The outside of the door should be fitted with air curtains of suitable capacity.
- 6) Minimum door size recommended is 1mtr x 2 mtr ($\pm 5\%$ variation would be accepted on the min recommended size, however the upper size can be selected as per requirement). The no. of doors would be equivalent to no. of mezzanine floors.

5. ANTE ROOMS:

Ante Rooms should be designed on each floor and shall be designed to accommodate stair case, hoists, lifts, fire exits, as per local norms and regulations as applicable on the type of building. Suitable design innovations should be incorporated to accommodate certain ancillaries in these ante rooms however, not jeopardizing the safety of the human.

Each ante room should have doors leading to the cold rooms on every floor. The inner walls of the cold rooms can serve as the walls for the ante rooms. The ceiling of the ante room should be closed with 60 mm PUF panel insulation, and the ends should be sealed as much as possible (though not mandatory). However, the side facing the fire exit must be fully enclosed and fitted with fire exit doors.



6. REFRIGERATION:

Energy efficient refrigeration based systems need to be installed. For any operations which may require temperature condition and humidity condition upto 0°C and above refrigerants with GWP between 1000 to 1500 to be used. **Individual systems would not be allowed above capacities which are 2000 MT or more.** In case of any further expansion more than 2000 MT, the same rule shall apply. And no individual refrigeration units for the expansion would be allowed. For further details on expansion, please refer chapter no. 23 (Expansion & Modernisation)

7. LOADING/UNLOADING AREA:

Loading and unloading docks shall be designed with RCC slab roof or sheet roofing and these should be wide enough to allow loading and unloading simultaneously when the loading/un-loading area should bifurcated from the cold room ante rooms by an insulated sliding door.



8. ELECTRICAL INSTALLATIONS:

Suitable step down **OLTC transformers** (if required) with earthing stations as per requirements, main power distribution panel for refrigeration lightning, electric hoists and lifts, automatic power factor correction panel (APFC), fire fighting equipments, etc.

DG Sets, 1 small and 1 big equalling to the total requirement load in the cold storages. The type of DG sets should be considered as per applicable laws of pollution control board.

9. MECHANISATION:

Appropriate Lifts/ conveyors/ electrical hoists with wire ropes, a steel fabricated cage with guides, and openable doors should be provided for material handling for managing the goods. Material movement can be facilitated using BOPTs for easier access to storage areas on the mezzanine floors, with the materials being transported from hoist, lifts, conveyer etc. through the ante room of the respective mezzanine floor into cold store.

10. UNIFIED CONTROL SYSTEM / AUTOMATION:

Suitable configuration of electrical panels with microprocessors, and HMIs, to be installed on the electrical panels with suitable sensors where, analog input received from all the equipments that is consuming electrical energy is converted into digital output for the purpose of bringing in energy efficiency into the building management system, These microprocessors should be operated with static IPs and allow control and visualisation of cold room temperatures, humidity and other necessary parameters remotely by the authorised person. The microprocessor panel should also control necessary work done in terms of compressors for automatic operations and thereby, reducing the power consumption on the compressors, evaporator fans, pumps, condenser fans, etc. to bring in suitable energy efficiency into the facility.

The IoT based systems should be installed for real time monitoring, tracking and surveillance of the facility remotely. This system is also equipped with early hazard detection and alarm activation protocols.

11. RENEWABLE ENERGY:

The facility should be capable to generate atleast that much amount of the required energy which can run electrical lights, pumps (if possible), fan motors during holding period in daily operations from renewable sources of energy. The energy may be obtained by harnessing solar energy, wind energy, etc. and stored in auxiliary batteries if possible. (Batteries are not mandatory)

12. ADMINISTRATIVE BLOCK:

Every cold store should have a separate admin block equipped with office room,

13. SAFETY & HAZARD CONTROL:

Provision for handling accidental leakage of refrigerant:

- 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: To be inverter based

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: To be installed as per clearance and requirement of Fire Regulatory authority

E.g.-

DRY TYPE

- i) Dry chemical powder type 5.0 Kg Cap with ISI Mark Fire Extinguisher complete with wall mounting bracket.
- ii) Carbon Di-Oxide (CO₂) type 4.5 Kg. capacity Fire Extinguisher complete with wall mounting bracket.
- iii) G.I. Fire Buckets
- iv) M.S. Stand for Fire Buckets

WATER BASED

- 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

MANDATORY SUBSIDY COMPONENTS:

FOR NHM

COMPONENT NO.	DESCRIPTION & NAME	Max. ALLOWABLE QTY./CAPACITY	COST
C-7 (i)	<u>Cold Storage type –I (CS-1)</u> are cold storages designed mostly for single product storage where bulk and long term storage is preferred. They are normally seen in brick and mortar structure, however, an applicant can also develop it under the pre-engineered building (PEB). It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas, loading docks, PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places. Consisting of :	For Civil Construction of capacity upto 4999 MT ~ 5000 MT capacity	Rs. 9600/MT
C-7 (ii)		For PEB Construction of capacity upto 4999 MT ~ 5000 MT capacity	Rs. 12,000

	i. Construction: Foundation/ slab/ columns/ pillars/ PEB structure ii. Insulation: Walls, Ceiling, Floors, etc. iii. All refrigeration Units iv. Electrical Installations: Transformers/DG Sets, VFDs, etc. v. Administrative Block: CCTV/ parking areas / Office block/ Convenience areas vi. Safety & Hazard control: Fire fighting equipments/ fire exits/ fire doors- as per norms and conditions of the building		
	CO2 SCRUBBER with CO2 MONITORING SYSTEM FOR REMOVAL OF CO₂ Mandatory only for those produces generating lot of CO₂. E.g.- potato, onions, apples, etc	Max. 1 system/ project	Rs. 10 lakh/system
	Unified Control System- PLC,BMS, IoT, Remote monitoring, etc.	Max. 1 system/ project	Rs. 5 lakh/system
	Conveying/Hoist system/Material Service lifts for material handling of suitable capacity in the anteroom with provision of unloading on common landing near and outside cold rooms. (upto 5000 MT) (refer point no. 9-MECHANISATION)	Max. 1 system/ project	Rs. 5 lakh/system
	Dock Leveller System comprising of: (components of 1 set) A. Dock Leveller B. Dock Door C. Dock Shelter D. Vehicle Barrier/ Hit Alarm	Max. 2 sets	Rs. 8.4 lakh/set
	Material Handling Equipments: HPT 1 ton and above BOPT 1 ton and above	Max. 4 units Max 2 unit	Rs. 20000/ unit Rs. 1.5 lakh/ unit
	Doors	Max. 20 doors/ project	Rs. 25000 / door
	Automated computerised system with software for generating QR/bar code labelling, farmers details, date of arrival, variety of the crop at the time of arrival, etc.	Max. 1 system/ project	Rs. 3.5 lakh/system

FOR NHB

COMPONENT NO.	DESCRIPTION & NAME	Max. ALLOWABLE QTY./CAPACITY	COST
C-7 (i)	Cold Storage type –I (CS-1) are cold storages designed mostly for single product storage where bulk and long term storage is preferred. They are normally seen in brick and mortar structure, however, an applicant can also develop it under the pre-engineered building (PEB). It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas, loading docks, PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places. Consisting of :	For CIVIL Construction of capacity between: 5001 to 6500 MT 6501 to 8000 MT 8001 to 10000 MT 10001 to 20000 MT*	Rs. 9120/MT Rs. 8640/MT Rs. 8160/MT Rs. 4080/MT*
C-7 (ii)	i. Construction: Foundation/ slab/ columns/ pillars/ PEB structure ii. Insulation: Walls, Ceiling, Floors, etc. iii. All refrigeration Units iv. Electrical Installations: Transformers/DG Sets, VFDs, etc. v. Administrative Block: CCTV/ parking areas / Office block/ Convenience areas vi. Safety & Hazard control: Fire fighting equipments/ fire exits/ fire doors- as per norms and conditions of the building	For PEB Construction of capacity between: 5001 to 6500 MT 6501 to 8000 MT 8001 to 10000 MT 10001 to 20000 MT*	Rs. 11400/MT Rs. 10800/MT Rs. 10200/MT Rs. 5100/MT*

	CO ₂ SCRUBBER with CO ₂ MONITORING SYSTEM FOR REMOVAL OF CO ₂ Mandatory only for those produces generating lot of CO ₂ . E.g.- potato, onions, apples, etc	Max. 1 system/ project	Rs. 10 lakh/ system
	Unified Control System- PLC,BMS, IoT, Remote monitoring, etc.	Max. 1 system/ project	Rs. 5 lakh/ system
	Conveying/Hoist system/Material Service lifts for material handling of suitable capacity in the anteroom with provision of unloading on common landing near and outside cold rooms. (upto 5000 MT) (refer point no. 9-MECHANISATION)	Max. 1 system/ project	Rs. 5 lakh/ system
	Dock Leveller System comprising of: (components of 1 set) A. Dock Leveller B. Dock Door C. Dock Shelter D. Vehicle Barrier/ Hit Alarm	Max. 2 sets	Rs. 8.4 lakh/set
	Material Handling Equipments: HPT 1 ton and above BOPT 1 ton and above	Max. 4 units Max 2 unit	Rs. 20000 / unit Rs. 1.5 lakh / unit
	Doors	Max. 30 doors / project	Rs. 25000 / door
	Automated computerised system with software for generating QR/bar code labelling, farmers details, date of arrival, variety of the crop at the time of arrival, etc.	Max. 1 system / project	Rs. 3.5 lakh / system

Technical Evaluation while Claiming Subsidy: The following details need to submitted for Technical Evaluation while availing subsidy:

SUBMITALS along with DPR/Application:

1. Nomenclature: CS-1/ I F/II F/III F/I Vg/II Vg/III Vg/N X/Y MT/MIDH/NHB- District

- a) CS-1 Stands for COLD STORAGE TYPE-I
- b) I F/II F/III F/I Vg/II Vg/III Vg denotes commodity to be stored. (refer to chapter no. 31-COMMODITIES SPECIFICATIONS)
- c) N X denotes the no. of chambers (e.g.- N 4, N 8, etc.)
- d) Y MT denotes total capacity of the facility (e.g.- 1800 MT, 6540 MT, etc.)
- e) MIDH/NHB denotes under which subsidy scheme the project is being submitted.
- f) –District defines the district where the project is proposed.

2. Basic Data Sheet: Refer to Annexure III at the end of this book. (Basic Data Sheet of Cold Storage (CS-1/CS-1-Onion/CS-2/CS-2-CA/CS-4)

3. Heat Load Calculation Sheet: Enclose detail basis of heat load calculation.

4. Drawings: Enclose sketch with Plan layout and sections showing storage chambers and floor heights clearly.

5. Technical Performance Data Sheets of proposed Refrigeration Equipments, etc. to be installed, to be submitted from the respective equipment manufacturer.

6. Energy Efficiency Sheet: Refer to Annexure VI at the end of this book.

NOTE:

- i. Follow relevant BIS Codes on safety and Standards
- ii. Please provide relevant structural safety certificate from certified structural engineer, certified architects, certified agencies or certified person relevant to building norms.
- iii. Fire safety norms to be followed as per relevant BIS codes and Standards. Clearance certificate to be provided.
- iv. Environmental Clearance certificate to be provided as per requirement and relevant codes and standards.
- v. In conventional storage, Refrigerants having potential for Ozone Depletion# and GWP ranging more than 1500 (like R22, R404A etc.) are not allowed for temperature range 0° C and above.
- vi. Use of inverter compressor / Digital compressor/ compressors with capacity control/reciprocating or screw compressors with microprocessor based controls should be used with choice of natural refrigerants/ refrigerants as described above should also be considered to promote energy efficiency and sustainable development
- vii. For NHB:

Since, the maximum allowable capacity has been increased upto 20000 MT, for applications under NHB, an additional cost norm of Rs. 4080 (for civil) & Rs. 5100 (for PEB) (refer C- 7.1 & C- 7.2) would be applicable above 10001 MT upto 20000 MT, remaining guidelines remains same.

e.g. 1- For civil construction, say proposed capacity is 12000 MT, therefore cost applicable would be = Rs. 8160 * 10000 (MT) plus(+) Rs. 4080 * 2000 (MT)

e.g. 2- For civil construction say capacity is 16400 MT therefore, cost applicable would be = Rs. 8160 * 10000 (MT) plus(+) Rs. 4080 * 6400 (MT)

e.g. 3- For PEB construction, say proposed capacity is 10020 MT, therefore cost applicable would be = Rs. 10200 * 10000 (MT) plus(+) Rs. 5100 * 20 (MT)

e.g. 4- For PEB construction say capacity is 18000 MT therefore, cost applicable would be = Rs. 10200 * 10000 (MT) plus(+) Rs. 5100 * 8000 (MT)

*** Bunker Coil System is not allowed refer NOTES on page no. 100.**

NOTE- Add-on Component: To promote renewable energy, applicant can also avail component Alternate Technology as an add-on component (please refer point no.#10 in chapter no. 16- CS-2-CA)

14. COLD STORAGE TYPE-I- Onion

Cold Storage Type-I can also be utilized for the special purpose of storing onions in bulk. The facility should be constructed in a similar manner to CS-1, with a different set of specific components to onion storage. All other constructional details should follow the specifications outlined for CS-1, as described in the previous chapter.

The details are as follows:

FOR NHM

COMPONENT NO.	DESCRIPTION & NAME	Max. ALLOWABLE QTY./CAPACITY	COST
C-8 (i)	Cold Storage type –I - Onion (CS-1-Onion) are cold storages designed for onion storage where bulk and long term storage is preferred. They are normally seen in brick and mortar structure, however, an applicant can also develop it under the pre-engineered building (PEB). It is further stated that all the building safety norms, furnishing of stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas(receiving shed), PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places. Consisting of :	For Civil Construction of capacity upto 4999 MT ~ 5000 MT capacity	Rs. 9600/MT
C-8 (ii)	For PEB Construction of capacity upto 4999 MT ~ 5000 MT capacity i. Construction: Foundation/ slab/ columns/ pillars/ Receiving Area or shed/ PEB structure ii. Insulation: Walls, Ceiling, Floors, etc. iii. All refrigeration Units iv. Electrical Installations:		Rs. 12,000

	Transformers/DG Sets, VFDs, etc.		
	v. Administrative Block: CCTV/ parking areas / Office block/ Convenience areas		
	vi. Safety & Hazard control: Fire fighting equipments/ fire exits/ fire doors- as per norms and conditions of the building		
	Ventilation system#	Max. upto 5000 MT/ project	Rs. 3000/MT
	Specialised Stacking System appropriate for Onions*	Max. upto 5000 MT/ project	Rs. 2000/MT
	CO2 SCRUBBER with CO2 MONITORING SYSTEM FOR REMOVAL OF CO2 Mandatory only for those produces generating lot of CO2. E.g.- potato, onions, apples, etc	Max. 1 system/ project	Rs. 10 lakh/ system
	Unified Control System- PLC,BMS, IoT, Remote monitoring, etc.	Max. 1 system/ project	Rs. 5 lakh/system
	Conveying/Hoist system/Service lifts for material handling of suitable capacity in the anteroom with provision of unloading on common landing near and outside cold rooms. (upto 5000 MT)	Max. 1 system/ project	Rs. 5 lakh/system
	Doors	Max. 20 doors/ project	Rs. 25000 / door
	Automated computerised system with software for generating QR/bar code labelling, farmers details, date of arrival, variety of the crop at the time of arrival, etc.	Max. 1 system/ project	Rs. 3.5 lakh/system

FOR NHB

COMPONENT NO.	DESCRIPTION & NAME	Max. ALLOWABLE QTY./CAPACITY	COST
C-8 (i)	<u>Cold Storage type –I - Onion (CS-1-Onion)</u> are cold storages designed for onion storage where bulk and long term storage is preferred. They are normally seen in brick and mortar structure, however, an applicant can also develop it under the pre-engineered	For CIVIL Construction of capacity between: 5001 to 6500 MT	Rs. 9120/MT

	building (PEB). It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas(receiving shed), PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places. Consisting of :	6501 to 8000 MT	Rs. 8640/MT
		8001 to 10000 MT	Rs. 8160/MT
		10001 to 20000 MT	Rs. 4080/MT
C-8 (ii)	For PEB Construction of capacity between:		
		5001 to 6500 MT	Rs. 11400/MT
	i. Construction: Foundation/ slab/ columns/ pillars/ Receiving Area or shed/ PEB structure	6501 to 8000 MT	Rs. 10800/MT
	ii. Insulation: Walls, Ceiling, Floors, etc.	8001 to 10000 MT	Rs. 10200/MT
	iii. All refrigeration Units		
	iv. Electrical Installations: Transformers/DG Sets, VFDs, etc.	10001 to 20000 MT	Rs. 5100/MT
	v. Administrative Block: CCTV/ parking areas / Office block/ Convenience areas		
	i. Safety & Hazard control: Fire fighting equipments/ fire exits/ fire doors- as per norms and conditions of the building		
	Ventilation system#	Max. upto 20000 MT/ project	Rs. 3000/MT Total max cost capped to 300 lakhs/project
	Specialised Stacking System appropriate for Onions*	Max. upto 20000 MT/ project	Rs. 2000/MT Total max cost capped to 200 lakhs/project

	CO2 SCRUBBER with CO2 MONITORING SYSTEM FOR REMOVAL OF CO2 Mandatory only for those produces generating lot of CO2. E.g.- potato, onions, apples, etc	Max. 1 system/ project	Rs. 10 lakh/ system
	Unified Control System- PLC,BMS, IoT, Remote monitoring, etc.	Max. 1 system/ project	Rs. 5 lakh/system
	Conveying/Hoist system/Service lifts for material handling of suitable capacity in the anteroom with provision of unloading on common landing near and outside cold rooms. (upto 5000 MT)	Max. 1 system/ project	Rs. 5 lakh/system
	Doors	Max. 30 doors/ project	Rs. 25000 / door
	Automated computerised system with software for generating QR/bar code labelling, farmers details, date of arrival, variety of the crop at the time of arrival, etc.	Max. 1 system/ project	Rs. 3.5 lakh/system

Technical Evaluation while Claiming Subsidy: The following details need to submitted for Technical Evaluation while availing subsidy:

SUBMITALS along with DPR/Application:

1. Nomenclature: CS-1-Onion/I Vg/N X/Y MT/MIDH/NHB- District

- a) CS-1-Onion Stands for COLD STORAGE TYPE-I-Onion
- b) I Vg denotes commodity to be stored. (refer to chapter no. 31- COMMODITIES SPECIFICATIONS)
- c) N X denotes the no. of chambers (e.g.- N 4, N 8, etc.)
- d) Y MT denotes total capacity of the facility (e.g.- 1800 MT, 6540 MT, etc.)
- e) MIDH/NHB denotes under which subsidy scheme the project is being submitted.
- f) –District defines the district where the project is proposed.

2. Basic Data Sheet: Refer to Annexure III at the end of this book. (Basic Data Sheet of Cold Storage (CS-1/CS-1-Onion/CS-2/CS-2-CA/CS-4)

3. Heat Load Calculation Sheet: Enclose detail basis of heat load calculation.

4. Drawings: Enclose sketch with Plan layout and sections showing storage chambers and floor heights clearly.

5. Technical Performance Data Sheets of proposed Refrigeration Equipments, etc. to be installed, to be submitted from the respective equipment manufacturer.

6. Energy Efficiency Sheet: Refer to Annexure VI at the end of this book.

7. Refer and submit Annexure VIII.

NOTE:

- i. Follow relevant BIS Codes on safety and Standards
- ii. Please provide relevant structural safety certificate from certified structural engineer, certified architects, certified agencies or certified person relevant to building norms.
- iii. Fire safety norms to be followed as per relevant BIS codes and Standards. Clearance certificate to be provided.
- iv. Environmental Clearance certificate to be provided as per requirement and relevant codes and standards.
- v. In conventional storage, Refrigerants having potential for Ozone Depletion# and GWP ranging more than 1500 (like R22, R404A etc.) are not allowed for temperature range 0° C and above.
- vi. Use of inverter compressor / Digital compressor/ compressors with capacity control/reciprocating or screw compressors with microprocessor based controls should be used with choice of natural refrigerants/ refrigerants as described above should also be considered to promote energy efficiency and sustainable development
- vii. For NHB:

Since, the maximum allowable capacity has been increased upto 20000 MT, for applications under NHB, an additional cost norm of Rs. 4080 (for civil) & Rs. 5100 (for PEB) (refer C- 8.1 & C- 8.2) would be applicable above 10001 MT upto 20000 MT, remaining guidelines remains same.

e.g. 1- For civil construction, say proposed capacity is 12000 MT, therefore cost applicable would be = Rs. 8160 * 10000 (MT) plus(+) Rs. 4080 * 2000 (MT)

e.g. 2- For civil construction say capacity is 16400 MT therefore, cost applicable would be = Rs. 8160 * 10000 (MT) plus(+) Rs. 4080 * 6400 (MT)

e.g. 3- For PEB construction, say proposed capacity is 10020 MT, therefore cost applicable would be = Rs. 10200 * 10000 (MT) plus(+) Rs. 5100 * 20 (MT)

e.g. 4- For PEB construction say capacity is 18000 MT therefore, cost applicable would be = Rs. 10200 * 10000 (MT) plus(+) Rs. 5100 * 8000 (MT)

NOTE- Add-on Component: To promote renewable energy, applicant can also avail component Alternate Technology as an add-on component (please refer point no.#10 in chapter no. 16- CS-2-CA)

In order to promote storing of Onions, Storage under category CS-1-Onion has been introduced. Ventilation system can be availed by submitting details of the special ventilation process adopted by the applicant in addition to the use of refrigeration equipments controlling and achieving required temperature and humidity. The applicant needs to provide details of the equipment, methodology and integration of the ventilation system with the other components to synchronize the operation inside the onion store.

* In order to promote storing of Onions, Storage under category CS-1-Onion has been introduced. Stacking system can be availed by submitting details of stacking pattern adopted by the applicant. It is not a mezzanine floor/normal racking system and provision of stacking system as a component is to allow stacking of onions in a way which allows free movement of huge quantity of air through onion stocks in the onion stores to prevent sprouting, water losses and shrinkages.

* Bunker Coil System is not allowed refer NOTES on page no. 100.

15. COLD STORAGE TYPE-II (MULTI-COMMODITY/ MULTI-TEMPERATURE)

A cold storage under type-II category (CS-2) are aligned for long term bulk storage for storing of multi-produce in bags, bulk or lots for the purpose of catering to off season demands. This type of storage can also be equipped with Controlled Atmosphere type storage for keeping in produces like apples, etc. The produce can be brought from either packhouses or directly from farms. The produce/commodity classification is as per the attached List-1 (attached at the back of this book).

This can be developed by an individual farmer, FPO, group of farmers or any legal entity, etc. These stores act as place of storage with maintenance of temperature, relative humidity or any further requirement deemed necessary for bulk and long storage. These can be constructed either near the growing areas or at the place of consumption depending upon the requirement and maintaining the necessary chain and connectivity at the back end with either integrated packhouses, aggregation centres or directly with the farms and simultaneously used as part of the distribution network for forward linkages with the consumer centres through a well-connected temperature-controlled supply chain network.

Essentials of Cold Storage Type- II (CS-2):

To identify the cold storage location for the produce that is coming into the store.

- i. Relevant data and information on the production area, type of produce, quality of produce, and connectivity and target market or hubs should be properly recorded and known for utmost utilisation of the facility.
- ii. A Cold Store should be located close to the farm, should provide services to local farmers and should have facilities for pick and drop of produce by way of large or medium size reefer vehicles.
- iii. A Cold Store should be connected to good roads and should be covered properly to prevent from sun, rain and other contaminants from environment.
- iv. A Cold Store should be designed well with sufficient areas for loading and unloading bays. It should have adequate water and electricity supplies and the drainage system should be done in a very well manner and necessary water treatment plant should be used wherever applicable.
- v. A Cold Store should have all the necessary arrangements for safety and other desirables for the comfort of workers and other skilled professionals.
- vi. A Cold Store may also have a weigh scale at the receiving side. (Optional)
- vii. It may be connected to various numbers of aggregation centres, etc. of a farmer produce organisations or any other help groups which allows seamless connectivity of the produce to the Cold stores in the shortest possible time thereby reducing post harvest losses.

Minimum Guidelines to follow:

Cold Storage Construction Features:

- Foundation/slab/columns/pillars/ PEB structure- civil foundation/dock/Cold Store Area/PEB
- Insulation/refrigeration - Cold Chambers (Max. capacity 4999 MT)
- Insulation/finish floor etc. -Floor
- Mezzanine/pallets/racks/crates/bins/bags etc. - Inter-floors
- Insulated doors/strip curtains/air curtains- Doors
- Insulation- Ante room
- Compressors/condensers/pressure vessels/ heat exchangers/electrical panels/ power factor banks etc. -Machine rooms
- Dock levelers/ dock shelters/ dock doors etc.- loading/unloading areas
- Transformers/ DG set/Earthing/Light/lightning arrestors etc. -Electrical installations
- Conveyor belts/ lifts etc. –Mechanisation
- Microprocessors/data loggers/IoT/alternate energy etc.- Automation & energy efficiency
- CCTV/ parking areas / Office block/ Convenience areas – administrative block
- Fire fighting equipments/ fire exits/ fire doors- Safety & Hazard control
- Controlled Atmosphere - CA

Civil Construction for PEB: The foundation has to be designed by certified structural/ civil engineer/ architect/ certified agency. The design shall meet all BIS standards and relevant seismic zone norms for earthquake proof design. The building can be constructed with RCC slab as table top with foundations for PEB structure, docking bays, packaging areas and cold rooms under a suitable Pre-Fabricated shed.

Note:

- Super structure and foundation to be designed by certified structural/ civil engineer/ architect/ certified agency.
- Certification of the building by a certified structural/ civil engineer/ architect/ certified agency should be furnished while applying for subsidy.

In case of pre-fabricated PUF panels when used directly as a **Box-In** option after following necessary standards and safety protocols, necessary safety and stability certification of the building should be done by a certified structural/ civil engineer/ architect/ certified agency.

Special consideration with reference to hanging arrangement of unit coolers from bottom of the PUF insulated ceiling panel with PEB shed, purlins, etc. on top of it-

- Prevent condensation and water leakages through gaps into the cold storage.

- Provision of cat walks for maintenance of pipes, controls, etc. in case of pipes running around the building.
- Installation of ceiling PUF panels below the PEB shed, purlins, etc. with minimum gap between the purlins and the panel.
- Provision of load bearing on the shed structure, especially designing of purlins and trusses.
- Provision of water proofing with chemicals, etc. to prevent water seepage from any civil construction onto the PUF insulation or the PUF insulated ceiling of the cold room.
- Special kind of runners, running alongside the building to allow holding of the PUF panels.
- Sunken floors for laying and fixing of floor insulation in the areas where insulation is to be done.
- Thermal barriers to be made between cold rooms and ante rooms
- The floor levels need to be in level at all the places for easy movement of MHEs.
- Use of material handling lifts which can accommodate both BOPTs and HPTs from basement (in case basement is done) upto the top floor.
- Each mezzanine floor inside the cold chamber to be connected through doors to the ante room at the same level of the mezzanine floor or to a landing area at the same level as that of mezzanine with easy access to fire exits as well as allowing movement of material handling equipments from lifts to the mezzanine floor.
- The landing areas of the ante rooms should be constructed appropriately to handle loads either in civil or in structure with all necessary safety and BIS standards.
- Two stair cases to be made at appropriate ends allowing movement of goods as well as acting as easy escape points. One staircase to be isolated with the cold storage area/ante rooms by fire rated doors which should be ISI/BIS marked for 120 minutes integrity and 30 minutes insulation.



PEB structure: The building should be constructed as per drawings and dimensions indicated. It is recommended to construct such facilities using steel construction/ Pre-Engineered construction confirming to the relevant BIS codes for live load as per IS 875 part – II, wind load as per IS 875 part-III, seismic load as per IS 1893 and other codes and standards as applicable. Also factors like wind, storms, lightning, thunderstorms, hail, heavy rains, snow, etc. should be taken in the safety designs and optimum care has to be taken on these factors to protect the cold room from these hazards. Earthing pits, Earthing, Lighting arrestors need to be installed to ensure safety from electric hazards and protection against fire, etc. The steel structure component /construction sections to be fabricated confirming to relevant codes and standards of ASTM /BIS.

Care needs to be taken in ensuring that this kind of installation uses proper thickness of the panel and does not allow condensation or water dripping due to some part of the PEB structure inside the cold storage and some outside thereby causing thermal shock and allowing leakages. The building should be constructed as per drawings and dimensions indicated confirming to relevant codes and standards of BIS, IS.

In case of truss roof, provisions to be made for fixing insulated panels to the ceiling and support of the cooling unit from the trusses in case of ceiling suspended evaporators/ unit coolers/ cooling units.

Special attention should be given to the hanging arrangement of unit coolers from the trusses to prevent condensation and water leakage through gaps into the cold storage. Joints at the top and access areas should be sealed. Ideally, a catwalk should be provided between the insulated box and the bottom of the PEB structure sheeting, along with ventilation fans. Additionally, special under-deck insulation should be included to lower temperatures in these areas, thereby reducing heat infiltration from the top and contributing to improved energy efficiency.

2. Cold Chambers: (QUALIFICATION FOR CS-2)

Rule no.	Minimum Storage Capacity (MT)	Maximum Storage Capacity (MT)	Balance Storage Capacity other than fixed 6 chambers (MT)	MIDH/NHM Configuration	NHB Configuration
1	1500 (min. 6 chamber x 250 MT = 1500 MT) *	4999 ~ 5000	3500	The applicant has to construct min. 6 chambers of capacity less than 250 MT as described in NCCD Guidelines totaling to 1500 MT capacity. For the balance capacity of 3500 MT, the combination of capacity of chambers in a project can be divided between min. capacity of 500 MT and up to a max. capacity of 1500 MT (per chamber).	NA

2	1500 (min. 6 chamber x 250 MT = 1500 MT) *	20,000	18500	NA	The applicant has to construct min. 6 chambers of capacity less than 250 MT as described in NCCD Guidelines totaling to 1500 MT capacity. (For chamber size configuration of remaining capacity, please refer point 2 (a) and 2 (b).
2 (a)	1500 ~ 1501	10,000	10,000	NA	For the balance capacity from 1501 MT up to a max. of 10,000 MT, the combination of capacity of chambers in a project can be divided between min. capacity of 1500 MT and up to a max. capacity of 2500 MT (per chamber).
2 (b)	10,001	20,000	0	NA	For storage capacity above 10,000 MT up to max. 20,000 MT, the combination of capacity of chamber can be divided up to a max. capacity of 5000 MT per chamber but not less than 1500 MT capacity in any case.

Note: Mezzanine bifurcation inside the chambers would not amount to single chamber and would be considered as 1 chamber from to bottom unless there is proper bifurcation inside the chamber and fulfilling all the criteria in terms of hard flooring, insulated flooring, dedicated refrigeration unit and access doors from the respective floor and connectivity to lifts and fire exits.

The cold chamber is a box of specific size which is constructed with the help of insulation of different thicknesses to maintain temperature, humidity, etc. inside that cold chamber referred to as a cold storage. This cold storage is meant for storing different types of fruits and vegetables and other horticulture products which may or may not require pre-cooling depending upon the requirement to preserve the freshness, quality and shelf life.

These cold storages require adequate refrigeration, air circulation, proper stacking and storage arrangements to achieve the required conditions for maintaining product temperature and other required conditions like humidity, CO₂ levels, Ethylene levels, etc. to enhance the shelf life of the produce.

Efficiency and performance in such stores is vital and depends upon various factors like appropriate storage system, optimizing space, allowing uniform air circulation through the produce, requirement of stock rotation if necessary. This is abundantly important to consider in design so as to allow the economic viability of the cold store as it allows reduction in energy bills, less wastage and maintaining the quality of the produce.

The cold storage consists of components which have been categorized for the purpose of submission in the applications for the purpose availing subsidy following the below specified minimum standards and guidelines under various components:

DETAILED SPECIFICATIONS

1. Cold Store Building- In general, under CS type-II (CS-2) as PEB structures are allowed confirming to relevant BIS codes, fire safety guidelines as per state regulations and BIS standards applicable to buildings.

Sl. No.	Description	Remarks
1	Cold Store Building	The total height of the building including dock or foundation should not be more than 18 mtrs.
		The height of the dock should be not less than 1.06 mtr or as required from the finished road level
		In case of PEB structure holding cold rooms with boxes inside the PEB columns (Box-in type), special Z runners/supports should be placed at every 3~4 mtr. around these structure from the dock level for holding the wall insulation panels securely and tightly. Sufficient space should be provided outside of the foundation of PEB columns in and around dock/platform.
		The PEB building should be constructed as per drawings and dimensions indicated. It is recommended to construct such facilities using steel construction/ Pre-Engineered construction confirming to the relevant BIS codes for live load as per IS 875 part – II, wind load as per IS 875 part-III, seismic load as per IS 1893 and other codes and standards as applicable. Also factors like wind, storms, lightning, thunderstorms, hail, heavy rains, snow, etc. should be taken in the safety designs and optimum care has to be taken on these factors to protect the cold room from these hazards.
		The design should be innovative with appropriate measures taken to ensure use of space with design of sunken floors, inverted beams, as required to allow maximum utilisation of space, minimum cutting of insulation panels, and easy installation for reducing gaps between the joints and preventing loss of cold, disallowing condensation and other problems. Appropriate care to be taken inside the cold storage flooring and use of technology, proper expansion joints

		resins, epoxy, to create smooth floor level and prevent cracking of the floors thereby, not allowing moisture and water to travel upto insulation and creating efficiency issues as well as hazards to building. Suitable grade of concrete example M25, M28, M30 etc. with block testing should be done as per standards and guidelines.
		For all types of construction atleast 1 mandatory service lift/ conveyors/ material hoisting system should be operational from the table-top dock upto the top floor alongwith 2 stair cases on two sides of the building which can be used for loading as well as fire exits. One stair case of the two needs to be placed at the end of the loading/un-loading ante rooms with closure at one end with a rated fire safety door at each floor.
		Preferably, a catwalk should be designed & provided to access areas above the cold storages. These areas should preferably include ventilation fans and special under-deck insulation to lower temperatures in these areas, reducing heat infiltration from the top and improving overall energy efficiency but not mandatory.
		While designing it should be considered to leave appropriate space for movement of fire trucks around the building, loading/unloading trucks, space for utilities like transformers, DG sets, in such a way that it does not hinder operations and possess threat to human safety and well being.

2. 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:

Rigid Polyurethane foam: Chlorofluorocarbon (CFC) free and self-extinguishing and shall conform to IS 12436: 1988.

vacuum Insulated Panels: Conforming to BIS and IS standards

PIR PUF panels: Conforming to BIS and IS standards

Pre Painted Galvanized Iron (PPGI): The PPGI sheet shall have adequate thickness to withstand load and shall have zinc coating of min. 90 Gsm.

Flashing/Accessories: Made of PPGI sheet conforming to IS 14246:2013

Walls & Ceiling: Rigid PUF panels/PIR/VIP

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 / trimix 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

Minimum insulation thickness for various insulation materials

Type of insulation	Material		Wall		Ceiling/ roof U value = 0.24 W/m ² K	Floor U value = 0.29W/m ² K
			External U value = 0.27W/m ² K	Partition U value = 0.58W/m ² K		
	ρ Density Kg/m ³	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

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)

1. FLOOR:

- The floor in the cold rooms should be of base concrete, with kota stone/ epoxy or any other finished floor type inside the floor chambers. Floor insulation slab preferably XPS (EPS not allowed) laid in two layers. The Floor should be cleaned, painted with black japan paint and then laid with 1st layer of vapour barrier which can be either 250 microns tarfelt sheet or polythene sheet of suitable thickness. The vapour barrier should be covered with 1st layer of insulation and overlaid with 2nd layer of insulation in a manner to cut the gaps in the first layer of insulation. The joints can be filled with suitable hot grade bitumen (80:25). The 2nd layer of insulation is then covered with 2nd layer of vapour barrier which would be upto 1 mm thick tar felt or poly felt sheets with 5 mm overlap on the walls.
- The laying of Trimix should be 75 MM to 100 MM thickness with any suitable finish like kota stone, epoxy etc. or any other finish floor. The floor level of the cold storage should match the floor level of the cold store for easy movement of material as well as MHEs. In case of raised floor levels a suitable graded ramp to be either fixed or made outside the door for mechanised movement of the goods.

2. INSULATION & DOORS:

- The Cold Room should be installed in such a way that small HPTs/BOPTs can be used to load/un-load the material mechanically.
- The cold room insulation should be PUF/PIR or any other new environment friendly insulating material of thickness min 100 mm. sandwiched in either pre-painted GI(0.45 mm Min. thickness) or SS(food grade SS-306) sheets.
- The insulated door should be either overlap or inline or sliding but of the same thickness as that of the panel with a view window on the door properly fitted alongwith heater for anti-condensation on the glass. The door should be fitted with strip curtains form inside with 0.5 mm overlap from SS hooks or hangers. The outside of the door should be fitted with air curtains of suitable capacity.
- Minimum door size recommended is 1mtr x 2 mtr ($\pm 5\%$ variation would be accepted on the min recommended size, however the upper size can be selected as per requirement). The no. of doors would be equivalent to no. of mezzanine floors.

3. ANTE ROOMS:

Ante Rooms should be designed on each floor and shall be designed to accommodate stair case, hoists, lifts, fire exits, as per local norms and regulations as applicable on the type of building. Suitable design innovations should be incorporated to accommodate certain ancillaries in these ante rooms however, not jeopardizing the safety of the human.

The interfloors in the ante rooms to have doors to each cold room on each floor. The cold room inner walls can act as ante room walls. The ante room ceiling shall be closed with 60 mm PUF panel insulation and ends closed as far as possible (not mandatory) however, the side on the fire exit side needs to be closed and fitted with fire exit doors.

4. REFRIGERATION:

Energy efficient refrigeration-based systems need to be installed. For any operations which may require temperature condition and humidity condition upto 0°C refrigerants with GWP between 1000 to 1500 to be used. Individual systems would not be allowed above capacities which are 2000 MT or more. In case of any further expansion other than 2000 MT, the same rule shall apply. And no individual refrigeration units for the expansion would be allowed. For further details on expansion please refer chapter no. 23 (Expansion & Modernisation)

5. LOADING/UNLOADING AREA:

Loading and unloading docks shall be designed with RCC slab roof or sheet roofing and these should be wide enough to allow loading and unloading simultaneously when the loading/un-loading area should be bifurcated from the cold room ante rooms by an insulated sliding door.

6. ELECTRICAL INSTALLATIONS:

Suitable step down OLTC transformers (if required) with earthing stations as per requirements, main power distribution panel for refrigeration lighting, electric hoists and lifts, automatic power factor correction panel (APFC), fire fighting equipments, etc.

DG Sets, 1 small and 1 big equalling to the total requirement load in the cold storages. The type of DG sets should be considered as per applicable laws of pollution control board.

7. MECHANISATION:

Appropriate Lifts/ conveyors/ electrical hoists with wire ropes, a steel fabricated cage with guides, and openable doors should be provided for material handling for managing the goods. Material movement can be facilitated using BOPTs for easier access to storage areas on the mezzanine floors, with the materials being transported from hoist, lifts, conveyer etc. through the ante room of the respective mezzanine floor into cold store.

8. UNIFIED CONTROL SYSTEM / AUTOMATION:

Suitable configuration of electrical panels with microprocessors, and HMIs, to be installed on the electrical panels with suitable sensors where, analog input received from all the equipments that is consuming electrical energy is converted into digital output for the purpose of bringing in energy efficiency into the building management system. These microprocessors should be operated with static IPs and allow control and visualisation of cold room temperatures, humidity and other necessary parameters remotely by the authorised person. The microprocessor panel should also control necessary work done in terms of compressors for automatic operations and thereby, reducing the power consumption on the compressors, evaporator fans, pumps, condenser fans, etc. to bring in suitable energy efficiency into the facility.

The IoT based systems should be installed for real time monitoring, tracking and surveillance of the facility remotely. This system is also equipped with early hazard detection and alarm activation protocols.

9. RENEWABLE ENERGY:

The facility should be capable to generate atleast that much amount of the required energy which can run electrical lights, pumps (if possible), fan motors during holding period in daily operations from renewable sources of energy. The energy may be obtained by harnessing solar energy, wind energy, etc. and stored in auxiliary batteries if possible. (Batteries are not mandatory)

10. ADMINISTRATIVE BLOCK:

Every cold store should have a separate admin block equipped with office room, rest rooms, and other amenities which are important to create a comfortable working condition. Clean drinking water and toilets for workers and staff is very important to build in the facility.

11. SAFETY & HAZARD CONTROL:

Provision for handling accidental leakage of refrigerant:

- 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: To be inverter based

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: To be installed as per clearance and requirement of Fire Regulatory authority

e.g.-

DRY TYPE

- i) Dry chemical powder type 5.0 Kg Cap with ISI Mark Fire Extinguisher complete with wall mounting bracket.
- ii) Carbon Di-Oxide (CO₂) type 4.5 Kg. capacity Fire Extinguisher complete with wall mounting bracket.
- iii) G.I. Fire Buckets
- iv) M.S. Stand for Fire Buckets

WATER BASED

- 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

SUBSIDY COMPONENTS DETAIL:

FOR NHM

COMPONENT NO.	DESCRIPTION & NAME	Max. ALLOWABLE QTY./CAPACITY	COST
C-9	<u>Cold Storage type -II (CS-2)</u> are cold storages designed mostly for multi product storage where bulk and long term storage is preferred. They are normally seen in pre-engineered building and certain areas like docks, plant rooms, offices, convenience areas can be constructed with brick and		

	mortar and integrated with the PEB. It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas, loading docks, PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places. Consisting of : i. Construction: Foundation/ slab/ columns/ pillars/ PEB structure ii. Insulation: Walls, Ceiling, Floors, etc. iii. All refrigeration Units iv. Electrical Installations: Transformers/ DG Sets, VFDs, etc. v. Administrative Block: CCTV/ parking areas / Office block/ Convenience areas. vi. Safety & Hazard control: Fire fighting equipments/ fire exits/ fire doors- as per norms and conditions of the building	For PEB Construction of capacity upto 4999 MT ~ 5000 MT capacity	Rs. 12,000
	CO2 SCRUBBER with CO2 MONITORING SYSTEM FOR REMOVAL OF CO2 Mandatory only for those produces generating lot of CO2. E.g.- potato, onions, apples, etc	Max. 1 system/ project	Rs. 10 lakh/system
	Unified Control System- PLC,BMS, IoT, Remote monitoring, etc.	Max. 1 system/ project	Rs. 5 lakh/system
	Conveying/Hoist system/Material Service lifts for material handling of suitable capacity in the anteroom with provision of unloading on common landing near and outside cold rooms. (upto 5000 MT) (refer point no.7)	Max. 1 system/ project	Rs. 5 lakh/system

	Dock Leveller System comprising of: (components of 1 set) A. Dock Leveller B. Dock Door C. Dock Shelter D. Vehicle Barrier/ Hit Alarm	Max. 2 sets	Rs. 8.4 lakh/set
	Material Handling Equipments: HPT above 1 ton	Max. 4 units	Rs. 20000/unit
	BOPT 1 ton and above	Max 2 unit	Rs. 1.5 lakh/ unit
	Doors	Max. 20 doors/ project	Rs. 25000 / door
	Automated computerised system with software for generating QR/bar code labelling, farmers details, date of arrival, variety of the crop at the time of arrival, etc.	Max. 1 system/ project	Rs. 3.5 lakh/system

FOR NHB

COMPONENT NO.	DESCRIPTION & NAME	Max. ALLOWABLE QTY./CAPACITY	COST
C-9	Cold Storage type –II (CS-2) are cold storages designed mostly for multi product storage where bulk and long term storage is preferred. They are normally seen in pre-engineered building and certain areas like docks, plant rooms, offices, convenience areas can be constructed with brick and mortar and integrated with the PEB. It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas, loading docks, PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general	For PEB Construction of capacity between: 5001 to 6500 MT 6501 to 8000 MT	Rs. 11400/MT Rs. 10800/MT

	requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places. Consisting of : i. Construction: Foundation/ slab/ columns/ pillars/ PEB structure ii. Insulation: Walls, Ceiling, Floors, etc. iii. All refrigeration Units iv. Electrical Installations: Transformers/DG Sets, VFDs, etc. v. Administrative Block: CCTV/ parking areas / Office block/ Convenience areas. vi. Safety & Hazard control: Fire fighting equipments/ fire exits/ fire doors- as per norms and conditions of the building	8001 to 10000 MT 10001 to 20000 MT*	Rs. 10200/MT Rs. 5100/MT*
	CO2 SCRUBBER with CO2 MONITORING SYSTEM FOR REMOVAL OF CO2 Mandatory only for those produces generating lot of CO2. E.g.- potato, onions, apples, etc	Max. 1 system/ project	Rs. 10 lakh/ system
	Unified Control System- PLC,BMS, IoT, Remote monitoring, etc.	Max. 1 system/ project	Rs. 5 lakh/ system
	Conveying/Hoist system/material service lift for material handling of suitable capacity in the anteroom with provision of unloading on common landing near and outside cold rooms. (upto max. 20000 MT) (refer point no.7)	Max. 1 system/ project	Rs. 5 lakh/ system
	Dock Leveller System comprising of: (components of 1 set) A. Dock Leveller B. Dock Door C. Dock Shelter D. Vehicle Barrier/ Hit Alarm	Max. 2 sets	Rs. 8.4 lakh/set
	Material Handling Equipments: HPT 1 ton and above BOPT 1 ton and above	Max. 4 units	Rs. 20000 / unit

		Max 2 unit	Rs. 1.5 lakh / unit
	Doors	Max. 30 doors / project	Rs. 25000 / door
	Automated computerised system with software for generating QR/bar code labelling, farmers details, date of arrival, variety of the crop at the time of arrival, etc.	Max. 1 system / project	Rs. 3.5 lakh / system

Technical Evaluation while Claiming Subsidy: The following details need to be submitted for Technical Evaluation while availing subsidy:

SUBMITALS along with DPR/Application:

1. Nomenclature: CS-2/ I F/II F/III F/I Vg/II Vg/III Vg/N X/Y MT/MIDH/NHB- District

- a) CS-2 Stands for COLD STORAGE TYPE-II
- b) I F/II F/III F/I Vg/II Vg/III Vg denotes commodity to be stored. (refer to chapter no. 31-COMMODITIES SPECIFICATIONS)
- c) N X denotes the no. of chambers (e.g.- N 14, N 8, etc.)
- d) Y MT denotes total capacity of the facility (e.g.- 3000 MT, 6540 MT, etc.)
- e) MIDH/NHB denotes under which subsidy scheme the project is being submitted.
- f) –District defines the district where the project is proposed.

2. Basic Data Sheet: Refer to Annexure III at the end of this book. (Basic Data Sheet of Cold Storage (CS-1/CS-1-Onion/CS-2/CS-2-CA/CS-4))

3. Heat Load Calculation Sheet: Enclose detail basis of heat load calculation.

4. Drawings: Enclose sketch with Plan layout and sections showing storage chambers and floor heights clearly.

5. Technical Performance Data Sheets of proposed Refrigeration Equipments, etc. to be installed, to be submitted from the respective equipment manufacturer.

6. Energy Efficiency Sheet: Refer to Annexure VI at the end of this book.

Note:

- i. Follow relevant BIS Codes on safety and Standards
- ii. Please provide relevant structural safety certificate from certified structural engineer, certified architects, certified agencies or certified person relevant to building norms.
- iii. Fire safety norms to be followed as per relevant BIS codes and Standards. Clearance certificate to be provided.
- iv. Environmental Clearance certificate to be provided as per requirement and relevant codes and standards.

- v. In conventional storage, Refrigerants having potential for Ozone Depletion# and GWP ranging more than 1500 (like R22, R404A etc.) are not allowed for temperature range 0° C and above.
- vi. Use of inverter compressor / Digital compressor/ compressors with capacity control/reciprocating or screw compressors with microprocessor based controls should be used with choice of natural refrigerants/ refrigerants as described above should also be considered to promote energy efficiency and sustainable development
- vii. ***For NHB:**

Since, the maximum allowable capacity has been increased upto 20000 MT, for applications under NHB, an additional cost norm of Rs. 5100 (for PEB) (refer C-9) would be applicable above 10001 MT upto 20000 MT, remaining guidelines remains same.

e.g. 1- For PEB construction, say proposed capacity is 10020 MT, therefore cost applicable would be = Rs. 10200 * 10000 (MT) plus(+) Rs. 5100 * 20 (MT)

e.g. 2- For PEB construction say capacity is 18000 MT therefore, cost applicable would be = Rs. 10200 * 10000 (MT) plus(+) Rs. 5100 * 8000 (MT)

*** Bunker Coil System is not allowed refer NOTES on page no. 100.**

NOTE- Add-on Component: To promote renewable energy, applicant can also avail component Alternate Technology as an add-on component (please refer point no.#10 in chapter no. 16- CS-2-CA)

National Centre for Cold-chain Development

16. CONTROLLED ATMOSPHERE (CS-2-CA)

A cold storage under type-II category (CS-2-CA) are aligned for long term bulk storage for storing of multi-produce in bags, bulk or lots for the purpose of catering to off season demands. This type of storage can also be equipped with Controlled Atmosphere type storage for keeping in produces like apples, etc. The produce can be brought from either packhouses or directly from farms. The produce/commodity classification is as per the attached List-1 (attached at the back of this book).

This can be developed by an individual farmer, FPO, group of farmers or any legal entity, etc. These stores act as place of storage with maintenance of temperature, relative humidity or any further requirement deemed necessary for bulk and long storage. These can be constructed either near the growing areas or at the place of consumption depending upon the requirement and maintaining the necessary chain and connectivity at the back end with either integrated packhouses, aggregation centres or directly with the farms and simultaneously used as part of the distribution network for forward linkages with the consumer centres through a well-connected temperature-controlled supply chain network.

Controlled Atmosphere Chamber: CA rooms are Positive pressure gas tight chambers in facilities with precise control over temperature, humidity, Oxygen and CO₂ concentrations. These stores are mostly designed and installed in the growing areas to prevent ripening process and storage disorders mostly in apples. They are mostly helpful in maintaining the desirable flavor, quality, colour and other textural properties for a longer period of time which can extend upto 6 months and more.

CA Storages use oxygen and carbon dioxide concentration of about 1-3% for each gas in most applications. CA chambers are generally multiple chambers where produce is stored in large bins or in PVC crates which can be stacked on mild steel frames to allow maximum usage of space.

The international standard ISO 6949:1988 specifies the extension of keeping period, use of cold storage with the control of relative humidity and temperature, Gas composition in case of climacteric products such as apples, pears, bananas, and tomatoes.

An atmosphere with reduced Oxygen content (1%-2%) and CO₂ content (1%-2%), so that the sum of O₂ and CO₂ in the controlled chamber is less than 21% is generally known as Controlled Atmosphere Chamber. Special equipments are necessary to obtain these concentrations.

Allowed Capacity:

- **National Horticulture Missions (NHM):** Approve projects with a capacity of **4,999 MT ~ 5000 MT (Metric Tons)**.
- **National Horticulture Board (NHB):** Approve projects from **5,001 MT** and upto **20000 MT**.

Essentials of Cold Storage Type- II (CS-2-CA):

- i. The location of the CA chambers has to be in the growing areas only. The CA Chambers are presently recommended only for Apples and need to be set up in apple growing areas only with relevant justification and production details.

- ii. Relevant data and information on the production area, type of produce, quality of produce, and connectivity and target market or hubs should be properly recorded and known for utmost utilisation of the facility.
- iii. A CA Cold Store should be located close to the farm, should provide services to local farmers and should have facilities for pick and drop of produce by way of large or medium size reefer vehicles.
- iv. A CA Cold Store should be connected to good roads and should be covered properly to prevent from sun, rain and other contaminants from environment.
- v. A CA Cold Store should be designed well with sufficient areas for loading and unloading bays. It should have adequate water and electricity supplies and the drainage system should be done in a very well manner and necessary water treatment plant should be used wherever applicable.
- vi. A CA Cold Store should have all the necessary arrangements for safety and other desirables for the comfort of workers and other skilled professionals.
- vii. A CA Cold Store may also have a weigh scale at the receiving side. (Optional)
- viii. It may be connected to various numbers of aggregation centres, etc. of a farmer produce organisations or any other help groups which allows seamless connectivity of the produce to the Cold stores in the shortest possible time thereby reducing post harvest losses.
- ix. In case of new produce which can be stored under CA storages and have proper justification, research/ background details where trials have been conducted on such produces which can be stored under CA and have reasonably impact on the cost during off-season and justifies commercial-economic viability after storage under CA should also be considered either as a pilot but not exceeding more than 2000 MT.
- x. In growing areas where the CA storage capacity exceeds 80% of the capacity of storable grade/variety of apples (e.g.- A++, A+, etc.), new stores should be allowed only after justification by the mission/agency forwarding the proposals. Other new areas in the growing area which allow construction of such stores should be also considered and developed with proper road connectivity and other infrastructure required.

Minimum Guidelines to follow:

Cold Storage Construction Features:

- Foundation/slab/columns/pillars/ PEB structure- civil foundation/dock/Cold Store Area/PEB
- Insulation/refrigeration - Cold Chambers (Max. capacity 4999 MT)
- Insulation/finish floor etc. -Floor
- Mezzanine/pallets/racks/crates/bins/bags etc. - Inter-floors
- Insulated doors/strip curtains/air curtains- Doors
- Insulation- Ante room
- Compressors/condensers/pressure vessels/ heat exchangers/electrical panels/ power factor banks etc. -Machine rooms

- Dock levelers/ dock shelters/ dock doors etc.- loading/unloading areas
- Transformers/ DG set/Earthing/Light/lightning arrestors etc. -Electrical installations
- Conveyor belts/ lifts etc. –Mechanisation
- Microprocessors/data loggers/IoT/alternate energy etc.- Automation & energy efficiency
- CCTV/ parking areas / Office block/ Convenience areas – administrative block
- Fire fighting equipments/ fire exits/ fire doors- Safety & Hazard control
- Controlled Atmosphere equipments – CO2 scrubber, N2 generators, Gas Tightening, CA Doors, Stacking system, etc.

Civil Construction for PEB: The foundation has to be designed by certified structural/ civil engineer/ architect/ certified agency. The design shall meet all BIS standards and relevant seismic zone norms for earthquake proof design. The building can be constructed with RCC slab as table top housing, foundations for PEB structure, docking bays, packaging areas and cold rooms under a suitable pre-fabricated shed.

Note:

- Super structure and foundation to be designed by certified structural/ civil engineer/ architect/ certified agency.
- Certification of the building by a certified structural/ civil engineer/ architect/ certified agency should be furnished while applying for subsidy.

In case of pre-fabricated PUF panels when used directly as a **Box-In** option after following necessary standards and safety protocols, necessary safety and stability certification of the building should be done by a certified structural/ civil engineer/ architect/ certified agency.

Special consideration with reference to hanging arrangement of unit coolers from bottom of the PUF insulated ceiling panel with PEB shed, purlins, etc. on top of it-

- Prevent condensation and water leakages through gaps into the cold storage.
- Provision of cat walks for maintenance of pipes, controls, etc. in case of pipes running around the building.
- Installation of ceiling PUF panels below the PEB shed, purlins, etc. with minimum gap between the purlins and the panel.
- Provision of load bearing on the shed structure, especially designing of purlins and trusses.
- Provision of water proofing with chemicals, etc. to prevent water seepage from any civil construction onto the PUF insulation or the PUF insulated ceiling of the cold room.
- Special kind of runners, running alongside the building to allow holding of the PUF panels.
- Sunken floors for laying and fixing of floor insulation in the areas where insulation is to be done.
- Thermal barriers to be made between cold rooms and ante rooms
- The floor levels need to be in level at all the places for easy movement of MHEs.
- The landing areas of the ante rooms should be constructed appropriately to handle loads either in civil or in structure with all necessary safety and BIS standards.
- Two stair cases to be made at appropriate ends allowing movement of goods as well as acting as easy escape points. One staircase to be isolated with the cold storage area/ante rooms by

fire rated doors which should be ISI/BIS marked for 120 minutes integrity and 30 minutes insulation.

PEB structure: The building should be constructed as per drawings and dimensions indicated. It is recommended to construct such facilities using steel construction/ Pre-Engineered construction confirming to the relevant BIS codes for live load as per IS 875 part – II, wind load as per IS 875 part-III, seismic load as per IS 1893 and other codes and standards as applicable. Also factors like wind, storms, lightning, thunderstorms, hail, heavy rains, snow, etc. should be taken in the safety designs and optimum care has to be taken on these factors to protect the cold room from these hazards. Earthing pits, Earthing, Lighting arrestors need to be installed to ensure safety from electric hazards and protection against fire, etc. The steel structure component /construction sections to be fabricated confirming to relevant codes and standards of ASTM /BIS.

Care needs to be taken in ensuring that this kind of installation uses proper thickness of the panel and does not allow condensation or water dripping due to some part of the PEB structure inside the cold storage and some outside thereby causing thermal shock and allowing leakages. The building should be constructed as per drawings and dimensions indicated confirming to relevant codes and standards of BIS, IS and certified by structural engineer or relevant agency.

In case of truss roof, provisions to be made for fixing insulated panels to the ceiling and support of the cooling unit from the trusses in case of ceiling suspended evaporators/ unit coolers/ cooling units.

Special consideration should be given to the hanging arrangement of unit coolers from the trusses to prevent condensation and water leakage through gaps into the cold storage. Joints at the top and access areas should be sealed, and a catwalk should be provided if needed, particularly in the case of CS-2-CA.



2. Cold Chambers: (QUALIFICATION FOR CS-2-CA)

Rule no.	Minimum Storage Capacity (MT)	Maximum Storage Capacity (MT)	Balance Storage Capacity other than fixed 6 chambers (MT)	MIDH/NHM Configuration	NHB Configuration
1	1500 (min. 6 chamber x 250 MT = 1500 MT) *	4999 ~ 5000	3500	The applicant has to construct min. 6 chambers of capacity less than 250 MT as described in NCCD Guidelines totaling to 1500 MT capacity. For the balance capacity of 3500 MT, the combination of capacity of chambers in a project can be divided between min. capacity of 500 MT and up to a max. capacity of 1500 MT (per chamber).	NA
2	1500 (min. 6 chamber x 250 MT = 1500 MT) *	20,000	18500	NA	The applicant has to construct min. 6 chambers of capacity less than 250 MT as described in NCCD Guidelines totaling to 1500 MT capacity. (For chamber size configuration of remaining capacity, please refer point 2 (a) and 2 (b).
2 (a)	1501	10,000	10,000	NA	For the balance capacity from 1501 MT up to a max. of 10,000 MT, the combination of capacity of chambers in a project can be divided between min. capacity of 1500 MT and up to a max. capacity of 2500 MT (per chamber).

2 (b)	10,001	20,000	0	NA	For storage capacity above 10,000 MT up to max. 20,000 MT, the combination of capacity of chamber can be divided up to a max. capacity of 5000 MT per chamber but not less than 1500 MT capacity in any case.

Note: Mezzanine bifurcation inside the chambers would not amount to single chamber and would be considered as 1 chamber from inside the ceiling to bottom (finish floor level).

Note: For calculation purposes in CA Storage for apple: 4.4 Cu. Mtr. is considered as 1MT

The cold chamber is a box of specific size which is constructed with the help of insulation of different thicknesses to maintain temperature, humidity, etc. inside that cold chamber referred to as a cold storage. This cold storage is meant for storing different types of fruits and vegetables and other horticulture products which may or may not require pre-cooling depending upon the requirement to preserve the freshness, quality and shelf life.

These cold storages require adequate refrigeration, air circulation, proper stacking and storage arrangements to achieve the required conditions for maintaining product temperature and other required conditions like humidity, CO₂ levels, Ethylene levels, etc. to enhance the shelf life of the produce.

Efficiency and performance in such stores is vital and depends upon various factors like appropriate storage system, optimizing space, allowing uniform air circulation through the produce, requirement of stock rotation if necessary. This is abundantly important to consider in design so as to allow the economic viability of the cold store as it allows reduction in energy bills, less wastage and maintaining the quality of the produce.

The cold storage consists of components which have been categorized for the purpose of submission in the applications for the purpose availing subsidy following the below specified minimum standards and guidelines under various components:

DETAILED SPECIFICATIONS

Cold Store Building- In general, under CS type-II (CS-2-CA) as PEB structures are allowed confirming to relevant BIS codes, fire safety guidelines as per state regulations and BIS standards applicable to buildings.

Sl. No.	Description	Remarks
1	Cold Store Building	The total height of the building including dock or foundation should not be more than 18 mtrs.
		The height of the dock should be not less than 1.06 mtr or as required from the finished road level
		In case of PEB structure holding cold rooms with boxes inside the PEB columns (Box-in type), special Z runners/supports should be placed at every 3-4 mtr. around these structure from the dock level for holding the wall insulation panels securely and tightly. Sufficient space should be provided outside of the foundation of PEB columns grooved on dock/platform.
		The PEB building should be constructed as per drawings and dimensions indicated. It is recommended to construct such facilities using steel construction/ Pre-Engineered construction confirming to the relevant BIS codes for live load as per IS 875 part – II, wind load as per IS 875 part-III, seismic load as per IS 1893 and other codes and standards as applicable. Also factors like wind, storms, lightning, thunderstorms, hail, heavy rains, snow, etc. should be taken in the safety designs and optimum care has to be taken on these factors to protect the cold room from these hazards.
		The design should be innovative with appropriate measures taken to ensure use of space with design of sunken floors, inverted beams, as required to allow maximum utilisation of space, minimum cutting of insulation panels, and easy installation for reducing gaps between the joints and preventing loss of cold, disallowing condensation and other problems. Appropriate care to be taken inside the cold storage flooring and use of technology, proper expansion joints resins, epoxy, to create smooth floor level and prevent cracking of the floors thereby, not allowing moisture and water to travel upto insulation and creating efficiency issues as well as hazards to building. Suitable grade of concrete example M25, M28, M30 etc. with block testing should be done as per standards and guidelines.
		Preferably, a catwalk should be designed & provided to access areas above the cold storages. These areas should preferably include ventilation fans and special under-deck insulation to lower temperatures in these areas, reducing heat infiltration from the top and improving overall energy efficiency but not mandatory.
		While designing it should be considered to leave appropriate space for movement of fire trucks around the building, loading/unloading trucks, space for utilities like transformers, DG sets, in such a way that it does not hinder operations and possess threat to human safety and well being.

2. 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:

Rigid Polyurethane foam: Chlorofluorocarbon (CFC) free and self-extinguishing and shall conform to IS 12436: 1988.

vacuum Insulated Panels: Conforming to BIS and IS standards

PIR PUF panels: Conforming to BIS and IS standards

Pre Painted Galvanized Iron (PPGI): The PPGI sheet shall have adequate thickness to withstand load and shall have zinc coating of min. 90 Gsm.

Flashing/Accessories: Made of PPGI sheet conforming to IS 14246:2013

Walls & Ceiling: Rigid PUF panels/PIR/VIP

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

Minimum insulation thickness for various insulation materials

Type of insulation	Material		Wall		Ceiling/ roof U value = 0.24 W/m ² K	Floor U value = 0.29W/m ² K
			External U value = 0.27W/m ² K	Partition U value = 0.58W/m ² K		
	ρ Density Kg/m ³	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

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)

1. FLOOR:

- The floor in the cold rooms should be of base concrete, with kota stone/ epoxy or any other finished floor type inside the floor chambers. Floor insulation slab preferably XPS (EPS not allowed) laid in two layers. The Floor should be cleaned, painted with black japan paint and then laid with 1st layer of vapour barrier which can be either 250 microns tarfelt sheet or polythene sheet of suitable thickness. The vapour barrier should be covered with 1st layer of insulation and overlaid with 2nd layer of insulation in a manner to cut the gaps in the first

layer of insulation. The joints can be filled with suitable hot grade bitumen (80:25). The 2nd layer of insulation is then covered with 2nd layer of vapour barrier which would be upto 1 mm thick tar felt or poly felt sheets with 5 mm overlap on the walls.

- The laying of Trimix should be 75 MM to 100 MM thickness with any suitable finish like epoxy etc. or any other finish floor conforming to standards which does not allow leakage from the floor. The floor level of the cold storage should match the floor level of the cold store for easy movement of material as well as MHEs. In case of raised floor levels a suitable graded ramp to be either fixed or made outside the door for mechanised movement of the goods.
- The Cold Room should be installed in such a way that small HPTs/BOPTs can be used to load/un-load the material mechanically.

2. INSULATION & DOORS:

- The cold room insulation should be PUF/PIR or any other new environment friendly insulating material of thickness min 100 mm. sandwiched in either pre-painted GI(0.45 mm Min. thickness) or SS(food grade SS-306) sheets.
- Minimum door size recommended is 1mtr x 2 mtr ($\pm 5\%$ variation would be accepted on the min recommended size, however the upper size can be selected as per requirement).

3. ANTE ROOMS:

Ante Rooms should be designed in such a way to accommodate opening of CA chambers, stair case, hoists, lifts, fire exits, as per local norms and regulations as applicable on the type of building. Suitable design innovations should be incorporated to accommodate certain ancillaries in these ante rooms however, not jeopardizing the safety of the human.

The ante room ceiling shall be closed with 60 mm PUF panel insulation and ends closed as far as possible however, the side on the fire exit side needs to be closed and fitted with fire exit doors confirming to the fire norms.

4. REFRIGERATION:

Energy efficient refrigeration-based systems need to be installed. For any operations which may require temperature condition and humidity condition up to 0°C refrigerants with GWP between 1000 to 1500 to be used. Individual systems would not be allowed above capacities which are 2000 MT or more. In case of any further expansion other than 2000 MT, the same rule shall apply. And no individual refrigeration units for the expansion would be allowed. For further details on expansion please refer chapter no. 23 (Expansion & Modernisation)

CS-2-CA Components:

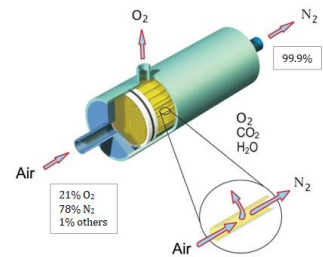
A. CA generator:

- N2 generator:** The workhorse of the CA system, the N2 generator, utilizes a technology called Pressure Swing Adsorption (PSA) to separate nitrogen from compressed air. Here's how it works with screw compressors:

- **Air Intake & Compression:** Ambient air is drawn in by a powerful screw compressor, which significantly increases its pressure.
- **Molecular Sieve Beds:** The compressed air is then directed through vessels containing a special material called a molecular sieve. These sieves have a strong affinity for oxygen molecules.
- **Separation:** As the air passes through the sieve beds, oxygen gets preferentially adsorbed, allowing nitrogen-enriched gas to flow through.
- **PSA Cycle & Regeneration:** The system employs multiple sieve beds that alternate between adsorption and regeneration phases. This ensures a continuous supply of high-purity nitrogen.

Screw compressors provide several advantages in N₂ generation:

- **High Efficiency:** They offer superior energy efficiency compared to other compressor types.
- **Reliability:** Screw compressors are known for their robust design and long-term reliability.
- **Continuous Operation:** They can deliver a constant stream of compressed air, crucial for uninterrupted N₂ production.



Hollow fibre membranes (semi-permeable) are used to filter out oxygen from atmospheric air, allowing for a nitrogen rich output from the membrane cylinder. Nitrogen purity up-to 99.99% is obtained. (Our atmosphere is 78% nitrogen and available in abundance, making it suitable as the purging medium for obtaining low oxygen levels in a chamber)

ii. **CO₂ Absorbers/Scrubber:** While N₂ generation lowers oxygen levels, CO₂ management is equally important. Produce naturally releases CO₂ during respiration. CO₂ absorbers play a critical role in maintaining the optimal CO₂ concentration within the cold store. Common CO₂ absorption technologies include:

- **Chemical Scrubbers:** These use specific chemical solutions that react with and remove CO₂ from the air stream.
- **Membrane Separators:** These employ selective membranes that allow CO₂ to pass through while blocking other gases.

The choice of CO₂ absorber depends on factors like desired CO₂ removal rate, cost-effectiveness, and environmental considerations.

iii. **Analysers:** The "eyes" of the CA system, the analyser continuously monitors the gas composition within the cold storage. It typically measures oxygen, carbon dioxide, and sometimes nitrogen levels. This real-time data is fed back to the control system, which then adjusts the N₂ generation or CO₂ removal processes to maintain the desired gas levels.

Precise gas analysis is crucial for several reasons:

- **Maintaining Optimal Conditions:** It ensures that the correct gas composition is achieved and maintained for the specific produce being stored.
- **Preventing Product Damage:** Deviations from the desired gas levels can lead to spoilage or loss of quality.
- **Optimizing Efficiency:** Real-time data allows for adjustments to minimize N₂ generation or CO₂ removal when not required.



B. Specialised CA Doors: Within controlled atmosphere (CA) storage facilities, CA doors function as a critical access point while simultaneously safeguarding the meticulously controlled gaseous environment. Unlike standard cold storage doors, CA doors are specifically designed to achieve an impenetrable seal, preventing the ingress of ambient air and the egress of the precisely controlled gas mixture.

CA doors are meticulously engineered components featuring several key elements:

- **Door Skin:** High-density, low-permeability materials like 304 stainless steel or composite panels with closed-cell polyurethane (PU) foam core are preferred. These materials offer exceptional structural integrity, minimizing deflection and ensuring a tight seal.
- **Sealing Mechanisms:** Multi-layered gasket systems employing elastomeric materials with low gas permeation coefficients are paramount. Common choices include silicone and fluoroelastomers (FKM) due to their excellent resistance to O₂ and CO₂. Two primary sealing mechanisms are employed:
 - **Compression Seals:** Continuously compressed gaskets, achieved mechanically (spring-loaded) or pneumatically (positive pressure systems), create a form-fitting seal against the door frame.
 - **Labyrinth Seals:** Interlocking channels within the door frame and on the door itself create a tortuous path that hinders gas molecule permeation.
- **Inspection Windows:** Double or triple-paned windows with inert gas (e.g., argon) filling the gap between panes allow for visual inspection without compromising the atmosphere. These windows are often constructed with a heated perimeter to prevent condensation at low temperatures.
- **Pressure Relief Valves:** Safety features that release excess pressure buildup within the chamber in case of accidental malfunctions.
- **Door Activation Systems:** Manual, automatic, or semi-automatic opening mechanisms are chosen based on operational needs and throughput requirements.

C. Gas Tightening: Maintaining a consistent, low-temperature environment within a cold storage facility is paramount for preserving food and other perishables. Even minor refrigerant leaks can disrupt temperature control, leading to spoilage, increased energy consumption, and potential environmental hazards. Gas tightening systems are the silent guardians, ensuring a leak-proof environment for optimal cold storage operation.

Component Breakdown: While the core principles remain similar, gas tightening systems for cold storage have specific component choices optimized for the unique challenges of this environment:

- **CA Primer:** As before, a CA primer can enhance adhesion on metal surfaces commonly used in cold storage construction. However, consider primers specifically formulated for low-temperature applications to ensure proper adhesion at sub-zero temperatures.
- **Film/Fleece:** It's a material with exceptional gas barrier properties for common refrigerants like ammonia, HFCs and carbon dioxide, etc. The layer boasts excellent thermal insulation, reflecting heat radiation back into the cold storage space, improving energy efficiency.
- **Elastomeric Paint:** Elastomeric paint fills minor gaps and irregularities on uneven surfaces, enhancing overall gas tightness. However, ensure the chosen paint offers excellent low-temperature flexibility to maintain a proper seal throughout the cold storage operating range. It is also applied around pipe connections for an extra layer of sealing, particularly for rigid connections that might experience slight movement due to thermal cycling



D. Dock Leveler System:

A dock leveler system is a combination of integrated components that bridge the gap between a warehouse floor and a docked trailer, specifically designed to minimize thermal intrusion and

maintain a cold storage environment. It goes beyond a simple adjustable ramp and encompasses various elements working together for optimal performance.

This combination of integrated components consists of:

- a. Dock Levelers
- b. Dock Shelter
- c. Dock Door
- d. Vehicle Barrier/ Hit Alarms

For detailed description refer to chapter no. 17 (DOCK LEVELER SYSTEM)

E. Integrated Specialized Packaging Machines/Lines with Farm Code Labeling:

Automated packaging lines/machines should be installed to manufacture in-house corrugated packaging boxes of various sizes and strengths, including categories 3, 5, 7, and 9-ply, with both single and double walls. The boxes should feature farm code labeling for traceability, including the arrival farm and date of arrival. Each package should have a QR code that includes the packhouse information, dispatch date, and other relevant details such as washing, grading, and other processes the produce has undergone. Additionally, an **automated computerized system** with software should be in place to generate QR/barcode labels, capturing farmers' details, the date of arrival, and the crop variety at the time of arrival at the CA store.

NOTE: In case **Automated computerised system** with software for generating QR/bar code labelling, farmers details, date of arrival, variety of the crop at the arrival of the Integrated Packhouse/Aggregation Centre then, only automated packaging line can be installed at the CA Store.

F. High Reach Handling Equipment:

Specialized material Handling equipment comprising of: (components of one set)

- A. Fork Lifts
- B. Battery Operated Pallet Truck
- C. Hand Pallet Trucks

G. Advanced Grader:

Computerized, Optical Grading Lines (Imported/Indigenous) alongwith other components like conveyors, belts, washer, waxers, exits, packaging & inspection station (indigenous/imported) integrated and tested duly by manufacturers before site installation.

For detailed description of components of Advanced Grader refer to chapter no. 26 (WASHING, SORTING, GRADING LINES)

H. Stacking System:

The Stacking System pertains to storage structures like racks, bins, mezzanine and pallets designed to hold unitized cargo during storage and transportation. These structures are

crafted from materials such as metal, plastic, or wood, meeting specifications suitable for temperature-controlled conditions.

For detailed description of components of Stacking System refer to chapter no. 19 (STACKING SYSTEM)

5. LOADING/UNLOADING AREA:

Loading and unloading docks shall be designed with RCC slab roof or sheet roofing and these should be wide enough to allow loading and unloading simultaneously when the loading/un-loading area should be bifurcated from the cold room ante rooms by an insulated sliding door.

6. ELECTRICAL INSTALLATIONS:

Suitable OLTC step-down transformers (if required) with mandatory earthing stations as per requirements, main power distribution panel for refrigeration lightning, electric hoists and lifts, automatic power factor correction panel (APFC), fire fighting equipments, etc.

DG Sets, 1 small and 1 big equalling to the total requirement load in the cold storages. The type of DG sets should be considered as per applicable laws of pollution control board.

7. MECHANISATION:

Suitable High reach material handling equipment to be used for shifting, loading etc of produce. (Refer chapter no. 18- Material Handling Equipments)

8. UNIFIED CONTROL SYSTEM / AUTOMATION:

Suitable configuration of electrical panels with microprocessors, and HMIs, to be installed on the electrical panels with suitable sensors where, analog input received from all the equipments that is consuming electrical energy is converted into digital output for the purpose of bringing in energy efficiency into the building management system, These microprocessors should be operated with static IPs and allow control and visualisation of cold room temperatures, humidity and other necessary parameters remotely by the authorised person. The microprocessor panel should also control necessary work done in terms of compressors for automatic operations and thereby, reducing the power consumption on the compressors, evaporator fans, pumps, condenser fans, etc. to bring in suitable energy efficiency into the facility.

The IoT based systems should be installed for real time monitoring, tracking and surveillance of the facility remotely. This system is also equipped with early hazard detection and alarm activation protocols.

9. RENEWABLE ENERGY:

The facility should be capable to generate at least that much amount of the required energy which can run electrical lights, pumps (if possible), fan motors during holding period in daily operations from renewable sources of energy. The energy may be obtained by harnessing solar energy, wind energy, etc. and stored in auxiliary batteries if possible. (Batteries are not mandatory)

10. ADMINISTRATIVE BLOCK:

Every cold store should have a separate admin block equipped with office room, rest rooms, and other amenities which are important to create a comfortable working condition. Clean drinking water and toilets for workers and staff is very important to build in the facility.

11. SAFETY & HAZARD CONTROL:

Provision for handling accidental leakage of refrigerant:

- 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: To be inverter based
- 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: To be installed as per clearance and requirement of Fire Regulatory authority

Eg.-

DRY TYPE

- i) Dry chemical powder type 5.0 Kg Cap with ISI Mark Fire Extinguisher complete with wall mounting bracket.
- ii) Carbon Di-Oxide (CO₂) type 4.5 Kg. capacity Fire Extinguisher complete with wall mounting bracket.
- iii) G.I. Fire Buckets
- iv) M.S. Stand for Fire Buckets

WATER BASED

- 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

SUBSIDY COMPONENTS DETAIL:

FOR NHM

COMPONENT NO.	DESCRIPTION & NAME	Max. ALLOWABLE QTY./CAPACITY	COST
C-10	<u>Controlled Atmosphere Storage type –II-CA (CS-2-CA)</u> are cold storages designed for controlled atmosphere storage where bulk, short and long term storage is preferred as required. These storages should be equipped with all necessary equipments to maintain		

	and monitor the required concentration of N₂, CO₂ and O₂ levels along with temp and humidity control. They are normally seen in pre-engineered building and certain areas like docks, plant rooms, offices, convenience areas can be constructed with brick and mortar and integrated with the PEB. It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas, loading docks, PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places. Consisting of : i. Construction: Foundation/ slab/ columns/ pillars/ PEB structure ii. Insulation: Walls, Ceiling, Floors, etc. iii. All refrigeration Units iv. Electrical Installations: Transformers/DG Sets, VFDs, etc. v. Administrative Block: CCTV/ parking areas / Office block/ Convenience areas. ii. Safety & Hazard control: Fire fighting equipments/ fire exits/ fire doors- as per norms and conditions of the building	For PEB Construction of capacity upto 4999 MT ~ 5000 MT capacity	Rs. 12,000
	Automated computerised system with software for generating QR/bar code labelling, farmers details, date of arrival, variety of the crop at the time of arrival, etc.	Max. 1 system/project	Rs. 3.5 lakh/system

CA Components for NHM:

S. NO.	COMPONENT	DESCRIPTION	MAX. ALLOWABLE QTY./CAPACITY	PRICE/ UNIT
1	CA GENERATORS	Should essentially include sensors, pressure equalising equipment, controls comprising:	Max. 2 units/ project	Rs. 150 lakh/unit
		A. N2 Generator with screw compressor		
		B. CO2 Absorber		
		C. Analyser, piping valves etc.		
2	Specialized CA doors	Specialized CA Doors for maintaining positive pressure inside the chambers and leakages	Max. 20 Doors / project	Rs. 3 lakh / Door
3	Gas Tightening (New Component)	Gas Tightening system comprising of	Upto Max. 5000 MT / project	Rs.2000/ MT
		A. CA primer for both walls and floor		
		B. Film/Fleece (Double layer on the joints)		
		C. Elastomeric Paint etc		
4	Unified Control System	Electronic and electrical logic controls for machinery & equipment, lots, sensors indicators, building management system etc	Max. one system/ project	Rs. 5 lakh / system
5	Dock Leveler System	Docking equipment comprising of -	Max. 3 units / project	Rs. 8.4 lakh / unit
		A. Dock Leveler		
		B. Dock Door		
		C. Dock Shelter		
		D. Vehicle Barrier/ Hit Alarm		
6	Integrated Specialized Packaging machines/ lines with farm code labeling.	Automated packaging lines/ machines to make in-house labeling and packaging boxes of various sizes and strength as per categories 3, 5, 7 & 9 ply. Both single & double walls with farm code labeling, i.e. arrival farm (traceability) and date of arrival. QR code of pack house & date showing dispatch and other relevant details the produce has gone through like washing, grading, etc.	Max. one system/ project	Rs. 15 lakh / system
7	High Reach handling equipment	Specialized material Handling equipment comprising of:	Max. 2 sets / project	Rs. 25 lakh/set
		A. Fork Lifts		
		B. Battery Operated Pallet Truck		
		C. Hand Pallet Trucks		

8	Advanced Grader (New Component)	Computerized, Optical Grading Lines (Imported/Indigenous) alongwith other components like conveyors, belts, washer, waxers/dryers, exits, packaging tables & inspection station (indigenous/imported) integrated and tested duly by manufacturers before site installation. The system should have atleast 30% made in India components.	5 MT/hr output line with max. upto 5000 MT	Rs. 5000/MT
9	Stacking System	Racking system include Bins, Pallets and storing systems inside CA chambers for storing and holding material	Max. 5000 MT	Rs. 2000 / MT
#10	Alternate technology (Vapour absorption, Solar, hybrids, etc.)	Vapour Absorption/ Phase change material/, Solar PV panels or Solar Thermal system	As applicable	Rs. 35 lakh / project

FOR NHB

COMPONENT NO.	DESCRIPTION & NAME	Max. ALLOWABLE QTY./CAPACITY	COST
C-10	<u>Controlled Atmosphere Storage type –II- CA (CS-2-CA)</u> are cold storages designed for controlled atmosphere storage where bulk, short and long term storage is preferred as required. These storages should be equipped with all necessary equipments to maintain and monitor the required concentration of N₂, CO₂ and O₂ levels along with temp and humidity control. They are normally seen in pre-engineered building and certain areas like docks, plant rooms, offices, convenience areas can be constructed with brick and mortar and integrated with the PEB. It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas, loading docks, PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general	For PEB Construction of capacity between: 5001 to 6500 MT 6501 to 8000 MT 8001 to 10000 MT 10001 to 20000 MT*	Rs. 11400/MT Rs. 10800/MT Rs. 10200/MT Rs. 5100/MT*

	requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places. Consisting of : i. Construction: Foundation/ slab/ columns/ pillars/ PEB structure ii. Insulation: Walls, Ceiling, Floors, etc. iii. All refrigeration Units iv. Electrical Installations: Transformers/DG Sets, VFDs, etc. v. Administrative Block: CCTV/ parking areas / Office block/ Convenience areas. vi. Safety & Hazard control: Fire fighting equipments/ fire exits/ fire doors- as per norms and conditions of the building		
	Automated computerised system with software for generating QR/bar code labelling, farmers details, date of arrival, variety of the crop at the time of arrival, etc.	Max. 1 system / project	Rs. 3.5 lakh / system

CA add-ons for NHB:

S. NO.	COMPONENT	DESCRIPTION	MAX. ALLOWABLE QTY./CAPACITY	PRICE/UNIT
1	CA GENERATORS	Should essentially include sensors, pressure equalising equipment, controls comprising:	Max. 2 units/ project	Rs. 150 lakh/unit
		A. N2 Generator with screw compressor		
		B. CO2 Absorber		
		C. Analyser, piping valves etc.		
2	Specialised CA doors	Specialized CA Doors for maintaining positive pressure inside the chambers and leakages	Max. 30 Doors / project	Rs. 3 lakh / Door
3	Gas Tightening (New Component)	Gas Tightening system comprising of	Upto Max. 6250 MT / project	Rs.2000/ MT
		A. CA primer for both walls and floor		

		B. Film/Fleece (Double layer on the joints)		
		C. Elastomeric Paint etc		
4	Unified Control System	Electronic and electrical logic controls for machinery & equipment, lots, sensors indicators, building management system etc	Max. one system/ project	Rs. 5 lakh / system
5	Dock Leveler System	Docking equipment comprising of -		
		A. Dock Leveler	Max. 3 units / project	Rs. 8.4 lakh / unit
		B. Dock Door		
		C. Dock Shelter		
		D. Vehicle Barrier/ Hit Alarm		
6	Integrated Specialised Packaging machines/ lines with farm code labeling.	Automated packaging lines/ machines to make in-house labeling and packaging boxes of various sizes and strength as per categories 3, 5, 7 & 9 ply. Both single & double walls with farm code labeling, i.e. arrival farm (traceability) and date of arrival. QR code of pack house & date showing dispatch and other relevant details the produce has gone through like washing, grading, etc.	Max. one system/ project	Rs. 15 lakh / system
7	High Reach handling equipment	Specialized material Handling equipment of:	Max. 2 sets / project	Rs. 25 lakh/set
		A. Fork Lifts		
		B. Battery Operated Pallet Truck		
		C. Hand Pallet Trucks		
8	Advanced Grader (New Component)	Computerized, Optical Grading Lines (Imported/ Indigenous) alongwith other components like conveyors, belts, washer, waxers/ dryers, exits, packaging tables & inspection station (indigenous /imported) integrated and tested duly by manufacturers before site installation. The system should have atleast 30% made in India components.	Min. 3 MT/hr. Max. 5 MT/hr output line with max. upto 5000 MT/project	Rs. 5000/MT
9	Stacking System	Racking system include Bins, Pallets and storing systems inside CA chambers for storing and holding material	Max. 5000 MT/project	Rs. 2000 / MT
#10	Alternate technology (Vapour absorption, Solar, hybrids, etc.)	Vapour Absorption/ Phase change material/, Solar PV panels or Solar Thermal system	As applicable	Rs. 35 lakh / project

Technical Evaluation while Claiming Subsidy: The following details need to be submitted for Technical Evaluation while availing subsidy:

SUBMITALS along with DPR/Application:

1. Nomenclature: CS-2-CA/ I F/II F/III F/I Vg/II Vg/III Vg/N X/Y MT/MIDH/NHB- District

- a) CS-2-CA Stands for COLD STORAGE TYPE-II Controlled Atmosphere
- b) I F/II F/III F/I Vg/II Vg/III Vg denotes commodity to be stored. (refer to chapter no. 31-COMMODITIES SPECIFICATIONS)
- c) N X denotes the no. of chambers (e.g.- N 14, N 8, etc.)
- d) Y MT denotes total capacity of the facility (e.g.- 3000 MT, 6540 MT, etc.)
- e) MIDH/NHB denotes under which subsidy scheme the project is being submitted.
- f) –District defines the district where the project is proposed.

2. Basic Data Sheet: Refer to Annexure III at the end of this book. (Basic Data Sheet of Cold Storage (CS-1/CS-2/CS-2-CA/CS-4))

3. Heat Load Calculation Sheet: Enclose detail basis of heat load calculation.

4. Drawings: Enclose sketch with Plan layout and sections showing storage chambers and floor heights clearly.

5. Technical Performance Data Sheets of proposed Refrigeration Equipments, etc. to be installed, to be submitted from the respective equipment manufacturer.

6. Energy Efficiency Sheet: Refer to Annexure VI at the end of this book.

Note:

- i. Follow relevant BIS Codes on safety and Standards
- ii. Please provide relevant structural safety certificate from certified structural engineer, certified architects, certified agencies or certified person relevant to building norms.
- iii. Fire safety norms to be followed as per relevant BIS codes and Standards. Clearance certificate to be provided.
- iv. Environmental Clearance certificate to be provided as per requirement and relevant codes and standards.
- v. In conventional storage, Refrigerants having potential for Ozone Depletion# and GWP ranging more than 1500 (like R22, R404A etc.) are not allowed for temperature range 0° C and above.
- vi. Use of inverter compressor / Digital compressor/ compressors with capacity control/reciprocating or screw compressors with microprocessor based controls should be used with choice of natural refrigerants/ refrigerants as described above should also be considered to promote energy efficiency and sustainable development
- vii. **For NHB:**

Since, the maximum allowable capacity has been increased upto 20000 MT, for applications under NHB, an additional cost norm of Rs. 5100 (for PEB) (refer C-10) would be applicable above 10001 MT upto 20000 MT, remaining guidelines remains same.

e.g. 1- For PEB construction, say proposed capacity is 10020 MT, therefore cost applicable would be = Rs. 10200 * 10000 (MT) plus(+) Rs. 5100 * 20 (MT)

e.g. 2- For PEB construction say capacity is 18000 MT therefore, cost applicable would be = Rs. 10200 * 10000 (MT) plus(+) Rs. 5100 * 8000 (MT)

NOTE- Add-on Component: To promote renewable energy, applicant can also avail component Alternate Technology as an add-on component (please refer point no.#10 in this chapter).

* Bunker Coil System is not allowed refer NOTES on page no. 100.



17. DOCK LEVELER SYSTEM

A dock leveler system is a combination of integrated components that bridge the gap between a warehouse floor and a docked trailer, specifically designed to minimize thermal intrusion and maintain a cold storage environment. It goes beyond a simple adjustable ramp and encompasses various elements working together for optimal performance.

The "Dock levelers" component requires electrical and hydraulic/pneumatic operations for the leveler, along with an associated dock door and necessary safety controls. The major admissible items under this component are:

1. Vehicle Barrier/Hit Alarm:

- i. **Component Definition:** A safety device installed at the dock opening to prevent accidental trailer impact with the building structure or equipment.

- ii. **Types:**

- a. **Mechanical barriers:** These physical barriers actuate upon contact with the trailer, typically a hinged bar that swings up or a retractable post that rises from the floor. They offer a simple and reliable solution.
- b. **Electronic hit alarms:** These utilize sensors, such as radar or ultrasonic, to detect approaching trailers and trigger an audible or visual warning (e.g., flashing light) before contact is made. They can be more sophisticated, offering adjustable sensitivity zones to avoid false alarms from pedestrians or forklifts.



- iii. **Technical Specifications:**

- a. **Barrier strength:** Should be rated to withstand the impact of a moving trailer, typically based on industry standards
- b. **Hit alarm sensitivity:** Adjustable to avoid triggering from everyday warehouse traffic but ensure detection of approaching trailers at a safe distance.
- c. **Warning signals:** Clear and audible (if applicable) to effectively alert dockworkers of an impending impact.



- iv. **Selection Guidelines:**

- a. Consider traffic volume and trailer size when choosing barrier strength. Facilities with heavier or faster-moving trailers may require higher-rated barriers.
- b. Select hit alarms with features suitable for the noise level of the dock environment. In very loud environments, visual alarms may be more effective.

2. Adjustable Ramp (Dock Leveler):

- i. **Component Definition:** A platform that bridges the gap between the warehouse floor and the trailer bed, allowing for safe and efficient movement of goods using forklifts, pallet jacks, and other material handling equipment. The platform must have appropriate anti-slip surface and the dimension considered is 3m x 2.5m. Smaller sizes would have a lower unit cost. A point load capacity of 6 tons is considered. The cost norms do not restrict the user from using higher capacity or design criteria. A plinth height of 1.2 mtrs is recommended norm for using levelers.

- ii. **Types:**

- a. **Hydraulic dock levelers:** Most common, utilize hydraulic cylinders for smooth and powerful lifting and lowering. They offer precise control and a wide range of working heights.
- b. **Mechanical dock levelers:** Manual operation using a hand crank or foot pedal, ideal for low-traffic areas or budget constraints. They are typically slower to operate and require more physical effort.
- c. **Air-powered dock levelers:** Utilize compressed air for operation, quieter than hydraulic models and require less maintenance. However, they may be slower and have a lower lifting capacity compared to hydraulic models.
- d. **Vertical storage dock levelers (VSLs):** Specifically designed for cold storage, store vertically within the building envelope when not in use, minimizing thermal transfer.



- iii. **Technical Specifications:**

- a. **Load capacity:** To match the heaviest expected loads on the dock, typically ranging from 5 MT to 10 MT or more.
- b. **Working range:** The vertical distance the leveler platform can travel to accommodate varying trailer heights. Standard ranges are typically 6 inches to 36 inches.
- c. **Lip length:** The length of the hinged platform extension that bridges the gap between the leveler and the trailer bed. This should ensure proper contact with different trailer sizes to prevent tipping hazards.



- iv. **Selection Guidelines:**

- a. Choose the leveler type based on traffic volume, budget, and desired operation speed. Hydraulic levelers offer the best combination of efficiency and power for most cold storage applications.
- b. Ensure the leveler's working range and lip length are compatible with the trailers used at the facility. Consider future trailer size expectations when making a selection.

3. Dock Door:

- i. **Component Definition:** A specialized door that seals the opening between the warehouse and the outside environment, helping to maintain the cold storage temperature. An opening size of 2.5 meters x 3 meters with a motorised sectional door is considered for the purpose of these cost norms.

ii. **Types:**

- a. **Sectional overhead doors:** Composed of insulated panels that slide vertically for opening and closing. These are the most common type in cold storage due to their excellent insulation properties. Panels are typically constructed with metal skins and a core of insulating material like polyurethane foam. The higher the R-value of the insulation core, the better the thermal resistance.

- b. **High-speed roll-up doors:** Made of a flexible curtain material that rolls up quickly for fast opening and closing. Ideal for high-traffic areas but offer less insulation compared to sectional doors due to the thinner material and air gaps between the slats.

- iii. **Bi-folding doors:** Two hinged sections that fold open to the sides, offering a wider opening but less insulation than sectional doors. These are typically used in maintenance applications or for oversized loads.

a. **Technical Specifications:**

- **Insulation value (R-value):** This rating indicates the door's resistance to heat transfer. Higher R-values are crucial for cold storage applications, typically ranging from R-16 to R-40 or higher.
- **Door opening speed and size:** Door opening speed should be considered based on traffic volume and desired efficiency. However, prioritize good insulation even if it means a slightly slower opening speed. Door size needs to accommodate the width and height of the largest trailers expected at the facility.
- **Safety features:** Look for doors with self-repairing edges that prevent pinching injuries and emergency breakaway mechanisms that allow the door to detach upon impact, preventing damage to the building structure and equipment.



b. **Selection Guidelines:**

- Prioritize high insulation value doors (R-value) for cold storage applications. Aim for a door R-value that aligns with the overall target temperature of the cold storage facility.
- Consider door opening speed based on traffic volume and desired efficiency. Balance speed with the need for maintaining a good seal.
- Choose doors with appropriate safety features to prevent injuries and protect the building structure.

4. Dock Shelter:

a. **Component Definition:** An inflatable or fabric enclosure that creates a temporary seal between the trailer and the building during loading/unloading operations. This helps to minimize warm air infiltration and maintain the cold chain.

b. **Types:**

- i. **Inflatable dock shelters:** Filled with compressed air to create a tight seal around the trailer. They offer the most effective sealing but require a compressed air supply system.
- ii. **Fabric dock shelters:** Made of heavy-duty fabric with weighted sides to maintain a seal against the trailer. They are a more cost-effective option but may not provide as tight a seal as inflatables.

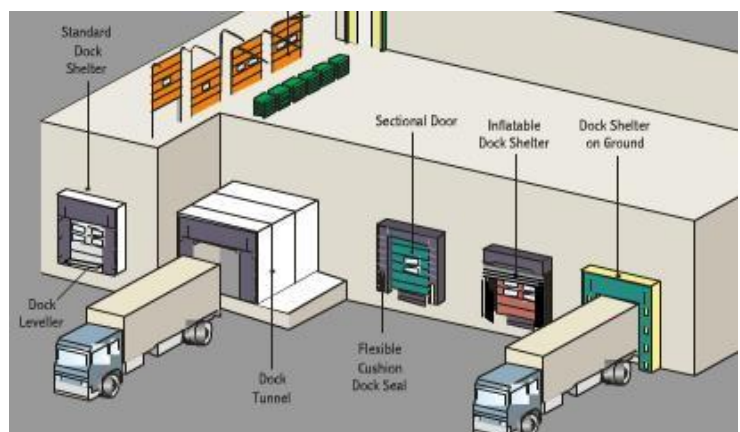
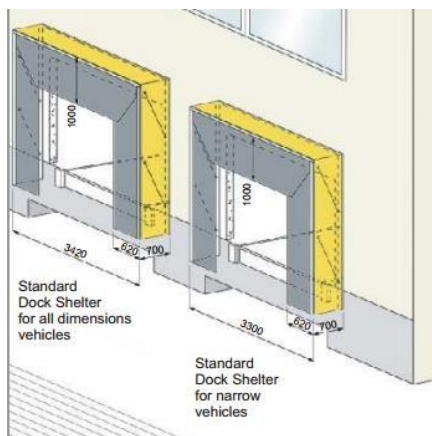


c. **Technical Specifications:**

- i. **Size:** The dock shelter needs to be large enough to fully encompass the trailer opening for optimal sealing, typically with adjustable head and side curtains for different trailer sizes.
- ii. **Durability:** The material should be able to withstand wind, weather conditions, and everyday wear and tear in the warehouse environment.
- iii. **Compatibility with the dock leveler:** Ensure the chosen dock shelter can properly integrate with the specific VSL model used at the facility, particularly regarding the head curtain design and attachment method.

d. **Selection Guidelines:**

- i. Inflatable shelters offer a tighter seal but require an additional compressed air system and ongoing maintenance.
- ii. Fabric shelters are a more cost-effective option but may not provide as tight a seal, impacting cold chain efficiency.
- iii. Ensure compatibility between the dock shelter and the chosen VSL model for proper operation and sealing.



18. MATERIAL HANDLING EQUIPMENT

A Material Handling Truck is a powered industrial lift vehicle featuring a vertically elevating load carriage frame and horizontal load forks designed for the lifting and positioning of pallets and wooden bins. These trucks are powered either by an internal combustion engine or an electric motor powered by a battery.

Technical Description: The term "Material Handling Truck" encompasses the following components:

1. **Truck Frame:** This includes axles, wheels, counterweights, and the power source attachment.
2. **Power Source:** Equipped with a backup battery for uninterrupted operation or I.C. Engine.
3. **Carriage:** The component to which forks or other attachments are mounted.
4. **Forks:** These enable the operator to lift and move pellets.
5. **Battery Bank:** Supplies the necessary energy for the truck's operation.

All relevant standards and norms applicable to such vehicles must be adhered to.

Hand Pallet Truck (HPT):



- **Function:** Manually maneuver and lift palletized goods over short distances.
- **Power Source:** Manually operated by pushing and pulling levers.
- **Capacity:** Typically 2-3 tons.
- **Lifting Height:** Limited, usually around 20 cm.
- **Cost:** Most affordable.
- **Advantages:** Compact, maneuverable in tight spaces, easy to operate, low maintenance.
- **Disadvantages:** Not suitable for heavy loads or high lifting, requires manual effort, can be physically demanding.

Forklift:



- **Function:** Lift, transport, and stack palletized goods over long distances and to high heights.
- **Power Source:** Engine-powered (gas, diesel, LPG) or electric.
- **Capacity:** Wide range, from 1 ton to 50 tons or more.
- **Lifting Height:** Can reach several meters.
- **Cost:** Expensive.
- **Advantages:** Versatile, handles heavy loads and high lifts, efficient for long distances.
- **Disadvantages:** Bulky, less maneuverable, requires operator training, higher maintenance costs.

Battery Operated Pallet Truck (BOPT):



- **Function:** Similar to HPT but powered by a battery for lifting and moving palletized goods.
- **Power Source:** Rechargeable battery.
- **Capacity:** Typically 2-3 tons.
- **Lifting Height:** Limited, usually around 20 cm.
- **Cost:** More expensive than HPT but less than a forklift.
- **Advantages:** Easier to operate than HPT, less physically demanding, quieter and emission-free, can handle slightly heavier loads than HPT.
- **Disadvantages:** Not as versatile as a forklift, limited lifting height and requires battery charging.

ELECTRICAL HOISTS:



An electrical hoist system is a type of material handling equipment that uses electric motors to lift, lower, and move heavy objects. They are commonly used in industrial settings, warehouses, and construction sites

Key components of an electrical hoist system:

- **Motor:** The motor provides the power to lift and lower the load.
- **Gearbox:** The gearbox reduces the motor's speed and increases its torque, allowing it to lift heavy loads.
- **Chain or rope:** The chain or rope is used to connect the load to the hoist.
- **Hook:** The hook is used to attach the load to the chain or rope.
- **Trolley:** The trolley allows the hoist to move horizontally along a beam or track.
- **Control panel:** The control panel is used to operate the hoist, including controlling the lifting speed and direction.



Types of electrical hoist systems:

- **Chain hoists:** Chain hoists use a chain to lift the load. They are typically used for lighter loads.
- **Wire rope hoists:** Wire rope hoists use a wire rope to lift the load. They are typically used for heavier loads.

Key Considerations for Cold Storage Hoists:

- **Low-Temperature Performance:** Components must be resistant to cold temperatures, preventing issues like:
 - **Lubricant Freezing:** Specialized lubricants are needed to maintain smooth operation at low temperatures.
 - **Metal Embrittlement:** Materials must be selected to withstand the increased brittleness at low temperatures.
 - **Electrical Component Failure:** Insulation and wiring must be designed to withstand cold conditions.
- **Corrosion Resistance:** The cold, humid environment can accelerate corrosion. Components like hooks, chains, and structural elements must be made of corrosion-resistant materials (e.g., stainless steel).
- **Condensation Control:** Temperature fluctuations can cause condensation, potentially damaging electrical components. Adequate ventilation and drainage are essential.
- **Safety Features:**
 - **Emergency Stop:** A reliable emergency stop button is crucial for immediate response in case of malfunctions.
 - **Overload Protection:** Prevents overloading the hoist, which could lead to equipment failure or accidents.
 - **Limited-Swing Hooks:** Reduce the risk of swinging loads that could damage products or injure personnel.

CONVEYOR SYSTEMS:



Conveyor systems are indispensable in cold storage facilities, streamlining material handling operations and enhancing efficiency. These systems are specifically designed to operate reliably in low-temperature environments while maintaining product integrity and worker safety.

Key Considerations for Cold Storage Conveyors:

- **Low-Temperature Performance:** Components must withstand freezing temperatures without compromising functionality. This includes:
 - **Belt Materials:** Belts should be made of materials that remain flexible and durable at low temperatures, preventing cracking or stiffening.
 - **Roller and Bearing Lubrication:** Specialized lubricants are needed to ensure smooth operation and prevent freezing.
 - **Motor and Gearbox Protection:** Motors and gearboxes may require heaters or insulation to maintain optimal operating temperatures.
- **Corrosion Resistance:** The cold, humid environment can accelerate corrosion. Components should be made of stainless steel or other corrosion-resistant materials.
- **Hygiene and Sanitation:** Regular cleaning is crucial to maintain hygiene standards. Conveyors should be easy to clean and sanitize, with smooth surfaces to prevent product contamination.
- **Product Protection:** Conveyors must handle products gently to prevent damage, especially for delicate or frozen items.

Common Types of Conveyors Used in Cold Stores:

- A. Roller Conveyors:** Simple and versatile, used for moving products along straight paths or inclines.



Roller Conveyor in a Cold Storage

- B. Belt Conveyors:** Ideal for transporting products over longer distances or on inclines. Belts can be made of various materials to suit different product types.



Belt Conveyor in a Cold Storage

- C. Chain Conveyors:** Durable and suitable for heavy loads or products that require precise positioning.



Chain Conveyor in a Cold Storage

- D. Modular Belt Conveyors:** Flexible and adaptable, allowing for easy customization to suit specific layout requirements.



Modular Belt Conveyor in a Cold Storage

Specialized Features for Cold Storage Conveyors:

- **Heated Enclosures:** For critical components like motors and gearboxes, heated enclosures can maintain optimal operating temperatures.
- **Anti-icing Systems:** Prevent ice buildup on components, ensuring smooth operation.
- **Sanitary Designs:** Rounded corners and smooth surfaces minimize product contamination and facilitate cleaning.

By carefully selecting and maintaining conveyor systems, cold storage facilities can optimize material flow, reduce labor costs, and ensure the safe and efficient handling of temperature-sensitive products.

Recommendations/Remarks: The subsidy aims to encourage the adoption of such Equipment for mechanizing cold chain operations. These trucks facilitate efficient and rapid movement of goods within cold storage facilities.

The High Reach trucks must be meticulously designed to achieve optimal reach height and lifting capabilities. Additional safety features specific to using this equipment should be installed on-site. It is advisable to incorporate spare parts and a battery charging station (as required), situated outside of food storage areas.

19. STACKING SYSTEM

The Stacking System pertains to storage structures like racks, bins, and pallets designed to hold unitized cargo during storage and transportation. These structures are crafted from materials such as metal, plastic, or wood, meeting specifications suitable for temperature-controlled conditions.

Technical Description: The "Stacking System" component consists of the following elements:

- A. **Pallets:** These are fork-lift-handled base platforms designed for storing packaged produce in unit loads, reaching heights of up to 2.1 meters and accommodating a total load of 1 ton. They are typically standardized in dimensions, enabling multi-tiered racked storage. (Refer IS 17427:2020). Generally, size of 48" x 40" with deck board 3 ½" wide and 5/16" thick.
- B. **Bins:** These fork-lift-handled storage boxes can handle loads of up to 3 tons per box. Constructed with a nesting design, they allow direct stacking, one on top of the other. Bins are primarily used for non-packaged bulk storage.



- C. **Racking System:** This is a multi-tiered framework, typically made of coated metal, intended for storing unitized cargo loads. The engineering design specifies the total safe load and the stress the strut-based structure can withstand. Such a storage system permits the concurrent use of multiple products under compatible temperature conditions in shared chambers.



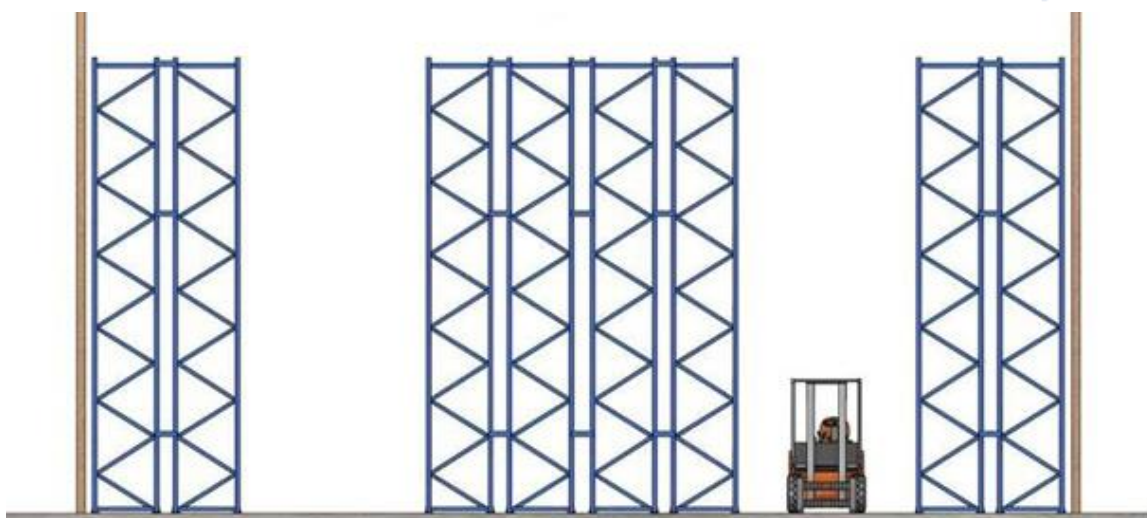
Types of Racking System:

A. Pallet Racking: Most common system and Suitable for storing palletized goods of various sizes and weights.

- i. **Selective Pallet Racking:** Selective pallet racking is the most commonly used pallet racking system. These systems are called “selective” because they allow users to select any pallet load from the pallet racking system without having to move any other pallets. Ideal for high picking activity.



- ii. **Double Deep Racking:** Double deep pallet racking is ideal for high storage density requirements. The system uses two bays of racks that can be accessed by double reach trucks or other such modified equipment. Maximizes space but requires a forklift with a reach mast.



- iii. **Drive-In Racking:** Instead of traditional pallet rack bays, pallets rest on rails that protrude into the open bay from both sides. The rail design allows the forklift to drive into the system to place and retrieve pallets. Forklifts drive directly into the lanes to load and unload pallets, minimizes

aisle space but not ideal for picking individual items. The construction material should be of Galvanized steel with cold-resistant coating for durability in freezing temperatures.



- iv. **Pallet flow racking:** This type of racking system uses gravity to move pallets. Pallets are loaded onto the top of the rack and then flow down to the front of the rack as they are picked. This is a good system for storing items that are first-in, first-out (FIFO). This consists of high-density storage structures formed by slightly sloped channels with rollers that enable pallets to slide into place. Palletized loads are inserted in the highest part of the channel and move by gravity to the opposite end, where they are ready to be removed.



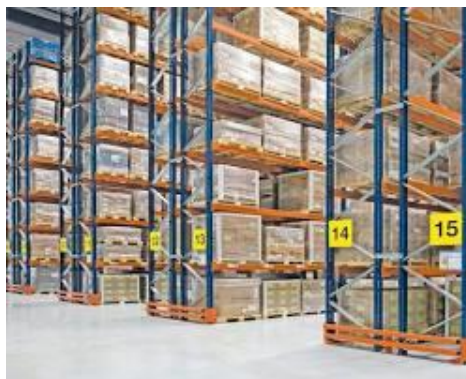
- v. **Push-back racking:** This type of racking system is similar to pallet flow racking, but it uses a series of carts that push the pallets back as new pallets are loaded. This is a good system for storing items that are last-in, first-out (LIFO).



- vi. **Cantilever racking:** This type of racking system is used to store long, bulky items that cannot be stored on pallets. Cantilever racking consists of arms that extend out from a wall or upright.



- vii. **Shuttle Racking:** This is a semi-automated storage system that uses a shuttle carriage to move pallets within the rack structure. This system is ideal for high-density storage applications where access to individual pallets is not required frequently.



B. Mobile Racking: Mobile Pallet Racking (AR Mobile) is a system where the pallet racks are placed on chassis or mobile bases guided through fixed tracks on the floor. Pallet racks are mounted on rails, movable with an electric motor. This system eliminates aisles when not in use, increases storage density by up to 70%, ideal for seasonal inventory fluctuations. But this system is more complex and expensive than static racking, requires regular maintenance of the rails and motors.



C. Automated Storage and Retrieval Systems (AS/RS): This component refers to a computer-controlled system for automatically storing and retrieving goods from defined storage locations. This is based on the technique of using an automatic system to manage processes to reduce human interaction achieved by Computer-controlled cranes and shuttles which move pallets or boxes within the racking system. This is highly efficient and space-saving, minimizes manual labor, and improves accuracy and product traceability. But involves high initial investment, complex maintenance, and not suitable for all product types.



Factors to Consider when Choosing a Stacking System for a Cold Store:

- **Product types and weights:** Consider the size, weight, and temperature sensitivity of the goods.
- **Storage capacity and space constraints:** Choose a system that maximizes storage density while ensuring efficient access.
- **Picking frequency and requirements:** Select a system that optimizes picking speed and accuracy for your specific needs.
- **Budget and operational costs:** Consider the initial investment, maintenance costs, and potential labor savings.

20. COLD STORAGE TYPE-III (RIPENING CHAMBER)

A cold storage under type-III category (CS-3) is aligned for Ripening of fruits and vegetables upto desired ripeness. Ripening is the process by which fruits attain their desirable flavor, quality, colour and other textural property. The produce/commodity classification is as per the attached List-1 (attached at the back of this book).

A ripening chamber within the cold chain is a meticulously controlled environment crafted for the swift ripening of fruits. Equipped with precision controls for temperature, humidity, and ethylene gas, these chambers establish ideal conditions. They not only guarantee consistent ripening but also shield fruits from external influences, playing a pivotal role in maintaining quality throughout the supply chain. Modern ripening facilities are prominently employed for ripening bananas and extend their utility to various other fruits such as mangoes, avocados, kiwis, tomatoes, pears, etc.

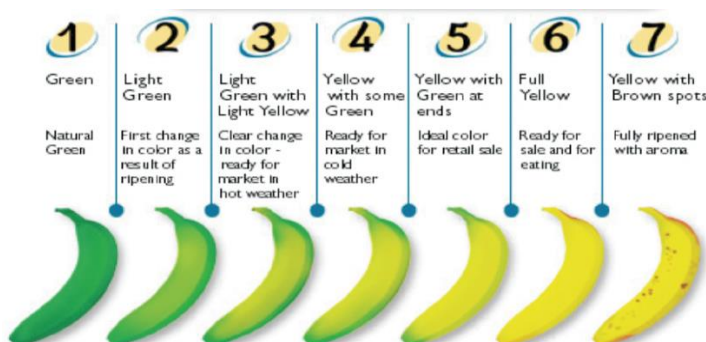
Fruits are ripened with ethylene exposure at certain prescribed Temperature and Relative Humidity level of 90-95%. Following is broad guide for fruit ripening condition.

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://postharvest.ucdavis.edu/produce/producefacts/fruits>, <http://fruit-ripening.com>

Banana Ripening Chart

Temperature in 0° Celsius Ripening Period		Daily Ripening Chart							
4 Days	18°	18°	16 1/2°	15 1/2°	14 1/2°				
5 Days	16 1/2°	16 1/2°	16 1/2°	16 1/2°	15 1/2°	14 1/2°			
6 Days	16 1/2°	16 1/2°	15 1/2°	15 1/2°	14 1/2°	14 1/2°	14 1/2°		
7 Days	15 1/2°	15 1/2°	15 1/2°	15 1/2°	14 1/2°	14 1/2°	14 1/2°	14 1/2°	
8 Days	14 1/2°	14 1/2°	14 1/2°	14 1/2°	14 1/2°	14 1/2°	14 1/2°	14 1/2°	14 1/2°
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	



Fruit Ripening is a developmental process which allows changes in colour, smell, flavor, etc. In fruit ripening regulation of ethylene plays a crucial role. Ethylene is a hormone which when triggered accelerates the process of ripening in many fruits. The process of ripening also involves conversion of starch into sugar, fruit texture which makes fruit edible, aroma which allows fruit to become palatable and distinct flavor.

In addition to hormonal regulation of ethylene temperatures, humidity, CO₂ etc. plays a major role in accelerating or delaying the process of ripening.

In various fruits, which tend to ripen naturally after post harvest, increase in respiration and ethylene rates also pushes the ripening process.

In fruits like mangoes, etc. heat treatment is done which allows destroying of micro organism, though it may cause change in colour and texture.

Artificial Ripening/ Induced Scientific Ripening:

Various types of artificial fruit ripening are done to make the fruit palatable because of their very limited shelf life after the harvest which results in post harvest and financial losses to growers and sellers. Therefore, in order to resolve the problem of distribution and to meet the demands of the markets, the certain fruits are ripened artificially depending upon their nature and sensitivity to ethylene, temperature, CO₂, respiration, humidity, etc.

The main ripening agent that is used to ripen the fruits is ETHYLENE, though ethylene is produced naturally in these fruits and therefore allows accelerating the process of artificial ripening.

PLEASE REFER GUIDANCE NOTE No. 04/2018 AND ITS UPDATED VERSION PUBLISHED BY FSSAI ON “ARTIFICIAL RIPENING OF FRUITS”. (Annexure X)

CLASSIFICATION ON THE BASIS OF FRUIT RIPENING BEHAVIOUR

On the basis of ripening behavior, 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 handling. 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, tomato 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.

SPECIAL APPLICATION FOR MANGO:

VHT stands for Vapor Heat Treatment. It's a quarantine treatment method used to eliminate pests like fruit flies from mangoes before exporting them to countries with strict phytosanitary regulations.

How VHT Works:

1. **Heating:** Mangoes are placed in a sealed chamber and exposed to hot, saturated water vapor.
2. **Temperature Control:** The temperature and humidity inside the chamber are carefully controlled to ensure the internal temperature of the mangoes reaches a specific level (usually around 46°C).
3. **Dwell Time:** The mangoes are held at this temperature for a specific duration to kill the pests.
4. **Cooling:** After the treatment, the mangoes are cooled down gradually to prevent damage.

Benefits of VHT:

- **Pest Elimination:** Effectively kills fruit fly eggs and larvae.
- **Preserves Quality:** Minimizes damage to the mangoes compared to other treatments.
- **Environmental Friendly:** Doesn't involve the use of harmful chemicals.
- **Market Access:** Enables export of mangoes to countries with strict quarantine regulations.

Important Considerations:

- **Timing:** VHT must be applied at the right stage of fruit maturity to avoid damage.
- **Temperature Control:** Precise temperature control is crucial to ensure pest elimination without harming the fruit.
- **Cooling:** Proper cooling is necessary to prevent post-treatment damage.

By undergoing VHT, mangoes can meet the stringent import requirements of countries like Japan, South Korea, and Australia, expanding market access for Indian mango exporters.

CLASSIFICATION OF FRUITS:

CLIMATRIC FRUITS	NON-CLIMATRIC FRUITS
mango, banana, papaya, guava, sapota, kiwi, persimmon, fig, apple, passion fruit, apricot, plum, tomato and pear	citrus, pineapple, grape, strawberry, pomegranate, lichi, watermelon and cherry

Types & Components of Ripening Chambers:

	Non- Pressurised Ripening	Pressurised Ripening
1	Building- CIVIL and PEB with docking area for loading/unloading.	Building- CIVIL and PEB with docking area for loading/unloading.
2	Receiving Area- comprising of area within the premises which allows receipt of raw fruits for cutting, washing and crating.	Receiving Area- comprising of area within the premises which allows receipt of raw fruits for cutting, washing and crating.

	In case of bananas coming packed in CFB boxes from the source, washing & crating would not be necessary.	In case of bananas coming packed in CFB boxes from the source, washing & crating would not be necessary.
3	PUF insulated cold rooms, insulated floor, insulated doors, etc.	PUF insulated cold rooms, insulated floor, insulated doors, etc. The insulated cold rooms have a system of false ceiling or annular space created above the cold rooms which holds cooling coils placed in such a way that the air is sucked through these coils and routed into the cold room by way of spaces/cut outs in the cold room ceiling and pushing cold air through annular spaces between wall and palletised crates/ CFB boxes with or without air inlet locking system to isolate the boxes or pallets. The technical arrangement may vary and should be followed in accordance to design consideration of pressurised ripening system.
4	Ceiling mounted evaporators/ unit coolers, etc. for maintaining uniform air circulation, temperature, humidity.	Special air flow system running through the depth of the chamber mounted on the ceiling which generates desired static pressure and allows suction from the centre.
5	Multi-compressor rack system/ individual condensing unit/ centralised chillers/ ammonia systems, etc.	Multi-compressor rack system/ individual condensing unit/ centralised chillers/ ammonia systems, etc.
6	Ethylene distribution system- ethylene generator or ethylene gas bank system.	Ethylene distribution system- ethylene generator or ethylene gas bank system.
7	Ventilation System – automatic to keep CO₂ within limits with the help of CO₂ analyser and controller Automatic Ventilation system works with a dual inlet/discharge dampers with fan to allow fresh air within the room when the concentration of CO₂ exceeds the desired limit.	Ventilation System – automatic to keep CO₂ within limits with the help of CO₂ analyser and controller Automatic Ventilation system works with a dual inlet/discharge dampers with fan to allow fresh air within the room when the concentration of CO₂ exceeds the desired limit. The placement etc. can vary and should be chosen as per requirement.
8	Crates/Bins etc.	Pallets, CFB boxes stacked in single or in multi tier system
9	HPTs	HPTs, Fork Lifts in case of multi tier
10	Weigh scale, firmness tester, refractometer, sizer and callipers and produce knife.	Weigh scale, firmness tester, refractometer, sizer and callipers and produce knife.
11	Electrical panels, lighting, earthing and power backup (DG Set)	Electrical panels, lighting, earthing and power backup (DG Set)
12	Ripening Management System (RMS)	Ripening Management System (RMS)

Essentials of Cold Storage Type- III (CS-3):

- i. To identify the Ripening Chamber location for the produce that is coming into the facility.
- ii. Relevant data and information on the production area, type of produce, quality of produce, and connectivity and target market or hubs should be properly recorded and known for utmost utilisation of the facility.
- iii. A Ripening Chamber should be connected to good roads and should be covered properly to prevent from sun, rain and other contaminants from environment.
- iv. A Ripening Chamber should be designed well with sufficient areas for easy movement of MHEs. It should have adequate water and electricity supplies and the drainage system should be done in a very well manner and necessary water treatment plant should be used wherever applicable.
- v. A Ripening Chamber should have all the necessary arrangements for safety and other desirables for the comfort of workers and other skilled professionals.
- vi. A Ripening Chamber should also have useful appliances and instruments such as weigh scale, firmness tester, refractometer, sizer and callipers and produce knife.

Minimum Guidelines to follow:

For NHM

For Qualifying under CS-3, the first criteria is that the applicant needs to make chambers of either equal sizes or different sizes of insulation not less than 60 - 120 mm of capacity maximum upto 300 MT.

The minimum chamber size should be 10 MT and not exceeding 30 MT per chamber.

For NHB

For Qualifying under CS-3, the first criteria is that the applicant needs to make chambers of either equal sizes or different sizes of insulation not less than 60 - 120 mm of capacity maximum upto 300 MT.

The minimum chamber size should be 15 MT and not exceeding 30 MT per chamber.

Note: Please note that for Cold Storage Type-III (CS-3), 11 cu. mtr. of storage space is considered equivalent to 1 MT of ripening capacity for both NHM & NHB.

DETAILED SPECIFICATIONS & GUIDELINES

1. Civil Construction:

Super structure and foundation to be designed by certified structural/ civil engineer/ architect/ certified agency. The design shall meet all BIS standards and relevant seismic zone norms for earthquake proof design. The building can be constructed either with brick walls with RCC slab at top.

In case pre-fabricated PUF/PIR panels are used directly as a box in option after following necessary standards and safety protocols, PEB structures are allowed after due consideration to structural stability and design & certification of the building by a certified structural/ civil engineer/ architect/ certified agency.

- Prevent condensation and water leakages through gaps into the cold storage.
- Installation of ceiling PUF panels below the RCC slab with minimum gap between the slab and the panel.
- Provision of inverted beams in the slabs allowing plain RCC slab from the bottom.
- Provision of water proofing with chemicals, etc. to prevent water seepage from RCC slab onto the PUF insulated ceiling of the cold room.
- Special kind of runners, running alongside the building to allow holding of the PUF panels.
- Extension of RCC slab around the building to prevent rain water to hit the panel directly and causing seepage and damage.
- Sunken floors for laying and fixing of floor insulation in the areas where insulation is to be done.
- Thermal barriers to be made between cold rooms and ante rooms
- The floor levels need to be in level at all the places for easy movement of MHEs.
- Use of material handling units.

2. PEB structure: The building should be constructed as per drawings and dimensions indicated. It is recommended to construct such facilities using steel construction/ Pre-Engineered construction confirming to the relevant BIS codes for live load as per IS 875 part – II, wind load as per IS 875 part-III, seismic load as per IS 1893 and other codes and standards as applicable. Also factors like wind, storms, lightning, thunderstorms, hail, heavy rains, snow, etc. should be taken in the safety designs and optimum care has to be taken on these factors to protect the ripening cold room from these hazards. Earthing pits, Earthing, Lighting arrestors need to be installed to ensure safety from electric hazards and protection against fire, etc. The steel structure component /construction sections to be fabricated confirming to relevant codes and standards of ASTM /BIS.

Care needs to be taken in ensuring that this kind of installation uses proper thickness of the panel and does not allow condensation or water dripping due to some part of the PEB structure inside the cold storage and some outside thereby causing thermal shock and allowing leakages. The building should be constructed as per drawings and dimensions indicated confirming to relevant codes and standards of BIS, IS, etc.

For truss roofs, provisions should be made to securely fix insulated panels to the ceiling and to support the cooling units, particularly in the case of ceiling-suspended evaporators, unit coolers, or cooling units. Special attention must be given to the hanging arrangement of these unit coolers to prevent condensation and water leakage through gaps into the cold storage. Proper sealing of joints and careful design of the suspension system are essential to maintain the integrity of the storage environment.

3. 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:

- **Rigid Polyurethane foam:** Chlorofluorocarbon (CFC) free and self-extinguishing and shall conform to IS 12436: 1988.
- **Vacuum Insulated Panels:** Conforming to BIS and IS standards
- **PIR PUF panels:** Conforming to BIS and IS standards
- **Pre Painted Galvanized Iron (PPGI):** The PPGI sheet shall have adequate thickness to withstand load and shall have zinc coating of min. 90 Gsm.
- **Flashing/Accessories:** Made of PPGI sheet conforming to IS 14246:2013

Walls & Ceiling: Rigid PUF panels/PIR/VIP

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 / trimix 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

Minimum insulation thickness for various insulation materials

Type of insulation	Material		Wall		Ceiling/ roof U value = 0.24 W/m ² K	Floor U value = 0.29 W/m ² K
			External U value = 0.27 W/m ² K	Partition U value = 0.58 W/m ² K		
	ρ Density Kg/m ³	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

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)

The floor in the cold rooms should be of base concrete, with kota stone/ epoxy or any other finished floor type inside the floor chambers. Floor insulation slab preferably XPS (EPS not allowed) laid in single layer. The Floor should be cleaned, painted with black japan paint and then laid with minimum 60 mm thickness insulation (EPS not allowed) with 1st layer of vapour barrier which can either be 250 microns tarfelt sheet or polythene sheet of suitable thickness on the insulation with overlapping of minimum 5 mm.

The laying of Trimix should be 80-100 MM thickness with any suitable finish like kota stone, epoxy etc. or any other finish floor. The floor level of the cold storage should match the floor level of the cold store for easy movement of material as well as MHEs. In case of raised floor levels a suitable graded ramp to be either fixed or made outside the door for mechanised movement of the goods.

The Ripening Chamber should be installed in such a way that small HPTs/BOPTs/Fork Lifts can be used to load/un-load the material mechanically.

The cold room insulation should be PUF/PIR or any other new environment friendly insulating material of thickness min 100 mm. sandwiched in either pre-painted GI(0.45 mm Min. thickness) or SS(food grade SS-306) sheets.

The insulated door should be either overlap or inline or sliding or automatic doors but of the same thickness as that of the panel with preferably, a view window on the door properly fitted along with heater for anti condensation on the glass. The door should be fitted with strip curtains form inside with 0.5 mm overlap from SS hooks or hangers. The outside of the door should be preferably fitted with air curtains of suitable capacity.

Minimum door size recommended is 1mtr x 2 mtr ($\pm$ 5% variation would be accepted on the min recommended size, however the upper size can be selected as per requirement). The no. of doors would be equivalent to no. of mezzanine floors.

Multi tier system:

In case of multi tier systems, special arrangement should be made to accommodate pallets on parallel rail type structures which allow free movement of fork lift between the supporting rails to place the pallet on the first tier.

Multi tier system allows ground floor and 1 tier above it only with possibilities of stacking pallets containing CFB boxes or specially designed cages holding crates with maximum load capacity of 1 ton for each cage. The shape of the room should be designed preferably in such a way so as to create a tunnel effect.

Special care needs to be taken in positioning of the doors. In case of multi tier stacking doors should be of rolling-up type (overhead) following safety features like internal door release, cable break electric safety stop, mechanical safety stop.

Suitable EPDM gaskets to be provided to form the seal around the door opening and all doors required should be operable from inside at all the times and should have manual override systems in case of mechanical, electrical or any other system failure.

Door protection should include a goalpost-style guard that shields the door perimeter, ensuring its safety during operations inside the ripening chamber. This setup should be equipped with hazard lights and alarms to enhance visibility and alert operators, promoting safety and preventing accidental damage.

General Guidelines:

With capacities divided in multiples of 10 MT upto 30 MT per chamber the internal height of the chamber should be restricted between 13 ft. to 14 ft.

The no. of evaporators in non pressurized ripening system should be placed in such a way so as to cover atleast 70% of the wall on which evaporator/unit cooler is installed.

One Ethylene generator required upto maximum capacity not exceeding more than 60 MT.

Two Ethylene generators required upto maximum capacity between 60 - 120 MT

Ethylene Gas Bank system required for plant capacities exceeding 120 MT upto 300 MT.

4. REFRIGERATION:

Temperature and humidity to be designed to achieve prescribed ripening conditions. Generally, ripening temp. of various produces vary between 7-18°C and RH levels between 90-95%.

Energy efficient refrigeration based systems need to be installed. For any operations which may require temperature condition and humidity condition upto 0°C refrigerants with GWP between 1000 to 1500 to be used.

Air flow should be designed @2000 CFM per MT of storage.

5. ELECTRICAL INSTALLATIONS:

Suitable OLTC step down transformers (as per requirement from discom) with earthing stations as per requirements, main power distribution panel for refrigeration lightning, automatic power factor correction panel (APFC), fire fighting equipments, etc.

DG Sets equalling to the total requirement load in the cold storages. The type of DG sets should be considered as per applicable laws of pollution control board.

6. AUTOMATION – Ripening Management System (RMS):

Suitable configuration of electrical panels with microprocessors, and HMIs, to be installed on the electrical panels with suitable sensors where, analog input received from all the equipments that is consuming electrical energy is converted into digital output for the purpose of bringing in energy efficiency into the ripening management system, These microprocessors should be operated with

static IPs and allow control and visualisation of ripening chamber temperatures, humidity and other necessary parameters remotely by the authorised person. The microprocessor panel should also control necessary work done in terms of compressors for automatic operations and thereby, reducing the power consumption on the compressors, evaporator fans, pumps, condenser fans, etc. to bring in suitable energy efficiency into the facility.

The IoT based systems should be installed for real time monitoring, tracking and surveillance of the facility remotely. This system is also equipped with early hazard detection and alarm activation protocols.

Suitable sensors and controllers should be used to maintain temperature, humidity, CO₂ concentration levels and preferable ethylene concentration level integrated in a Ripening Management System allowing real time temperature, humidity, lightening, energy usage, CO₂ concentration levels – DISPLAY & CONTROL.

7. RENEWABLE ENERGY:

The facility should be capable to generate atleast that much amount of the required energy which can run electrical lights, pumps (if possible), fan motors during holding period in daily operations from renewable sources of energy. The energy may be obtained by harnessing solar energy, wind energy, etc. and stored in auxiliary batteries if possible. (Batteries are not mandatory)

8. ADMINISTRATIVE BLOCK:

The facility should have a separate admin block equipped with office room, rest rooms, and other amenities which are important to create a comfortable working condition. Clean drinking water and toilets for workers and staff is very important to build in the facility.

9. SAFETY & HAZARD CONTROL:

Provision for handling accidental leakage of refrigerant:

- 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
- It may be borne in mind that ethylene concentration above 27000 ppm may explode.

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: To be inverter based
- 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: To be installed as per clearance and requirement of Fire Regulatory authority

Eg.-

DRY TYPE

- i) Dry chemical powder type 5.0 Kg Cap with ISI Mark Fire Extinguisher complete with wall mounting bracket.
- ii) Carbon Di-Oxide (CO₂) type 4.5 Kg. capacity Fire Extinguisher complete with wall mounting bracket.
- iii) G.I. Fire Buckets
- iv) M.S. Stand for Fire Buckets

10. RIPENING AGENTS:

The facility should be equipped with Ripening Dosing System. Usually piped to share across multiple chambers. The air flow should be designed in such way which will allow even spread of dosing gas, temperature control and ripening in the chambers.

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.

Centralized Ethylene supply with Automation for multiple chambers for controlled and safe dosing of ethylene may be preferred for larger units. 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. It may be borne in mind that ethylene in concentration above 27000 ppm may explode.

11. VENTILATION SYSTEM:

When fruits are ripening, they release carbon dioxide which will build up in a ripening room. The CO₂ 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 CO₂ concentration below 5000 ppm.

In ripening rooms ventilation may be automatic or manual. In case of ripening rooms with pallet isolation, ventilation may be provided by a roof mounted fan which is identical in specification to the pressure fans.

In case of automatic forced air exhaust / ventilation system with ducting, 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 vent is required. Automatic exhaust fans (either timed or sensor based) or "flow-through" (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 CO₂ concentration low (below 5000 ppm) during the ripening cycle for proper ripening. In such cases, opening and shutoff actuators/ valves control is affected by CO₂ sensor and timer device.

SUBSIDY COMPONENTS DETAIL:

FOR BOTH NHM & NHB

Component No.		Non- Pressurised Ripening	Pressurised Ripening	Cost Norm
C-15	1	Building- CIVIL and PEB with docking area for loading/unloading.	Building- CIVIL and PEB with docking area for loading/unloading.	<u>NON-PRESSURISED CHAMBER</u> Rs. 1 lakh per MT upto 300 MT per project per beneficiary. <u>PRESSURISED CHAMBER</u> Rs. 1.20 lakh per MT upto 300 MT per project per beneficiary.
	2	Receiving Area- comprising of area within the premises which allows receipt of raw fruits for cutting, washing and crating. In case of bananas coming packed in CFB boxes from the source, washing & crating would not be necessary.	Receiving Area- comprising of area within the premises which allows receipt of raw fruits for cutting, washing and crating. In case of bananas coming packed in CFB boxes from the source, washing & crating would not be necessary.	
	3	PUF insulated cold rooms, insulated floor, insulated doors, etc.	PUF insulated cold rooms, insulated floor, insulated doors, etc. The insulated cold rooms have a system of false ceiling or annular space created above the cold rooms which holds cooling coils placed in such a way that the air is sucked through these coils and routed into the cold room by way of spaces/cut outs in the cold room ceiling and pushing cold air through annular spaces between wall and palletised crates/ CFB boxes with or without air inlet locking system to isolate the boxes or pallets. The technical arrangement may vary and should be followed in accordance to design consideration of pressurised ripening system.	
	4	Ceiling mounted evaporators/ unit coolers, etc. for maintaining uniform air circulation, temperature,	Special air flow system running through the depth of the chamber mounted on the ceiling which generates	

		humidity.	desired static pressure and allows suction from the centre.	
	5	Multi-compressor rack system/ individual condensing unit/ centralised chillers/ ammonia systems, etc.	Multi-compressor rack system/ individual condensing unit/ centralised chillers/ ammonia systems, etc.	
	6	Ethylene distribution system- ethylene generator or ethylene gas bank system.	Ethylene distribution system- ethylene generator or ethylene gas bank system.	
	7	Ventilation System – automatic to keep CO ₂ within limits with the help of CO ₂ analyser and controller Automatic Ventilation system works with a dual inlet/discharge dampers with fan to allow fresh air within the room when the concentration of CO ₂ exceeds the desired limit.	Ventilation System – automatic to keep CO ₂ within limits with the help of CO ₂ analyser and controller Automatic Ventilation system works with a dual inlet/discharge dampers with fan to allow fresh air within the room when the concentration of CO ₂ exceeds the desired limit. The placement etc. can vary and should be chosen as per requirement.	
	8	Crates/Bins etc.	Pallets, CFB boxes stacked in single or in multi tier system	
	9	HPTs	HPTs, Fork Lifts in case of multi tier	
	10	Weigh scale, firmness tester, refractometer, sizer and callipers and produce knife.	Weigh scale, firmness tester, refractometer, sizer and callipers and produce knife.	
	11	Electrical panels, lighting, earthing and power backup (DG Set)	Electrical panels, lighting, earthing and power backup (DG Set)	
	12	Ripening Management System (RMS)	Ripening Management System (RMS)	

NOTE: Cost would be Rs. 1 lakh/MT or 1.2 Lakh/MT (as applicable) irrespective of solar, thermal bank, bio-mass or conventional grid powered technology used.

Technical Evaluation while Claiming Subsidy: The following details need to be submitted for Technical Evaluation while availing subsidy:

SUBMITALS along with DPR/Application:

1. Nomenclature: CS-3/ IV F/IV Vg/N X/Y MT/MIDH/NHB- District

- a) CS-3 Stands for COLD STORAGE TYPE-III- Ripening Chambers
- b) IV F/IV Vg denotes commodity type used for Ripening
- c) N X denotes the no. of chambers (e.g.- N 4, N 8, etc.)
- d) Y MT denotes total capacity of the facility (e.g.- 180 MT, 280 MT, etc.)
- e) MIDH/NHB denotes under which subsidy scheme the project is being submitted.
- f) –District defines the district where the project is proposed.

2. Basic Data Sheet: Refer to Annexure IV at the end of this book. (Basic Data Sheet of Ripening Chambers)

3. Heat Load Calculation Sheet: Enclose detail basis of heat load calculation.

4. Drawings: Enclose sketch with Plan layout and sections showing storage chambers and floor heights clearly.

5. Technical Performance Data Sheets of proposed Refrigeration Equipments, etc. to be installed, to be submitted from the respective equipment manufacturer.

6. Energy Efficiency Sheet: Refer to Annexure VI at the end of this book.

Note:

- i. Follow relevant BIS Codes on safety and Standards
- ii. Please provide relevant structural safety certificate from certified structural engineer, certified architects, certified agencies or certified person relevant to building norms.
- iii. Fire safety norms to be followed as per relevant BIS codes and Standards. Clearance certificate to be provided.
- iv. Environmental Clearance certificate to be provided as per requirement and relevant codes and standards.
- v. In conventional ripening storage, Refrigerants having potential for Ozone Depletion# and GWP ranging more than 1500 (like R22, R404A etc.) are not allowed for temperature range 0° C and above.
- vi. Use of inverter compressor / Digital compressor/ compressors with capacity control/reciprocating or screw compressors with microprocessor based controls should be used with choice of natural refrigerants/ refrigerants as described above should also be considered to promote energy efficiency and sustainable development

NOTE- Add-on Component: To promote renewable energy, applicant can also avail component Alternate Technology as an add-on component (please refer point no.#10 in chapter no. 16- CS-2-CA)

16. COLD STORAGE TYPE-IV (DRY SPICES/RAISINS)

A cold storage under type-IV category (CS-4) are aligned for long term bulk storage for storing of dry produces like spices and raisins in bags, bulk or lots for the purpose of catering to off season demands. The produce can be brought directly from farms or as it may be required. The produce/commodity classification is as per the attached List-1 (attached at the back of this book).

This can be developed by an individual farmer, FPO, group of farmers or any legal entity, etc. These stores act as place of storage with maintenance of temperature, relative humidity or any further requirement deemed necessary for bulk and long storage. These can be constructed either near the growing areas or at the place of consumption depending upon the requirement and maintaining the necessary chain and connectivity at the back end as part of the distribution network for forward linkages with the consumer centres through a well-connected temperature-controlled supply chain network.

Essentials of Cold Storage Type- IV (CS-4):

- i. To identify the cold storage location for the produce that is coming into the store.
- ii. Relevant data and information on the production area, type of produce, quality of produce, and connectivity and target market or hubs should be properly recorded and known for utmost utilisation of the facility.
- iii. A Cold Store should be located close to the farm, should provide services to local farmers and should have facilities for pick and drop of produce by way of large or medium size reefer vehicles.
- iv. A Cold Store should be connected to good roads and should be covered properly to prevent from sun, rain and other contaminants from environment.
- v. A Cold Store should be designed well with sufficient areas for loading and unloading bays. It should have adequate water and electricity supplies and the drainage system should be done in a very well manner and necessary water treatment plant should be used wherever applicable.
- vi. A Cold Store should have all the necessary arrangements for safety and other desirables for the comfort of workers and other skilled professionals.
- vii. A Cold Store may also have a weigh scale at the receiving side. (Optional)
- viii. It may be connected to various numbers of aggregation centres, etc. of a farmer produce organisations or any other help groups which allows seamless connectivity of the produce to the Cold stores in the shortest possible time thereby reducing post harvest losses.

**Please note that 1 MT of storage for CS-4 is equivalent to 4.0 m³ or 141 cu. ft.
of storage for produces like Tamarind, Dry Spices, Dry Chilli, etc.**

Minimum Guidelines to follow:

Cold Storage Construction Features:

- Foundation/slab/columns/pillars/ PEB structure- civil construction/PEB
- Insulation/refrigeration - Cold Chambers (Max. capacity 4999 MT)
- Insulation/finish floor etc. -Floor
- Mezzanine/pallets/racks/crates/bins/bags etc. - Inter-floors
- Insulated doors/strip curtains/air curtains- Doors
- Insulation- Ante room
- Compressors/condensers/pressure vessels/ heat exchangers/electrical panels/ power factor banks etc. -Machine rooms
- Dock levelers/ dock shelters/ dock doors etc.- loading/unloading areas
- Transformers/ DG set/Earthing/Light/lightning arrestors etc. -Electrical installations
- Conveyor belts/ lifts etc. –Mechanisation
- Microprocessors/data loggers/IoT/alternate energy etc.- Automation & energy efficiency
- CCTV/ parking areas / Office block/ Convenience areas – administrative block
- Fire fighting equipments/ fire exits/ fire doors- Safety & Hazard control

1. Civil Construction: Super structure and foundation to be designed by certified structural/ civil engineer/ architect/ certified agency. The design shall meet all BIS standards and relevant seismic zone norms for earthquake proof design. The building can be constructed either with brick walls with RCC slab at top. However, in case pre-fabricated PUF panels are used directly as a box in option after following necessary standards and safety protocols, brick walls can be eliminated from the civil construction after due consideration to structural stability and design & certification of the building by a certified structural/ civil engineer/ architect/ certified agency.

Note:

- Super structure and foundation to be designed by certified structural/ civil engineer/ architect/ certified agency.
- Certification of the building by a certified structural/ civil engineer/ architect/ certified agency should be furnished while applying for subsidy.

Special consideration with reference to hanging arrangement of unit coolers from bottom of the PUF insulated ceiling panel with RCC slab on top of it-

- Prevent condensation and water leakages through gaps into the cold storage.
- Provision of cat walks for maintenance of pipes, controls, etc. in case of pipes running around the building.
- Installation of ceiling PUF panels below the RCC slab with minimum gap between the slab and the panel.
- Provision of inverted beams in the slabs allowing plain RCC slab from the bottom.
- Provision of water proofing with chemicals, etc. to prevent water seepage from RCC slab onto the PUF insulated ceiling of the cold room.
- Special kind of runners, running alongside the building to allow holding of the PUF panels.

- Extension of RCC slab around the building to prevent rain water to hit the panel directly and causing seepage and damage.
- Sunken floors for laying and fixing of floor insulation in the areas where insulation is to be done.
- Thermal barriers to be made between cold rooms and ante rooms
- The floor levels need to be in level at all the places for easy movement of MHEs.
- Use of material handling lifts which can accommodate both BOPTs and HPTs from basement (in case basement is done) upto the top floor.
- Each mezzanine floor inside the cold chamber to be connected through doors to the ante room at the same level of the mezzanine floor or to a landing area at the same level as that of mezzanine with easy access to fire exits as well as allowing movement of material handling equipments from lifts to the mezzanine floor.
- Two stair cases to be made at appropriate ends allowing movement of goods as well as acting as easy escape points. One staircase to be isolated with the cold storage area/ante rooms by fire rated doors which should be ISI/BIS marked for 120 minutes integrity and 30 minutes insulation.

PEB structure: The building should be constructed as per drawings and dimensions indicated. It is recommended to construct such facilities using steel construction/ Pre-Engineered construction confirming to the relevant BIS codes for live load as per IS 875 part – II, wind load as per IS 875 part-III, seismic load as per IS 1893 and other codes and standards as applicable. Also factors like wind, storms, lightning, thunderstorms, hail, heavy rains, snow, etc. should be taken in the safety designs and optimum care has to be taken on these factors to protect the cold room from these hazards. Earthing pits, Earthing, Lighting arrestors need to be installed to ensure safety from electric hazards and protection against fire, etc. The steel structure component /construction sections to be fabricated confirming to relevant codes and standards of ASTM /BIS.

In case of PEB, roof insulated panels as per BIS guidelines can be also installed with plain ribbed sheets from inside and corrugated sheets from the outside with minimum 120 mm + 30mm thickness of the insulated panel.

Care needs to be taken in ensuring that this kind of installation uses proper thickness of the panel and does not allow condensation or water dripping due to some part of the PEB structure inside the cold storage and some outside thereby causing thermal shock and allowing leakages. The building should be constructed as per drawings and dimensions indicated confirming to relevant codes and standards of BIS, IS.

In case of truss roof, provisions to be made for fixing insulated panels to the ceiling and support of the cooling unit from the trusses in case of ceiling suspended evaporators/ unit coolers/ cooling units.

The structural certifying agency/ structural engineer etc. should pay special attention to the hanging arrangement of unit coolers from the trusses/supports to avoid condensation and prevent water leakage through gaps into the cold storage. The cold chain engineer should ensure world class installation that shall ensure that joints at the top does not leak and access areas should be sealed. Preferably, a catwalk should be designed & provided to access areas above the cold storages. These areas should preferably include ventilation fans and special under-deck insulation to lower temperatures in these areas, reducing heat infiltration from the top and improving overall energy efficiency.

Note: Mezzanine bifurcation inside the chambers would not amount to single chamber and would be considered as 1 chamber from to bottom unless there is proper bifurcation inside the chamber and fulfilling all the criteria in terms of hard flooring, insulated flooring, dedicated refrigeration unit and access doors from the respective floor and connectivity to lifts and fire exits.

2. Cold Chambers: (QUALIFICATION FOR CS-4)

Rule no.	Minimum Storage Capacity (MT)	Maximum Storage Capacity (MT)	MIDH/NHM Configuration	NHB Configuration
1	500	4999 ~ 5000	The combination of capacity of chambers in a project can be divided between min. capacity of 500 MT and up to a max. capacity of 1500 MT (per chamber).	NA
2	5001	10000	NA	The combination of capacity of chambers in a project can be divided between min. capacity of 1500 MT and up to a max. capacity of 2500 MT (per chamber).
3	10001	20000	NA	The combination of capacity of chambers in a project can be divided between min. capacity of 1500 MT and up to a max. capacity of 2500 MT (per chamber) up to 10,000 MT. And for storage capacity above 10,000 MT up to max. 20,000 MT, the combination of capacity of chamber can be divided up to a max. capacity of 5000 MT per chamber but not less than 1500 MT capacity in any case.

The cold chamber is a box of specific size which is constructed with the help of insulation of different thicknesses to maintain temperature, humidity, etc. inside that cold chamber referred to as a cold storage. This cold storage is meant for storing different types of fruits and vegetables and other horticulture products which may or may not require pre-cooling depending upon the requirement to preserve the freshness, quality and shelf life.

These cold storages require adequate refrigeration, air circulation, proper stacking and storage arrangements to achieve the required conditions for maintaining product temperature and other required conditions like humidity, etc. to enhance the shelf life of the produce.

Efficiency and performance in such stores is vital and depends upon various factors like appropriate storage system, optimizing space, allowing uniform air circulation through the produce, requirement of stock rotation if necessary. This is abundantly important to consider in design so as to allow the economic viability of the cold store as it allows reduction in energy bills, less wastage and maintaining the quality of the produce.

The cold storage consists of components which have been categorized for the purpose of submission in the applications for the purpose availing subsidy following the below specified minimum standards and guidelines under various components:

DETAILED SPECIFICATIONS

Cold Store Building- In general, under CS type-IV (CS-4) both civil as well as PEB structures are allowed conforming to relevant BIS codes, fire safety guidelines as per state regulations and BIS standards applicable to buildings.

Sl. No.	Description	Remarks
1	Cold Store Building	The total height of the building including dock or foundation should not be more than 20 mtrs.
		The height of the dock should be not less than 1.06 mtr or as required from the finished road level
		In case of PEB structure holding cold rooms with boxes inside the PEB columns (Box-in type), special Z runners/support should be placed at every 3-4 mtr. Around these structure from the dock level for holding the wall insulation panels securely and tightly. Sufficient space should be provided outside of the foundation of PEB columns in and around dock/platform.
		The design should be innovative with appropriate measures taken to ensure use of space with design of sunken floors, inverted beams, as required to allow maximum utilisation of space, minimum cutting of insulation panels, and easy installation for reducing gaps between the joints and preventing loss of cold, disallowing condensation and other problems. Appropriate care to be taken inside the cold storage flooring and use of technology, expansion joints, resins, epoxy, to create smooth floor level and prevent cracking of the floors thereby, not allowing moisture and water to travel upto insulation and creating efficiency issues as well as hazards to building. Suitable grade of concrete like M25, M28, M30, etc with block testing should be done as per standards and guidelines.
		For all types of construction atleast 1 mandatory service lift/ conveyor material hoist system/ mechanized material handling conveyors should be operational from the dock level upto the top floor alongwith 2 stair cases on two sides of the building which can be used for loading as well as fire exits. One stair case of the two needs to be placed at the end of the loading/un-loading ante rooms with closure at one end with a fire rated safety door at each floor.

		Preferably, a catwalk should be designed & provided to access areas above the cold storages. These areas should preferably include ventilation fans and special under-deck insulation to lower temperatures in these areas, reducing heat infiltration from the top and improving overall energy efficiency but not mandatory.
		While designing it should be considered to leave appropriate space for movement of fire trucks around the building, loading/unloading trucks, space for utilities like transformers, DG sets, in such a way that it does not hinder operations and possess threat to human safety and well being.

3. 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:

Rigid Polyurethane foam: Chlorofluorocarbon (CFC) free and self-extinguishing and shall conform to IS 12436: 1988.

vacuum Insulated Panels: Conforming to BIS and IS standards

PIR PUF panels: Conforming to BIS and IS standards

Pre Painted Galvanized Iron (PPGI): The PPGI sheet shall have adequate thickness to withstand load and shall have zinc coating of min. 90 Gsm.

Flashing/Accessories: Made of PPGI sheet conforming to IS 14246:2013

Walls & Ceiling: Rigid PUF panels/PIR/VIP

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 / trimix 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

Minimum insulation thickness for various insulation materials

Type of insulation	Material		Wall		Ceiling/ roof U value = 0.24 W/m ² K	Floor U value = 0.29W/m ² K
			External U value = 0.27W/m ² K	Partition U value = 0.58W/m ² K		
	ρ Density Kg/m ³	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

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)

4. FLOOR:

- The floor in the cold rooms should be of base concrete, with kota stone/ epoxy or any other finished floor type inside the floor chambers. Floor insulation slab preferably XPS (EPS not allowed) laid in two layers. The Floor should be cleaned, painted with black japan paint and then laid with 1st layer of vapour barrier which can be either 250 microns tarfelt sheet or polythene sheet of suitable thickness. The vapour barrier should be covered with 1st layer of insulation and overlaid with 2nd layer of insulation in a manner to cut the gaps in the first layer of insulation. The joints can be filled with suitable hot grade bitumen (80:25). The 2nd layer of insulation is then covered with 2nd layer of vapour barrier which would be upto 1 mm thick tar felt or poly felt sheets with 5 mm overlap on the walls.
- The laying of Trimix should be 75 MM to 100 MM thickness with any suitable finish like kota stone, epoxy etc. or any other finish floor. The floor level of the cold storage should match the floor level of the cold store for easy movement of material as well as MHEs. In case of raised floor levels, a suitable graded ramp to be either fixed or made outside the door for mechanised movement of the goods.
- The Cold Room should be installed in such a way that small HPTs/BOPTs can be used to load/un-load the material mechanically.

INSULATION & DOOR

- The cold room insulation should be PUF/PIR or any other new environment friendly insulating material of thickness min 100 mm. sandwiched in either pre-painted GI (0.45 mm Min. thickness) or SS (food grade SS-306) sheets.
- The insulated door should be either overlap or inline or sliding but of the same thickness as that of the panel with a view window on the door properly fitted alongwith heater for anti-condensation on the glass. The door should be fitted with strip curtains form inside with 0.5 mm overlap from SS hooks or hangers. The outside of the door should be fitted with air curtains of suitable capacity.
- Minimum door size recommended is 1mtr x 2 mtr ($\pm 5\%$ variation would be accepted on the min recommended size, however the upper size can be selected as per requirement). The no. of doors would be equivalent to no. of mezzanine floors.

5. ANTE ROOMS:

Ante Rooms should be designed on each floor and shall be designed to accommodate stair case, hoists, lifts, fire exits, as per local norms and regulations as applicable on the type of building. Suitable design innovations should be incorporated to accommodate certain ancillaries in these ante rooms however, not jeopardizing the safety of the human.

The ante rooms on each floor should have doors providing access to the respective cold rooms. The inner walls of the cold rooms can also serve as the walls of the ante rooms. The ceiling of the ante rooms should be enclosed with 60 mm PUF panel insulation, and the ends should be sealed as much as possible (though not mandatory). However, the side adjacent to the fire exit must be fully enclosed and equipped with fire exit doors to ensure safety compliance.

6. REFRIGERATION:

Energy efficient refrigeration based systems need to be installed. For any operations which may require temperature condition and humidity condition upto 0°C and above refrigerants with GWP between 1000 to 1500 to be used. **Individual systems would not be allowed above capacities which are 2000 MT or more.** In case of any further expansion more than 2000 MT, the same rule shall apply. And no individual refrigeration units for the expansion would be allowed. For further details on expansion, please refer chapter no. 23 (Expansion & Modernisation)

7. LOADING/UNLOADING AREA:

Loading and unloading docks shall be designed with RCC slab roof or sheet roofing and these should be wide enough to allow loading and unloading simultaneously when the loading/un-loading area should bifurcated from the cold room ante rooms by an insulated sliding door.

8. ELECTRICAL INSTALLATIONS:

Suitable OLTC step down transformers with earthing stations as per requirements, main power distribution panel for refrigeration lightning, electric hoists and lifts, automatic power factor correction panel (APFC), fire fighting equipments, etc.

DG Sets, 1 small and 1 big equalling to the total requirement load in the cold storages. The type of DG sets should be considered as per applicable laws of pollution control board.

9. MECHANISATION:

Appropriate Lifts/ conveyors/ electrical hoists with wire ropes, a steel fabricated cage with guides, and openable doors should be provided for material handling for managing the goods. Material movement can be facilitated using BOPTs for easier access to storage areas on the mezzanine floors, with the materials being transported from hoist, lifts, conveyer etc. through the ante room of the respective mezzanine floor into cold store.

10. UNIFIED CONTROL SYSTEM / AUTOMATION:

Suitable configuration of electrical panels with microprocessors, and HMIs, to be installed on the electrical panels with suitable sensors where, analog input received from all the equipments that is consuming electrical energy is converted into digital output for the purpose of bringing in energy efficiency into the building management system, These microprocessors should be operated with static IPs and allow control and visualisation of cold room temperatures, humidity and other necessary parameters remotely by the authorised person. The microprocessor panel should also control necessary work done in terms of compressors for automatic operations and thereby, reducing the power consumption on the compressors, evaporator fans, pumps, condenser fans, etc. to bring in suitable energy efficiency into the facility.

The IoT based systems should be installed for real time monitoring, tracking and surveillance of the facility remotely. This system is also equipped with early hazard detection and alarm activation protocols.

11. RENEWABLE ENERGY:

The facility should be capable to generate atleast that much amount of the required energy which can run electrical lights, pumps (if possible), fan motors during holding period in daily operations from renewable sources of energy. The energy may be obtained by harnessing solar energy, wind energy, etc. and stored in auxiliary batteries if possible. (Batteries are not mandatory)

12. ADMINISTRATIVE BLOCK:

Every cold store should have a separate admin block equipped with office room,

13. SAFETY & HAZARD CONTROL:

Provision for handling accidental leakage of refrigerant:

- 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: To be inverter based

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: To be installed as per clearance and requirement of Fire Regulatory authority

Eg.-

DRY TYPE

- i) Dry chemical powder type 5.0 Kg Cap with ISI Mark Fire Extinguisher complete with wall mounting bracket.
- ii) Carbon Di-Oxide (CO₂) type 4.5 Kg. capacity Fire Extinguisher complete with wall mounting bracket.
- iii) G.I. Fire Buckets
- iv) M.S. Stand for Fire Buckets

WATER BASED

- 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

SUBSIDY COMPONENTS DETAIL:

FOR NHM

COMPONENT NO.	DESCRIPTION & NAME	Max. ALLOWABLE QTY./CAPACITY	COST
C-11 (i)	Cold Storage type –IV (CS-4) is cold storages designed mostly for dry spices/raisins storage where bulk and long term storage is preferred. They are normally seen in brick-and-mortar structure; however,	For Civil Construction of capacity upto 4999 MT ~ 5000 MT capacity	Rs. 9600/MT
C-11 (ii)	an applicant can also develop it under the pre-engineered building. It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas, loading docks, PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under	For PEB Construction of capacity upto 4999 MT ~ 5000 MT capacity	Rs. 12,000

	this category. The list of BIS standards has been attached to be followed at all the relevant places. Consisting of : i. Construction: Foundation/ slab/ columns/ pillars/ PEB structure ii. Insulation: Walls, Ceiling, Floors, etc. iii. All refrigeration Units iv. Electrical Installations: Transformers/DG Sets, VFDs, etc. v. Administrative Block: CCTV/ parking areas / Office block/ Convenience areas. vi. Safety & Hazard control: Fire fighting equipments/ fire exits/ fire doors- as per norms and conditions of the building		
	Conveying/Hoist system/material service lift of suitable and appropriate capacity for material handling of in the anteroom with provision of unloading on common landing near and outside cold rooms. (upto 5000 MT) (refer point no. 9)	Max. 1 system/ project	Rs. 5 lakh/system
	Dock Leveler System comprising of: (components of 1 set) A. Dock Leveler B. Dock Door C. Dock Shelter D. Vehicle Barrier/ Hit Alarm	Max. 2 sets	Rs. 8.4 lakh/set
	Material Handling Equipments: HPT above 1 ton BOPT 1 ton and above	Max. 4 units Max 2 unit	Rs. 20000/unit Rs. 1.5 lakh/ unit
	Doors	Max. 20 doors/ project	Rs. 25000 / door

FOR NHB

COMPONENT NO.	DESCRIPTION & NAME	Max. ALLOWABLE QTY./CAPACITY	COST
C-11 (i)	Cold Storage type -IV (CS-4) is cold storages designed mostly for dry spices/raisins storage where bulk and long term storage is preferred. They are normally	For CIVIL Construction of capacity between:	

	seen in brick-and-mortar structure; however, an applicant can also develop it under the pre-engineered building. It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas, loading docks, PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places. Consisting of :	5001 to 6500 MT 6501 to 8000 MT 8001 to 10000 MT 10001 to 20000 MT*	Rs. 9120/MT Rs. 8640/MT Rs. 8160/MT Rs. 4080/MT*
C-11 (ii)	Consisting of : i. Construction: Foundation/ slab/ columns/ pillars/ PEB structure ii. Insulation: Walls, Ceiling, Floors, etc. iii. All refrigeration Units iv. Electrical Installations: Transformers/DG Sets, VFDs, etc. v. Administrative Block: CCTV/ parking areas / Office block/ Convenience areas. vi. Safety & Hazard control: Fire fighting equipments/ fire exits/ fire doors- as per norms and conditions of the building	For PEB Construction of capacity between: 5001 to 6500 MT 6501 to 8000 MT 8001 to 10000 MT 10001 to 20000 MT*	 Rs. 11400/MT Rs. 10800/MT Rs. 10200/MT Rs. 5100/MT*
	Conveying/Hoist system/Material Service lift for material handling of suitable capacity in the anteroom with provision of unloading on common landing near and outside cold rooms. (upto 5000 MT) (refer point no. 9)	Max. 1 system/ project	Rs. 5 lakh/ system
	Dock Leveler System comprising of: (components of 1 set) A. Dock Leveler B. Dock Door C. Dock Shelter	Max. 2 sets	Rs. 8.4 lakh/set

	D. Vehicle Barrier/ Hit Alarm		
	Material Handling Equipments:		
	HPT above 1 ton	Max. 4 units	Rs. 20000 / unit
	BOPT above 1 ton	Max 2 unit	Rs. 1.5 lakh / unit
	Doors	Max. 30 doors / project	Rs. 25000 / door

Technical Evaluation while Claiming Subsidy: The following details need to submitted for Technical Evaluation while availing subsidy:

SUBMITALS along with DPR/Application:

1. Nomenclature: CS-4/ S/N X/Y MT/MIDH/NHB- District

- a) CS-4 Stands for COLD STORAGE TYPE-IV
- b) S denotes commodity type as Spices and Raisins
- c) N X denotes the no. of chambers (e.g.- N 4, N 8, etc.)
- d) Y MT denotes total capacity of the facility (e.g.- 1800 MT, 6540 MT, etc.)
- e) MIDH/NHB denotes under which subsidy scheme the project is being submitted.
- f) –District defines the district where the project is proposed.

2. Basic Data Sheet: Refer to Annexure III at the end of this book. (Basic Data Sheet of Cold Storage (CS-1/CS-1-Onion/CS-2/CS-2-CA/CS-4)

3. Heat Load Calculation Sheet: Enclose detail basis of heat load calculation.

4. Drawings: Enclose sketch with Plan layout and sections showing storage chambers and floor heights clearly.

5. Technical Performance Data Sheets of proposed Refrigeration Equipments, etc. to be installed, to be submitted from the respective equipment manufacturer.

6. Energy Efficiency Sheet: Refer to Annexure VI at the end of this book.

Note:

- i. Follow relevant BIS Codes on safety and Standards
- ii. Please provide relevant structural safety certificate from certified structural engineer, certified architects, certified agencies or certified person relevant to building norms.
- iii. Fire safety norms to be followed as per relevant BIS codes and Standards. Clearance certificate to be provided.
- iv. Environmental Clearance certificate to be provided as per requirement and relevant codes and standards.

- v. In conventional storage, Refrigerants having potential for Ozone Depletion# and GWP ranging more than 1500 (like R22, R404A etc.) are not allowed for temperature range 0° C and above.
- vi. Use of inverter compressor / Digital compressor/ compressors with capacity control/reciprocating or screw compressors with microprocessor based controls should be used with choice of natural refrigerants/ refrigerants as described above should also be considered to promote energy efficiency and sustainable development
- vii. **For NHB:**

Since, the maximum allowable capacity has been increased upto 20000 MT, for applications under NHB, an additional cost norm of Rs. 4080 (for civil) & Rs. 5100 (for PEB) (refer C- 11 (i) & C- 11 (ii)) would be applicable above 10001 MT upto 20000 MT, remaining guidelines remains same.

e.g. 1- For civil construction, say proposed capacity is 12000 MT, therefore cost applicable would be = Rs. 8160 * 10000 (MT) plus(+) Rs. 4080 * 2000 (MT)

e.g. 2- For civil construction say capacity is 16400 MT therefore, cost applicable would be = Rs. 8160 * 10000 (MT) plus(+) Rs. 4080 * 6400 (MT)

e.g. 3- For PEB construction, say proposed capacity is 10020 MT, therefore cost applicable would be = Rs. 10200 * 10000 (MT) plus(+) Rs. 5100 * 20 (MT)

e.g. 4- For PEB construction say capacity is 18000 MT therefore, cost applicable would be = Rs. 10200 * 10000 (MT) plus(+) Rs. 5100 * 8000 (MT)

NOTE- Add-on Component: To promote renewable energy, applicant can also avail component Alternate Technology as an add-on component (please refer point no.#10 in chapter no. 16- CS-2-CA)

* Bunker Coil System is not allowed refer NOTES on page no. 100.

22. REFRIGERATED TRANSPORT

Refrigerated Transport is transferring the produces in maintained temperature and humidity conditions. This is very important segment to keep our cold chain intact. The refrigerated transport is usually carried on roadways on Electric or I.C. Engine based vehicles. This basically comprises of two segments:

- A. Reefer Containers
- B. Reefer Trucks

Please note that all subsidies on the reefer will be based on “The Load Carrying Capacity of the Container” only.

The load carrying capacity of container is determined after subtracting the sum of kerb weight of the chassis + container weight + weight of Reefer unit from the Gross Vehicle Weight (GVW) of the chassis.

Sample Calculation Sheet:

S. No.	DESCRIPTION	WIGHT IN KGS	WEIGHT IN MT
1	GROSS VEHICLE WEIGHT (GVW) OF CHASSIS	16000	16
2	KERB WEIGHT OF CHASSIS	5000	5
3	CONTAINER WEIGHT	2000	2
4	WEIGHT OF REEFER UNIT	600	0.6
	LOAD CARRYING CAPACITY OF REEFER TRUCK	8400	8.4

Let's discuss both the segments separately,

A. REEFER CONTAINERS

Reefer containers, also known as refrigerated containers, are the workhorses of global trade for perishable goods. They ensure temperature-sensitive cargo arrives at its destination fresh and in optimal condition. Here's a breakdown of its key components:

- **Insulated Box:** The core of the container is a heavily insulated box that minimizes heat transfer, keeping the internal temperature stable.
- **Refrigeration Unit:** Mounted on one end of the container, this self-contained unit cools the air inside using a compressor, condenser, evaporator, and coolant.
- **Air Circulation System:** Fans and vents ensure proper air circulation throughout the container, creating a uniform temperature distribution.
- **Temperature Control Panel:** This panel allows for precise temperature adjustments and monitoring during transport.



- **Door Gaskets:** Airtight seals prevent external temperature from affecting the internal environment.
- **Data Loggers (optional):** These devices record temperature data throughout the journey, ensuring proper temperature control and providing valuable insights for future shipments.



Technical Specifications:

- **Temperature Range:** While the standard range for reefer containers is -30°C to $+30^{\circ}\text{C}$, some specialized units can achieve even lower temperatures, down to -70°C for flash-freezing applications. The specific temperature range capability depends on the refrigerant type used (e.g., Ammonia for ultra-low temperatures, R-134A for moderate to low temperatures).
- **Power Source:** For uninterrupted cooling during transport, reefer containers can be equipped with on-board diesel generators. These generators are typically self-contained and come with fuel tanks for extended journeys, ensuring consistent power supply for the refrigeration unit.
- **Atmosphere Control Systems (optional):** Advanced reefer units offer features like:
 - **Controlled Atmosphere (CA):** This system regulates oxygen (O_2) and carbon dioxide (CO_2) levels within the container. Lowering O_2 levels slows down the respiration process of fruits and vegetables, extending their shelf life. Conversely, specific fruits might benefit from slightly elevated CO_2 levels to inhibit spoilage.
 - **Nitrogen Injection:** Inert nitrogen gas can be introduced into the container to displace oxygen, preventing oxidation and spoilage. This is particularly beneficial for delicate fruits and meats.
- **Monitoring and Alarm Systems:** Modern reefer units are equipped with sophisticated monitoring systems that provide real-time temperature and humidity data. These systems can be interfaced with remote monitoring platforms, allowing for proactive intervention if temperature deviations occur. Additionally, built-in alarm systems trigger alerts if pre-set thresholds are breached.
- **Multi-modal utility:** This will help develop and optimize goods movement by rail or coastal shipping without undue handling of goods.
- **Ventilation System:** The design includes fresh air venting, which is essential for transporting perishable crops over long distances, such as the journey from Himachal to Bangalore, a road trip lasting over 9 days (similar to a trans-Atlantic crossing by ship). This venting also helps reduce ethylene buildup in fruits and vegetables.



Selection Considerations:

- **Cargo Type:** Understanding your specific cargo's ideal temperature range and sensitivity is crucial. Different products require specific temperature and potentially even atmosphere control settings. For example:
 - Fresh fruits and vegetables generally require temperatures between 0°C and 15°C with higher relative humidity (RH) levels (85-95%) to maintain freshness and prevent wilting.
 - Frozen meat and seafood require temperatures between -18°C and -25°C to ensure food safety and prevent spoilage.
 - Some pharmaceutical products might require very specific and stable temperature ranges, demanding high-precision reefer units.
- **Journey Length and Power Source:** Consider the trip duration and potential logistical challenges. If the journey involves multiple legs with potential delays at terminals, a generator-equipped reefer might be necessary for uninterrupted cooling. Additionally, for land-based transportation legs, the availability of compatible shore power connections at terminals needs to be factored in.
- **Packing Considerations:** The way cargo is packed inside the container also plays a role in optimizing performance. Proper palletization and dunnage (filler materials) ensure optimal airflow around pallets and boxes. Here are some specifics:
 - **Air Channel Blocking:** Avoid blocking airflow channels with cargo or dunnage. This disrupts the uniform temperature distribution within the container.
 - **Pallet Spacing:** Maintain adequate space between pallets to allow for proper air circulation.
 - **Cargo Securing:** Secure your cargo to prevent movement and potential damage during transport, which can disrupt airflow and temperature control.

Recommendations:

- **Pre-cooling:** Pre-cooling the container to the desired temperature before loading helps maintain a consistent temperature throughout the journey. The ideal pre-cooling time depends on the cargo type, initial temperature, and container size.

- **Proper Packing:** Utilize dunnage strategically to allow for proper air circulation around pallets and boxes. Secure your cargo to prevent movement and potential damage during transport.
- **Temperature Monitoring:** Regularly monitor temperature data during the journey, especially for long voyages. This allows for adjustments if needed to maintain optimal conditions for your cargo. Advanced data loggers can provide real-time insights and remote monitoring capabilities.
- **Maintenance:** Schedule regular preventive maintenance for your reefer unit to ensure optimal performance and avoid unexpected breakdowns during transport. This includes checking components like the compressor, condenser, evaporator coils, air circulation system, and door gaskets for wear and tear.

Standard Sizes of Containers:

CATEGORY	CONTAINER SIZE IN FT (L X W X H)	SUITABLE CHASSIS	INTERNAL VOL IN CU. Mtr. (APPX.)
R1 (FOR LAST MILE DELIVERY)	8 X 5.5 X 5.5	MAHINDRA BOLERO / MARUTI SUPER CARRY / TATA /AL CHOTA HAATHI / ISUZU	4.3
	9 X 5.5 X 5.5	MAHINDRA BOLERO / MARUTI SUPER CARRY / TATA /AL CHOTA HAATHI	4.9
	10 X 6.5 X 6.5	MAHINDRA BOLERO / MARUTI SUPER CARRY / TATA /AL CHOTA HAATHI	8.2
R2 (FOR SECONDARY DELIVERY)	12 X 7 X 7.5	TATA / EICHER / SML /AL	12.9
	14 X 7 X 7.5	TATA / EICHER / SML /AL	15.2
	17 X 7 X 7.5	TATA / EICHER / SML /AL / BHARAT BENZ	18.6
	19 X 7 X 7.5	TATA / EICHER / SML /AL / BHARAT BENZ	20.9
R3 (FOR PRIMARY DELIVERY)	20 X 8 X 8.5	TATA / EICHER / SML /AL / BHARAT BENZ	30.7
	22 X 8.5 X 8.75	TATA / EICHER / SML /AL / BHARAT BENZ	36.14
	24 X 8.5 X 8.75	TATA / EICHER /AL / MAHINDRA / BHARAT BENZ	39.55
	28 X 8.5 X 8.75	TATA / EICHER /AL / MAHINDRA / BHARAT BENZ	46.38
	30 X 8.5 X 8.75	TATA / EICHER /AL / MAHINDRA / BHARAT BENZ	49.79
	32 X 8.5 X 8.75	TATA / EICHER /AL / MAHINDRA / BHARAT BENZ	53.21

* Dimensional Variations $\pm$ 5% can be accepted.

B. REEFER TRUCKS

The cold chain's success hinges on meticulously engineered refrigerated transport systems. This chapter delves into the technical considerations for optimizing refrigerated vehicles, emphasizing the importance of integrated telematics systems for real-time monitoring and control.

Selecting a Refrigerated Vehicle: A Thermodynamic Approach

i. Thermal Load Calculations:

- **Cargo Specific Heat Capacity:** Utilize reference tables or laboratory measurements to determine the specific heat capacity (C_p) of the cargo in $\text{kJ/kg}^\circ\text{C}$. This value represents the amount of energy required to raise the temperature of 1 kg of the cargo by 1°C .
- **Heat Transfer Calculations:** Employ the following equation to calculate the heat transfer rate (Q) required to maintain the desired temperature (T_{desired}) within the cargo compartment:

$$Q = m * C_p * (T_{\text{desired}} - T_{\text{initial}}) / t$$

where:

- m = mass of cargo (kg)
- T_{initial} = initial temperature of cargo ($^\circ\text{C}$)
- t = time period (hours)
- **Environmental Heat Gain:** Consider solar radiation, ambient temperature, and infiltration through doors and leaks. Utilize relevant standards like **ISO 15800** (Road vehicles - Refrigerated vehicles - Test methods for heat transfer performance) to determine heat gain coefficients for different body types and environmental conditions.

ii. Refrigeration Unit Selection Based on Performance Curves:

- **Cooling Capacity (BTU/hr):** Select a unit with a capacity exceeding the calculated heat transfer rate to account for real-world inefficiencies and potential peak loads. Utilize manufacturer-provided performance curves to ensure sufficient capacity at anticipated ambient temperatures according to **ATP (Agreement on the International Carriage of Perishable Foodstuffs)** temperature classifications.
- **Airflow Rate (CFM):** Evaluate the unit's ability to deliver a minimum airflow rate (e.g., 40 air changes per hour) throughout the cargo space as per **ATP** guidelines. Consider computational fluid dynamics (CFD) analysis for optimal fan placement and air distribution channel design.

iii. Vehicle Body Design and Insulation Optimization

- **Insulation Material and K-Factor:** Specify high-performance insulation materials with a low thermal conductivity (K-factor) like closed-cell spray polyurethane foam ($\text{K-factor} \leq 0.025$

W/mK). Utilize appropriate insulation thickness based on desired temperature range and operating environment as outlined in **EN 13445** (Road vehicles - Insulated bodies for the transport of perishable foodstuffs - Definitions, construction requirements and testing methods).

Designing a Refrigerated Vehicle for Peak Performance

i. Computational Fluid Dynamics (CFD) Analysis:

Utilize CFD software to simulate airflow patterns within the cargo compartment, considering factors like vent placement, air distribution channels, refrigeration unit configuration, and different loading scenarios. This allows for optimization of airflow for uniform temperature distribution and minimizes temperature stratification.

ii. Advanced Temperature Control Systems:

Implement programmable microprocessor-based temperature control systems with data logging capabilities compliant with **HACCP (Hazard Analysis and Critical Control Points)** regulations. These systems enable precise temperature set points, multi-stage cooling, and automatic defrost cycles based on pre-programmed profiles for different cargo types.

iii. Door Management Systems with Interlocks:

Integrate automatic door opening and closing systems with interlocks that prevent accidental operation during refrigeration cycles. This minimizes thermal intrusion during loading and unloading, as mandated by **ATP** regulations. Consider door heating systems to prevent ice buildup and ensure proper sealing in freezing temperature applications.

Integrated Telematics Systems for Enhanced Cold Chain Visibility

i. Wireless Sensor Network and Real-time Temperature Monitoring:

Implement a wireless sensor network with strategically placed temperature probes throughout the cargo compartment, adhering to **ATP** sensor placement guidelines. Utilize cellular connectivity for continuous, real-time temperature data transmission to a central monitoring platform. This allows for proactive intervention in case of temperature deviations or equipment malfunctions.

ii. Remote Reefer Unit Control and Geo-fencing:

Integrate a telematics system enabling remote monitoring and control of the refrigeration unit. This allows for adjustments to temperature set points, defrost cycles, and operational parameters based on real-time conditions and location data. Geo-fencing capabilities can trigger alerts for unauthorized route deviations or potential tampering with the cargo compartment.

iii. Fuel Management and Eco-driving Features:

Utilize telematics data to track fuel consumption, identify inefficient driving habits, and implement driver coaching programs. Integrate features like engine optimization software and route planning tools to promote fuel efficiency and minimize environmental impact.

iv. Predictive Maintenance with Machine Learning:

Leveraging sensor data from refrigeration units, vehicle systems, and environmental conditions (via GPS location) allows the implementation of predictive maintenance strategies. By utilizing machine learning algorithms to analyze this data, patterns can be identified, and potential equipment failures predicted before they occur. This enables:

- **Early detection of issues:** Proactive maintenance can be scheduled to address minor problems before they escalate into major breakdowns, minimizing downtime and ensuring uninterrupted operation.
- **Sensor health monitoring:** The system can monitor sensor performance and identify potential sensor drift or malfunctioning, ensuring the accuracy of temperature data and preventing false alarms.
- **Optimization of maintenance schedules:** Based on predicted maintenance needs, service intervals can be optimized, avoiding unnecessary preventive maintenance while ensuring critical components are addressed before failure.

Standards and Regulations for Refrigerated Transport

- **ATP (Agreement on the International Carriage of Perishable Foodstuffs):** Establishes international standards for the construction, testing, and operation of refrigerated vehicles for perishable goods. It defines temperature classifications, insulation requirements, and documentation for international transport.
- **EN 13445 (Road vehicles - Insulated bodies for the transport of perishable foodstuffs - Definitions, construction requirements and testing methods):** Specifies the technical requirements for the design, construction, and testing of insulated bodies for refrigerated vehicles used in Europe.
- **HACCP (Hazard Analysis and Critical Control Points):** A risk-based system for ensuring food safety throughout the entire food supply chain, including refrigerated transport. It mandates the monitoring and control of critical parameters like temperature to prevent foodborne illness.
- **ISO 15800 (Road vehicles - Refrigerated vehicles - Test methods for heat transfer performance):** Provides standardized test methods for evaluating the thermal performance of refrigerated vehicles under controlled conditions. This data is used to determine the heat gain coefficients used in refrigeration unit selection.

Conclusion

A data-driven and scientifically optimized approach to refrigerated vehicle selection, design, and operation, coupled with integrated telematics systems, is paramount for ensuring efficient and sustainable cold chain logistics. By adhering to international standards and regulations, businesses can guarantee the safe, high-quality delivery of temperature-sensitive goods while minimizing environmental impact.

SUBSIDY COMPONENTS DETAIL:

Component No.	Component Description	NHM	NHB
C-13	Max. Vehicle capacity	4 MT and upto max. 14 MT	15 MT and upto max. 30 MT
	Cost	For the purpose of calculation Rs. 3.45 lakhs/MT would be considered. The cost would be calculated on the pro-rata basis from 4MT upto max. of 14MT.	For the purpose of calculation Rs. 3.45 lakhs/MT would be considered. The cost would be calculated on the pro-rata basis from 15MT upto max. of 30MT.

FOR NHM -

- The beneficiary cannot claim more than 70MT in one application (e.g.- 14MT x 5 no. vehicles) and after submitting due usage of vehicles - purpose of transporting horticulture produce, names of the produce transported, Reefer RCs, insurance, etc. at the time of new application can apply for another 5 no. vehicles (e.g.- 14MT x 5 no. vehicles) under the same name and style. The max. capping is as follows:
 - 4 MT - 6 MT: Max. 11 vehicles in batches of two application
 - 6MT – 9MT: Max. 11 vehicles in batches of two application
 - 10MT – 14MT: Max. 10 vehicles in batches of two application

A beneficiary cannot avail subsidy under the same name and style on more than cumulative capacity of 140MT (irrespective of reefer capacity or combination) in a period of 4 years.

- Mission can support Refrigerated Transport between 4 MT upto 14 MT.
- The new technologies should be promoted and capacities to be derived on the basis of **The Load Carrying Capacity of the Container** (as described in the chapter).
- The vehicle should be equipped with GPS enabled systems and telematics for access and control.
- Liquified N₂ technology, etc. will also be admissible.

FOR NHB-

- NHB should promote refrigerated vehicles from 15 MT and upto max. 30 MT
- The new technologies should be promoted and capacities to be derived on the basis of **The Load Carrying Capacity of the Container** (as described in the chapter).
- The maximum subsidy is limited to Rs. 80 lakhs/ project in general areas and Rs. 100 lakhs/ project in North-Eastern and Himalayan states, Scheduled Areas, Vibrant Villages, Andaman & Nicobar and Lakshadweep islands. (Refrigerated Transport).
- The vehicle should be equipped with GPS enabled systems and telematics for access and control.
- Liquified N₂ technology, etc. will also be admissible.

NOTE:

- i. All the trucks must be registered as “Refrigerated Truck” under RTO’s for claiming subsidy.
- ii. Registration Certificate copy to be submitted to NMH/NHB/NCCD with project details and vehicle details before the subsidy is released.
- iii. The Small Refrigerated Vehicles, with a capacity ranging from 1 MT upto 2 MT, provided under the Integrated Packhouse and Collection Aggregation Centre in the guidelines, could potentially be adapted into Mobile Vending Trucks. These trucks could feature foldable counters and other modifications, enabling them to serve as efficient units for the sale of fresh fruits and vegetables. However, it does not mean/ imply that these vehicles as described above could be given as Stand-alone component for vending of fruits and vegetables.

SUBMITTALS:

BASIC DATA SHEET: Refer to Annexure V at the end of this book



23. EXPANSION & MODERNISATION

A. MODERNISATION

In recent years, the modernization of refrigeration technology has become a critical focus in the cold chain industry. This approach aims to significantly improve the energy efficiency and safety of refrigeration systems, particularly in cold storage facilities that play an essential role in preserving food and other perishable products. Modernizing these systems not only enhances operational efficiency but also contributes to a reduction in carbon footprint, aligning with global efforts toward environmental sustainability.

This chapter explores how modernization initiatives in cold storage facilities are contributing to a more energy-efficient and environmentally friendly cold chain. It discusses the upgrades to evaporators, compressors, and associated refrigeration components, as well as considerations for enhancing insulation. These improvements not only support energy savings but also ensure adherence to food and product safety standards.

MODERNIZATION OF REFRIGERATION COMPONENTS

Modernizing the refrigeration components of cold storage facilities involves upgrading key elements such as evaporators, compressors, and flow control valves. By implementing these changes, cold storage operators can achieve substantial improvements in both energy efficiency and operational safety.

1. Evaporators

Traditional open-tube evaporators are often energy-intensive and may not meet current food safety standards. Upgrading to more efficient evaporator types, such as plate or finned evaporators, can reduce energy consumption while improving the consistency of cooling performance. These modern evaporators are designed to provide optimal thermal transfer, ensuring that products are stored at the ideal temperature. Enhanced efficiency also reduces the strain on other refrigeration components, leading to further energy savings.

2. Compressors

Compressors are central to the functionality of refrigeration systems, but older models are typically less energy-efficient. Modern compressors, equipped with technologies that allow for variable loads, can adjust their output based on the current cooling requirements of the facility. This design not only reduces energy consumption but also extends the lifespan of the compressor by minimizing unnecessary operation. High-efficiency compressors can also support both full and partial load operations, which add flexibility in managing energy consumption during different phases of demand.

3. Control and Safety Valves

The modernization of refrigeration systems often includes upgrading flow control valves, regulation valves, safety valves, and pressure relief valves. Modern valves enable more precise control over the refrigeration cycle, enhancing the efficiency and safety of the system. Updated pressure relief

valves, in particular, are essential for maintaining safe operating conditions by preventing pressure build-up, which could otherwise result in system failure or safety hazards.

4. Automation with PLC/ microprocessor-based monitoring and controls.

Modernizing cold storage facilities with PLC (Programmable Logic Controller) or microprocessor-based monitoring and control systems significantly enhances operational efficiency and precision. These automated systems allow for real-time monitoring and control of temperature, humidity, and energy use, ensuring optimal storage conditions while minimizing human intervention. By providing detailed data analytics, predictive maintenance capabilities, and remote management, these technologies support both energy efficiency and consistent product quality, contributing to a more sustainable and reliable cold chain.

ENHANCING ENERGY EFFICIENCY AND SAFETY THROUGH IMPROVED INSULATION

While modernization may not focus solely on replacing existing insulation, it emphasizes enhancing the thermal barrier where it can significantly reduce energy consumption. Effective insulation is critical for maintaining stable temperatures within cold storage facilities, as it minimizes heat gain from external sources, thereby reducing the load on refrigeration systems.

Using advanced insulation materials such as vacuum-insulated panels or high-density polyurethane or PUF can dramatically reduce energy loss, allowing facilities to maintain desired temperatures more efficiently. When upgrading insulation, modern materials that meet or exceed current standards are preferable, as they offer improved performance over conventional insulation solutions.

Operational Maintenance

Insulation in operational cold storage facilities should be periodically inspected and upgraded as needed to maintain efficiency. Facilities should integrate insulation maintenance into their standard operational practices, ensuring that walls, doors, and other thermal barriers retain their efficacy over time. However, modernization efforts should focus on installing insulation that can demonstrably reduce energy usage in alignment with facility upgrades.

Environmental Impact: Reducing the Carbon Footprint

One of the overarching goals of modernization in cold chain facilities is to create a more environmentally friendly supply chain. Upgraded refrigeration components and improved insulation contribute to a significant reduction in the facility's carbon footprint. By lowering energy consumption, these modernized systems decrease greenhouse gas emissions associated with energy production, aligning the cold chain industry with sustainable development goals. Moreover, these energy-efficient upgrades have the potential to reduce operational costs over time.

Modernizing refrigeration in cold chain facilities is essential to ensuring both energy efficiency and operational safety. By upgrading components such as evaporators, compressors, and valves, as well as enhancing insulation where necessary, cold storage facilities can reduce energy consumption and improve safety standards. This modernization not only helps facilities adhere to food and product safety guidelines but also contributes to a more sustainable and environmentally responsible cold chain.

Cost Components:

1. **Refrigeration:** The cost norm applicable is as per present cost norms by NHM/NHB.

The component “Modernisation of Refrigeration” may include the following items:

- a) Up-gradation of Evaporators.
- b) Up-gradation of Compressors.
- c) Replacement of Refrigeration Valves including Electronic Expansion valves
- d) Automation with PLC/ microprocessor based monitoring and controls.

Modernisation must result in a change to more efficient refrigeration system which brings at least 5% reduction in energy consumption of the subject facility. Each up-gradation case must submit existing energy consumption patterns.

2. **Insulation:** The cost norm applicable is as per present cost norms by NHM/NHB.

This does not limit the cold-chain facility from utilising more insulation as per requirement or from sourcing equipment with other options.

The insulation used should be CFC and preferably HCFC free material with minimal negative impact to the environment. Insulation modernisation must require a change to a more efficient thermal barrier (compare material ‘U’ values between existing and proposed barrier) to result in at least 5% reduction in energy consumption. In case of cold stores where the existing insulation is older than 20 years, and the facility is operating to commercial capacity, this component can also be availed. Insulation cost will be evaluated at published rates. This component does not apply towards movable barriers such as swing doors, sliding doors, hinged doors and other openings including rubber joints.

Essentials For MODERNISATION:

Cold Storages under any type which have been constructed previously-

1. **Refrigeration:** The cost norm applicable is as per present cost norms by NHM/NHB.

The component “Modernisation of Refrigeration” may include the following items:

- a) Up-gradation of Evaporators.
- b) Up-gradation of Compressors.
- c) Replacement of Refrigeration Valves including Electronic Expansion valves
- d) Automation with PLC/ microprocessor based monitoring and controls.

Modernisation must result in a change to more efficient refrigeration system which brings at least 5% reduction in energy consumption of the subject facility. Each up-gradation case must submit existing energy consumption patterns.

2. **Insulation:** The cost norm applicable is as per present cost norms by NHM/NHB.

This does not limit the cold-chain facility from utilising more insulation as per requirement or from sourcing equipment with other options.

The insulation used should be CFC and preferably HCFC free material with minimal negative impact to the environment. Insulation modernisation must require a change to a more efficient thermal

barrier (compare material 'U' values between existing and proposed barrier) to result in at least 5% reduction in energy consumption. In case of cold stores where the existing insulation is older than 20 years, and the facility is operating to commercial capacity, this component can also be availed. Insulation cost will be evaluated at published rates. This component does not apply towards movable barriers such as swing doors, sliding doors, hinged doors and other openings including rubber joints

COST NORM:

For Both NHM & NHB

Component No.	COMPONENT	DESCRIPTION	COST
C-12	Modernisation for Refrigeration	Modernisation for Refrigeration with latest technologies including refrigeration plant and associated equipments with the refrigeration system to reduce energy consumption.	Rs.120 lakh / project
		Unified Control System – PLC, BMS, IoT, Remote Monitoring, etc.	Rs. 5 lakh/ project
	Modernisation for Insulation & Doors	The insulation used should be CFC and preferably HCFC free material with minimal negative impact to the environment. Insulation modernisation must require a change to a more efficient thermal barrier (compare material 'U' values between existing and proposed barrier) to result in at least 5% reduction in energy consumption. EPS is not allowed.	Rs.120 lakh / project

B. EXPANSION

Cold Storage Expansion is defined as adding up additional capacity to the existing capacity which is done by creating new chambers along with new installation of essential refrigeration and electrical equipment. Since cost norm applicable to the expansion projects are same as that of a new project, Expansion projects should be regarded as entirely new endeavors, necessitating the installation of all new equipment with the appropriate capacity. Therefore, it is essential to understand that expansion projects require the implementation of fresh equipment to meet the demands of the expanded space.

When applying for an expansion project, applicants must also provide comprehensive details of the existing project.

NOTE: Applicants are advised not to over-design the existing project with potential future expansions in mind, as only new equipments will be allowed to be installed during the expansion phase.

CHAMBER CAPACITY CONFIGURATION - NEW PROJECTS (CS-1/CS-4)

Rule no.	Minimum Storage Capacity (MT)	Maximum Storage Capacity (MT)	MIDH/NHM Configuration	NHB Configuration
1	500	4999 ~ 5000	The combination of capacity of chambers in a project can be divided between min. capacity of 500 MT and up to a max. capacity of 1500 MT (per chamber).	NA
2	5001	10000	NA	The combination of capacity of chambers in a project can be divided between min. capacity of 1500 MT and up to a max. capacity of 2500 MT (per chamber).
3	10001	20000	NA	The combination of capacity of chambers in a project can be divided between min. capacity of 1500 MT and up to a max. capacity of 2500 MT (per chamber) up to 10,000 MT. And for storage capacity above 10,000 MT up to max. 20,000 MT, the combination of capacity of chamber can be divided up to a max. capacity of 5000 MT per chamber but not less than 1500 MT capacity in any case.

CHAMBER CAPACITY CONFIGURATION - EXPANSION PROJECTS (CS-1/CS-4)

1. If the total capacity of the project after expansion lies between capacity of min. 500 MT up to max. 4999 ~ 5000 MT, then the configuration of capacity of each new chamber in expansion project has to follow Rule no. 1 of Chamber Capacity Configuration for New Projects.
2. If the total capacity of the project after expansion lies between capacity of min. 5000MT up to max. 10,000 MT, then the configuration of capacity of each new chamber in expansion project has to follow Rule no. 2 of Chamber Capacity Configuration for New Projects.
3. If the total capacity of the project after expansion lies between the capacity above 10,000 MT up to max. 20,000 MT, then the configuration of capacity of each new chamber in expansion project has to follow Rule no. 3 of Chamber Capacity Configuration for New Projects.

CHAMBER CAPACITY CONFIGURATION - NEW PROJECTS (CS-2/CS-2-CA)

Rule no.	Minimum Storage Capacity (MT)	Maximum Storage Capacity (MT)	Balance Storage Capacity other than fixed 6 chambers (MT)	MIDH/NHM Configuration	NHB Configuration
1	1500 (min. 6 chamber x 250 MT = 1500 MT) *	4999 ~ 5000	3500	The applicant has to construct min. 6 chambers of capacity less than 250 MT as described in NCCD Guidelines totaling to 1500 MT capacity. For the balance capacity of 3500 MT, the combination of capacity of chambers in a project can be divided between min. capacity of 500 MT and up to a max. capacity of 1500 MT (per chamber).	NA
2	1500 (min. 6 chamber x 250 MT = 1500 MT) *	20,000	18500	NA	The applicant has to construct min. 6 chambers of capacity less than 250 MT as described in NCCD Guidelines totaling to 1500 MT capacity. (For chamber size configuration of remaining capacity, please refer point 2 (a) and 2 (b).
2 (a)	1501	10,000	10,000	NA	For the balance capacity from 1501 MT up to a max. of 10,000 MT, the combination of capacity of chambers in a project can be divided between min. capacity of 1500 MT and up to a max. capacity of 2500 MT (per chamber). For storage capacity

2 (b)	10,001	20,000	0	NA	above 10,000 MT up to max. 20,000 MT, the combination of capacity of chamber can be divided up to a max. capacity of 5000 MT per chamber but not less than 1500 MT capacity in any case.

CHAMBER CAPACITY CONFIGURATION - EXPANSION PROJECTS (CS-2/CS-2-CA)

1. If the total capacity of the project after expansion lies from capacity under 5000 MT up to max. 10,000 MT, then the configuration of capacity of each new chamber has to follow Rule no. 2 (a) of Chamber Capacity Configuration for New Projects.
2. If the total capacity of the project after expansion lies between the capacity above 10,000 MT up to max. 20,000 MT, then the configuration of capacity of each new chamber in expansion project has to follow Rule no. 2 (b) of Chamber Capacity Configuration for New Projects.

Essentials For EXPANSION:

Cold Storages under any type which have been constructed previously-

1. Expansion means adding of more capacity in terms of MT upto maximum prescribed limits by NHM & NHB.
2. Cold Storage Expansion is defined as adding up additional capacity to the existing capacity which is done by creating new chambers along with new installation of essential refrigeration and electrical equipment. **Since cost norm applicable to the expansion projects are same as that of a new project, Expansion projects should be regarded as entirely new project**, necessitating the installation of all new equipment with the appropriate capacity. Therefore, it is essential to understand that expansion projects require the implementation of fresh equipment to meet the demands of the expanded space.
3. Expansion also includes additional components like CO2 monitoring System, Unified Control System, Hoists/Conveying systems, Dock Leveler System, MHTs, Automated Computerised System with software, etc. – This will be provided only one time either during the existing project or during the expansion project.
4. For the purpose of integration, only plant room, admin block, office, etc. can be used commonly between the existing and the expansion project.
5. If the existing subsidy has been claimed from NHM and the cumulative new capacity for expansion has not crossed 5000 MT then, the applicant cannot avail subsidy from NHB. In case, the applicant has availed subsidy from NHM, and in the expansion mode if the cumulative capacity crosses 5000 MT then the applicant has to apply for the new expansion under the NHB schemes & guidelines.
6. While applying for expansion project the applicant also needs to submit the details and drawings of the existing facility, drawing of new facility (expansion), years of operation of previous facility & date of inception, previous BDS, state/district from where previous subsidy was claimed, etc.

7. Expansion can be applied only after successful completion of min. 3 years of the existing project from the start of commercial operation of the project.
8. Individual condensing units can be considered upto 2000 MT expansion once, even if the applicant has already availed the benefit of using individual condensing units upto 2000 MT previously. In no case it will be allowed further during further expansion, therefore, the applicant should plan and design his facility with great consideration of energy efficiency, refrigerants and climate.
9. For purpose of expansion in Ripening the applicant can submit details of previous application but the total capacity installed previously and the new proposed capacity during expansion should not exceed 300 MT. The applicant can apply either in NHM or NHB for expansion.
10. For expansion projects in case applicant changes from NHM to NHB or vice-versa the applicant needs to submit an undertaking and NOC from the previous dept/authorised authority stating the details of the previous project.
11. Expansion is not allowed for Integrated Packhouse & Collection Aggregation Centre.

Technical Evaluation while Claiming Subsidy: The following details need to be submitted for Technical Evaluation while availing subsidy:

SUBMITALS along with DPR/Application:

1. **Nomenclature:** Refer to chapter no. 13,14,15,16, 20 & 21 (as applicable)
2. **Basic Data Sheet:** Refer to Annexure III or IV at the end of this book. (Basic Data Sheet of Cold Storage (CS-1/CS-1-Onion/CS-2/CS-2-CA/CS-4 or CS-3). Submit Annexure IX specifically for expansion projects.
3. **Heat Load Calculation Sheet:** Enclose detail basis of heat load calculation.
4. **Drawings:** Enclose sketch with Plan layout and sections showing storage chambers and floor heights clearly.
5. **Technical Performance Data Sheets of proposed Refrigeration Equipments, etc. to be installed, to be submitted from the respective equipment manufacturer.**
6. **Energy Efficiency Sheet:** Refer to Annexure VI at the end of this book.

Note:

- i. **Follow relevant BIS Codes on safety and Standards**
- ii. **Please provide relevant structural safety certificate from certified structural engineer, certified architects, certified agencies or certified person relevant to building norms.**
- iii. **Fire safety norms to be followed as per relevant BIS codes and Standards. Clearance certificate to be provided.**
- iv. **Environmental Clearance certificate to be provided as per requirement and relevant codes and standards.**
- v. **In conventional storage, Refrigerants having potential for Ozone Depletion# and GWP ranging more than 1500 (like R22, R404A etc.) are not allowed for temperature range 0° C and above.**

vi. **Use of inverter compressor / Digital compressor/ compressors with capacity control/reciprocating or screw compressors with microprocessor based controls should be used with choice of natural refrigerants/ refrigerants as described above should also be considered to promote energy efficiency and sustainable development**

vii. **For NHB:**

Since, the maximum allowable capacity has been increased upto 20000 MT, for applications under NHB, an additional cost norm of Rs. 4080 (for civil) & Rs. 5100 (for PEB) would be applicable above 10001 MT upto 20000 MT, remaining guidelines remains same.

e.g. 1- For civil construction, say proposed expansion capacity is 4000 MT and the existing capacity is 8000 MT, therefore cost applicable would be = Rs. 8160 * 2000 (MT) plus(+) Rs. 4080 * 2000 (MT)

e.g. 2- For civil construction say capacity is 10000 MT and the existing capacity is 10000 MT therefore, cost applicable would be = Rs. 4080 * 10000 (MT)

e.g. 3- For PEB construction say capacity is 4000 MT and the existing capacity is 8000 MT therefore, cost applicable would be = Rs. 10200 * 2000 (MT) plus(+) Rs. 5100 * 2000 (MT)

In case, an applicant has already crossed 10000 MT in existing facility and since NHB was not allowing more than 10000 MT, the applicant cannot avail subsidy for remaining 10000 MT under expansion and their total existing capacity would be considered as the installed capacity out of the maximum 20000 MT and remaining can be availed under the expansion following all minimum standards and guidelines as prescribed in this book under various chapters.

NOTE- Add-on Component: To promote renewable energy, applicant can also avail component Alternate Technology as an add-on component (please refer point no.#10 in chapter no. 16- CS-2-CA)

*** Bunker Coil System is not allowed refer NOTES on page no. 100.**

24. INSULATING MATERIALS & DOORS

Maintaining a precise and energy-efficient cold chain environment requires meticulous selection of insulating materials. This chapter delves deeper into the technical aspects of commonly used cold storage insulation materials, exploring their properties and performance characteristics.

A. Thermal Performance Metrics

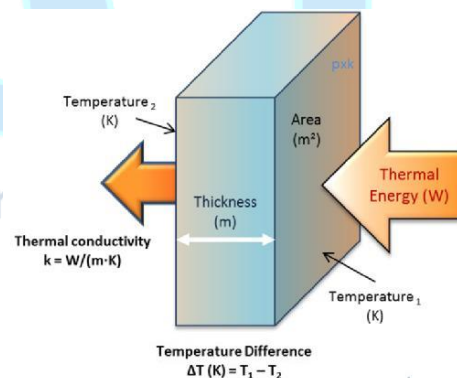
Beyond basic thermal conductivity (k-value), several metrics are crucial for evaluating cold storage insulation:

- **R-Value:** Defined as the material's thermal resistance per unit thickness ($\text{ft}^2 \cdot ^\circ\text{F}/\text{Btu}$). Higher R-value signifies greater insulating power, allowing for thinner walls while achieving the desired temperature control.
- **Mean Temperature (MT):** The average temperature within the insulation material during operation. This value is crucial for calculating accurate thermal conductivity at operating conditions, as k-value often varies with temperature.
- **Thermal Bridging:** This refers to heat transfer through structural elements like fasteners or poorly insulated connections. Minimizing thermal bridging is essential for optimal performance.

B. Material Properties and Performance

i. Polyurethane (PU) Foam:

- **Chemistry:** A two-component liquid system reacting to form rigid, closed-cell foam.
- **k-value:** As low as $0.018 \text{ W}/(\text{m} \cdot \text{K})$, offering exceptional thermal performance.
- **R-Value:** Achieves high R-values per inch thickness due to its low k-value.
- **Moisture Resistance:** Closed-cell structure provides good moisture resistance, but a vapor barrier is still recommended.
- **Adhesion:** Excellent adhesion to various substrates, creating a continuous, seamless insulation layer.
- **Versatility:** PUF can be applied in a variety of ways: panels, spray, blocks and in situ.
- **Considerations:** Requires specialized equipment and trained applicators. May have higher initial cost compared to some alternatives.



$$\frac{Q}{t} = \frac{kA(T_{\text{hot}} - T_{\text{cold}})}{d}$$

Q = Heat transferred in time = t
 k = thermal conductivity of barrier
 A = area of barrier
 T = temperature
 d = thickness of barrier

However, with advantages of Fire Performance and Compressive Strength added to the above, PUF has the most optimum density and thickness insulating value with performance.

ii. Fiberglass:

- **Chemistry:** Glass fibers bonded with a resin binder.
- **k-value:** Varies depending on density, typically around 0.040 W/(m·K).
- **R-Value:** Offers moderate thermal performance.
- **Moisture Resistance:** Susceptible to moisture absorption, requiring a vapor barrier for optimal performance.
- **Fire Resistance:** Inherently fire-resistant, making it a good choice for specific applications.
- **Considerations:** Requires careful handling due to potential fiber irritation. May not be ideal for applications with high humidity.

Material examples	Indicated Thermal conductivity (W/m K)
PUF Composite Panel	0.023
Brick, red	0.6
Aluminium	205.0
Ice	1.6
Glass ordinary	0.8
Concrete	0.8
Water at 20° C	0.6
Asbestos	0.08
Fiberglass	0.04
Brick, insulating	0.15
Cork board	0.04
Rock wool	0.04
Polystyrene sheet	0.033
Polyurethane Foam	0.021
Wood	0.12
Air at 0° C	0.024
Silica aerogel	0.003

iii. Other Advanced Insulation Materials:

- **Phenolic Foam:** Excellent fire resistance, dimensional stability, and moisture resistance, but typically the most expensive option.
- **Polyisocyanurate (PIR) Foam:** Similar thermal performance to PU foam with slightly better fire resistance and better compressive strength.
- **Cellular Glass:** Highly durable, closed-cell glass structure offering exceptional moisture resistance and fire resistance, but also the most expensive material on this list.

iv. Selection Criteria and Considerations

Choosing the optimal cold storage insulation involves a comprehensive evaluation of factors including:

- **Desired Temperature Range:** Different materials perform better at specific temperature applications. For ultra-low temperatures, PU foam or PIR foam might be preferred.
- **Budgetary Constraints:** Material cost, installation complexity, and required thickness all influence overall project cost.
- **Application Requirements:** Spray foam excels for complex shapes, while rigid boards are suitable for walls, ceilings and floorings.
- **Fire Safety Regulations:** Certain applications may necessitate materials with superior fire resistance properties.
- **Environmental Considerations:** Some materials might have higher embodied energy or require specialized disposal procedures.

v. Advanced Techniques and Simulations:

Computational fluid dynamics (CFD) simulations can be employed to analyze thermal performance and identify potential thermal bridges within the cold storage design. This allows for optimized insulation placement and minimizes energy losses. The cold storage industry is constantly evolving, and advancements in insulation materials are keeping pace. Blowing agents technology has evolved into low ODP and GWP with HC, HFC & HFO. This is a first step towards sustainability. An important aspect of sustainability emphasises the Recycling aspect: Mechanical & Chemical types have advanced and user should study the end of life.

Here's a glimpse into some promising developments:

- **Vacuum Insulated Panels (VIPs):** These panels utilize a core with a near-perfect vacuum, achieving exceptionally low thermal conductivity. While currently expensive, VIPs offer the potential for thinner walls and improved energy efficiency.
- **Aerogels:** These ultralight materials boast incredibly low thermal conductivity due to their highly porous structure filled with air. Research is ongoing to improve their mechanical strength and cost-effectiveness for broader cold storage applications.
- **Nanotechnology:** Nanoparticles with unique thermal properties are being explored for incorporation into insulation materials. This could lead to the development of next-generation insulation with superior performance.
- **Bio-based Insulation Materials:** Sustainable alternatives like hemp or mycelium-based insulation materials are being investigated. These offer potential environmental benefits while maintaining good thermal performance.

For PUF/PIR- Bio attributed Mass Balance options are already available which gives an option of using sustainable option without compromising physical properties.

Selecting the most suitable insulation material for cold storage facilities requires careful consideration of technical properties, application requirements, and long-term operational costs. By staying informed about emerging technologies and trends, cold storage professionals can make informed decisions that optimize energy efficiency, minimize environmental impact, and ensure the effective preservation of temperature-sensitive products.

In addition to the points above, here are some further considerations:

- **Life Cycle Analysis (LCA):** Evaluating the environmental impact of different materials throughout their entire life cycle, from production to disposal, is becoming increasingly crucial. Life Cycle Analysis is very important with respect to potential environmental impact hence analysis should cover Global Warming Potential (GWP), Abiotic depletion potential - fossil, Acidification potential, eutrophication potential as well as photochemical ozone creation potential etc.
- **Maintenance and Repair:** Different insulation materials have varying maintenance requirements. Materials might require periodic inspections to ensure their integrity.

- **Regulations and Standards:** Staying up-to-date with relevant building codes and industry standards for cold storage insulation materials is crucial for project compliance.

INSULATING PANELS

The wall and ceiling of the STORAGE FACILITY are constructed using pre-fabricated, self supported, sandwich panels insulated with rigid polyurethane foam (PUF free of CFC) of various thickness with partition walls. This foam is injected using high-pressure equipment in a precise proportion. The foam density is to be strictly controlled to provide excellent thermal insulation, strength and stability.

The dimensions of the panel should be stable over a temperature range of (-) 60 deg. C to 100 deg. C.

Broad specification of the INSULATED panels

PUF/PIR Thickness	: As required
Density	: 40 ± 2 kg/cu.m
Thermal conductivity	: 0.022 W/sq.m/deg.K
Tensile strength	: 3.7 kg/sq.m
Adhesion strength	: 2.9~3.0 kg/sq.cm (PUF to steel) (0.1-0.5 N/sq.m)
Closed cell contents	: 90 to 95%
Fire resistance	: Self extinguishing
Water Absorption	: 0.1% by volume at 100% RH
Thickness of outer sheets	: As required
Material of outer sheets	: Profiled Galvanised Sheet Steel (PP/PP) with tread / Depth of profile approx 2.2 mm (± 0.5)
Amount of zinc coating	: Min. 90 ~120 gm/sq.m

Outer finish on the sheets: The panels on both outer and inner side shall be pre-painted sheet suitable thickness/ S.S. sheet. The colour of the sheet will be decided later on and as per requirement of customer and can be changed on specific request to the customer

JOINING OF PANELS

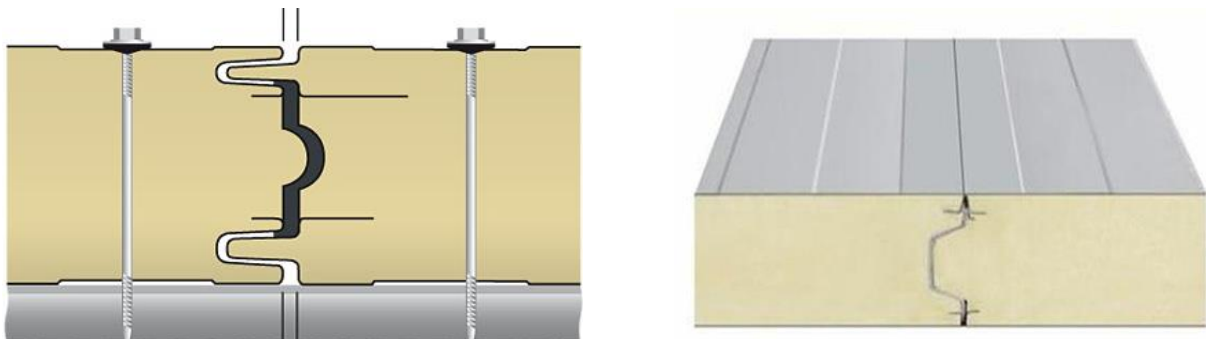
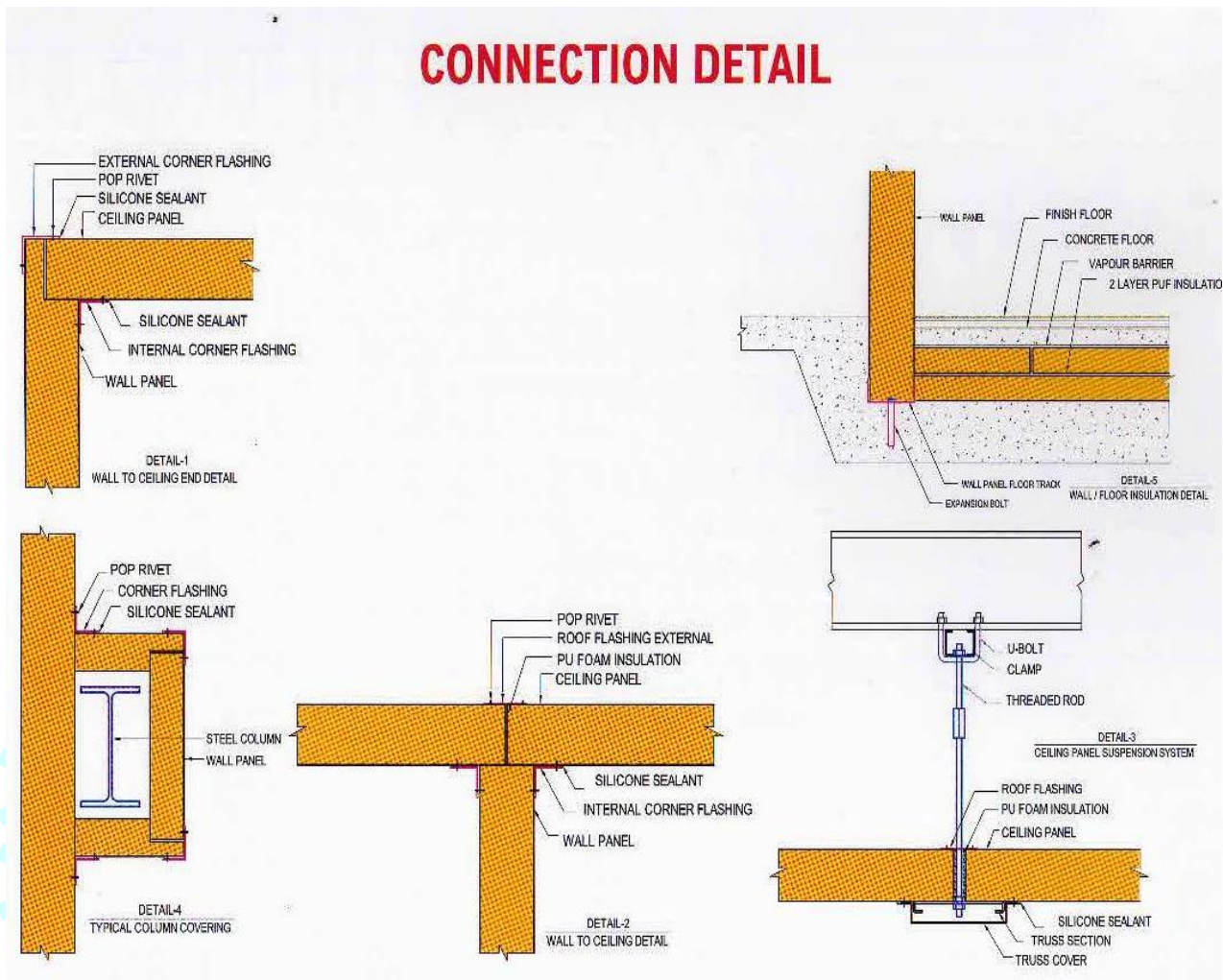


Fig.- Ceiling Panel Joint



1. Panels are joined by 'tongue-and-groove' system or other similar arrangement continuous type
2. Panels for ceiling - these are manufactured in maximum two lengths and shall be mounted throughout the width of the Chambers without longitudinal jointing of the panels and may be supported with intermediate supports.
3. The ceiling supports will be arranged with suitable U hat hollow section to be filled with PUF chemical along with GI rods to be used for the purpose of hanging and will have proper thermal barrier.
4. The offer include cutting of PUF Sandwich Panels, wherever necessary, as well as assembly of doorframes.

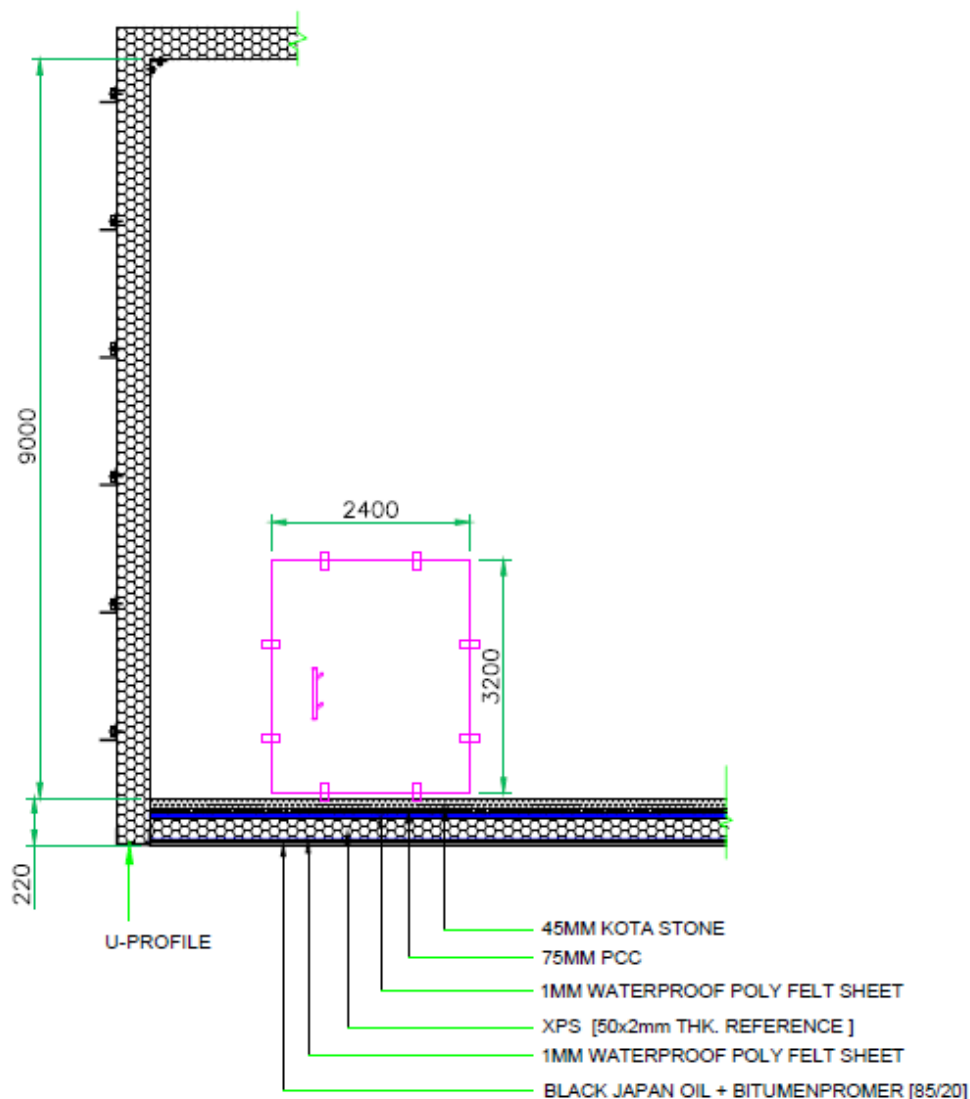
Internal /external angle: The corner joints shall be homogeneously foamed (also to be CFC-Free), sealed with Silicone Sealing Compound and shall be covered with galvanized sheet steel angles. (Drawing attached)

Installation of Panels on Floor

1. Panels shall be erected on the floor and sealed with galvanized corner steel (equal to the thickness of the panels), which shall then be fastened with plugs on the floor.
2. All joints, angles and U-shells shall be foamed homogeneously and then sealed with Silicon Sealing Compound.

3. All the materials to be used in this job shall meet the sanitary standards for Chambers for Storage of Food Products according to International regulation.
4. For supporting the wall panels the horizontal supporting arrangement along the outer periphery will be provided by the Client
5. The colour of the PP GI sheet should be preferably Appliance white.

FLOOR INSULATION: (only for reference)



For Controlled Atmosphere (CA) Manual Sliding Doors:

Parameter	Details
Definition	Manual sliding doors designed for air-tight controlled atmosphere (CA) applications.
Operating Temperature	-5°C to +5°C
Panel Specifications	- Thickness: as required - Includes a visual double-glass window with a locking mechanism.
Frames & Sliding Mechanism	- Supplied with frames and counter frames. - Equipped with a manual sliding system.
Seals	- Made of closed-cell mousse rubber foam. - Fitted to an aluminum guide for tight sealing.
Observation Window	- Dimensions: as required - Anodized aluminum frame with thermopane glass (4+9+4).
Sampling Hatch	- Integrated into the observation window for easy sampling through the opening.
Closing & Sliding Hardware	- Galvanized steel profiles. - Lateral hooks ensure a superior seal and gas tightness.
Opening Mechanism	- Levers allow easy opening from both inside and outside.

By adopting a comprehensive approach that considers both technical performance and broader environmental and economic factors, cold storage facilities can achieve optimal thermal control while ensuring a sustainable future.

National Centre for Cold-chain Development

25. REFRIGERATION SYSTEM AND COMPONENTS

A cold storage facility relies on a complex refrigeration system to maintain a consistently low temperature environment for perishable goods. This system operates on a closed loop, circulating a refrigerant through four main components:

- **Evaporator:** The evaporator absorbs heat from the air within the cold storage room. The refrigerant undergoes a phase change from a liquid to a gas state, absorbing heat in the process. This chilled gas is then drawn away from the evaporator.
- **Compressor:** The compressor increases the pressure and temperature of the refrigerant gas. This compression process further removes heat from the refrigerant.
- **Condenser:** The hot, high-pressure refrigerant gas enters the condenser. Here, it releases heat to the surrounding environment, typically air or water, causing it to condense back into a liquid state.
- **Expansion Valve (or Metering Device):** The expansion valve reduces the pressure of the liquid refrigerant. This pressure reduction lowers the boiling point of the refrigerant, allowing it to readily absorb heat again when it reaches the evaporator, completing the cycle.



Components of Refrigeration System:

i. Compressor:

A compressor is a mechanical device used to increase the pressure of a gas by reducing its volume. Compressors are widely used in various industries and applications, including refrigeration, air conditioning, gas processing, and pneumatic systems.

There are several types of compressors, each with its own unique design, working principle, and applications. The main types of compressors include:

- Reciprocating Compressors:** These compressors use a piston-cylinder mechanism to compress the gas. The piston moves back and forth within the cylinder to compress the gas. Reciprocating compressors are commonly used in household refrigerators, air compressors, and some industrial applications.

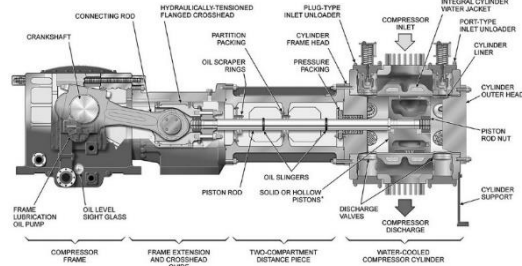


Fig 6: Reciprocating Compressor(left)

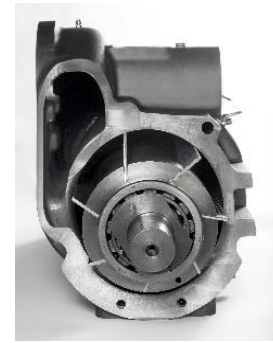


Fig 7: Vane Compressor(right)

b. Rotary Compressors: Rotary compressors operate by rotating a rotor within a chamber to compress the gas. There are several subtypes of rotary compressors, including:

- **Vane Compressors:** These use vanes or blades attached to a rotor to compress the gas as the rotor rotates.
- **Scroll Compressors:** Scroll compressors use two interleaving scrolls to compress the gas by trapping it and reducing the volume between the scrolls.

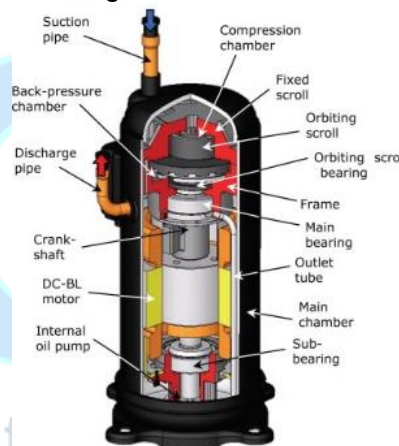


Fig 8: Scroll Compressor

- **Screw Compressors:** Screw compressors use rotating screws to compress the gas between the screw threads.

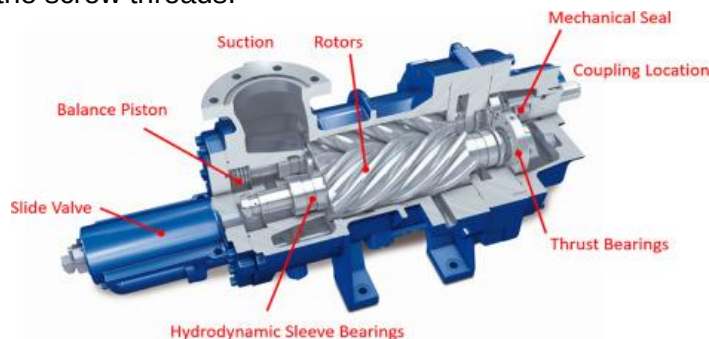


Fig 9: Screw Compressor

- **Lobe Compressors:** Lobe compressors use lobed rotors to compress the gas as the rotors rotate.



Fig 10: Lobe Compressor

- c. **Centrifugal Compressors:** Centrifugal compressors use a rotating impeller to accelerate the gas and then convert its kinetic energy into pressure. These compressors are commonly used in large industrial applications such as gas turbines, air conditioning systems, and petrochemical plants.

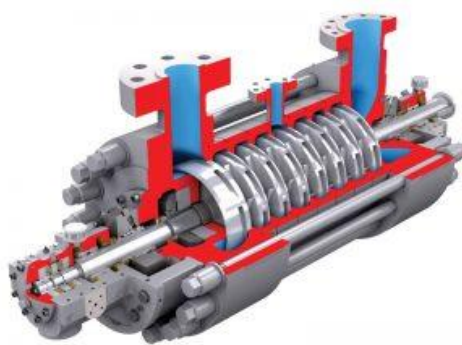


Fig 11: Centrifugal Compressor

- d. **Axial Compressors:** Axial compressors use a series of rotating and stationary blades to compress the gas in a continuous flow. They are often used in aircraft engines, gas turbines, and some industrial processes.

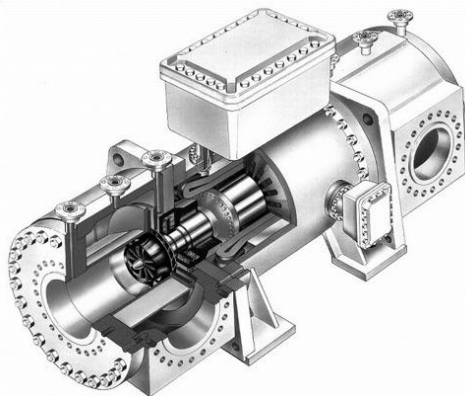


Fig 12: Axial Compressor

In refrigeration systems, the most commonly used types of compressors are reciprocating compressors, rotary compressors, and scroll compressors

Each type of compressor has its own advantages and disadvantages, and the choice of compressor depends on factors such as the required pressure ratio, flow rate, efficiency, size, and application-specific requirements.

e. Semi Hermetic Compressors: semi-hermetic compressor has both the compressor and the motor fully protected from the environment within a sealed shell. Unlike the hermetic compressor, though, semi-hermetic models are designed so they can be opened for diagnosis and periodic maintenance.

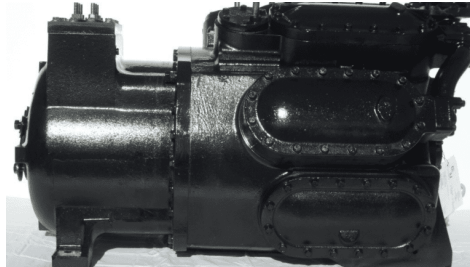


Fig 13: Semi-Hermetic Compressor

ii. Evaporator:

An evaporator is a heat exchanger used in refrigeration and air conditioning systems to absorb heat from a substance (such as air, water, or a refrigerant) and facilitate its phase change from liquid to vapor. Evaporators play a crucial role in cooling processes by removing heat from the surroundings, thus causing the substance to evaporate and lower its temperature.

There are several types of evaporators, each designed for specific applications and operating conditions. The main types of evaporators include:

a. Bare Tube Evaporators:

- a) Bare tube evaporators consist of a network of straight or coiled tubes through which the refrigerant flows. These tubes are usually made of materials like copper, aluminum, or steel.
- b) The refrigerant evaporates inside these tubes, absorbing heat from the surroundings. Since there are no additional surfaces for heat exchange, bare tube evaporators typically have a simpler design and are easier to clean.
- c) Bare tube evaporators are commonly used in applications where space is limited, such as in small refrigerators or air conditioning units.

b. Plate Surface Evaporators:

- a) Plate surface evaporators feature a series of flat or corrugated plates with refrigerant passages. These plates are often made of materials like stainless steel or aluminum.
- b) Refrigerant flows through the passages between the plates, while the substance to be cooled (such as air or water) passes over the external surface of the plates.
- c) Plate surface evaporators offer a large surface area for heat transfer, resulting in efficient cooling. They are commonly used in applications where high heat transfer rates are required, such as in industrial refrigeration systems or large-scale air conditioning units.



Fig 14: Bare Tube & Plate Surface Evaporator

c. Finned Tube Evaporators:

- a) Finned tube evaporators consist of tubes with external fins attached to increase the surface area available for heat transfer. These fins can be straight or corrugated, and they are typically made of materials like aluminum or copper.
- b) The refrigerant flows through the tubes, while the substance to be cooled passes over the fins. This configuration enhances heat transfer efficiency by increasing the contact area between the refrigerant and the substance being cooled.
- c) Finned tube evaporators are widely used in various refrigeration and air conditioning applications, including household refrigerators, commercial freezers, and HVAC systems.



Fig 15: Finned Tube Evaporator

d. Shell and Tube Evaporators:

- a) Shell and tube evaporators consist of a cylindrical shell containing multiple tubes through which the refrigerant flows. The shell is typically made of steel, while the tubes can be made of materials like copper or aluminum.
- b) The substance to be cooled surrounds the tubes, and heat transfer occurs as the refrigerant evaporates inside the tubes. This design allows for efficient heat exchange and is suitable for high-capacity cooling applications.
- c) Shell and tube evaporators are commonly used in industrial refrigeration systems, large-scale air conditioning units, and heat pump systems due to their robust construction and high heat transfer capabilities.



Fig 16: Shell and Tube Evaporator & Unit Cooler

iii. **Unit Coolers:**

A unit cooler is a refrigeration equipment used to maintain low temperatures within a specific enclosed space, typically a cold storage room. It comprises a heat exchanger (evaporator coil), a fan, and a housing. The unit cooler circulates refrigerant through the evaporator coil, which absorbs heat from the warm air within the space. The cooled air is then distributed by the fan, maintaining a consistent low temperature.

iv. **Condenser:**

A condenser is a heat exchanger in a refrigeration system that is responsible for removing heat from the refrigerant gas and converting it back into a liquid state. It operates in the opposite manner to an evaporator, where heat is absorbed to change the refrigerant from a liquid to a vapor.

There are several types of condensers used in refrigeration systems, each with its own advantages and applications. The main types of condensers include:

- a. **Air-Cooled Condensers:** Air-cooled condensers transfer heat from the refrigerant to the surrounding air using fins and fans. The refrigerant flows through tubes or coils, and ambient air is forced over the coils by fans, removing heat and causing the refrigerant to condense. Air-cooled condensers are commonly used in residential and small commercial refrigeration systems due to their simplicity and cost-effectiveness.



Fig 17: Air-Cooled Condenser(Left)

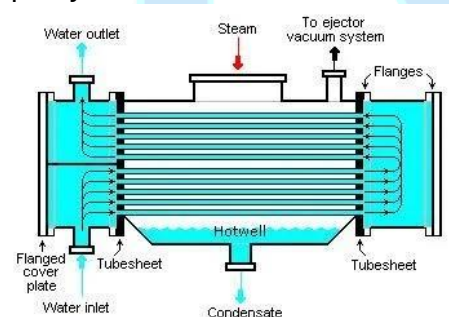


Fig 18: Water-Cooled Condenser(right)

- b. **Water-Cooled Condensers:** Water-cooled condensers use water as the cooling medium to remove heat from the refrigerant. The refrigerant flows through tubes or coils, and water circulates around the tubes, absorbing heat and causing the refrigerant to condense. Water-cooled condensers are often used in larger commercial and industrial refrigeration systems where water is readily available and air-cooled options may not be suitable due to space or environmental constraints.
- c. **Evaporative Condensers:** Evaporative condensers combine elements of air-cooled and water-cooled condensers. They use both ambient air and water to remove heat from the refrigerant. The refrigerant flows through tubes or coils, and water is sprayed over the coils while ambient air is forced over the wet coils by fans. As the water evaporates, it absorbs heat from the refrigerant, causing it to condense. Evaporative condensers are commonly used in industrial refrigeration systems where high heat rejection rates are required.

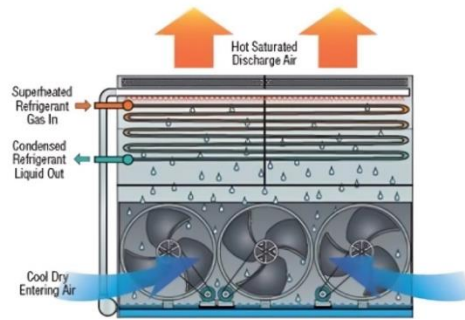


Fig 19: Evaporative Condenser

d. Shell and Tube Condensers: Shell and tube condensers consist of a shell containing multiple tubes through which the refrigerant flows. Cooling water circulates around the tubes, absorbing heat and causing the refrigerant to condense. Shell and tube condensers are commonly used in large industrial refrigeration systems and air conditioning units due to their high heat transfer efficiency and robust construction.

v. Expansion Valve or Throttle:

Expansion valves are crucial components in refrigeration systems, responsible for regulating the flow of refrigerant into the evaporator. They control the rate at which the high-pressure liquid refrigerant is allowed to expand and enter the evaporator, where it undergoes evaporation and absorbs heat from the surroundings. There are several types of expansion valves used in refrigeration systems, each with its own characteristics and applications:

a. Thermostatic Expansion Valve (TXV):

- The thermostatic expansion valve is one of the most common types of expansion valves used in refrigeration and air conditioning systems.
- It consists of a temperature-sensitive bulb attached to the suction line of the evaporator and a diaphragm or piston mechanism inside the valve body.
- The temperature-sensitive bulb senses the temperature of the refrigerant leaving the evaporator. As the temperature changes, the pressure in the bulb changes, causing the diaphragm or piston to move and adjust the size of the valve opening.
- The TXV maintains a constant superheat at the evaporator outlet by controlling the flow of refrigerant into the evaporator, ensuring optimal performance and efficiency.



Fig 20: Thermostatic Expansion Valve (TXV) (left)

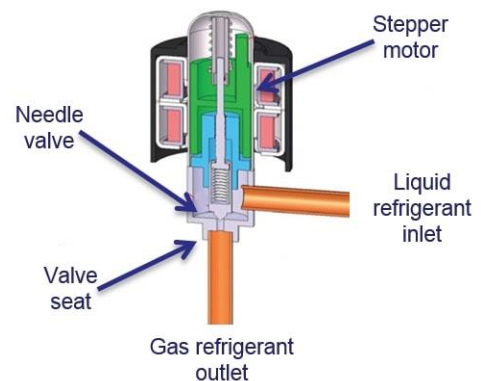


Fig 21: Electronic Expansion Valve (right)

b. Electronic Expansion Valve (EEV):

- Electronic expansion valves utilize electronic controls to modulate the flow of refrigerant into the evaporator.
- They consist of a stepper motor or electronic solenoid that adjusts the valve opening based on signals from a controller or electronic sensing devices.
- EEVs offer precise control over refrigerant flow and can adapt quickly to changing operating conditions, making them suitable for applications requiring tight temperature control and efficiency.

c. Capillary Tube:

- A capillary tube is a simple, inexpensive type of expansion device consisting of a narrow, thin-walled tube with a small diameter.
- The capillary tube restricts the flow of refrigerant into the evaporator, causing a pressure drop and facilitating expansion.
- Capillary tubes are commonly used in small refrigeration systems, such as domestic refrigerators and freezers, where precise control is not required.



Fig 22: Capillary Tube

d. Float Valve:

- Float valves are typically used in large industrial refrigeration systems, such as those found in cold storage warehouses and food processing facilities.
- They operate based on the level of liquid refrigerant in the evaporator. As the level of liquid rises, the float valve opens, allowing more refrigerant to enter the evaporator. Conversely, as the level drops, the float valve closes to restrict the flow of refrigerant.

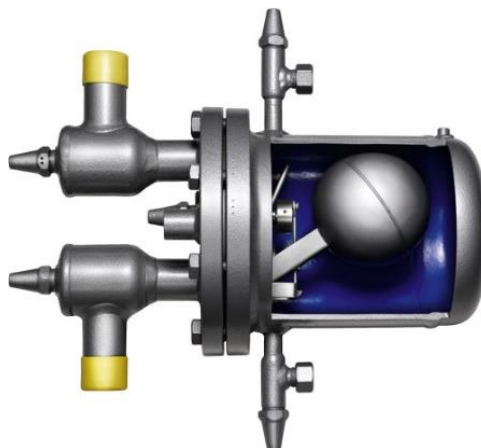


Fig 23: Float Valve

vi. Pumps:

In refrigeration systems, pumps are used to circulate refrigerants, coolants, or other fluids through various components of the system. The main types of pumps used in refrigeration systems include:

i. Centrifugal Pumps:

- Centrifugal pumps use centrifugal force to generate pressure and move fluids. They consist of a rotating impeller inside a casing. As the impeller spins, it creates a centrifugal force that propels the fluid outward from the center of the impeller, increasing its velocity and pressure.
- Centrifugal pumps are commonly used in large-scale refrigeration systems, such as industrial refrigeration plants, air conditioning systems, and chiller units, where high flow rates and moderate pressure requirements are typical.

ii. Reciprocating Pumps:

- Reciprocating pumps use a piston-cylinder mechanism to move fluids. A piston is driven back and forth inside a cylinder, alternately drawing fluid into the cylinder on the suction stroke and expelling it on the discharge stroke.
- Reciprocating pumps are often used in smaller refrigeration systems or applications where high pressure is required, such as in compression refrigeration systems for domestic refrigerators and freezers.

iii. Rotary Vane Pumps:

- Rotary vane pumps use rotating vanes or blades inside a cylindrical housing to create suction and move fluids. As the vanes rotate, they trap and move the fluid through the pump.
- Rotary vane pumps are commonly used in vacuum systems and low-pressure refrigeration applications, such as refrigeration and air conditioning evacuation processes.

iv. Screw Pumps:

- Screw pumps use one or more rotating screws to move fluids through the pump. The screws mesh together to form a seal and trap the fluid as they rotate, pushing it through the pump.
- Screw pumps are often used in refrigeration systems for high-pressure applications, such as in industrial refrigeration and HVAC systems, where reliability and efficiency are crucial.

Refrigeration System Differences in Cold Storage

Cold storage facilities require more robust refrigeration systems compared to typical domestic refrigerators or commercial freezers. Here's why:

- **Lower Temperatures:** Cold storage facilities maintain much colder temperatures, often ranging from -40°C for frozen goods to just above freezing for chilled products. This necessitates a more powerful refrigeration system capable of achieving and maintaining these temperatures efficiently.
- **Larger Spaces:** Cold storage facilities encompass vast volumes compared to domestic appliances. The refrigeration system must be designed to handle the larger thermal load associated with a bigger space.
- **Door Openings:** Frequent door openings in cold storage can significantly impact temperature control. The system needs to be able to rapidly recover lost cool air after door openings.

Construction Materials: Floors, Walls, and Ceilings

The building envelope of a cold storage facility plays a crucial role in maintaining low temperatures and minimizing energy consumption. Common construction materials include:

- **Insulated Metal Panels (IMPs):** These prefabricated panels consist of metal sheets with a high-performance insulation core, typically made of polyurethane or polyisocyanurate. IMPs offer excellent thermal resistance and ease of construction.
- **Concrete Tilt-up Panels:** Precast concrete panels with a layer of insulation can be used for structural support and thermal resistance. However, they require a longer construction time compared to IMPs.

Refrigerants

As we becoming more and more conscious about saving the environment, the selection of refrigerant becomes very crucial and important.

NOTE: For any operations which may require temperature condition and humidity condition upto 0°C refrigerants with GWP between 1000 to 1500 to be used.

where,

National Centre for Cold-chain Development

Global warming potential (GWP) is a measure of how much infrared radiation a greenhouse gas absorbs in the atmosphere over a given period of time. It's used to compare the effectiveness of different greenhouse gases at causing radiative forcing.

GWP is calculated relative to carbon dioxide (CO_2), which has a GWP of 1. Gases with a higher GWP absorb more energy per ton emitted than gases with a lower GWP, and contribute more to warming the Earth.

The selection of refrigerant in a cold storage facility depends on factors like desired temperature range, environmental regulations, and system efficiency. Common refrigerants include:

- **Ammonia (R-717):** A highly efficient and cost-effective option for large cold storage facilities. However, ammonia is toxic and requires specialized handling and safety procedures.
- **Hydrofluorocarbons (HFCs):** These synthetic refrigerants are being phased out due to their environmental impact. However, existing facilities may still utilize them.

- **Hydrocarbon refrigerants (HCs):** Natural refrigerants like propane (R-290) and propylene (R-1270) are gaining popularity due to their low environmental impact. However, they are flammable and require specific safety considerations.
- **Carbon Dioxide (CO₂, R-744):** This natural refrigerant offers good efficiency and environmental benefits. However, CO₂ systems operate at higher pressures, requiring specialized equipment.

NOTE: The refrigerants mentioned here, are for knowledge purpose, NCCD promotes green refrigerants, energy efficient refrigerants, refrigerants with low GWP/ zero ODP, etc. The selection of refrigerants has to be done as per necessary protocols that will come into effect from time to time.

Pressure Vessels

Cold storage refrigeration systems may incorporate pressure vessels for various purposes:

- **Receiver:** The receiver stores liquid refrigerant discharged from the condenser, acting as a buffer and maintaining a steady liquid supply for the expansion valve.
- **Surge Drum:** In some systems, a surge drum helps to dampen pressure fluctuations caused by compressor operation and sudden changes in load.

Cooling Towers

Water-cooled condenser systems utilize cooling towers to reject heat from the condenser water loop. Common cooling tower types include:

- **Evaporative Cooling Towers:** These towers cool water by promoting evaporation of a small portion of the water into the ambient air. They are efficient but require makeup water to compensate for evaporation losses.
- **Air-Cooled Chillers:** In some cases, air-cooled chillers may be used to cool the condenser water loop. This eliminates the need for a cooling tower but can be less efficient than evaporative towers, especially in hot climates.

Humidifiers & Dehumidifiers

Maintaining proper humidity levels is crucial for certain products stored in cold storage facilities. Humidifiers add moisture to the air, while dehumidifiers remove excess moisture. These systems can be integrated with the refrigeration system or operate independently.

Heat Recovery Systems

Cold storage facilities can utilize waste heat from the refrigeration system for various purposes, including:

- **Defrosting Evaporators:** Heat recovered from the condenser or compressor discharge can be used to defrost evaporator coils, reducing energy consumption for the defrost cycle.
- **Space Heating:** Recovered heat can be used to supplement space heating needs within the facility or other buildings on the site.
- **Domestic Hot Water Heating:** In some cases, recovered heat can be used to generate hot water for domestic purposes within the facility.

Additional Considerations

- **Control Systems:** Modern cold storage facilities utilize sophisticated control systems to monitor and optimize the operation of the refrigeration system. These systems can automatically adjust operating parameters based on real-time conditions, ensuring efficient and reliable temperature control.
- **Safety Systems:** Cold storage facilities require robust safety systems to mitigate potential hazards associated with refrigerants, such as ammonia leaks. These systems typically include leak detection, alarm systems, and emergency shut-off valves.

By understanding the different components and their functions, engineers can design and operate cold storage refrigeration systems that are efficient, reliable, and meet the specific storage requirements of the facility.



26. WASHING, SORTING & GRADING LINES

Cold storage facilities rely heavily on automated sorting, grading, and packing lines to ensure efficient and high-quality handling of perishable goods. This chapter delves into the technical aspects of these systems, exploring the equipment, technologies, and considerations specific to the cold storage environment.

Core Components: Their Functions and Benefits

1. Feeding Hopper

- **Purpose:** Receives the incoming produce from various sources like crates, bins, or directly from the field.
- **Components:**
 - Hopper: A large container with a sloping bottom to facilitate smooth flow of produce.
 - Conveyor belt: Transports the produce to the next stage of the processing line.
- **Technical Considerations:**
 - Hopper size should be adequate to accommodate the expected inflow of produce.
 - Conveyor belt speed should be adjustable to control the flow of produce.
 - The hopper and conveyor belt should be made of food-grade materials to ensure hygiene.



2. Inspection Conveyor

- **Purpose:** Allows manual inspection of the produce to identify and remove damaged, diseased, or substandard fruits and vegetables.
- **Components:**
 - Conveyor belt: Transports the produce for inspection.
 - Inspection table: A platform where workers can examine the produce closely.
 - Cull belt: A separate conveyor to transport the rejected produce.
- **Technical Considerations:**
 - The conveyor belt speed should be slow enough to allow for thorough inspection.
 - Adequate lighting should be provided to facilitate inspection.
 - The inspection table should be ergonomically designed for comfortable working conditions.



3. Cull Belt Conveyor

- **Purpose:** Transports the rejected produce to a designated disposal area.
- **Components:**
 - Conveyor belt: Carries the culls.
- **Technical Considerations:**
 - The conveyor belt should be easily cleaned and sanitized.
 - The disposal area should be properly designated and maintained.



4. Washer

- **Purpose:** Cleans the produce by removing dirt, debris, and pesticide residues.
- **Types:**
 - Flume washer: Uses a continuous flow of water to wash the produce.
 - Drum washer: Rotates the produce in a drum filled with water and cleaning solution.
 - Spray washer: Uses high-pressure water sprays to clean the produce.
- **Technical Considerations:**
 - The water used for washing should be clean and of adequate quality.
 - The washing solution, if used, should be food-grade and properly diluted.
 - The washer should be designed to minimize damage to the produce.



5. Dryer

- **Purpose:** Removes excess water from the washed produce to prevent spoilage and improve appearance.
- **Types:**
 - Air dryer: Uses fans to circulate air over the produce.
 - Forced-air dryer: Uses high-velocity fans to accelerate drying.
 - Heat dryer: Uses heat to evaporate water from the produce (less common for delicate fruits and vegetables).
- **Technical Considerations:**
 - The drying temperature should be carefully controlled to avoid damage to the produce.
 - The airflow should be sufficient to ensure efficient drying.



6. Waxer

- **Purpose:** Applies a thin layer of food-grade wax to the produce to reduce moisture loss and enhance appearance.
- **Components:**
 - Wax tank: Stores the melted wax.
 - Application system: Sprays or dips the produce in the wax.
- **Technical Considerations:**
 - The wax should be food-grade and applied in a controlled manner.
 - Excess wax should be removed to avoid a waxy residue on the produce.



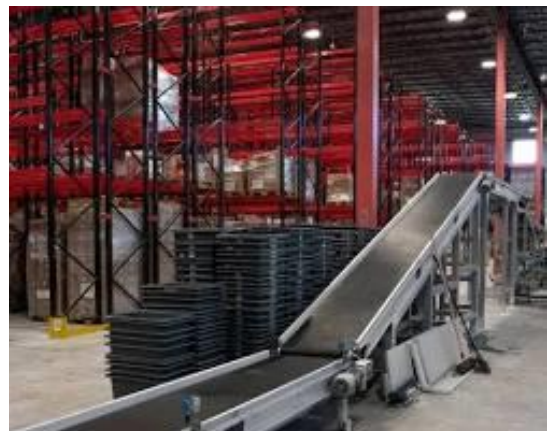
7. Drying Tunnel

- **Purpose:** Further dries the waxed produce to remove any residual moisture.
- **Components:**
 - Enclosed tunnel: Provides a controlled environment for drying.
 - Fans: Circulate air through the tunnel.
 - Heaters (optional): Provide additional heat for faster drying.
- **Technical Considerations:**
 - The drying temperature and humidity should be carefully controlled.
 - The tunnel should be designed to ensure uniform drying of the produce.



8. Inclined Roller Conveyor

- **Purpose:** Transports the processed produce to the next stage of the processing line.
- **Components:**
 - Roller conveyor: Consists of a series of rollers that gently transport the produce.
- **Technical Considerations:**
 - The roller spacing should be appropriate for the size and shape of the produce.
 - The conveyor speed should be adjustable to control the flow of produce.



9. Brusher Polisher

- **Purpose:** Polishes the produce to improve its appearance and remove any remaining dirt or debris.
- **Components:**
 - Rotating brushes: Gently scrub the surface of the produce.
- **Technical Considerations:**
 - Soft brush material to avoid damage.
 - Adjustable speed and pressure for controlled polishing.
 - Water spray to reduce friction.
 - Regular cleaning and sanitation for hygiene.



10. Roller Type Grading Machine

- **Purpose:** Grades the produce based on size, shape, and other quality parameters.
- **Components:**
 - Series of rollers with different sized openings: Sorts the produce into various grades.
- **Technical Considerations:**
 - The roller sizes should be calibrated accurately to ensure precise grading.
 - The grading machine should be easy to adjust to accommodate different product sizes and grades.



11. Feeding Hopper (Post-Grading)

- **Purpose:** Receives the graded produce from the grading machine.
- **Components:**
 - Hopper: A container to collect the graded produce.
 - Conveyor belt: Transports the graded produce to the packaging area.
- **Technical Considerations:**
 - The hopper should be designed to prevent mixing of different grades of produce.
 - The conveyor belt speed should be adjustable to control the flow of produce.



12. Control Panel

- **Purpose:** Monitors and controls the entire washing, sorting, and grading process.
- **Components:**
 - Motor controls: For conveyors, pumps, and other equipment.
 - Sensors: Monitor water flow, temperature, and other parameters.
 - Alarms and safety systems: Alert operators to potential problems.
- **Technical Considerations:**
 - The control panel should be user-friendly and easy to operate.
 - The system should be reliable and maintainable.
 - Safety features should be incorporated to protect workers and equipment.

Additional Considerations

- **Hygiene and Sanitation:**
 - Regular cleaning and sanitization of all equipment and surfaces.
 - Use of food-grade materials and cleaning agents.
 - Proper disposal of waste and wastewater.
- **Water Quality:**
 - Use of clean, potable water for washing and processing.
 - Treatment of wastewater to minimize environmental impact.
- **Energy Efficiency:**
 - Use of energy-efficient equipment and lighting.
 - Optimization of water usage.
- **Worker Safety:**
 - Proper training and safety procedures for workers.
 - Use of personal protective equipment.
 - Ergonomic design of workstations.

By carefully considering these factors, cold storage facilities can implement efficient and effective washing, sorting, and grading lines to ensure the quality and safety of their products.

Equipment Specifications for Cold Storage:

- **Conveyor Belts:**
 - **Material:** Stainless steel or food-grade plastic for corrosion resistance and hygiene.
 - **Variable Speed Control:** Allows for adjusting product flow based on processing requirements.
 - **Temperature-Controlled Belts:** Maintain a consistent cold environment for specific products.

- **Optical Sorting Systems:**

- **Camera Technology:** High-resolution cameras with specialized lighting for capturing clear product images.
- **Image Processing Software:** Advanced algorithms analyze image data to identify and classify products based on pre-defined parameters.
- **Temperature-Controlled Enclosures:** Maintain optimal operating temperature for camera systems.



Fig. 1: Optical Grader Capturing Image

Integration and Automation Considerations

- **Control Systems:** Centralized control systems manage product flow, equipment operation, and data collection.
- **Communication Protocols:** Standardized protocols like Ethernet or CAN enable communication between different system components.
- **Data Management and Analytics:** Real-time data from sensors and cameras is analyzed to optimize sorting parameters and identify potential quality issues.

Additional Considerations:

- **Water Resistance:** Equipment should be water-resistant to withstand splashes and condensation.
- **Sanitation and Maintenance:** Regular cleaning and maintenance are crucial to ensure hygiene and optimal performance.

The Component name “Advanced Grader” may consist of a complete automated grading solution. The major admissible items under this subsidy component are:

1. Automated grading mechanism (acoustic, optical)
2. Computerisation and associated software.

The automated grading component can be added to existing grading lines or incorporate a complete line based system, depending on the type of technology, handling capacity per hour of operation, type and source of equipment, among others. Capacity optimised grading lines with enhanced technologies should be used, where suitable, by cold-chain operators.



27. PACKAGING

Cold storage facilities are essential for maintaining the freshness and quality of fruits, vegetables, and flowers. While temperature control is paramount, specialized packaging creates a micro-environment around the produce, further optimizing storage conditions and minimizing spoilage. This chapter delves into the technical aspects of various packaging solutions used in cold stores for horticultural products.

Key Considerations for Cold Store Packaging:

i. Temperature Management: Different produce types have specific optimal storage temperatures. Packaging materials can influence temperature in several ways:

- **Insulation:** Materials like polystyrene foam boxes or bubble wrap can insulate temperature-sensitive items, delaying temperature fluctuations during handling or transport within the cold storage facility (Figure 1).



Fig 1: Polystyrene foam box for cold storage produce

- **Respiration Management:** Produce respires, releasing heat. Packaging with good gas permeability allows for proper airflow and heat dissipation, preventing temperature spikes within the package (Figure 2).



Fig 2: Perforated bag for cold storage produce

ii. Moisture Control: Excessive moisture can lead to rot and disease development. Packaging should:

- **Allow Respiration:** Micro-perforations in plastic films or breathable materials like vented woven polypropylene bags allow produce to "breathe" and release excess moisture (Figure 3).



Fig 3: Vented woven polypropylene bag for cold storage produce

- **Prevent Condensation:** Moisture-impermeable films like polyethylene liners can prevent condensation from forming on the produce surface when transitioning from warm to cold environments.



Fig 4: Clamshell container for cold storage produce

iii. Physical Protection: Packaging safeguards produce from:

- **Bruising and Punctures:** Rigid containers like cardboard cartons or clamshell containers offer structural support and protection from impact (Figure 4).
- **Crushing:** Breathable mesh bags with padding can be used for delicate fruits like berries, while strong, vented plastic crates are suitable for heavier vegetables.

iv. Ethylene Control: Certain fruits and vegetables are sensitive to ethylene gas, which hastens ripening. Here's how packaging can address this:

- o **Ethylene Absorbent Materials:** Pads impregnated with potassium permanganate or zeolites can be placed within packaging to absorb ethylene gas and slow down ripening (Figure 5).
- o **Ethylene-Blocking Films:** Specific plastic films can impede ethylene gas transmission into the package.



Fig 5: Ethylene absorbent pad for cold storage produce

v. Cost and Sustainability: Balancing cost-effectiveness with environmental responsibility is crucial.

- o **Reusability:** Reusable plastic crates or returnable containers can minimize waste but require proper cleaning and sanitation.
- o **Recyclability:** Packaging materials with good recyclability should be prioritized.
- o **Biodegradability:** Bio-based films or mushroom-based packaging materials offer a more sustainable alternative to traditional plastics.

Types of Specialized Packaging for Cold Storage:

- **Cartons:**
 - o **Corrugated Cardboard Cartons:** The most widely used option for bulk storage and transportation (Figure 6). They offer:
 - Ventilation: Slots and perforations allow for air circulation.
 - Stacking Strength: Fluted cardboard construction provides stability for stacking pallets.
 - Customization: Cartons can be customized with internal dividers or cushioning materials for specific produce.



Fig 6: Corrugated cardboard carton for cold storage produce

- **Pallet Covers and Wraps:**

- **Stretch Wraps:** Pallet wrapping with a high puncture resistance secures produce on pallets during storage and transport within the cold facility.
- **Ventilated Pallet Covers:** These breathable covers allow for air circulation while protecting produce from dust and debris.

- **Bags and Liners:**

- **Polyethylene Bags with Micro-perforations:** These provide:
 - **Moisture Control:** Micro-perforations allow for controlled release of moisture vapor.
 - **Pre-packing:** Bags can be used for pre-packing consumer-sized portions.
 - **Separation:** Bags can separate different produce types within a carton to prevent cross-contamination.

- **Controlled Atmosphere (CA) Storage:**

- For long-term storage of certain fruits and vegetables, CA storage utilizes specialized packaging:
 - **Gas-Impermeable Bags:** These multi-layered plastic bags with low gas permeability create a modified atmosphere around the produce (Figure 7).
 - **CA Chambers:** For bulk storage, large, walk-in chambers can be used to create a controlled atmosphere environment.



Fig 7: Gas-impermeable bag for cold storage produce

Biodegradable and Sustainable Packaging:

The growing focus on environmental sustainability has led to the development of eco-friendly packaging options for cold storage:

- **Bio-based Films:** These films are derived from renewable resources like corn starch or cellulose. They offer varying degrees of biodegradability and can be designed with good gas permeability and moisture control properties.
- **Wax Coatings:** A thin layer of natural wax, such as carnauba wax, can be applied to fruits to reduce moisture loss and extend shelf life.
- **Mushroom-based Packaging:** Mycelium, the root network of fungi, can be used to create a sustainable and biodegradable packaging material. This option is still under development but holds promise for the future.

Choosing the Right Packaging for Cold Storage

Selecting the most suitable packaging for cold storage involves considering several factors:

- **Type of Produce:** Different fruits, vegetables, and flowers have varying requirements for temperature, moisture control, and ethylene sensitivity. Researching the specific needs of the produce is crucial.
- **Storage Duration:** Packaging needs for short-term chilling may differ from those for long-term CA storage.
- **Cost and Sustainability:** Balancing cost-effectiveness with environmental responsibility is essential. Consider factors like reusability, recyclability, and biodegradability of the packaging materials.

Moving beyond the basic components, let's delve into the technical aspects of an automated packaging system designed specifically for cold storage produce:

A. Weighing Machine: High-Precision Measurement

- **Load Cell Selection:** The heart of the weighing machine is the load cell. For delicate produce, high-precision shear beam load cells with capacities matching the expected product weight range are crucial. These provide accurate weight measurement even with minimal product contact.
- **Data Acquisition System (DAQ):** The DAQ system acquires weight data from the load cell at high sampling rates (e.g., 1000 Hz) to capture even minor weight fluctuations during filling. Digital signal processing techniques can be employed to filter out noise and ensure accurate weight readings.
- **Real-time Feedback Control Loop:** The DAQ system transmits weight data to a Programmable Logic Controller (PLC) that acts as the brain of the system. The PLC continuously compares the real-time weight with the target weight and adjusts the filling process accordingly. Proportional-Integral-Derivative (PID) control algorithms are often implemented for precise weight regulation.

B. Final Packaging (Packing Table): Tailored Filling Systems

- **Volumetric Filling - Advanced Calibration:** For volumetric filling of free-flowing products, consider advanced calibration techniques that account for product density variations due to factors like temperature or moisture content. This ensures consistent fill volume despite these fluctuations.
- **Auger Filling - Variable Speed Control:** For auger filling of granular or powdery produce, precise control over auger speed is essential. Variable Frequency Drives (VFDs) can be employed to dynamically adjust auger speed based on real-time weight data, optimizing filling accuracy.
- **Weigh Filling - Multi-stage Filling:** For weigh filling of delicate or high-value produce, a multi-stage filling approach can be beneficial. An initial coarse filling stage at a high speed can be followed by a final, slow-speed dribble fill for precise weight achievement.

C. Coding and Labeling System: Durability and Traceability

- **Thermal Transfer Printing - Ribbon Selection:** For thermal transfer printing, selecting the appropriate ribbon is critical. Choose ribbons formulated for cold storage environments to ensure adhesion and print quality at low temperatures.
- **Laser Marking - Material Compatibility:** While laser marking offers permanence, not all packaging materials are suitable for this technology. Ensure compatibility testing is conducted to avoid damaging the packaging or altering its gas barrier properties.
- **Vision System Integration:** For enhanced quality control, a vision system can be integrated with the coding and labeling system. This vision system can inspect printed codes for legibility and data verification, ensuring proper product identification and traceability.

D. Packaging Material Inventory Management: Advanced Techniques

- **Machine Learning for Demand Forecasting:** Implement machine learning algorithms to analyze historical data on product volumes, packaging usage, and seasonal variations. This allows for more accurate demand forecasting and optimized inventory management.
- **Just-in-Time (JIT) Inventory Management:** By integrating with Enterprise Resource Planning (ERP) systems, the packaging system can leverage JIT inventory principles. This minimizes storage space requirements and ensures a steady supply of packaging materials without excessive stockpiling.
- **Smart Conveyor Systems:** Smart conveyor systems with embedded sensors can track the movement and usage of packaging materials within the system. This real-time data can be used for further optimization of material handling and refilling processes.

Various equipment suppliers offer different design specifications, which will influence the cost of this component. The subsidy aims to incentivize the use of specialized packaging in the cold chain, and beneficiaries should be advised not to directly compare standard costs with actual chargeable costs. Most importantly, the packaging system must have the capability for farm code labeling, essential for both exports and domestic trade, in compliance with the regulations of the Food Safety and Standards Authority of India (FSSAI).

The specialized packaging line should be well-designed for optimal throughput and enhanced operational efficiency. RFID tags can also be used to improve inventory management.

A packaging line must comply with the following goals:

- a) Containing the product and facilitating handling and marketing by standardizing the number of units or weight inside the package.
- b) Enabling packaging that protects the cargo from damage and injuries during storage and transportation.
- c) Equipping the packaged material with appropriate labeling or coding to enable traceability of all product information.

28. UNIFIED CONTROL SYSTEM

Modern cold storage facilities are complex ecosystems tasked with maintaining precise temperature, humidity, and atmospheric conditions for a diverse range of perishable goods. Traditional manual monitoring and control methods are no longer sufficient to meet the demands of efficiency, safety, and regulatory compliance. Automation and sophisticated instrumentation systems have become the cornerstone of successful cold storage operations.

Unified Control System majorly includes Automation, BMS, IoT, Remote Monitoring, etc.

The Heart of Automation: The Programmable Logic Controller (PLC)

The PLC serves as the central nervous system of a cold storage facility. It's a ruggedized industrial computer programmed to perform a predefined set of instructions based on real-time data acquired from a network of sensors. Here's a breakdown of its key functionalities with more technical details:

- **Data Acquisition:** The PLC interfaces with various sensors, including:
 - **Temperature Sensors:**
 - **Thermistors:** These semiconductor devices exhibit a predictable change in resistance with temperature variations. They offer a fast response time but may have limited accuracy over a wider temperature range. Typical operating range: -50°C to +150°C.
 - **Resistance Temperature Detectors (RTDs):** These sensors utilize the change in resistance of a pure metal (often platinum) with temperature. They offer high accuracy and a wider operating range compared to thermistors. Typical operating range: -200°C to +600°C.
 - **Thermocouples:** These sensors generate a voltage proportional to the temperature difference between two dissimilar metals in contact. They offer a wide operating range and are suitable for high-temperature applications. Typical operating range: -260°C to +2500°C.
 - **Humidity Sensors:**
 - **Capacitive Sensors:** These sensors measure the change in capacitance of a dielectric material due to the presence of moisture. They are sensitive to rapid changes in humidity but may be susceptible to dust and contamination.
 - **Resistive Sensors:** These sensors utilize a hygroscopic material that changes resistance based on the surrounding humidity. They offer a simple design but may have slower response times and require periodic calibration.
 - **Pressure Sensors:** These sensors convert pressure into an electrical signal, typically using piezoelectric or strain gauge technology. They are crucial for monitoring refrigerant pressure within the system and can be configured for various pressure ranges depending on the specific application (e.g., suction pressure, discharge pressure).

- **CO2 Sensors (Optional):** These sensors utilize infrared absorption or electrochemical principles to detect CO2 concentration. They play a vital role in maintaining optimal CO2 levels for controlled atmosphere (CA) storage environments. Sensor selection depends on the desired CO2 measurement range and accuracy.
- **Control Outputs:** Based on sensor data, the PLC sends control signals to various actuators and devices:
 - **Variable Speed Drives (VSDs):** These intelligent drives are rated for the specific motor horsepower (HP) and voltage requirements of the application. They typically utilize pulse width modulation (PWM) to control motor speed, enabling precise adjustments to cooling capacity. Communication protocols like Modbus RTU or Ethernet/IP are used for communication with the PLC.
 - **Solenoid Valves:** These valves are electronically controlled and offer fast response times for regulating refrigerant flow within the system. Selection factors include valve size, pressure rating, and flow characteristics based on the specific application. Communication protocols like Modbus or Profibus are commonly used for control.
 - **Expansion Valves:**
 - **Thermostatic Expansion Valves (TXVs):** These valves utilize a temperature-sensing bulb to regulate refrigerant flow based on the evaporator outlet temperature. They are a cost-effective option but may not offer the same level of precision as electronically controlled valves.
 - **Electronically Controlled Expansion Valves (EXVs):** These valves receive a control signal from the PLC, allowing for precise regulation of refrigerant flow based on various parameters like superheat or evaporator pressure. This optimizes system performance and energy efficiency. Communication protocols like BACnet or LonTalk may be used for advanced control strategies.
 - **Defrost Systems:** The PLC triggers defrost cycles based on pre-programmed timers (time-based defrost) or sensor readings (demand-based defrost using sensors like pressure differential switches or hot gas bypass sensors). The specific defrost method (electric, hot gas, water) and control strategy are chosen based on factors like evaporator size, fin spacing, and desired defrost time.

Communication Protocols and Network Infrastructure:

Modern PLCs utilize industry-standard communication protocols to communicate with various devices. Here's a breakdown of some common protocols and network considerations:

- **Communication Protocols:**
 - **Modbus:** A widely used serial communication protocol for industrial automation applications. It offers a simple and robust communication method for transmitting sensor data and control signals.

- **Profibus:** A high-speed fieldbus protocol that supports more complex communication functions and advanced diagnostics compared to Modbus. * **Ethernet/IP:** An adaptation of the Ethernet protocol for industrial automation applications. It enables seamless integration of devices from different manufacturers and supports real-time communication for high-performance control systems. * **BACnet (Building Automation and Control Networks):** A communication protocol specifically designed for building automation systems, including HVAC (Heating, Ventilation, and Air Conditioning) applications in cold storage facilities. It facilitates interoperability between different control systems and devices.
- **Network Infrastructure:**
 - **Field Instruments:** Sensors and actuators are connected to the network using dedicated communication cables or wireless protocols. Common cable types include shielded twisted-pair (STP) for wired connections and industrial-grade Wi-Fi or mesh networks for wireless communication.
 - **Data Highway:** The data highway serves as the backbone of the communication network. It can be a central cable (e.g., RS-485 for Modbus) or a network switch for Ethernet-based protocols. This highway transmits data between field instruments and the PLC.
 - **Human-Machine Interface (HMI):** A computer monitor or touchscreen HMI acts as the operator interface. It typically connects directly to the PLC or the network and provides a graphical representation of the system status, real-time sensor data, and control parameters. The HMI software should be user-friendly and allow for intuitive operation, alarm management, and historical data visualization.

Advanced Features of PLC Systems:

- **Data Logging and Reporting:** The PLC can continuously log sensor data at user-defined intervals. This data can be stored on the PLC itself or transferred to a centralized server for further analysis. Data logging allows for:
 - **Regulatory Compliance:** Generation of reports compliant with HACCP (Hazard Analysis and Critical Control Points) protocols, documenting temperature, humidity, and CO2 levels for regulatory audits.
 - **Historical Trend Analysis:** Analyzing historical data trends can help identify areas for improvement in system performance and optimize control strategies for energy efficiency and product quality.
- **Alarm Management:** The system can be configured to trigger various alarms based on user-defined criteria. These alarms can be:
 - **Audible Alarms:** Sirens or alarms that sound to alert personnel of critical events like temperature deviations or equipment malfunctions.

- **Visual Alarms:** Lights or notifications displayed on the HMI to provide a visual indication of abnormal conditions.
- **Email or SMS Notifications:** Automated email or SMS alerts can be sent to designated personnel for immediate response to critical situations.
- **Remote Monitoring and Control:** PLCs can be integrated with remote monitoring platforms allowing for:
 - **Real-Time Data Access:** Authorized personnel can access real-time sensor data and system status from anywhere with an internet connection.
 - **Remote Control Adjustments:** In some cases, remote adjustments to control parameters may be possible, enabling proactive fine-tuning of the system.
 - **Improved Maintenance Efficiency:** Remote monitoring facilitates preventive maintenance by allowing for early detection of potential issues and scheduling maintenance activities before critical failures occur.

Selection Considerations for Instrumentation and Control Systems:

When selecting instrumentation and control systems for a cold storage facility, several factors need to be considered:

- **Facility Size and Complexity:** Larger and more complex facilities will require a more sophisticated PLC system with a greater number of sensors and control points.
- **Storage Requirements:** The specific temperature, humidity, and atmospheric control needs of the products stored will influence the choice of sensors and control strategies. For example, facilities storing fruits and vegetables may require CO₂ sensors and control systems for CA storage, while those storing frozen products may prioritize accurate low-temperature control.
- **Budgetary Constraints:** The initial investment in automation and instrumentation systems needs to be balanced against the long-term benefits of increased efficiency, reduced operational costs, and improved product quality. A cost-benefit analysis should be conducted to identify the optimal solution that meets the facility's specific requirements and budget limitations.

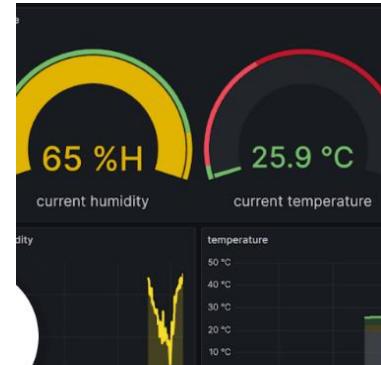
BMS:

A Building Management System (BMS) is a comprehensive computer system designed to aid with building management. Once installed, the BMS communicates with all of the equipment and systems currently installed in the building.

With integrated building management systems, owners can monitor and manage core systems, such as air conditioning, heating, ventilation, lighting, or energy supply systems. Dealing with multiple energy sources, such as electricity, gas, and rooftop solar panels. A good BMS system integrates each system individually, giving owners complete control over each supply.

IoT and Remote Monitoring in Cold Stores:

The Internet of Things (IoT) is transforming the way cold storage facilities are managed. By integrating sensors and connectivity, IoT enables remote monitoring and control of crucial parameters like temperature, humidity, and energy consumption. This technology empowers businesses to optimize operations, reduce spoilage, and ensure product quality.



How IoT Works in Cold Storage

1. **Sensor Deployment:** IoT sensors are strategically placed throughout the cold storage facility to monitor temperature, humidity, and other relevant parameters.
2. **Data Collection:** Sensors collect data and transmit it to a central cloud-based platform.
3. **Data Analysis:** The platform analyzes the data to identify trends, anomalies, and potential issues.
4. **Alert Generation:** If any parameter exceeds predefined thresholds, alerts are sent to facility managers via email, SMS, or mobile app notifications.
5. **Remote Control:** Managers can remotely adjust temperature settings, monitor alarms, and access historical data.

Conclusion:

Automation and instrumentation systems are no longer optional for modern cold storage facilities. These sophisticated systems offer a multitude of benefits, including enhanced efficiency, improved safety, optimized operations, and extended product shelf life. As sensor technology, communication protocols, and data analytics continue to evolve, we can expect even more intelligent and integrated cold storage control systems in the future, leading to smarter and more sustainable cold chain operations.

29. ELECTRICAL COMPONENTS & ENERGY EFFICIENCY

Cold storage facilities operate as precisely controlled environments, requiring the seamless integration and coordination of electrical components to ensure optimal functionality. This chapter dissects the core electrical systems that keep cold stores humming and delves into the technical considerations for maximizing their energy efficiency.

Core Electrical Components:

- **Refrigeration Systems:** The workhorses of a cold store, these systems employ vapor compression cycles. Here's a breakdown:
 - **Compressors:** These electrically driven pumps raise the pressure and temperature of the refrigerant gas, initiating the cooling cycle. Options include reciprocating, screw, and centrifugal compressors, each with efficiency trade-offs.
 - **Condensers:** Hot, high-pressure refrigerant gas enters the condenser, where it releases heat to the surrounding environment. Air-cooled (using condenser fans) or water-cooled condensers are employed depending on facility design.
 - **Expansion Valves:** These devices control the pressure and temperature of the refrigerant as it enters the evaporator. Different valve types (e.g., thermostatic expansion valves, electronic expansion valves) offer varying degrees of control and efficiency.
 - **Evaporators:** The cold, low-pressure refrigerant absorbs heat from the cold store environment, causing it to evaporate. This extracted heat is then rejected by the condenser. Finned-tube evaporators with optimized airflow patterns are crucial for efficient heat transfer.
- **Electric Motors and Drives:**
 - **AC Induction Motors:** These workhorses drive compressors and condenser fans. Selecting motors with the correct horsepower rating and implementing variable frequency drives (VFDs) to adjust motor speed based on actual demand can significantly improve efficiency.
 - **EC Motors:** Electronically commutated motors offer superior efficiency compared to traditional AC motors, particularly for fan applications.
- **Lighting:** Cold storage facilities require high illuminance levels. Traditional incandescent or fluorescent lighting, while providing sufficient light, generate unwanted heat within the cold space.
 - **LED Lighting:** Modern LED solutions offer exceptional energy efficiency, minimal heat output, and longer lifetimes, making them the preferred choice for cold storage applications. Color temperature and dimming capabilities should be considered for optimal performance and energy savings.

- **Control Systems:** Programmable logic controllers (PLCs) with sophisticated algorithms act as the brains of the operation. These systems:
 - **Monitor:** Temperature sensors throughout the cold store provide real-time feedback.
 - **Manage:** PLCs control defrost cycles, adjust compressor operation based on demand, and optimize equipment performance.
 - **Communicate:** Modern systems can integrate with building management systems for centralized control and data analysis.
- **Building Envelope:** While not strictly an electrical component, the building's thermal envelope plays a critical role.
 - **Insulation:** High-performance insulation materials with low thermal conductivity minimize heat transfer from the outside environment into the cold store.
 - **Door Systems:** High-speed doors with efficient sealing mechanisms and rapid opening/closing cycles reduce cold air loss when accessed.

The Imperative of Energy Efficiency:

Energy consumption in cold storage facilities is a major concern due to:

- **High Costs:** Electricity bills represent a significant operational expense. Reducing energy use translates directly to substantial cost savings.
- **Environmental Impact:** Refrigeration systems contribute to greenhouse gas emissions. Implementing energy-efficient technologies minimizes a facility's environmental footprint.

Optimizing for Efficiency: A Multi-Pronged Approach:

- **Equipment Selection:** Upgrading outdated, inefficient equipment with modern, energy-efficient models like variable-speed compressors and electronically commutated motors can yield dramatic savings.
- **System Design Optimization:** Employing computational fluid dynamics (CFD) modeling during system design allows for optimized pipe sizing, evaporator placement, and airflow patterns for maximum efficiency.
- **Advanced Control Systems:** Implementing sophisticated control systems with features like demand-defrost cycles, real-time temperature control, and integration with building management systems can significantly improve operational efficiency.
- **LED Lighting Retrofitting:** Replacing traditional lighting with high-efficiency LED solutions drastically reduces energy consumption and eliminates heat generation within the cold storage space.
- **Building Envelope Maintenance:** Regularly inspecting and repairing insulation, doors, and seals ensures optimal performance and minimizes energy loss. Leak detection systems can also be employed to identify and address cold air infiltration points.

By implementing these technical strategies, cold storage facilities can achieve significant energy efficiency gains. This not only translates to cost savings and a reduced environmental impact but also positions these facilities for long-term operational sustainability in a world increasingly focused on energy conservation.

To check that the facilities are energy efficient enough a separate datasheet regarding Energy Efficiency needs to be submitted by applicant alongwith the BDS.

The Energy Efficiency sheet is attached at Annexure: VI



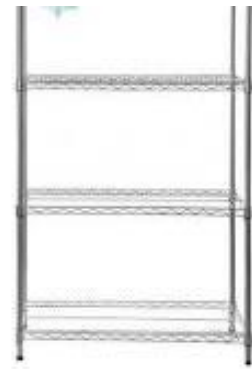
30. RETAIL SHELF

Retail shelves play a crucial role in maintaining the cold chain integrity of perishable products, from the moment they leave the warehouse until they reach the consumer's hands. These specialized shelves are designed to withstand the harsh conditions of refrigerated and frozen environments, while also optimizing product visibility and accessibility. In this chapter, we will delve into the various types of retail shelves used in the cold chain sector, their key features, and the factors to consider when selecting the right solution.

Types of Retail Shelves for Cold Chain

1. Wire Shelving:

- **Advantages:**
 - High air circulation: Promotes rapid temperature equalization and reduces product spoilage.
 - Easy cleaning: Simple to sanitize, preventing bacterial growth.
 - Versatile: Can be configured in various ways to accommodate different product sizes and weights.
- **Disadvantages:**
 - Less aesthetically pleasing than solid shelves.
 - Prone to rust if not made of corrosion-resistant materials.



2. Solid Shelf:

- **Advantages:**
 - Clean and professional appearance: Enhances product presentation.
 - Ideal for delicate or packaged products: Provides support and protection.
 - Customizable: Available in various materials (e.g., stainless steel, plastic) and finishes.
- **Disadvantages:**
 - Limited air circulation: May require additional ventilation for optimal temperature control.
 - More difficult to clean: Requires regular sanitation to prevent bacterial growth.



3. Gondola Shelving:

- **Advantages:**
 - High storage capacity: Maximizes floor space utilization.
 - Versatile configuration: Can be adapted to different store layouts and product categories.
 - Enhanced product visibility: Allows for effective merchandising and promotion.
- **Disadvantages:**
 - Complex installation and maintenance: Requires careful planning and execution.
 - Potential for product damage: Improper loading or handling can lead to product spoilage.



4. Refrigerated Display Cases:

- **Advantages:**
 - Precise temperature control: Maintains product quality and freshness.
 - Enhanced product visibility: Attracts customers and drives sales.
 - Ideal for high-value products: Protects and showcases premium items.
- **Disadvantages:**
 - High initial cost: Requires significant investment in equipment and installation.
 - Energy consumption: Requires careful energy management to minimize operating costs.
 - Regular maintenance: Frequent cleaning and calibration are essential for optimal performance.



Key Considerations for Selecting Cold Chain Retail Shelves

- **Material:** Stainless steel is the preferred material due to its durability, corrosion resistance, and ease of cleaning.
- **Design:** Shelves should have smooth surfaces, rounded edges, and adequate drainage to prevent water accumulation and bacterial growth.
- **Load capacity:** Shelves must be able to support the weight of products, especially in high-density storage areas.
- **Air circulation:** Adequate airflow is crucial for maintaining temperature and humidity levels, preventing condensation, and reducing product spoilage.

- **Energy efficiency:** Shelves should be designed to minimize energy consumption, such as using LED lighting and energy-efficient refrigeration systems.
- **Accessibility:** Shelves should be positioned at an optimal height for easy product retrieval and stocking.
- **Safety:** Shelves should be securely anchored to the wall or floor to prevent tipping and accidents.

A ventilated (forced-air) retail display shelf designed specifically for fruits and vegetables, offering high humidity and precise temperature control. This multi-deck unit features:

- **Night Curtain:** For energy conservation during non-operational hours.
- **LED Lighting:** Ensuring optimal visibility with energy efficiency.
- **System Options:** Available as a plug-in model or split system, using eco-friendly refrigerants.
- **Defrost Mechanism:** Equipped with electrical defrosting for efficient operation.
- **Construction:** Solid side panels for thermal efficiency and robust design.
- **Refrigerant:** R744 (CO₂) for sustainability and performance.
- **Temperature Range:** Adjustable between 0/+2°C and +3°C.
- **Shelving Configuration:** Four shelves excluding the base, with a maximum of two units per retail outlet.

Dimensions for Each Display Unit:

- **Length:** 4' to 8'
- **Height:** 6' to 8'
- **Depth:** 2.5' to 3.5'

Usage Limitations:

Each retail establishment can have a maximum of **two units**, with up to **two shelves** per unit for optimized product display.



Conclusion:

By carefully selecting and implementing appropriate retail shelf solutions, businesses can effectively maintain the cold chain integrity of their perishable products, reduce spoilage, and enhance customer satisfaction.

31. COMMODITIES SPECIFICATION

All major commodities which can be store under cold storages, integrated packhouse, aggregation centres, etc are classified as follows and grouped as per the temperature requirement for storing:

FRUITS

TYPE- IF (upto 2°C)

Sl. No.	Products	Temp	Humidity	Holding Time
1	Apples	0-2° C	90-95%	1-6 months
2	Apricot	-0.5 - 0°C	90-95%	1-3 Weeks
3	Blackberry	-0.5-0°C	90-95%	3-6 days
4	Blueberry	-0.5 - 0°C	90 - 95%	10-18 days
5	Cherries(sour)	0° C	90 - 95%	3-7 days
6	Cherries(sweet)	-1-0°C	90 - 95%	2-3 weeks
7	Grapes	-0.5-0°C	90 - 95%	1- 6 months
8	Kinnow	1°C	95%	2-4 weeks
9	Kiwi	0° C	90 - 95%	3-5 months
10	Litchi	1-2°	0.95	3-5 weeks
11	Orange(FL humid areas)	1 - 2°C	85 - 90%	8-12 weeks
12	Peaches	-0.5-0°C	90 - 95%	2-4 weeks
13	Pears	-1.5-.0.5° C	90-95%	2-7 months
14	Plum	-0.5-0°C	90-95%	2-5 weeks
15	Raspberry	-0.5-0°C	90-95%	3-6 days
16	Strawberry	0-1°C	90-95%	7-10 days

TYPE- II F (2°C – 5°C)

Sl. No.	Products	Temp	Humidity	Holding Time
1	cranberry	2-5°C	90-95%	8-16 weeks
2	Tangerine	3-6°C	85 - 90%	2-4 weeks
3	Pomegrenate	5°C	90-95%	2-3 months

TYPE- III F (5°C – 10°C)

<i>Sl. No.</i>	<i>Products</i>	<i>Temp</i>	<i>Humidity</i>	<i>Holding Time</i>
1	Guava	5 - 10°C	90%	2 - 3 weeks
2	Melons	5-10°C	85-90%	2-3 weeks
3	Avocado	5-8° C	85-90%	2-4 weeks
4	Papaya	7-13°C	85-90%	1-3 weeks
5	Dragon Fruit	4-10°C	90-95%	2-3 weeks
6	Pineapples	7-13° C	85-90%	2-4 weeks

TYPE- IV F (above 10°C)

<i>Sl. No.</i>	<i>Products</i>	<i>Temp</i>	<i>Humidity</i>	<i>Holding Time</i>
1	Passion fruit	10	85-90%	3-4 weeks
2	Rambutan	12	90-95%	1-3 weeks
3	Mango	12 - 13°C	85 - 90%	14 - 21 days
4	Banana	12 - 15°C	80 - 95%	14 - 21 days
5	Custard Apple	13°C	90-95%	2-4 weeks
6	Jackfruit	13°	85-90%	2-4 weeks

VEGETABLES

TYPE- I Vg (upto 2°C)

<i>Sl. No.</i>	<i>Products</i>	<i>Temp</i>	<i>Humidity</i>	<i>Holding Time</i>
1	carrot (Bunched)	0°C	98-100%	10-14 days
2	carrot (Topped)	0°C	98-100%	3-6 Months
3	cauliflower	0°C	95-98%	3-4 weeks
4	Corn	0°C	95-98%	5-8 days
5	Garlic	0°C	65-70%	6-7 months
6	Mint	0°C	95-100%	2-3 weeks
7	Lettuce	0°C	98-100%	2-3 weeks

8	Mushroom	0°C	90%	7-14 days
9	Radish	0°C	95-100%	1-2 months
10	Spinach	0°C	95-100%	10-14 days
11	Sprouts	0°C	95-100%	5-7 days
12	Turnip Root	0°C	95%	4-5 months
13	Beet (Bunched)	0°C	98-100%	10-14 days
14	Beet (Topped)	0°C	98-100%	4 Months
15	Broccoli	0°C	95-100%	10-14 days
16	Cabbage (early)	0°C	95-100%	3-6 weeks
17	Cabbage (late)	0°C	95-100%	5-6 months
18	Peas	0-1°C	90-98%	1-2 weeks
19	Shallot	0-2°C	65-70%	1-2 weeks
20	Water Chestnut	1-2°C	85-90%	2-4 months
21	Onion	1-3°C	60-65%	4-6 months

TYPE- II Vg (2°C – 5°C)

Sl. No.	Products	Temp	Humidity	Holding Time
1	Oregano	0-5°C	90-95%	1-2 weeks
2	Tamarind	2-7°C	92-95%	3-4 weeks
3	Tomato	3-4°C	85-95%	10 weeks
4	Beans	4-7°C	95%	7-10 days
5	Potato (some varieties)	2-4°C	90-95%	5-10 Months

TYPE- III Vg (5°C – 10°C)

Sl. No.	Products	Temp	Humidity	Holding Time
1	Potato (late)	4-12°C	90-95%	5-10 Months
2	Potato (early)	10-15°C	90-95%	10-14 days
3	Chilli	5-10°C	85-95%	2-3 weeks

4	Olives	5-10°C	85-90%	4-6 weeks
5	Okra	7-10°C	90-95%	7-10 days
6	Squash (courgette)	7-10°C	95%	1-2 weeks

TYPE- IV Vg (Above 10°C)

Sl. No.	Products	Temp	Humidity	Holding Time
1	Bitter Gourd	10-12°C	85-90%	2-3 weeks
2	Cucumber	10-12°C	85-90%	10-14 days
3	Eggplant	10-12°C	90-95%	1-2 weeks
4	Lemon	10-13°C	85-90%	1-6 months
5	Watermelon	10-15°C	90%	2-3 weeks
6	Pumpkin	12-15°C	50-70%	2-3 months
7	Squash (calabash)	12-15°C	50-70%	2-3 months
8	Ginger	13°C	65%	6 months
9	Sweet Potato	13-15°C	85-95%	4-7 months
10	Onion	25-29°C	60-65%	4-6 months

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DRY SPICES/ RAISINS

TYPE- S (4°- 10°C)

Sl. No.	Products	Temp	Humidity	Holding Time
1	Dry Spices	4-7° C	65-75%	8-9 months
2	Raisins	4-10° C	75-85%	6-12 months

Source: ASHRAE Handbook

32. SAFETY GUIDELINES

Personal Safety in Cold Storage Facilities: While cold stores offer numerous benefits, they also pose potential risks to personnel who work in or visit these facilities. To ensure the safety of all individuals, it is crucial to adhere to specific safety guidelines. Following are the essential safety practices for individuals who visit cold stores. By following these guidelines, you can significantly reduce the risk of accidents, injuries, and health issues.

When visiting a cold storage facility, it's crucial to prioritize personal safety. Here are essential guidelines to follow:

General Safety Precautions:

- **Adhere to Facility Instructions:** Always follow the specific safety instructions provided by the cold storage operator.
- **Escort Required:** When entering a cold room, always have an escort from the facility accompany you.
- **Thermal Shock Awareness:** Cold stores, especially those with sub-zero chambers, can cause sudden thermal shock. Limit your time inside cold rooms and wear appropriate warm clothing.
- **Machine Safety:**
 - Stay clear of operational refrigeration machines.
 - Avoid wearing loose clothing that could get caught in moving parts.
- **Controlled Atmosphere (CA) Chamber Safety:**
 - Do not enter a CA chamber unless it has been adequately ventilated to ensure safe oxygen levels.
- **Enclosed Space Safety:**
 - Seek permission before entering enclosed spaces that haven't been opened for a long time.
 - Ensure proper ventilation to eliminate potential hazards like high CO₂ or low O₂ levels.
 - Always have an escort when entering enclosed spaces.

Physical Safety Measures:

- **Footwear:** Wear proper anti-skid laced shoes to prevent slips and falls on icy or wet floors.
- **Head Protection:** In cold stores with overhead storage, wear a hard hat for added protection.
- **Respiratory Protection:** When visiting spice cold chambers, wear a face mask to avoid inhaling strong spice aromas.

Additional Safety Considerations:

- **Follow Designated Paths:** Adhere to marked walking zones to avoid accidents with machinery or workers.
- **Avoid Unauthorized Actions:** Refrain from touching or operating any buttons or switches within the facility.
- **Maintain Hygiene:** Practice good personal hygiene, especially in food zones. Avoid visiting cold stores if you are unwell.
- **Emergency Procedures:** If you hear an alarm, evacuate immediately to the designated emergency area and allow facility personnel to handle the situation.

- **Return Identification:** Return any identification or access passes to the facility manager before leaving.

By following these safety guidelines, you can significantly reduce the risk of accidents and injuries while visiting cold storage facilities.

FIRE SAFETY:

The cold, dry environment, combined with the presence of flammable materials and electrical equipment, creates a potential fire hazard. A fire in a cold storage facility can cause significant damage to property, loss of valuable inventory, and potential harm to personnel.

To mitigate these risks, it is crucial to implement comprehensive fire safety measures. This includes regular inspections, maintenance of fire protection systems, and adherence to strict fire safety regulations. By understanding the specific fire hazards associated with cold storage facilities and taking proactive steps to address them, we can significantly reduce the risk of fire and ensure the safety of both people and property.

1. Fire Alarm System

To ensure early detection and response to fires, an automatic fire alarm system conforming to **IS 2189:1988** should be installed in all godowns, unless they are protected by an automatic sprinkler system. For large, open-area sites, a well-designed manual fire alarm system is recommended.

i. Fire-Fighting Appliances:



All fire-fighting appliances should adhere to relevant Indian Standards to guarantee their effectiveness.

ii. Water Supply System

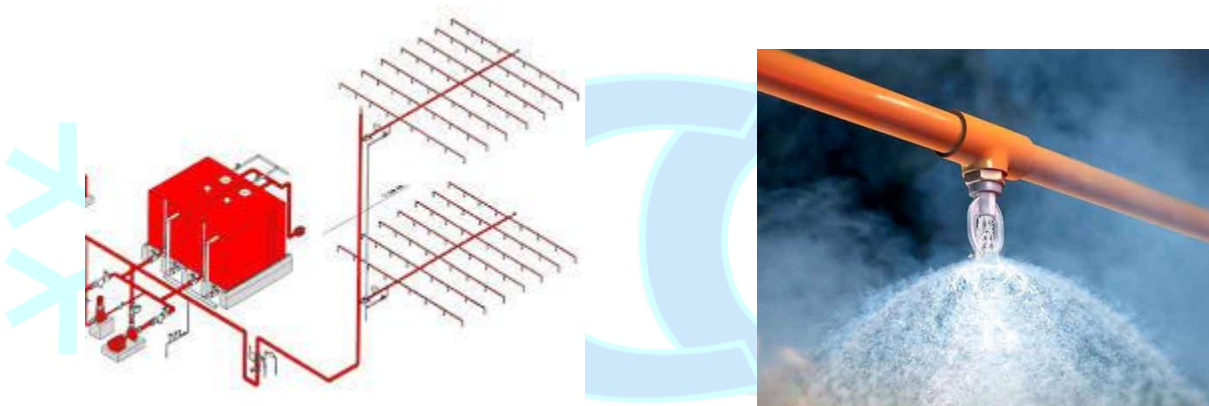
To combat large-scale fires, a robust water supply system is crucial. This system should include fire hydrants and static water tanks conforming to **IS 9668:1980**.

- **Large Storage Buildings:** All storage buildings exceeding 750 square meters and outdoor storage areas exceeding 2000 square meters should be equipped with this system.
- **Smaller Premises:** Premises smaller than these, especially those located more than 8 kilometers from a fire station, should have at least one self-fed static water tank with a capacity of 125,000 liters.

2. Portable Fire Extinguishers

Buckets and portable chemical fire extinguishers, compliant with relevant Indian Standards, should be strategically placed in the vicinity of godowns, as outlined in **IS 2190:1979**.

3. Automatic Sprinkler System



All godowns and warehouses exceeding 750 square meters in floor area should be protected by a well-designed automatic sprinkler system.

4. Regular Maintenance: All fixed fire protection systems must undergo regular inspections and maintenance to ensure their optimal functioning in case of emergencies. Consider engaging a certified maintenance agency for this purpose.

5. Dedicated Fire Brigade: For very large storage installations handling hazardous or valuable goods, a full-time fire brigade equipped with advanced firefighting equipment may be necessary. The specific requirements for such a brigade should be determined based on local regulations and industry standards.

6. Clear Signage: The location of all firefighting equipment, including hydrant valves, landing valves, and hand appliances, should be clearly indicated on building plans and prominently displayed at the entrance of godowns.



General Safety Measures:

- **Clear Instructions:** Display clear instructions for staff on how to call the fire brigade and respond to fires.
- **Smoking Restrictions:** Prohibit smoking except in designated areas.
- **Hazardous Operations:** Restrict hazardous operations like welding, cutting, and spray painting to designated, isolated buildings.
- **Fuel Storage:** Fuel tanks for machinery should be filled in designated areas only.
- **Vehicle Safety:** Vehicles should not be left running inside warehouses or near storage areas.
- **Cleanliness:** Daily cleaning of warehouses and removal of weeds is essential.
- **Inspection:** Thorough inspections of warehouses before and after closure are mandatory.
- **Door and Window Security:** Fire doors should be kept closed, and windows and doors should be secured.
- **Storage Restrictions:** Avoid temporary storage that obstructs access to doors, hydrants, and sprinkler valves.

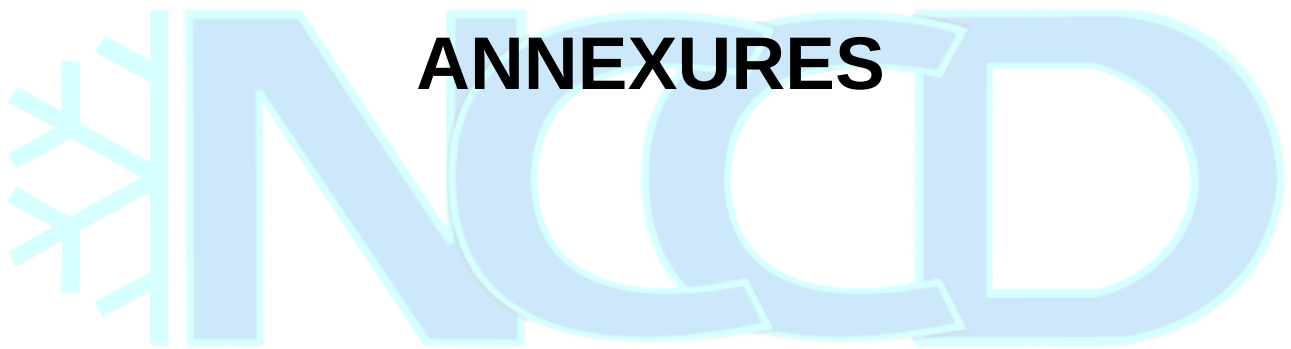
Emergency Planning:

- **Fire Emergency Plan:** Establish a detailed fire emergency plan, outlining procedures for alerting staff, responding to fires, and seeking external assistance.

By adhering to these guidelines, warehouses can significantly reduce the risk of fire and ensure the safety of both personnel and property.

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ANNEXURES



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ANNEXURE I

BASIC DATA SHEET FOR FARMGATE PACKHOUSE

NOMENCLATURE: _____

S. No.	Description	Unit	Details /Description
1	Name of the Produce	NA	
2	Room size	m x m x m	Chamber 1: l x b x h; Chamber 2: l x b x h; so on
3	Vol of each room	Cu. mtr	Chamber 1 : MT; Chamber 2 : MT (min. -5 MT, Max.-10MT)
4	Total number of room	No	
5	Total capacity of the facility	MT	
6	Room Temp	°C	
7	Relative Humidity	%	Depending upon the produce RH is to be maintained
8	Produce loading rate	Kgs./day	
9	Produce incoming Temp	°C	
10	Ambient Temp	°C	
11	Pull Down Time	Hrs	
12	Insulation- walls	mm	Follow BIS standards (min. Thickness not less than 100 mm)
13	Insulation- floor	mm	Follow BIS standards (min. Thickness not less than 80 mm)
14	Insulation- door	mm	Follow BIS standards (min. Thickness not less than 100 mm)
15	Insulation- ceiling	mm	Follow BIS standards (min. Thickness not less than 100 mm)
16	Type of Cold Room	NA	Please specify whether Solar based (Off-grid/On-Grid)/Bio-mass powered/Grid with thermal technology is being installed. At Farm gates conventional cold storages which work only on electricity will not be allowed.
17	Type	NA	Please mention as described above
18	technology	NA	Mention Briefly about Type of Technology
19	Refrigeration capacity	kW	(including 10% Factor of Safety)
20	Type of Compressor	NA	Please specify type whether hermetic/semi-hermetic/scroll
21	Evaporating Temp	°C	
22	Condensing Temp	°C	

23	Type of Evaporator	NA	Please specify type
24	No. Of Fans in Evaporator/Size of fans	No./mm	
25	Air Flow	CFM/CMH	
26	Available grid connection at the site/type of phase/voltage	kW	Available connected load/ single phase/3-phase- give details
27	Solar Panel Capacity	kW	
28	Types & No. of solar panels	No.	Mono, etc.- please specify
29	DG Set capacity, fuel (optional as required)	kW	With catalytic convertor
30	Type of thermal storage	NA	Whether water/PCM
31	Qty of PCM	Kgs.	
32	No. of thermal storages	No.	In case of more than one room whether entire thermal storage capacity is accessible by all rooms. Please specify.
33	NO. of batteries and capacity/ type of battery	No./VAH/NA	Lithium-ion/lead, etc.
34	Electrical Load Connected on batteries	kW	
35	Type of fuel for bio-mass	NA	Specify type
36	Consumption rate of bio-mass	Kg/hr	
37	All Electrical load used in bio-mass technology	kW	Please specify total load or no. of batteries /capacity of the batteries in case electrical load is not used
38	Refrigeration technology in bio-mass	NA	Whether absorption or adsorption?
39	Machine make & model /Number	NA	
40	Type of refrigeration system	NA	Individual /centralised
41	Refrigerant Used	NA	R404A, R134A etc.
42	Secondary Refrigerant if used	NA	

43	Ante room size and capacity	L x b x h / MT	Follow BIS standards (min. Thickness not less than 60 mm)
44	Ante Room Temp	°C	
45	Method of stacking	NA	Boxes, crates, racks, double deep racks, pallets etc.
46	Total Power Consumption per Day	kWH	
47	Unit Rate per Day	Rs./unit	
48	Cost of Energy	Rs./day	
49	Movable Handling Trolley Details	NA	
50	Sorting Table Details	NA	

*Follow NCCD Guidelines for the purpose of installing cold room. E.g.- Insulation, Doors, Floors, Strip Curtains, Ante Rooms, Volumetric Conversion, Refrigeration, etc. (refer Chapter no. 10-TRANSIT COLD STORAGE)

All mandatory rules and regulations (BIS, ISO, IS, MNRE, etc.) relevant to the item must be complied with.

Please don't leave any space blank. Write N/A at place which is not applicable.

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ANNEXURE II

BASIC DATA SHEET FOR INTEGRATED PACKHOUSE/COLLECTION AGGREGATION CENTRE

NOMENCLATURE: _____

S. No.	Description	Unit	Remark
SHED AREA			
1	Compound Area/Gated Plot Size	mxm	
2	Size of Shed (lxbxh)	mxmxm	
3	Dimension of Dock Area	mxm	
4	a) Dock Leveler		
	i. Size (lxbxh)	mxmxm	
	ii.Capacity	MT	
	iii.Make	NA	
	b) Dock Door		
	i. Size & Opening	mxm	
	ii.Type of Insulation & thickness	mm	
	iii. Make	NA	
	c) Dock Shelter		
	i. Type of Dock Shelter	NA	
	ii. Vehicle Hazard Light	No.	
	iii. Size of Dock Shelter	mxm	
	d) Packhouse shutter doors- Size & No.	mxm	
Integrated Packhouse Internal Details			
5	Washing Area Size (lxb)	mxm	
6	Washing Type		
	a) integrated with conveyor system	NA	
	b) Support washing tank with stirrer size (lxb)	mxm	
7	Conveyor Capacity	MT/hr.	
8	Conveyor Size (lxbxh)	mxmxm	
9	Type of Fruits conveyor can handle	NA	Round/Long
10	Operating Method of Sorting/grading Unit		Automatic or Manual. Provide details
11	Total conveyor system electricity consumption	kWh	
12	Weighing Bridge Capacity	MT	Capacity of the weighing bridge
13	Dimensions of the weighing bridge	m x m	

14	MHE – HPT (capacity & make)	MT	
15	MHE – BOPT (capacity & make)	MT	
16	Safe Working load of MHE	MT	

Pre-Cooler Details:

1	Size of the precooler (l x b x h)	M x m x m	
2	Produce to be precooled	NA	
3	Precooler capacity	MT	
4	Temperature and RH%	°C/ %	
5	Insulation Thickness	Mm	
6	No. Of Doors & thickness	No./mm	
7	Type of Precooler Evaporator	NA	
8	Type of Condensing Unit	NA	Water/air cooled etc.
9	Capacity of the condensing unit	kW	
10	Loading per batch	Ton/Batch	
11	Pull Down Time	Hrs	
12	Air Flow inside the precooler	CFM	
13	Evaporating Temp of the precooler	°C	
14	Ambient Temp	°C	
15	Refrigerant Used	NA	
16	No. Of Fans on the evaporator & size	No./mm	
17	Whether forced draft or induced draft	NA	
18	No. Of batches in a day	No.	
19	Type of stacking	NA	crates/pallets/bins, etc.
20	Total Connected Power	KW	

Cold Room Details:

S. No.	Description	Unit	Details /Description
1	Name of the Produce	NA	
2	Room size	m x m x m	Chamber 1: l x b x h; Chamber 2: l x b x h; so on
3	Vol of each room	Cu. mtr	Chamber 1 : MT; Chamber 2 : MT (min. -5 MT, Max.-10MT)
4	Total number of room	No	
5	Total capacity of the facility	MT	
6	Room Temp	°C	
7	Relative Humidity	%	Depending upon the produce RH is to be maintained
8	Produce loading rate	Kgs./day	

9	Produce incoming Temp	°C	
10	Ambient Temp	°C	
11	Pull Down Time	Hrs	
12	Insulation- walls	mm	Follow BIS standards (min. Thickness not less than 100 mm)
13	Insulation- floor	mm	Follow BIS standards (min. Thickness not less than 80 mm)
14	Insulation- door	mm	Follow BIS standards (min. Thickness not less than 100 mm)
15	Insulation- ceiling	mm	Follow BIS standards (min. Thickness not less than 100 mm)
16	Type of Cold Room	NA	Please specify whether Solar based (Off-grid/On-Grid)/Bio-mass powered/Grid with thermal technology is being installed. At Farm gates conventional cold storages which work only on electricity will not be allowed.
17	Type	NA	Please mention as described above
18	technology	NA	Mention Briefly about Type of Technology
19	Refrigeration capacity	kW	(including 10% Factor of Safety)
20	Type of Compressor	NA	Please specify type whether hermetic/semi-hermetic/scroll
21	Evaporating Temp	°C	
22	Condensing Temp	°C	
23	Type of Evaporator	NA	Please specify type
24	No. Of Fans in Evaporator/Size of fans	No./mm	
25	Air Flow	CFM/CMH	
26	Available grid connection at the site/type of phase/voltage	kW	Available connected load/ single phase/3-phase- give details
27	Solar Panel Capacity	kW	
28	Types & No. of solar panels	No.	Mono, etc.- please specify
29	DG Set capacity, fuel (optional as required)		With catalytic convertor
30	Type of thermal storage	NA	Whether water/PCM
31	Qty of PCM	Kgs.	
32	No. of thermal storages	No.	In case of more than one room whether entire thermal storage capacity is accessible by all rooms. Please specify.
33	NO. of batteries and capacity/ type of battery	No./VAH/NA	Lithium-ion/lead, etc.

34	Electrical Load Connected on batteries	kW	
35	Type of fuel for bio-mass		Specify type
38	Consumption rate of bio-mass	Kg/hr	
39	All Electrical load used in bio-mass technology	kW	Please specify total load or no. of batteries /capacity of the batteries in case electrical load is not used
40	Refrigeration technology in bio-mass	NA	Whether absorption or adsorption?
41	Machine make & model /Number	NA	
42	Type of refrigeration system	NA	Individual /centralised
43	Refrigerant Used	NA	R404A, R134A etc.
44	Secondary Refrigerant if used	NA	
45	Ante room size and capacity	L x b x h / MT	Follow BIS standards (min. Thickness not less than 60 mm)
46	Ante Room Temp	°C	
47	Method of stacking	NA	Boxes, crates, racks, double deep racks, pallets etc.
48	Total Power Consumption per Day	kWH	
49	Unit Rate per Day	Rs./unit	
50	Cost of Energy	Rs./day	

Reefer Details:

1	Type of Reefer Vehicle	NA	
2	Container Size In Ft (L X W X H)	M x m x m	
3	Gross Vehicle Weight (Gvw) Of Chassis	Tons	
4	Kerb Weight Of Chassis	Kgs	
5	Container Weight	Kgs	
6	Weight Of Reefer Unit	Kgs	
7	Load Carrying Capacity Of Reefer Truck	Kgs	
8	Component: Refrigerated Transport	NA	Description
A	Truck Chassis Details		
1	Chassis number	NA	
2	Make and Engine Model	NA	
3	Type of Vehicle (Diesel / CNG / Electric/ Others)	NA	
4	Engine power (kw)	kW	
5	Rated payload – carrying capacity of vehicle (tons)	Tons	
6	Outer dimensions of vehicle (L x B x H) Mt	M x m x m	

7	Drive Cabin details (with AC / without AC)	NA	
8	Total number of tyres	No.	
B	Insulated Container		
1	Container dimensions (L x B x H) Mt	M x m x m	
2	Insulation Material Type	NA	
3	Insulation Thermal Conductivity (K Factor)	W/m °C	
4	Insulation Thickness (in MM)	mm	
5	Container Type (GRP / MS/ STEEL/OTHER)	NA	
6	Weight (Kgs) of Container	Kgs	
7	Name of Container Manufacturer	NA	
8	Year of Container manufacturing	NA	
9	Application (Chilled / Frozen)	NA	
C	Refrigeration Unit		
1	Make and Model number	NA	
2	Unit Type (Self Powered/ Vehicle Powered/ Electric/ Eutectic/ Other)	NA	
3	Refrigerant used	NA	
4	Refrigeration capacity (kW)	Kw	
5	Compressor Displacement (CC)	Cm ³	
6	Defrosting system (Hot gas/ Electric)	NA	
7	Air flow (cum/hr.)	CFM/CFH	
8	Standby Motor Load (kW)	kW	
9	Diesel/ electric auto- switching used	NA	
10	Controls Type (Manual/ Automatic)	NA	
D	Telematics		
1	Temperature remote Monitoring & Controlling device Type	NA	
2	GPS (Make and model)	NA	

Automated computerised system

1	Type of Software used	Brief description about the software, system and application
2	Name of the Software manufacturer	
3	Traceability system	Provide details, ability to assign farm codes, build code plan, to print labels, RFID tags, etc.

4	Labelling System & Printing details	Describe type of labelling done on the material enumerating all the details regarding produce, name of the produce, input received, name of the farmer, no. Of packages, days to be stored, and appropriate final destination,
5	Certification details (if any)	type of tests conducted and certifying authority

S. No.	Parameters	Unit	Value	Power Utilisation Ratio
1	Sanctioned Load by the Respective Board	kW	Please specify load that you are going to install	
2	Total Power Requirement at Peak Load Period	kW-h		Power requirement at peak load / Total Sanctioned Power
3	Total Power Requirement at Holding Load Period	kW-h		Power requirement at holding load / Total Sanctioned Power
4	Total Power Requirement at Lean Load Period	kW-h		Power requirement at Lean load / Total Sanctioned Power

*Follow NCCD Guidelines for the purpose of installing cold room. E.g.- Insulation, Doors, Floors, Strip Curtains, Ante Rooms, Volumetric Conversion, Refrigeration, etc. (refer Chapter no. 10-TRANSIT COLD STORAGE)

All mandatory rules and regulations (BIS, ISO, IS, MNRE, etc.) relevant to the item must be complied with.

Please don't leave any space blank. Write N/A at place which is not applicable.

ANNEXURE III

BASIC DATA SHEET FOR COLD STORAGE (CS-1/CS-1- Onion/CS-2/CS-2-CA/CS-4)

NOMENCLATURE: _____

COLD STORE CHAMBER & PRODUCE DETAILS

S. No.	Description	Unit	Details /Specification
1	Name of the Produce	NA	
2	Room size	m x m x m	Chamber 1: l x b x h; Chamber 2: l x b x h; so on
3	Capacity of each room	MT	Chamber 1 : MT; Chamber 2 : MT (min. -5 MT, Max.-10MT)
4	Total capacity of the facility	MT	
5	Number of Platforms per chamber	no.	
6	Type of platform used	NA	
7	Total number of room	no	
8	Room Temp	°C	
9	Relative Humidity	%	Depending upon the produce RH is to be maintained
10	Produce incoming Temp	°C	
11	Pull Down Time	Hrs	
12	Produce loading rate	Kg/day	
13	Loading Period	days/week s	
14	Maximum Storage Period	weeks/mon ths	
15	Method of stacking	NA	Boxes, crates, racks, double deep racks, pallets etc.
16	Ambient Temp	°C	
17	Refrigerant Used	NA	R404A, R134A etc.
18	Secondary Refrigerant if used	NA	
19	Ante room size and capacity	Lx bxh / MT	
20	Ante Room Temp	°C	
21	CO2 Concentration Control	PPM	Loading/Holding period
22	Fresh Air Changes	Changes per day	
23	Air Flow Rate	CMH	
24	Description of Fresh Air Ventilation System	NA	

FACILITY AREA DETAILS

S. No.	Description	Unit	Details /Specification
1	Cold Storage Area and height	m x m	
2	Machine room area/ height	m x m	
3	Generator room area / height (if applicable)	m x m	
4	Admin Block area / height	m x m	
5	Describe Handling, receiving area (covered, open shed)	m x m	

BUILDING & CONSTRUCTION DETAILS

S. No.	Description	Unit	Details /Specification
1	Type of building construction	NA	Civil/PEB
2	External/Internal Walls of cold chambers	NA	
3	Roof Specification	NA	
4	Lighting Fixtures	NA	
5	Compound Area Specification	NA	

INSULATION DETAILS

S. No.	Description	Unit	Details /Specification
1	Type of Insulation	NA	e.g. PUF/PIR etc.
2	Density of Insulation	kg/m ³	
3	Insulation- walls	mm	Follow BIS standards (min. Thickness not less than 100 mm)
4	Insulation- floor	mm	Follow BIS standards (min. Thickness not less than 80 mm)
5	Insulation- door	mm	Follow BIS standards (min. Thickness not less than 100 mm)
6	Insulation- ceiling	mm	Follow BIS standards (min. Thickness not less than 100 mm)
7	Thermal Conductivity	W/m.K	
8	Thickness	mm	
9	U-Value	W/m ² K	
10	Adhesion Strength	N/sq. mtr.	
11	Fire Resistance	NA	Yes/No, Safety Rating etc.
12	Water Absorption	% by vol. at 100% RH	
13	Material of Sheet	PP/SS	
14	Sheet thickness	mm	
15	Joining of panels	Cam lock /Continuous	
16	Area of Floor Insulation	Sq. mtr.	
17	Floor installation thickness	mm	Details of flooring
18	No. of Layers of floor insulation	No	

19	Type of vapour barrier on floor insulation	NA	Details of Vapour barrier
20	Number of layers of Vapour barrier	No	
21	finish floor Type	NA	kota / trimix/ epoxy etc
22	Thickness of Finish floor level	mm	

DOOR DETAILS

S. No.	Description	Unit	Details /Specification
1	Type of Door	NA	sliding/in line /overlap/ Hinged
2	Thickness of Door	mm	
3	U-Value	W/m ² K	
4	Heater Tapes/Door Frame	NA	
5	Size of Door l x b	mx m	
6	Door Skin type	NA	PP/SS
7	Handle type	NA	
8	View Port	mm x mm	
9	No. of Doors/ Chamber	no.	
10	No. of Ante Room Doors	no.	
11	Total no. of Doors	no.	
12	Type of Curtain used	NA	Strip curtain/ Air curtain
13	Number of Strip/Air curtains	no.	

HEAT LOAD CALCULATION

S. No.	Refrigeration Load	During Loading (kW)	During Holding (kW)
1	Transmission Load (kW)		
2	Product Load (kW)		
3	Lighting load		
4	Occupancy load		
5	Infiltration Load (kW)		
6	Ventilation/Fresh Air load (kW)		
7	Equipment Load - Evap. Fan motors, MHEs etc.		

Total Load	Peak Period (kW)	Holding Period (kW)
Compressor Operation Hours/Day	Pull Down Period	
	Holding period	
	Defrosting Period	

REFRIGERATION EQUIPMENT DETAILS:

COMPRESSOR DETAILS

S. No.	Description	Unit	Details /Specification
1	Compressor Type	NA	Reciprocating/Screw/Scroll etc.
2	Make & Model	NA	
3	Compressor Capacity at Design conditions	KW	
4	Refrigerant used	NA	
5	Sat. Suction Temp	°C	
6	Design Ambient Temp	°C	
7	Total Cooling Capacity	kW	
8	Suction Superheat	kW	
9	RPM	RPM	

CONDENSER DETAILS

S. No.	Description	Unit	Details /Specification
1	Condenser Type	NA	Atmospheric/ Air-cooled/Water-cooled etc.
2	Make & Model	NA	
3	Quantity	no.	
4	Heat Rejection Capacity at Design conditions	kW	
5	Operating Parameters	°C	condensing temp., water in/out temp. etc.

PRESSURE VESSELS

S. No.	Description	Unit	Details /Specification (Low Pressure)	Details /Specification (High Pressure)
1	Type of Vessel	NA	Horizontal/Vertical	
2	Refrigerant	NA		
3	Operating Temp & Pressure	°C & Bar		
4	Construction Shell, Dish Ends & Nozzles	NA		
5	Total Refrigeration load	kW		
6	Holding Volume	ltr.		

EVAPORATOR DETAILS

S. No.	Description	Unit	Details /Specification

1	Make & Model	NA	
2	No. of Units	no.	
3	No. of Fans	no.	
4	Cooling capacity req./chamber	kW	
5	Room Temp	°C	
6	Evaporating Temp	°C	
7	Delta T	°C	
8	Refrigerant used	NA	
9	No. of evaporators/ chamber	no.	
10	Air Flow Rate	CMH	
11	Fin Spacing	mm	

DOCK LEVELER SYSTEM

S. No.	Description	Unit	Details /Specification
A	DOCK LEVELERS		
1	Name of Manufacturer and model	NA	
2	Type of operation	NA	Method of Operation used - electrical/hydraulic/pneumatic
3	Ramp-Platform Material	NA	
4	Number of cylinders	no.	
5	Platform size (W x L)	m x m	
6	Max vertical Lift up & down	mm	
7	Load capacity	MT	
8	Plinth height of facility	m	
9	Standard safety provisions	NA	
10	Emergency stop switch	NA	YES/NO
11	Dock pit dimensions	m	
B	DOCK DOORS		
12	Manufacturer and model	NA	
13	Dimension of Door opening	m x m	
14	Loading area temperature	°C	
15	Insulation-material, thickness and U value.	mm, W/m ² K	
16	Safety Provision	NA	
C	DOCK SHELTER		
17	Name of Manufacturer and model	NA	
18	Dimensions	m x m x m	
19	Sealing Material & type	NA	
20	Size/Dimension of Bumper	m x m x m	

21	Safety Provision	NA	

CO₂ SCRUBBER

S. No.	Description	Details /Specification
1	CO ₂ Scrubber make & model	
2	Justify the use of CO ₂ Scrubber for the proposed commodity*	
3	Monitoring System for removal of CO ₂	Describe in brief

*Please ensure that CO₂ Scrubber is only used for those commodities which generates lot of CO₂, e.g. Potato, Onion, Apple etc.

CONVEYING/HOIST SYSTEM

S. No.	Description	Details /Specification
1	Make & Model	
2	Load carrying capacity	
3	Any other Specification	Describe in brief

MATERIAL HANDLING EQUIPMENT

S. No.	Description	Details /Specification
1	Make & Model of HPT	
2	Load carrying capacity of HPT	
3	Number of HPTs	
4	Make & Model of BOPT	
5	Load carrying capacity of BOPT	
6	Number of BOPTs	
7	Make & Model of Fork Lift	
8	Load carrying capacity of Fork Lift	
9	Number of Fork Lifts	
10	Mast height (metres)	
11	Turning Radius (metres)	
12	Battery capacity (Amp-hour)	
13	Backup battery (Amp-hour)	
14	Capacity of Battery Chargers (no.s & kVA)	
15	Safety Protection (describe)	
16	Any other Specification	Describe in brief

AUTOMATED COMPUTERISED SYSTEM

S. No.	Description	Details /Specification
1	Type of Software used	Brief description about the software, system and application
2	Name of the Software manufacturer	
3	Traceability system	Provide details, ability to assign farm codes, build code plan, to print labels, RFID tags, etc.

4	Labelling System & Printing details	Describe type of labelling done on the material enumerating all the details regarding produce, name of the produce, input received, name of the farmer, no. Of packages, days to be stored, and appropriate final destination,
5	Certification details (if any)	type of tests conducted and certifying authority

To be filled only if Controlled Atmosphere is used: (otherwise write NA)

CA GENERATOR

S. No.	Description	Details /Specification
A	Nitrogen Generator	
1	Make and Model number	
2	Type	
3	Capacity of each Generator (m ³ /hour)	
4	Total volume of chamber(m ³)	
5	Free Volume (m ³)	
6	Pull down time (hours)	
7	Nitrogen Buffer Tank capacity	
8	Capacity of breather bags	
9	Power Consumption (kW)	
B	CO₂ Absorber	
10	Make and Model Number.	
11	Product Stored	
12	Capacity of Absorber (kgs)	
13	Pull down time (hours)	
14	Power Consumption (kW)	
15	Control Valves	
C	PLC Control System	

16	Sensors and Analyser	
D	Safety O2 monitors	
E	Gas Tightening System	
17	CA Primer Details for walls & floor	
18	Film/Fleece material and thickness	
19	Details of Elastomeric paint used	

CA DOORS

S. No.	Description	Details /Specification
1	Name of Manufacturer	
2	Size of the door-(Height, Width, Leaf Thickness)	
3	Insulation material thickness along with its 'U-value'	
4	Sealing type	
5	Sighting ports	
6	Emergency Door release fitted (Y/N)	

ADVANCED GRADER

S. No.	Description	Details /Specification
1	Produce	
2	Weight Sorting / Grading	
3	Colour Sorting / Grading	
4	Optical/Acoustic Diameter Grading	
5	IQS (Intelligent quality Sorting/Grading)	
6	Safety Precautions	
7	Output capacity (units/hr or tons/hr)	
8	Power consumption (kW)	

9	Name of manufacturer	
10	Year of manufacture	

STACKING SYSTEM

S. No.	Description	Details /Specification
A	Bins	
1	Name of Manufacturer	
2	Material of construction	
3	Load capacity (kgs)	
4	Storage volume (L x B x H)	
5	Stacking Height (metres)	
B	Pallets	
1	Material & working load (kgs/tons)	
2	Dimensions (L x B x H) mtrs	
3	No of cartons per pallet	
4	Type of access	
C	Racking System	
1	Name of Manufacturer	
2	Type of racking system	
3	Design Overview of rack	
4	Material of construction	
5	No of tiers	
6	Net storage capacity (MT)	
7	Load bearing weight per position	

INTEGRATED SPECIALISED PACKAGING MACHINES

S. No.	Description	Details /Specification
1	Briefly describe about the Integrated Specialised Packaging Machines proposed	Describe in brief
2	Name of Manufacturer	
3	Feed line	
4	Sorting Grading unit	
5	Weighing Machine	
6	Final Packaging	

7	Traceability system	
8	Labelling System, printing system.	
9	Throughput capacity	
10	Total Power consumption (kW)	

	Unit	Value	Power Utilisation Ratio
Sanctioned Load by the Respective Board	kW	Please specify load that you are going to install	
Total Power Requirement at Peak Load Period	kW-h		Power requirement at peak load / Total Sanctioned Power
Total Power Requirement at Holding Load Period	kW-h		Power requirement at holding load / Total Sanctioned Power
Total Power Requirement at Lean Load Period	kW-h		Power requirement at Lean load / Total Sanctioned Power

All mandatory rules and regulations (BIS, ISO, IS, MNRE, etc.) relevant to the item must be complied with.

Please don't leave any space blank. Write N/A where not applicable

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ANNEXURE IV

BASIC DATA SHEET FOR RIPENING CHAMBER (CS-3)

NOMENCLATURE: _____

S. No.	Component	Units	Description
A	Capacity Details		
1	Holding Capacity	MT	
2	Room Volume	m ³	
3	Room Size	m x m x m	
4	Number of ripening rooms	No.s	
5	Peak ambient temperature	°C	
B	Pallets		
6	Size of Pallet	mm x mm x mm	
7	Size of crate/box	mm x mm x mm	
8	Crates/boxes per pallet	No.s	
9	Pallets in each chamber	No.s	
10	No. of tiers	No.s	
11	Pallet Lifting System	NA	
C	Ripening Parameters		
12	Ripening room temp.	°C	
13	Relative Humidity	%RH	
14	CO ₂ concentration	PPM	
15	Ethylene concentration	PPM	
16	Product incoming temp.	°C	
17	Pull down period	Hr	
18	Air flow	CMH/CFM	
D	Insulation details		
19	Walls, ceiling and partition (material, U-value & thickness)	NA/ W/m ² -K / mm	
20	Floor-Type (material, U-value and thickness of insulation)	NA/ W/m ² -K / mm	
21	Exterior wall construction (material and type)	NA	
E	Doors		
22	Size of door	mm x mm	
23	Type of door used	NA	
24	Number of doors	No.s	

25	Emergency measures (alarm, exit system)	NA	
26	Gasket Details	NA	
F	Refrigeration load		
27	Estimated refrigeration load per chamber	kW	
28	Total refrigeration load	kW	
G	Refrigeration system/ Condensing Unit Details		
29	Refrigerant used	NA	
30	Refrigeration system	NA	
31	Refrigeration capacity	kW	
32	Total No. of Condensing Units	No.s	
33	Capacity of Compressors	kW	
34	COP of refrigeration system	NA	
35	Evaporator and condenser details	NA	
36	Air flow	CFM	
37	Static pressure & fan rating	Pa & kW	
38	Manufacturer name	NA	
J	Ripening system		
39	Ethylene applicator (Maker name)	NA	
40	Number of cylinders and capacity per cylinder	No.s	
41		m ³	
42	Portable or Centralized	NA	
43	Type of controller and Ethylene range	NA	
44	CO2 exhaust system	NA	
45	Humidifier system details	NA	
K	Others		
46	Lighting load	kW	
47	Refrigeration load	kW	
48	Total facility power consumption	kW	

	Unit	Value	Power Utilisation Ratio
Sanctioned Load by the Respective Board	kW	Please specify load that you are going to install	
Total Power Requirement at Peak Load Period	kW-h		Power requirement at peak load / Total Sanctioned Power
Total Power	kW-h		Power requirement at

Requirement at Holding Load Period			holding load / Total Sanctioned Power
Total Power Requirement at Lean Load Period	kW-h		Power requirement at Lean load / Total Sanctioned Power

All mandatory rules and regulations (BIS, ISO, IS, MNRE, etc.) relevant to the item must be complied with.

Please don't leave any space blank. Write N/A where not applicable



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ANNEXURE V

BASIC DATA SHEET FOR REFRIGERATED TRANSPORT

S. No.	Component: Refrigerated Transport	Unit	Description
A	Truck Chassis Details		
1	Chassis number	NA	
2	Make and Engine Model	NA	
3	Type of Vehicle (Diesel / CNG / Electric/ Others)	NA	
4	Engine power (kw)	kW	
5	Rated payload – carrying capacity of vehicle (tons)	MT	
6	Outer dimensions of vehicle (L x B x H) Mt	m x m x m	
7	Drive Cabin details (with AC / without AC)	NA	
8	Total number of tyres	No.	
B	Insulated Container		
9	Container dimensions (L x B x H) Mt	m x m x m	
10	Insulation Material Type	NA	
11	Insulation Thermal Conductivity (K Factor)	W/m.K	
12	Insulation Thickness (in MM)	mm	
13	Container Type (GRP / MS/ STEEL/OTHER)	NA	
14	Weight (Kgs) of Container	Kgs.	
15	Name of Container Manufacturer	NA	
16	Container manufacturing year	Year	
17	Application (Chilled / Frozen)	NA	
C	Refrigeration Unit		
18	Make and Model number	NA	
19	Unit Type (Self Powered/ Vehicle Powered/ Electric/ Eutectic/ Other)	NA	
20	Refrigerant used	NA	
21	Refrigeration capacity (kW)	kW	
22	Compressor Displacement (CC)	cc	
23	Defrosting system (Hot gas/ Electric)	NA	
24	Air flow (cum/hr.)	m ³ /hr.	

25	Standby Motor Load (kW)	kW	
26	Diesel/ electric auto- switching used	NA	
27	Controls Type (Manual/ Automatic)	NA	
D	Telematics		
28	Temperature remote Monitoring & Controlling device Type	NA	
29	GPS (Make and model)	NA	
E	Registration Details		
30	Vehicle Registered As:	NA	
31	State of Registration	NA	
32	RTO Office	NA	
33	RC Details	NA	
34	Any Other	NA	
F	Details of Existing Vehicles		
35	No. of vehicles availed previously	No. s	
36	Capacity of availed vehicles	MT	
37	Date of claiming previous subsidy	NA	
38	Board/ Organization from where subsidy released		

All mandatory rules and regulations (BIS, ISO, IS, MNRE, etc.) relevant to the item must be complied with.

Please don't leave any space blank. Write N/A at place which is not applicable.

ANNEXURE VI

BASIC DATA SHEET FOR ENERGY EFFICIENCY

1. Proposed List of Electrical Equipment Installed:

S. No.	Equipment	Make & Model	Quantity	Capacity of Transformer
1	Transformer			
2				

S. No.	Equipment	Make & Model	Quantity
1	Compressor		
2	Evaporator		
3	Mechanized Conveyors/Lifts		
4	Sorting & Grading Lines		
5	Ammonia Pumps		
6	CA Generator		
7	Water Pumps		
8	Mechanized Doors		
9	Ventilation Fans		
10	Lights		
11	Air Curtains		
12	D.G. Set		
13	CO ₂ Scrubber		
14	Recovery Wheel		
15	Dock Levelers		

2. Electrical Load Details:

	Unit (kW)	Value	Power Utilisation Ratio
Sanctioned Load by the Respective Board		Please specify load that you are going to install	
Total Power Requirement at Peak Load Period			Power requirement at peak load / Total Sanctioned Power
Total Power Requirement at Holding Load Period			Power requirement at holding load / Total Sanctioned Power
Total Power Requirement at Lean Load Period			Power requirement at Lean load / Total Sanctioned Power

3. Equipment Details:

Table 1:

Equipment	Rating of connected motor	Refrigeration capacity (kW)	Designed Evaporating Temp. or (SST)	Power Consumption (kW)	Motor output at Peak Load (kW)	Motor output at Holding Load (kW)	Motor output at Lean Load (kW)
Compressor 1							
Compressor 2							
Compressor 3							
Total Connected Load							

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Table 2:

Equipment	Rating of connected motor	Refrigeration capacity (kW)	Designed Evaporating Temp. or (SST)	Power Consumption (kW)	Motor output at Peak Load (kW)	Motor output at Holding Load (kW)	Motor output at Lean Load (kW)
Evaporator 1							
Evaporator 2							
Evaporator 3							

Total Connected Load							

Table 3:

Equipment	Rating of connected motor	Unit	capacity	Power Consumption (kW)	Motor output at Peak Load (kW)	Motor output at Holding Load (kW)	Motor output at Lean Load (kW)
Ammonia Pump 1							
Ammonia Pump 2							
Water Pump 1							
Water Pump 2							
Total Connected Load							

Table 4:

Other Equipment	Power Rating	Average Power Consumption Per Day
Mechanized Conveyors/ Lifts		
Mechanized Doors		
Ventilation Fans		
Electrical Lights		
Air Curtains		
Recovery Wheel		
Dock Levelers		
N ₂ Generator		
Sensors & Analyzers		
Control System		
CO ₂ Absorber		
Sorting & Grading Line		
*Please add more equipment as per installations.		

Table 5:

Equipment	Make & Model	Capacity	Efficiency	Consumption of Diesel on full Load
D.G. Set				

4. Automation & Controls:

Component	Remarks	Description	Make & Model
VFD / Electronic Technology for Compressors	Please ensure VFDs/ Microprocessor panel for energy efficiency of overall plant (compressors / fan / condensers / pumps etc.) should be installed and described thoroughly in design	Please specify the Upper limit & Lower limit of the Frequency	
Power Factor Controller			
PLC Control & Data Acquisition	1. Processor system 2. Number of Input (IU)/ Number of Output (OU) 3. Type of Report generation		
IoT based monitoring system			
Senser based temperature control & alert			
Measurement Systems			
SMS & Email Alerts			
Online Stock details			
Online Air Monitoring System			
Monthly Inventory report			
Monthly monitoring Data logger sheet			

Phone app			
Inventory Day report			
*Please add more equipment as per installations.			

All mandatory rules and regulations (BIS, ISO, IS, MNRE, etc.) relevant to the item must be complied with.

Please don't leave any space blank. Write N/A where not applicable



National Centre for Cold-chain Development

Annexure VII

UNDERTAKING FOR USING VACUUM COOLING

Description	Details
Name of the produce for which vacuum cooling is proposed.	
Is vacuum cooling is required for the product/ produce. (Give Yes/no and give details)	
Is this produce vacuum cooled or come under the category of forced cooling. (Give details about vacuum cooling technology).	.
Temperature of the produce before vacuum cooling (°C)	.
RH of the produce before vacuum cooling (°C/%RH)	.
Temperature of vacuum cooled produce of Refrigerant (°C/%RH)	.
Ethylene sensitivity of the vacuum cooling produce. (Give Yes/No)	
Next process after vacuum cooling (Define in 150-200 words)	
How much is the shelf life going to increase after using vacuum cooling technology? (Give details in 150 words)	

Annexure VIII

UNDERTAKING FOR INSTALLATION OF ONION COLD STORAGE

This is to submit that I Mr./Mrs.M/S..... is setting up an.....MT Onion Storage at (Address) for store onions under CS-I onion from NHM/MIDH/NHB.

S. No.	Description
Type of store-Nomenclature	CS-I onion
Name of Applicant and address	
Capacity (in MT)	
Temp/RH (°C/%)	
Details of Refrigeration Unit (Give what type of refrigeration system you are using.)	
Ventilation System	
1. Type	
2. Make	
3. Airflow CFM	
4. No. of air change (No)	
5. Fan/Type (No/Type)	
6. Motor (kW)	
Define Technology and how you are designing ventilation system (Give all necessary details/drawings and write details of ventilation systems and how it would improve quality of onions in 200 words.)	
Onion Stacking System (Give all necessary details/drawings and how movement of air has been designed specific to onion through this stacking system in 200 words.)	

I submit that details provided are correct to my knowledge and storage is being constructed for the purpose of storing onions.

Signature

Annexure IX

SUBMITAL FOR EXPANSION PROJECT

While applying for expansion project the applicant also needs to submit:

Description	Details
Detailed drawings of the existing facility	Attach
Drawing of new facility (expansion)	Attach
Years of operation of previous facility Date of start of commercial	
Previous BDS	Attach Details
State/district from where previous subsidy was claimed	
Previous installed capacity (in MT) Type of Cold Storage installed	
New Proposed Capacity (in MT) Proposed Type of Cold Storage	
In case the previous capacity is up to 2000 MT (max), type of refrigeration unit installed	Individual/Central
Proposed type of refrigeration	Individual/Central
NOC from previous department	Attach

ANNEXURE X

Guidance Note No.04/2018*

ARTIFICIAL RIPENING OF FRUITS Ethylene gas - A safe fruit ripener

SUMMARY

Fruits are best natural food for all and provide essential nutrients. The consumption of fruits has increased considerably in recent years due to awareness about their benefits and their availability round the year. Fruit trade involves transporting fruits to distant places. Highly perishable fruits such as mango, papaya, banana, etc. cannot be stored and transported to long distances after ripening as they tend to spoil. Therefore, to avoid spoilage of fruit during transportation, traders generally harvest raw fruits and ripen them artificially at the destination market before sale. Considering the importance of artificial ripening in supply chain of certain fruits, Food Safety & Standards Authority of India (FSSAI) permitted the use of ethylene gas for artificial ripening of fruits. Ethylene gas can be generated from various sources. Due to high cost and scarce availability of ethylene gas, traders often use unsafe and banned ripeners like carbide gas which can be potentially harmful to our health. The purpose of this guidance note is to create awareness among food business operators/traders, consumers and food safety officials related to different aspects of artificial ripening of fruits. It also includes Standard Operating Procedures (SOP) detailing all facets of artificial ripening of fruits using ethylene gas and its reliable sources.

KEY TAKEAWAYS

- Use of carbide gas or acetylene gas is not permitted for artificial ripening of fruits under Food Safety and Standards Regulations, 2011 due to the potential health hazards.
- Ethylene gas can be used for artificial ripening at a concentration up to 100 ppm (100 µl/L).
- Ethylene plays a vital role in natural ripening of fruits. It is a hormone produced naturally within the fruits to stimulate ripening process.
- Ethylene, being a natural hormone does not pose any health hazard to consumers.
- External application of ethylene gas generated from various sources such as ethylene gas cylinders, compressed ethylene gas, ethanol, ethephon, etc. can be used on fruits to trigger the ripening process in fruits.
- Any source of ethylene gas coming in direct contact with fruits is not permitted.
- Consumers should purchase fruits from known sellers/reputed stores/dealers who declare that fruits sold have not been ripened using harmful/banned chemicals.

This Guidance Note has been prepared by Ms. Ruby Mishra, Technical Officer at FSSAI. This note contains information collected and compiled by the author from various sources and does not have any force of law. FSSAI does not take any responsibility for any error and omission in this note.

*This guidance note is an updated version of the earlier guidance note dated 17 August 2018.

A. Introduction

Fruit ripening is a combination of physiological, biochemical, and molecular processes which lead to changes in colour, sugar content, acidity, texture, and aroma. In general, it is a physiological process which makes the fruit edible, palatable and nutritious. Fruits are classified into two categories according to the ripening pattern:

- a. Climacteric fruits: These fruits are usually harvested once they have reached its full maturity and can be further ripened during transit or storage. These include banana, guava, avocado, mango, apple, pears, apricots, peach, tomato etc.
- b. Non-climacteric fruits: These fruits do not ripen after harvest. Thus, in order to attain full ripeness and flavour, these fruits are often harvested once they have fully matured and ripened in the orchard. It includes fruits such as lemons, orange, grape, cherry, pineapple, strawberry etc.

B. Need for artificial ripening

Artificial ripening is the process by which ripening is controlled to achieve desired characteristics intended for better consumer acceptance and improving sales. It is generally done for climacteric fruits such as mango, papaya, banana, etc. to achieve faster and uniform ripening characteristics. Globally, artificially ripened fruits are considered as safe for human consumption if done using safe ripening agents. It facilitates the transportation of fruits like mango, banana, etc. which become soft and perishable after ripening. These fruits are transported to distant places in unripe condition to avoid loss and are artificially ripened at the destination market before sale.

C. Provisions for artificial ripening of fruits under food safety & standards regulations, 2011

Artificial ripening of fruits by acetylene gas, commonly known as carbide gas is prohibited as per the provision in sub regulation 2.3.5 of Food Safety and Standards (Prohibition and Restrictions on Sales) Regulation, 2011. It permits the use of ethylene gas at a concentration up to 100 ppm (100 µl/L) depending upon the crop, variety and maturity for artificial ripening of fruits.

D. Issues in artificial ripening

The Industrial-grade calcium carbide, popularly known as "masala" is often used by some unscrupulous traders to release acetylene gas for artificial ripening of fruits like mango, banana, papaya, etc. Calcium carbide contains traces of arsenic and phosphorus which is harmful for humans and may cause dizziness, frequent thirst, irritation, weakness, difficulty in swallowing, vomiting, skin ulcer, etc. The acetylene gas released from calcium carbide is equally harmful for handlers. There are chances that calcium carbide may come in direct contact with fruits during application and leave residues of arsenic and phosphorus on fruits. Thus, use of this chemical for ripening of fruits is banned in India.

Considering the issue of rampant use of banned calcium carbide and non-availability of alternative ripening agent, Food Safety & Standards Authority of India (FSSAI) permitted the use of ethylene gas for ripening of fruits in India vide notification dated 23.08.2016.

E. Artificial ripening using ethylene gas (C_2H_4)

Ethylene is a hormone naturally produced within the fruit and regulates fruit ripening by initiating and controlling a series of chemical and biochemical activities. The treatment of unripe fruits with ethylene gas triggers the natural ripening until the fruit itself starts producing ethylene in large quantities.

A Standard Operating Procedures (SOP) detailing all aspects of artificial ripening of fruits by ethylene gas is developed by the Working Group constituted at FSSAI on the recommendation of Scientific Panel on Fruits & Vegetables and their Products (Including dried fruits and nuts, salt, spices and condiments). The Working Group consists of members from the Scientific Panel and experts from relevant research institutes.

F. Standard Operating Procedure

1. Restrictions

- Any preparation containing calcium carbide or acetylene gas
- Any source of ethylene gas coming in direct contact with fruits

2. Requirements for Ethylene Ripening System/Chamber

- Air tight room, preferably an insulated one for better temperature control
- Temperature regulation systems (cooling heating)
- Humidity regulation system
- Proper air circulation and ventilation
- Ethylene gas generation / injection system
- Ensured power supply (for ripening chambers)
- Display board indicating temperature, relative humidity, ethylene concentration, CO_2 concentration



Ripening chamber

3. Suggested handling conditions for stacking of fruits and air circulation

Fruits should be kept in ventilated plastic crates or stackable fruit boxes inside the ripening chamber/temporary structure. Stacking of boxes should be done keeping minimum 4-6 inch space from the walls and between the adjacent crates. For uniform ripening, airflow throughout the chamber shall be maintained. Fruit should not occupy more than 75% of the volume of the chamber (as well as crate) during the treatment.

Table 1. Requirements of exposure time and ripening temperature for different fruits

Fruit	Ethylene exposure time (hours)	Ripening temperature (°C) *	Relative Humidity (RH) (%)
Banana	24-48	15-18	90-95
Mango	24-48	20-22	90-95
Papaya	24-48	20-25	90-95
Pear	24-48	18-22	90-95
Tomato	24-48	18-20	90-95

*Fruits should be transferred to ripening chamber once the ripening temperature is attained after pre-cooling by appropriate method.

4. Sources of Ethylene Gas: Ethylene gas obtained through the following systems may be used for artificial ripening of fruits:

- a) For Ripening Chambers
 - Ethylene gas cylinders
 - Compressed ethylene gas (aerosol cans)
 - Ethylene generators
 - 2 chloroethylphosphonic acid (Ethephon/Ethrel) with alkali
- b) For Cartons/Boxes
 - 2 chloroethylphosphonic acid (Ethephon) in powdered form
 - Ethylene gas encapsulated in biologically safe ingredients such as cellulose, starch, and proteins



Ethylene gas cylinder



Compressed ethylene gas



Ethylene generators



Ethephon sachet

5. Protocol for application of Ethylene gas from various sources

- (i) Ethylene gas cylinders:
 - a. Maintain the temperature and RH inside the empty ripening chamber as per Table 1, depending upon the commodity.
 - b. Once desired temperature and RH is achieved, place the crates containing fruits into the ripening chamber. Temperature of fruits should be as close as possible to the temperature mentioned in Table 1, above.
 - c. Introduce ethylene gas into the chamber (up to 100 ppm) through the gas cylinders.
 - d. Monitor CO₂ inside the chamber and maintain it below 5000 ppm.
 - e. Maintain the temperature, RH, concentration of ethylene gas and CO₂ levels as suggested above for 24-48 hours.

- f. Remove the fruits from the ripening chamber and store in another chamber at optimum storage temperature till further use.
- g. Avoid excess of ethylene accumulation in the chamber for desired results.

(ii) Compressed ethylene gas (aerosol cans):

- a. All items as in 5(I) above except (c).
- b. Instead of introducing ethylene through the gas cylinders, spray of compressed ethylene gas inside the ripening chamber (2.7 litres gas per can for 27 m³ volume or in the same ratio) shall be used, which result in maximum ethylene concentration of 100 ppm.
- c. Ethylene gas should be sprayed in the empty/open space in the chamber, not directly on the fruits.

(i) Ethylene generators:

- a. All items as in 5(I) above except (c).
- b. In this method ethylene gas is generated using catalytic converter from ethanol, and is brought into the ripening chamber through a calibrated gas regulator (up to 100 ppm).

(ii) 2 Chloroethylphosphonic acid (Ethephon 39% SL) with alkali:

- a. All items as in 5(I) above except (c).
- b. In this method ethylene gas is generated from 2 chloroethylphosphonic acid (ethephon 39% SL). 0.50 g is added in 2 ml of ethephon 39% SL for every 1 m³ air tight room / ripening chamber. Gas formation will start immediately. The maximum concentration of ethylene gas generated will be 100 ppm.

(iii) Sachet containing 2 chloroethylphosphonic acid (Ethephon) in powder form:

Ethephon in powder form may be used for artificial ripening of fruits. It shall be packed in 40-60 micron cellulose membrane paper or its equivalent in form of small sachets. The ripening mixture in the sachets should be as per the composition recommended below. This ripening method may be used where ripening chambers are not available or for in-transit ripening. The sachet must generate ethylene gas only and should not contain any traces of calcium carbide or acetylene gas.

Composition: 2 chloroethylphosphonic acid (Ethephon), and combination of alkali (oxides and carbonates of magnesium and calcium, sodium and potassium carbonates and bicarbonates, magnesium silicates).

- a. Keep the fruit in air tight boxes or make the boxes air tight by paper etc.
- b. Take ethylene forming sachet [(500 mg containing 50 mg 2 chloroethylphosphonic acid (Ethephon))] and dip it in water for 5- 10 seconds.
- c. Place the water soaked sachet in perforated plastic box (approximately 5cm x 5 cm x 5 cm size).
- d. Place this small plastic box containing the sachet into the fruit box / crate (approximately at the centre of box/crate) having volume of 2.7 m³, which should be sufficient for 10 kg fruits. The ethylene gas generated will not exceed 100 ppm.
- e. Remove the small plastic box containing the sachet after 24 hours.

G. For food business operators/traders

- a. Pre-treatment operations:
 - Harvest the fruits at optimum maturity.
 - Treatment with ethylene up to 100 ppm concentration should be used for ripening. The concentration of ethylene may go up due to autocatalytic production of ethylene once ripening is triggered by exogenous application of ethylene.
 - Procure ethylene cylinder/aerosol cans/Ethephon/Ethrel from reputed companies
 - Ensure authenticity / purity of the sachet containing ethephon in powder form and other components.
 - Use well labelled sachets mentioning details of manufacturer, composition, instructions for use etc.
 - Ethylene releasing agents shall not come in direct contact with fruits.
 - For uniform ripening in chambers, airflow throughout the room shall be maintained. Fruit should not occupy more than 75% of the volume of the chamber (as well as crate) during the treatment.
 - Relative Humidity, temperature and exposure time shall be maintained as prescribed in table 1 during ripening for best results.
 - CO₂ concentration shall be maintained below 5000 ppm. It can be achieved by CO₂ scrubbing devices or air exchange at interval of every 6 hours. High concentration of CO₂ will retard the ripening process.
- b. Post-treatment operations:
 - Transfer the fruits to ventilated room with appropriate storage temperature and relative humidity for ripening after completion of the treatment.
 - Remove the sachet out of the fruit boxes after completion of the treatment (24 hours).
- c. Guidelines for safety
 - Ethylene gas is highly inflammable. Cylinders should be used with caution. Ethylene concentrations above 27000 ppm are explosive.
 - Smoking should be strictly prohibited around the premises.
 - Electrical circuits should be properly monitored.
 - Gas leakage monitoring system should be installed in the commercial ripening chambers.

H. For consumers

- Purchase fruits and vegetables from known sellers/reputed stores/ dealers who claim that fruits are not ripened by using harmful/banned chemicals.
- Wash fruits thoroughly with running potable water before eating.
- Avoid fruits with black blotches on the skin as these fruits are likely to be ripened by acetylene gas produced from calcium carbide.

I. For Food Safety Officials

- The illegal use of calcium carbide in fruit markets/mandi's and shops shall be monitored.
- Safety and purity of sources used for generating ethylene gas shall be monitored and regulated. Any source of ethylene gas should not come in direct contact with fruits.
- Labelling on ethylene releasing sources must be checked for composition, name of manufacturers, instructions for use, etc.

- Suspected samples of any source of ethylene gas shall be analysed for absence of calcium carbide by the authorized labs.

The display units, if available in the ripening chambers may be checked for concentration of ethylene gas used.

- Capacity building of fruit traders/FBOs may be encouraged for permitted source of ethylene gas and its use as ripening agent as per the standard operating procedure mentioned in section (F) of this document.
- The fruit traders need to be made aware of the danger of unsafe ripening agents such as calcium carbide.

J. Guidelines for natural ripening

Fruits may be ripened naturally using the below mentioned methods within 4-6 days, if kept at room temperature. These methods entrap ethylene around fruit and facilitates faster ripening.

- Harvest the fruits at optimum maturity.
- Wrap the fruits individually with paper or place it in paper bag.
- Keep unripe fruits as layers over paddy husk or wheat straw.
- Keep unripe fruits inside an air tight rice bin/container.



(a) Ripening in air tight rice bin



(b) Ripening using paddy straw

References

1. Standard Operating Procedure (SOP) developed by Working Group and recommended by Scientific Panel on Fruits & Vegetables and their Products (Including dried fruits and nuts, salt, spices and condiments).
2. Food Safety and Standards (Prohibition and Restriction on Sales) Regulations, 2011
3. Consuming Fruits Ripened Artificially by Calcium Carbide may pose Health Problems, Food Safety and Standards Authority of India, available at http://old.fssai.gov.in/Portals/0/Pdf/Article_on_fruits.pdf
4. Indian Institute of Horticultural Research (2009) Uniform bulk ripening of Mango, Banana and Papaya, New Delhi: Indian Council of Agricultural Research. Available at : <https://icar.org.in/files/newsletters/icar-news/ICAR-News-Oct-Dec-09.pdf>
5. Dhall RK and Singh P. (2013) 'Effect of Ethephon and Ethylene Gas on Ripening and Quality of Tomato (Solanum Lycopersicum L.) during Cold Storage', Journal of Nutrition & Food Sciences, 3(6), pp. 1-7.
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7. Rahman A, Chowdhury FR, Alam (2008) 'Artificial Ripening: What We Are Eating', Journal of Medicine, 9(1), pp. 42-44.
8. Ripening- an important process in fruit development, Prof. S. N. Naik, Centre for Rural Development & Technology, IIT Delhi.
9. Siddiqui Md. Wasim and Dhua R.S. (2010), Eating artificially ripened fruits is harmful, Current Science; 99(12).

ANNEXURE C-1

COST NORMS FOR FARMGATE PACKHOUSE

For Both NHM/NHB

COMPONENT NO.	DESCRIPTION & NAME	Max. ALLOWABLE QTY.	COST
C-1	Farm Gate Packhouse Shed with finished concrete floor, Movable Handling trolley which can carry crates or boxes from the farm up to the unit. Min. Equipment like electrical ceiling fans, lighting, ventilation etc.	Size of 6m x 9m per project	Rs. 4.8 lakh / project
	Movable Handling Trolley: A critical feature of the unit is the use of movable trolleys designed to carry crates or boxes filled with produce. These trolleys facilitate the smooth transportation of goods from the farm fields to the handling unit, reducing manual labour and minimizing the risk of bruising or damaging the produce.	Max 5 units	
	Sorting Table: Tables of size 3' x 2' installed inside the facility to manually sort/grade produces by workers/growers.	Max. 3 units	
*Add-on:	Farm Gate Standalone Cold Storage The rationale is to provide short term storage which is able to help the farmer etc. in terms of curtailing the economic loss. In this case, in either of the three options only one can be chosen with capacity maximum upto 10MT/project- Option I: Solar Photo Voltaic based system with battery and thermal storage Option II: Thermal Storage type (PCM, water) with auxiliary batteries, cold room running on grid where minimum 8-10 hrs of electricity is available (DG Set not allowed) Option III: Cold Storage running on Bio-mass with either vapour absorption or adsorption technologies. Option IV: Conventional Cold Store running on grid electricity.		Rs. 20 lakh/ project Rs. 8 lakh/ project Rs. 12 lakh/ project Rs. 5 lakh/ project

ANNEXURE C-2

COST NORMS FOR INTEGRATED PACKHOUSE

For Both NHM/NHB

COMPONENT NO.	DESCRIPTION & NAME	MAX. ALLOWABLE QTY	CAPACITY/UNITS/SIZES
C-2	Integrated Packhouse (IP) Integrated Packhouse (IP) of size 18m x 22m with facilities of Receiving Area, weighing bridge, Washing, Enclosed Sorting and Grading Area with mechanised sorting/grading conveyor-based system. (refer point 1, and other relevant points)	Size of 18m x 22m per project	Rs. 60 lakh / project
	Material Handling Equipment (MHE): Above 1 ton HPT	Max. 2 unit/ project	Rs. 20000/unit
	Crates/Bins	Max. 50 MT/ project	Rs.2000/MT (max. 50 MT allowed)
	Dock Leveller System(DLS)	Max. 2 units/ project	Rs. 8.4 lakh/unit
	Precooling (if required)* (Based on requirement, not exceeding more than 3 MT as cumulative capacity) Refer Chapter No. 8 for details	Max. 3 MT/ project	Rs. 5 lakh/MT

Refer to Chapter no. 9 (COLD ROOM TRANSIT) for technical details.	Cold Room Transit (Option I) Decentralised cold storages based on solar technologies or hybrid running on batteries, solar PV panels, microcontrollers, etc. along with ante rooms, Thermal storages (all kinds), insulation, doors, necessary civil work and refrigeration systems. (refer point no. 6) Refer Chapter No. 10 for details	Max. 30 MT (2 chambers of 15 MT)	Rs. 26 lakh/chamber
	Cold Room Transit (Option II) In case of cold rooms based on Thermal storage type where electric energy is available for 8 hrs/day (No DG Sets are allowed) (refer point no. 6)	Max. 30 MT (2 chambers of 15 MT)	Rs. 15 lakh/chamber
	Cold Room Transit (Option III) The cold room transit are conventional cold rooms working on conventional refrigerants with ante rooms, insulation, doors necessary inside civil work and refrigeration systems. (Refer Chapter No. 9 for details)	Max. 30 MT (2 chambers of 15 MT)	Rs. 7.5 lakh/chamber
	Reefer Vehicle of load carrying capacity of min. 1 MT upto 2 MT (EV or ICE) The load carrying capacity of container is determined after subtracting the sum of (kerb weight of the chassis + container weight + weight of Reefer unit) from the Gross Vehicle Weight (GVW) of the chassis. Refer Chapter No. 22 for details	1 no. Vehicle of min. 1 MT upto 2MT (Either 1 ICE based OR 1 EV based)	Rs. 12 lakh/vehicle Rs. 14 lakh/vehicle

ANNEXURE C-3

COST NORMS FOR COLLECTION AGGREGATION CENTRE

FOR Both NHM & NHB

COMPONENT NO.	DESCRIPTION & NAME	MAX. ALLOWABLE QTY.	CAPACITY/UNITS/SIZES
C-3	To connect rural areas with urban markets Collection & Aggregation Centre of size 22m x 26m with facility of receiving area, weighing bridge, Washing, with Enclosed weight, size Sorting and Grading Areas with automatic/ mechanised sorting, grading, waxing line of 1MT~2MT/hr, with packing system consisting of strap packing machines, etc.	Size of 22m x 26m per project	Rs. 120 lakh / project
Refer to chapter no. 9 (COLD ROOM TRANSIT) for technical details	Automated computerised system with software for generating QR/bar code labelling, farmers details, date of arrival, variety of the crop at the arrival of Collection & aggregation center	One system/ project	Rs. 3.5 lakh / project
	Material Handling Equipment (MHE) Above 1 Ton HPT	Max. 4 units	Rs. 20000/ unit
	Above 1 Ton BOPT	Max. 2 units	Rs. 1.5 lakh/ unit
	Crates/Bins	Max. 100 MT	Rs. 2000/MT
	Dock Leveller System	Max. 3 units	Rs. 8.4 lakh/unit
	Precooling (if required)* (Based on requirement, not exceeding more than 6 MT as cumulative capacity and min 3MT)	Min 3 MT up to Max. 6 MT	Rs. 5 lakh/MT
	Cold Room Transit (Option I) Decentralised cold storages based on solar technologies or hybrid running on batteries, solar PV panels, microcontrollers,etc. alongwith ante rooms, Thermal storages(all kinds), insulation, doors, necessary civil work and refrigeration systems. (refer point no. 9)	Max. 60 MT (4 chambers of 15 MT)	RS. 26 lakh/chamber for Capacity allowed in multiples of 15 MT

	Cold Room Transit (Option II) In case of cold rooms based on Thermal storage type where electric energy is available for 8 hrs/day(No DG Sets are allowed) . (refer point no. 9) Cold Room Transit (Option III) The cold room transit are conventional cold rooms working on conventional refrigerants with ante rooms, insulation, doors necessary inside civil work and refrigeration systems. . (refer point no. 9)	Max. 60 MT (4 chambers of 15 MT) Max. 60 MT (4 chambers of 15 MT)	Rs. 15 lakh/chamber for Capacities allowed in multiples of 15 MT Rs. 7.5 lakh/chamber for Capacity allowed in multiples of 15 MT
	Reefer Vehicle of load carrying capacity min. 1 MT (EV or ICE) upto 2 MT. ADD-ON: Reefer Vehicle of load carrying capacity min. 9 MT. upto 14 MT (for NHM) And 15 MT and above (for NHB) The load carrying capacity of container is determined after subtracting the sum of (kerb weight of the chassis + container weight + weight of Reefer unit) from the Gross Vehicle Weight (GVW) of the chassis. Collection & Aggregation centres should be set up near urban areas, market yards, distribution centres, consumer centres, National Highways and should integrate with farm handling units for forward linkage and with rural retail markets for backward linkage.	Max 2 no. vehicle of capacity min. 1MT upto 2 MT (Either ICE based or EV based) To be availed as per component C-13 (Refrigerated Transport)	Rs. 12 lakh / ICE vehicle Rs. 14 lakh/ EV This can be availed as an Add-on component on need basis as per applicable norms defined in component C-13 (Refrigerated transport vehicle)
Weigh Bridge	Weigh Bridge of capacity min 25 MT	Max. 1 unit / project	Rs. 4 lakh/unit

ANNEXURE C-6

COST NORMS FOR COLD ROOM TRANSIT

FOR Both NHM & NHB

COMPONENT NO.	AVAILABLE OPTIONS	CAPACITY	COST NORM
C-6	Cold Room Transit (Option I) Decentralised cold storages based on solar technologies or hybrid running on batteries, solar PV panels, microcontrollers, etc. along with ante rooms, Thermal storages(all kinds), insulation, doors, necessary civil work and refrigeration systems. Refer Chapter No. 10 for details	Max. 30 MT (2 chambers of 15 MT)	Rs. 26 lakh/chamber
	Cold Room Transit (Option II) In case of cold rooms based on Thermal storage type where electric energy is available for 8 hrs/day(No DG Sets are allowed)	Max. 30 MT (2 chambers of 15 MT)	Rs. 15 lakh/chamber
	Cold Room Transit (Option III) The cold room transit are conventional cold rooms working on conventional refrigerants with ante rooms, insulation, doors necessary inside civil work and refrigeration systems. Refer Chapter No. 9 for details	Max. 30 MT (2 chambers of 15 MT)	Rs. 7.5 lakh/chamber

ANNEXURE C-7

COST NORMS FOR COLD STORAGE TYPE-I (SINGLE)

FOR NHM

COMPONENT NO.	DESCRIPTION & NAME	Max. ALLOWABLE QTY./CAPACITY	COST
C-7 (i)	Cold Storage type –I (CS-1) are cold storages designed mostly for single product storage where bulk and long term storage is preferred. They are normally seen in brick and mortar structure, however, an applicant can also develop it under the pre-engineered building (PEB). It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas, loading docks, PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places. Consisting of :	For Civil Construction of capacity upto 4999 MT ~ 5000 MT capacity	Rs. 9600/MT
C-7 (ii)	For PEB Construction of capacity upto 4999 MT ~ 5000 MT capacity i. Construction: Foundation/ slab/ columns/ pillars/ PEB structure ii. Insulation: Walls, Ceiling, Floors, etc. iii. All refrigeration Units iv. Electrical Installations: Transformers/DG Sets,VFDs, etc. v. Administrative Block: CCTV/ parking areas / Office block/ Convenience areas vi. Safety & Hazard control: Fire fighting equipments/ fire exits/ fire		Rs. 12,000

	doors- as per norms and conditions of the building		
	CO2 SCRUBBER with CO2 MONITORING SYSTEM FOR REMOVAL OF CO2 Mandatory only for those produces generating lot of CO2. E.g.- potato, onions, apples, etc	Max. 1 system/ project	Rs. 10 lakh/system
	Unified Control System- PLC,BMS, IoT, Remote monitoring, etc.	Max. 1 system/ project	Rs. 5 lakh/system
	Conveying/Hoist system/Material Service lifts for material handling of suitable capacity in the anteroom with provision of unloading on common landing near and outside cold rooms. (upto 5000 MT) (refer point no. 9-MECHANISATION)	Max. 1 system/ project	Rs. 5 lakh/system
	Dock Leveller System comprising of: (components of 1 set) A. Dock Leveller B. Dock Door C. Dock Shelter D. Vehicle Barrier/ Hit Alarm	Max. 2 sets	Rs. 8.4 lakh/set
	Material Handling Equipments: HPT 1 ton and above BOPT 1 ton and above	Max. 4 units Max 2 unit	Rs. 20000/ unit Rs. 1.5 lakh/ unit
	Doors	Max. 20 doors/ project	Rs. 25000 / door
	Automated computerised system with software for generating QR/bar code labelling, farmers details, date of arrival, variety of the crop at the arrival of aggregation center	Max. 1 system/ project	Rs. 3.5 lakh/system

FOR NHB

COMPONENT NO.	DESCRIPTION & NAME	Max. ALLOWABLE QTY./CAPACITY	COST
C-7 (i)	Cold Storage type –I (CS-1) are cold storages designed mostly for single product storage where bulk and long term storage is preferred. They are normally seen in brick and mortar structure, however, an applicant can also develop it under the pre-engineered building (PEB). It is further stated that all the building safety norms,	For CIVIL Construction of capacity between: 5001 to 6500 MT 6501 to 8000 MT	Rs. 9120/MT Rs. 8640/MT

	stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas, loading docks, PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places. Consisting of :	8001 to 10000 MT	Rs. 8160/MT
		10001 to 20000 MT*	Rs. 4080/MT*
C-7 (ii)	For PEB Construction of capacity between: 5001 to 6500 MT 6501 to 8000 MT 8001 to 10000 MT 10001 to 20000 MT* i. Construction: Foundation/ slab/ columns/ pillars/ PEB structure ii. Insulation: Walls, Ceiling, Floors, etc. iii. All refrigeration Units iv. Electrical Installations: Transformers/DG Sets,VFDs, etc. v. Administrative Block: CCTV/ parking areas / Office block/ Convenience areas vi. Safety & Hazard control: Fire fighting equipments/ fire exits/ fire doors- as per norms and conditions of the building		Rs. 11400/MT
			Rs. 10800/MT
			Rs. 10200/MT
			Rs. 5100/MT*
	CO2 SCRUBBER with CO2 MONITORING SYSTEM FOR REMOVAL OF CO2	Max. 1 system/ project	Rs. 10 lakh/ system
	Mandatory only for those produces generating lot of CO2. E.g.- potato, onions, apples, etc		
	Unified Control System- PLC,BMS, IoT, Remote monitoring, etc.	Max. 1 system/ project	Rs. 5 lakh/ system
	Conveying/Hoist system/Material Service lifts for material handling of suitable capacity in the anteroom with provision of unloading on common landing near and outside cold rooms. (upto 5000 MT) (refer point no. 9-MECHANISATION)	Max. 1 system/ project	Rs. 5 lakh/ system

	Dock Leveller System comprising of: (components of 1 set) A. Dock Leveller B. Dock Door C. Dock Shelter D. Vehicle Barrier/ Hit Alarm	Max. 2 sets	Rs. 8.4 lakh/set
	Material Handling Equipments:		
	HPT 1 ton and above	Max. 4 units	Rs. 20000 / unit
	BOPT 1 ton and above	Max 2 unit	Rs. 1.5 lakh / unit
	Doors	Max. 30 doors / project	Rs. 25000 / door
	Automated computerised system with software for generating QR/bar code labelling, farmers details, date of arrival, variety of the crop at the arrival of aggregation center	Max. 1 system / project	Rs. 3.5 lakh / system

National Centre for Cold-chain Development

ANNEXURE C-8

COST NORMS FOR COLD STORAGE TYPE- I-ONION

FOR NHM

COMPONENT NO.	DESCRIPTION & NAME	Max. ALLOWABLE QTY./CAPACITY	COST
C-8 (i)	Cold Storage type –I - Onion (CS-1-Onion) are cold storages designed for onion storage where bulk and long term storage is preferred. They are normally seen in brick and mortar structure, however, an applicant can also develop it under the pre-engineered building (PEB). It is further stated that all the building safety norms, furnishing of stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas(receiving shed), PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places. Consisting of :	For Civil Construction of capacity upto 4999 MT ~ 5000 MT capacity	Rs. 9600/MT
C-8 (ii)	For PEB Construction of capacity upto 4999 MT ~ 5000 MT capacity i. Construction: Foundation/ slab/ columns/ pillars/ Receiving Area or shed/ PEB structure ii. Insulation: Walls, Ceiling, Floors, etc. iii. All refrigeration Units iv. Electrical Installations: Transformers/DG Sets, VFDs, etc. v. Administrative Block: CCTV/ parking areas / Office block/ Convenience areas		Rs. 12,000

	vi. Safety & Hazard control: Fire fighting equipments/ fire exits/ fire doors- as per norms and conditions of the building		
	Ventilation system#	Max. upto 5000 MT/ project	Rs. 3000/MT
	Specialised Stacking System appropriate for Onions*	Max. upto 5000 MT/ project	Rs. 2000/MT
	CO2 SCRUBBER with CO2 MONITORING SYSTEM FOR REMOVAL OF CO2 Mandatory only for those produces generating lot of CO2. E.g.- potato, onions, apples, etc	Max. 1 system/ project	Rs. 10 lakh/ system
	Unified Control System- PLC,BMS, IoT, Remote monitoring, etc.	Max. 1 system/ project	Rs. 5 lakh/system
	Conveying/Hoist system/Service lifts for material handling of suitable capacity in the anteroom with provision of unloading on common landing near and outside cold rooms. (upto 5000 MT)	Max. 1 system/ project	Rs. 5 lakh/system
	Doors	Max. 20 doors/ project	Rs. 25000 / door
	Automated computerised system with software for generating QR/bar code labelling, farmers details, date of arrival, variety of the crop at the arrival of aggregation center	Max. 1 system/ project	Rs. 3.5 lakh/system

FOR NHB

COMPONENT NO.	DESCRIPTION & NAME	Max. ALLOWABLE QTY./CAPACITY	COST
C-8 (i)	<u>Cold Storage type –I - Onion (CS-1-Onion)</u> are cold storages designed for onion storage where bulk and long term storage is preferred. They are normally seen in brick and mortar structure, however, an applicant can also develop it under the pre-engineered building (PEB). It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety	For CIVIL Construction of capacity between: 5001 to 6500 MT 6501 to 8000 MT	Rs. 9120/MT Rs. 8640/MT

	norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas(receiving shed), PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places. Consisting of :	8001 to 10000 MT	Rs. 8160/MT
		10001 to 20000 MT	Rs. 4080/MT
C-8 (ii)	For PEB Construction of capacity between: 5001 to 6500 MT 6501 to 8000 MT 8001 to 10000 MT 10001 to 20000 MT iii. Safety & Hazard control: Fire fighting equipments/ fire exits/ fire doors- as per norms and conditions of the building		Rs. 11400/MT Rs. 10800/MT Rs. 10200/MT Rs. 5100/MT
	Ventilation system#	Max. upto 20000 MT/ project	Rs. 3000/MT Total max cost capped to 300 lakhs/project
	Specialised Stacking System appropriate for Onions*	Max. upto 20000 MT/ project	Rs. 2000/MT Total max cost capped to 200 lakhs/project
	CO2 SCRUBBER with CO2 MONITORING SYSTEM FOR REMOVAL OF CO2 Mandatory only for those produces generating lot of CO2. E.g.- potato, onions, apples, etc	Max. 1 system/ project	Rs. 10 lakh/ system
	Unified Control System- PLC,BMS, IoT,	Max. 1 system/	Rs. 5

	Remote monitoring, etc.	project	lakh/system
	Conveying/Hoist system/Service lifts for material handling of suitable capacity in the anteroom with provision of unloading on common landing near and outside cold rooms. (upto 5000 MT)	Max. 1 system/ project	Rs. 5 lakh/system
	Doors	Max. 30 doors/ project	Rs. 25000 / door
	Automated computerised system with software for generating QR/bar code labelling, farmers details, date of arrival, variety of the crop at the arrival of aggregation center	Max. 1 system/ project	Rs. 3.5 lakh/system



National Centre for Cold-chain Development

ANNEXURE C-9

COST NORMS FOR COLD STORAGE TYPE-II (MULTI)

FOR NHM

COMPONENT NO.	DESCRIPTION & NAME	Max. ALLOWABLE QTY./CAPACITY	COST
C-9	Cold Storage type -II (CS-2) are cold storages designed mostly for multi product storage where bulk and long term storage is preferred. They are normally seen in pre-engineered building and certain areas like docks, plant rooms, offices, convenience areas can be constructed with brick and mortar and integrated with the PEB. It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas, loading docks, PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places. Consisting of : i. Construction: Foundation/ slab/ columns/ pillars/ PEB structure ii. Insulation: Walls, Ceiling, Floors, etc. iii. All refrigeration Units iv. Electrical Installations: Transformers/ DG Sets, VFDs, etc. v. Administrative Block: CCTV/ parking areas / Office block/ Convenience areas. vi. Safety & Hazard control: Fire	For PEB Construction of capacity upto 4999 MT ~ 5000 MT capacity	Rs. 12,000

	fighting equipments/ fire exits/ fire doors- as per norms and conditions of the building		
	CO2 SCRUBBER with CO2 MONITORING SYSTEM FOR REMOVAL OF CO2 Mandatory only for those produces generating lot of CO2. E.g.- potato, onions, apples, etc	Max. 1 system/ project	Rs. 10 lakh/system
	Unified Control System- PLC,BMS, IoT, Remote monitoring, etc.	Max. 1 system/ project	Rs. 5 lakh/system
	Conveying/Hoist system/Material Service lifts for material handling of suitable capacity in the anteroom with provision of unloading on common landing near and outside cold rooms. (upto 5000 MT) (refer point no.7)	Max. 1 system/ project	Rs. 5 lakh/system
	Dock Leveller System comprising of: (components of 1 set) A. Dock Leveller B. Dock Door C. Dock Shelter D. Vehicle Barrier/ Hit Alarm	Max. 2 sets	Rs. 8.4 lakh/set
	Material Handling Equipments: HPT above 1 ton	Max. 4 units	Rs. 20000/unit
	BOPT 1 ton and above	Max 2 unit	Rs. 1.5 lakh/ unit
	Doors	Max. 20 doors/ project	Rs. 25000 / door
	Automated computerised system with software for generating QR/bar code labelling, farmers details, date of arrival, variety of the crop at the arrival of aggregation center	Max. 1 system/ project	Rs. 3.5 lakh/system

FOR NHB

COMPONENT NO.	DESCRIPTION & NAME	Max. ALLOWABLE QTY./CAPACITY	COST
C-9	Cold Storage type –II (CS-2) are cold storages designed mostly for multi product storage where bulk and long term storage is preferred. They are normally seen in pre-engineered building and certain areas like		

	docks, plant rooms, offices, convenience areas can be constructed with brick and mortar and integrated with the PEB. It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas, loading docks, PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places. Consisting of : i. Construction: Foundation/ slab/ columns/ pillars/ PEB structure ii. Insulation: Walls, Ceiling, Floors, etc. iii. All refrigeration Units iv. Electrical Installations: Transformers/DG Sets, VFDs, etc. v. Administrative Block: CCTV/ parking areas / Office block/ Convenience areas. vi. Safety & Hazard control: Fire fighting equipments/ fire exits/ fire doors- as per norms and conditions of the building	For PEB Construction of capacity between: 5001 to 6500 MT 6501 to 8000 MT 8001 to 10000 MT 10001 to 20000 MT*	Rs. 11400/MT Rs. 10800/MT Rs. 10200/MT Rs. 5100/MT*
	CO₂ SCRUBBER with CO₂ MONITORING SYSTEM FOR REMOVAL OF CO₂ Mandatory only for those produces generating lot of CO₂. E.g.- potato, onions, apples, etc	Max. 1 system/ project	Rs. 10 lakh/ system
	Unified Control System- PLC,BMS, IoT, Remote monitoring, etc.	Max. 1 system/ project	Rs. 5 lakh/ system

	Conveying/Hoist system/material service lift for material handling of suitable capacity in the anteroom with provision of unloading on common landing near and outside cold rooms. (upto max. 20000 MT) (refer point no.7)	Max. 1 system/ project	Rs. 5 lakh/ system
	Dock Leveller System comprising of: (components of 1 set) A. Dock Leveller B. Dock Door C. Dock Shelter D. Vehicle Barrier/ Hit Alarm	Max. 2 sets	Rs. 8.4 lakh/set
	Material Handling Equipments: HPT 1 ton and above BOPT 1 ton and above	Max. 4 units Max 2 unit	Rs. 20000 / unit Rs. 1.5 lakh / unit
	Doors	Max. 30 doors / project	Rs. 25000 / door
	Automated computerised system with software for generating QR/bar code labelling, farmers details, date of arrival, variety of the crop at the arrival of aggregation center	Max. 1 system / project	Rs. 3.5 lakh / system

National Centre for Cold-chain Development

ANNEXURE C-10

COST NORMS FOR COLD STORAGE TYPE-II-CA FOR NHM

COMPONENT NO.	DESCRIPTION & NAME	Max. ALLOWABLE QTY./CAPACITY	COST
C-10	<u>Controlled Atmosphere Storage type –II-CA (CS-2-CA)</u> are cold storages designed for controlled atmosphere storage where bulk, short and long term storage is preferred as required. These storages should be equipped with all necessary equipments to maintain and monitor the required concentration of N₂, CO₂ and O₂ levels along with temp and humidity control. They are normally seen in pre-engineered building and certain areas like docks, plant rooms, offices, convenience areas can be constructed with brick and mortar and integrated with the PEB. It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas, loading docks, PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places. Consisting of : i. Construction: Foundation/ slab/ columns/ pillars/ PEB structure ii. Insulation: Walls, Ceiling, Floors, etc. iii. All refrigeration Units iv. Electrical Installations: Transformers/DG Sets, VFDs, etc. v. Administrative Block: CCTV/	For PEB Construction of capacity upto 4999 MT ~ 5000 MT capacity	Rs. 12,000

	parking areas / Office block/ Convenience areas.		
	iv. Safety & Hazard control: Fire fighting equipments/ fire exits/ fire doors- as per norms and conditions of the building		
	Automated computerised system with software for generating QR/bar code labelling, farmers details, date of arrival, variety of the crop at the arrival of aggregation center	Max. 1 system/ project	Rs. 3.5 lakh/system

CA Components for NHM:

S. NO.	COMPONENT	DESCRIPTION	MAX. ALLOWABLE QTY./CAPACITY	PRICE/ UNIT
1	CA GENERATORS	Should essentially include sensors, pressure equalising equipment, controls comprising: A. N2 Generator with screw compressor B. CO2 Absorber C. Analyser, piping valves etc.	Max. 2 units/ project	Rs. 150 lakh/unit
2	Specialized CA doors	Specialized CA Doors for maintaining positive pressure inside the chambers and leakages	Max. 20 Doors / project	Rs. 3 lakh / Door
3	Gas Tightening (New Component)	Gas Tightening system comprising of A. CA primer for both walls and floor B. Film/Fleece (Double layer on the joints) C. Elastomeric Paint etc	Upto Max. 5000 MT / project	Rs.2000/ MT
4	Unified Control System	Electronic and electrical logic controls for machinery & equipment, lots, sensors indicators, building management system etc	Max. one system/ project	Rs. 5 lakh / system
5	Dock Leveler System	Docking equipment comprising of - A. Dock Leveler B. Dock Door C. Dock Shelter D. Vehicle Barrier/ Hit Alarm	Max. 3 units / project	Rs. 8.4 lakh / unit

6	Integrated Specialized Packaging machines/ lines with farm code labeling.	Automated packaging lines/ machines to make in-house labeling and packaging boxes of various sizes and strength as per categories 3, 5, 7 & 9 ply. Both single & double walls with farm code labeling, i.e. arrival farm (traceability) and date of arrival. QR code of pack house & date showing dispatch and other relevant details the produce has gone through like washing, grading, etc.	Max. one system/ project	Rs. 15 lakh / system
7	High Reach handling equipment	Specialized material Handling equipment comprising of: (components of one set)	Max. 2 sets / project	Rs. 25 lakh/set
		A. Fork Lifts		
		B. Battery Operated Pallet Truck		
		C. Hand Pallet Trucks		
8	Advanced Grader (New Component)	Computerized, Optical Grading Lines (Imported/Indigenous) alongwith other components like conveyors, belts, washer, waxers/dryers, exits, packaging tables & inspection station (indigenous/imported) integrated and tested duly by manufacturers before site installation. The system should have atleast 30% made in India components.	5 MT/hr output line with max. upto 5000 MT	Rs. 5000/MT
9	Stacking System	Racking system include Bins, Pallets and storing systems inside CA chambers for storing and holding material	Max. 5000 MT	Rs. 2000 / MT
#10	Alternate technology (Vapour absorption, Solar, hybrids, etc.)	Vapour Absorption/ Phase change material/, Solar PV panels or Solar Thermal system	As applicable	Rs. 35 lakh / project

FOR NHB

COMPONENT NO.	DESCRIPTION & NAME	Max. ALLOWABLE QTY./CAPACITY	COST
C-10	<u>Controlled Atmosphere Storage type –II- CA (CS-2-CA)</u> are cold storages designed for controlled atmosphere storage where bulk, short and long term storage is preferred as required. These storages should be equipped with all necessary equipments to maintain and monitor the required concentration of N ₂ , CO ₂ and O ₂ levels along with temp and humidity control. They are normally seen in pre-engineered building and certain areas like docks, plant	For PEB Construction of capacity between:	

	rooms, offices, convenience areas can be constructed with brick and mortar and integrated with the PEB. It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas, loading docks, PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places. Consisting of : i. Construction: Foundation/ slab/ columns/ pillars/ PEB structure ii. Insulation: Walls, Ceiling, Floors, etc. iii. All refrigeration Units iv. Electrical Installations: Transformers/DG Sets, VFDs, etc. v. Administrative Block: CCTV/ parking areas / Office block/ Convenience areas. vi. Safety & Hazard control: Fire fighting equipments/ fire exits/ fire doors- as per norms and conditions of the building	5001 to 6500 MT 6501 to 8000 MT 8001 to 10000 MT 10001 to 20000 MT*	Rs. 11400/MT Rs. 10800/MT Rs. 10200/MT Rs. 5100/MT*
	Automated computerised system with software for generating QR/bar code labelling, farmers details, date of arrival, variety of the crop at the arrival of aggregation center	Max. 1 system / project	Rs. 3.5 lakh / system

CA add-ons for NHB:

S. NO.	COMPONENT	DESCRIPTION	MAX. ALLOWABLE QTY./CAPACITY	PRICE/UNIT
1	CA GENERATORS	Should essentially include sensors, pressure equalising equipment, controls comprising:	Max. 2 units/ project	Rs. 150 lakh/unit
		A. N2 Generator with screw compressor		
		B. CO2 Absorber		
		C. Analyser, piping valves etc.		
2	Specialised CA doors	Specialized CA Doors for maintaining positive pressure inside the chambers and leakages	Max. 30 Doors / project	Rs. 3 lakh / Door
3	Gas Tightening (New Component)	Gas Tightening system comprising of	Upto Max. 6250 MT / project	Rs.2000/ MT
		A. CA primer for both walls and floor		
		B. Film/Fleece (Double layer on the joints)		
		C. Elastomeric Paint etc		
4	Unified Control System	Electronic and electrical logic controls for machinery & equipment, lots, sensors indicators, building management system etc	Max. one system/ project	Rs. 5 lakh / system
5	Dock Leveler System	Docking equipment comprising of -	Max. 3 units / project	Rs. 8.4 lakh / unit
		A. Dock Leveler		
		B. Dock Door		
		C. Dock Shelter		
		D. Vehicle Barrier/ Hit Alarm		
6	Integrated Specialised Packaging machines/ lines with farm code labeling.	Automated packaging lines/ machines to make in-house labeling and packaging boxes of various sizes and strength as per categories 3, 5, 7 & 9 ply. Both single & double walls with farm code labeling, i.e. arrival farm (traceability) and date of arrival. QR code of pack house & date showing dispatch and other relevant details the produce has gone through like washing, grading, etc.	Max. one system/ project	Rs. 15 lakh / system
7	High Reach handling equipment	Specialized material Handling equipment comprising of:	Max. 2 sets / project	Rs. 25 lakh/set
		A. Fork Lifts		
		B. Battery Operated Pallet Truck		
		C. Hand Pallet Trucks		

8	Advanced Grader (New Component)	Computerized, Optical Grading Lines (Imported/ Indigenous) alongwith other components like conveyors, belts, washer, waxers/ dryers, exits, packaging tables & inspection station (indigenous /imported) integrated and tested duly by manufacturers before site installation. The system should have atleast 30% made in India components.	Min. 3 MT/hr. Max. 5 MT/hr output line with max. upto 5000 MT/project	Rs. 5000/MT
9	Stacking System	Racking system include Bins, Pallets and storing systems inside CA chambers for storing and holding material	Max. 5000 MT/project	Rs. 2000 / MT
#10	Alternate technology (Vapour absorption, Solar, hybrids, etc.)	Vapour Absorption/ Phase change material/, Solar PV panels or Solar Thermal system	As applicable	Rs. 35 lakh / project



National Centre for Cold-chain Development

ANNEXURE C-11

COST NORMS FOR COLD STORAGE TYPE-IV (DRY SPICES/ RAISINS)

FOR NHM

COMPONENT NO.	DESCRIPTION & NAME	Max. ALLOWABLE QTY./CAPACITY	COST
C-11 (i)	Cold Storage type –IV (CS-4) is cold storages designed mostly for dry spices/raisins storage where bulk and long term storage is preferred. They are normally seen in brick-and-mortar structure; however,	For Civil Construction of capacity upto 4999 MT ~ 5000 MT capacity	Rs. 9600/MT
C-11 (ii)	an applicant can also develop it under the pre-engineered building. It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas, loading docks, PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached to be followed at all the relevant places. Consisting of : i. Construction: Foundation/ slab/ columns/ pillars/ PEB structure ii. Insulation: Walls, Ceiling, Floors, etc. iii. All refrigeration Units iv. Electrical Installations: Transformers/DG Sets, VFDs, etc. v. Administrative Block: CCTV/ parking areas / Office block/ Convenience areas. vi. Safety & Hazard control: Fire fighting equipments/ fire exits/ fire	For PEB Construction of capacity upto 4999 MT ~ 5000 MT capacity	Rs. 12,000

	doors- as per norms and conditions of the building		
	Conveying/Hoist system/material service lift of suitable and appropriate capacity for material handling of in the anteroom with provision of unloading on common landing near and outside cold rooms. (upto 5000 MT) (refer point no. 9)	Max. 1 system/project	Rs. 5 lakh/system
	Dock Leveler System comprising of: (components of 1 set) A. Dock Leveler B. Dock Door C. Dock Shelter D. Vehicle Barrier/ Hit Alarm	Max. 2 sets	Rs. 8.4 lakh/set
	Material Handling Equipments: HPT above 1 ton BOPT 1 ton and above	Max. 4 units Max 2 unit	Rs. 20000/unit Rs. 1.5 lakh/ unit
	Doors	Max. 20 doors/project	Rs. 25000 / door

FOR NHB

COMPONENT NO.	DESCRIPTION & NAME	Max. ALLOWABLE QTY./CAPACITY	COST
C-11 (i)	Cold Storage type –IV (CS-4) is cold storages designed mostly for dry spices/raisins storage where bulk and long term storage is preferred. They are normally seen in brick-and-mortar structure; however, an applicant can also develop it under the pre-engineered building. It is further stated that all the building safety norms, stability certificates from architects or authorized agencies or certified person relevant to building norms, etc. electrical safety and earthing, fire safety norms as per applicable regulations, use of fire exit doors at places of exits, plant room safety norms, environmental clearances, handling areas, loading docks, PPE kits, hygienic storage spaces and storing methods, HACCP norms and regulations, FSSAI norms and mandated clearances, office and convenience areas (restrooms, parking, etc.) shall be considered as general requirement for the purpose of development of the cold store facility under this category. The list of BIS standards has been attached	For CIVIL Construction of capacity between: 5001 to 6500 MT 6501 to 8000 MT 8001 to 10000 MT 10001 to 20000 MT*	Rs. 9120/MT Rs. 8640/MT Rs. 8160/MT Rs. 4080/MT*
C-11 (ii)		For PEB Construction of capacity between: 5001 to 6500 MT 6501 to 8000 MT 8001 to 10000 MT 10001 to 20000	Rs. 11400/MT Rs. 10800/MT Rs. 10200/MT Rs. 5100/MT*

	to be followed at all the relevant places. Consisting of : i. Construction: Foundation/ slab/ columns/ pillars/ PEB structure ii. Insulation: Walls, Ceiling, Floors, etc. iii. All refrigeration Units iv. Electrical Installations: Transformers/DG Sets, VFDs, etc. v. Administrative Block: CCTV/ parking areas / Office block/ Convenience areas. vi. Safety & Hazard control: Fire fighting equipments/ fire exits/ fire doors- as per norms and conditions of the building	MT*	
	Conveying/Hoist system/Material Service lift for material handling of suitable capacity in the anteroom with provision of unloading on common landing near and outside cold rooms. (upto 5000 MT) (refer point no. 9)	Max. 1 system/ project	Rs. 5 lakh/ system
	Dock Leveler System comprising of: (components of 1 set) A. Dock Leveler B. Dock Door C. Dock Shelter D. Vehicle Barrier/ Hit Alarm	Max. 2 sets	Rs. 8.4 lakh/set
	Material Handling Equipments: HPT above 1 ton BOPT above 1 ton	Max. 4 units Max 2 unit	Rs. 20000 / unit Rs. 1.5 lakh / unit
	Doors	Max. 30 doors / project	Rs. 25000 / door

ANNEXURE C-12

COST NORMS FOR MODERNISATION

For Both NHM & NHB

Component No.	COMPONENT	DESCRIPTION	COST
C-12	Modernisation for Refrigeration	Modernisation for Refrigeration with latest technologies including refrigeration plant and associated equipments with the refrigeration system to reduce energy consumption.	Rs.120 lakh / project
		Unified Control System – PLC, BMS, IoT, Remote Monitoring, etc.	Rs. 5 lakh/ project
	Modernisation for Insulation & Doors	The insulation used should be CFC and preferably HCFC free material with minimal negative impact to the environment. Insulation modernisation must require a change to a more efficient thermal barrier (compare material 'U' values between existing and proposed barrier) to result in at least 5% reduction in energy consumption. EPS is not allowed.	Rs.120 lakh / project

National Centre for Cold-chain Development

ANNEXURE C-13

COST NORMS FOR REFRIGERATED TRANSPORT

Component No.	Component Description	NHM	NHB
C-13	Max. Vehicle capacity	4 MT and upto max. 14 MT	15 MT and upto max. 30 MT
	Cost	For the purpose of calculation Rs. 3.45 lakhs/MT would be considered. The cost would be calculated on the pro-rata basis from 4MT upto max. of 14MT.	For the purpose of calculation Rs. 3.45 lakhs/MT would be considered. The cost would be calculated on the pro-rata basis from 15MT upto max. of 30MT.

FOR NHM -

1. The beneficiary cannot claim more than 70MT in one application (e.g.- 14MT x 5 no. vehicles) and after submitting due usage of vehicles - purpose of transporting horticulture produce, names of the produce transported, Reefer RCs, insurance, etc. at the time of new application can apply for another 5 no. vehicles (e.g.- 14MT x 5 no. vehicles) under the same name and style. The max. capping is as follows:
 - a. 4 MT - 6 MT: Max. 11 vehicles in batches of two application
 - b. 6MT – 9MT: Max. 11 vehicles in batches of two application
 - c. 10MT – 14MT: Max. 10 vehicles in batches of two application

A beneficiary cannot avail subsidy under the same name and style on more than cumulative capacity of 140MT (irrespective of reefer capacity or combination) in a period of 4 years.

2. Mission can support Refrigerated Transport between 4 MT upto 14 MT.
3. The new technologies should be promoted and capacities to be derived on the basis of **The Load Carrying Capacity of the Container** (as described in the chapter).
4. The vehicle should be equipped with GPS enabled systems and telematics for access and control.
5. Liquified N₂ technology, etc. will also be admissible.

FOR NHB-

1. NHB should promote refrigerated vehicles from 15 MT and upto max. 30 MT
2. The new technologies should be promoted and capacities to be derived on the basis of **The Load Carrying Capacity of the Container** (as described in the chapter).
3. The maximum subsidy is limited to Rs. 80 lakhs/ project in general areas and Rs. 100 lakhs/ project in North-Eastern and Himalayan states, Scheduled Areas, Vibrant Villages, Andaman & Nicobar and Lakshadweep islands. (Refrigerated Transport).
4. The vehicle should be equipped with GPS enabled systems and telematics for access and control.
5. Liquified N₂ technology, etc. will also be admissible.

ANNEXURE C-15

COST NORMS FOR COLD STORAGE TYPE-III (RIPENING)

FOR BOTH NHM & NHB

Component No.		Non- Pressurised Ripening	Pressurised Ripening	Cost Norm
C-15	1	Building- CIVIL and PEB with docking area for loading/unloading.	Building- CIVIL and PEB with docking area for loading/unloading.	<u>NON-PRESSURISED CHAMBER</u> Rs. 1 lakh per MT upto 300 MT per project per beneficiary. <u>PRESSURISED CHAMBER</u> Rs. 1.20 lakh per MT upto 300 MT per project per beneficiary.
	2	Receiving Area- comprising of area within the premises which allows receipt of raw fruits for cutting, washing and crating. In case of bananas coming packed in CFB boxes from the source, washing & crating would not be necessary.	Receiving Area- comprising of area within the premises which allows receipt of raw fruits for cutting, washing and crating. In case of bananas coming packed in CFB boxes from the source, washing & crating would not be necessary.	
	3	PUF insulated cold rooms, insulated floor, insulated doors, etc.	PUF insulated cold rooms, insulated floor, insulated doors, etc. The insulated cold rooms have a system of false ceiling or annular space created above the cold rooms which holds cooling coils placed in such a way that the air is sucked through these coils and routed into the cold room by way of spaces/cut outs in the cold room ceiling and pushing cold air through annular spaces between wall and palletised crates/ CFB boxes with or without air inlet locking system to isolate the boxes or pallets. The technical arrangement may vary and should be followed in accordance to design consideration of pressurised ripening system.	
	4	Ceiling mounted evaporators/	Special air flow system	

		unit coolers, etc. for maintaining uniform air circulation, temperature, humidity.	running through the depth of the chamber mounted on the ceiling which generates desired static pressure and allows suction from the centre.	
	5	Multi-compressor rack system/ individual condensing unit/ centralised chillers/ ammonia systems, etc.	Multi-compressor rack system/ individual condensing unit/ centralised chillers/ ammonia systems, etc.	
	6	Ethylene distribution system- ethylene generator or ethylene gas bank system.	Ethylene distribution system- ethylene generator or ethylene gas bank system.	
	7	Ventilation System – automatic to keep CO ₂ within limits with the help of CO ₂ analyser and controller Automatic Ventilation system works with a dual inlet/discharge dampers with fan to allow fresh air within the room when the concentration of CO ₂ exceeds the desired limit.	Ventilation System – automatic to keep CO ₂ within limits with the help of CO ₂ analyser and controller Automatic Ventilation system works with a dual inlet/discharge dampers with fan to allow fresh air within the room when the concentration of CO ₂ exceeds the desired limit. The placement etc. can vary and should be chosen as per requirement.	
	8	Crates/Bins etc.	Pallets, CFB boxes stacked in single or in multi tier system	
	9	HPTs	HPTs, Fork Lifts in case of multi tier	
	10	Weigh scale, firmness tester, refractometer, sizer and callipers and produce knife.	Weigh scale, firmness tester, refractometer, sizer and callipers and produce knife.	
	11	Electrical panels, lighting, earthing and power backup (DG Set)	Electrical panels, lighting, earthing and power backup (DG Set)	
	12	Ripening Management System (RMS)	Ripening Management System (RMS)	



National Centre for Cold-chain Development

LIST I

COMMODITY SPECIFICATIONS

FRUITS

TYPE- IF (upto 2°C)

Sl. No.	Products	Temp	Humidity	Holding Time
1	Apples	0-2° C	90-95%	1-6 months
2	Apricot	-0.5 - 0°C	90-95%	1-3 Weeks
3	Blackberry	-0.5-0°C	90-95%	3-6 days
4	Blueberry	-0.5 - 0°C	90 - 95%	10-18 days
5	Cherries(sour)	0° C	90 - 95%	3-7 days
6	Cherries(sweet)	-1-0°C	90 - 95%	2-3 weeks
7	Grapes	-0.5-0°C	90 - 95%	1- 6 months
8	Kinnow	1°C	95%	2-4 weeks
9	Kiwi	0° C	90 - 95%	3-5 months
10	Litchi	1-2°	0.95	3-5 weeks
11	Orange(FL humid areas)	1 - 2°C	85 - 90%	8-12 weeks
12	Peaches	-0.5-0°C	90 - 95%	2-4 weeks
13	Pears	-1.5-.0.5° C	90-95%	2-7 months
14	Plum	-0.5-0°C	90-95%	2-5 weeks
15	Raspberry	-0.5-0°C	90-95%	3-6 days
16	Strawberry	0-1°C	90-95%	7-10 days

TYPE- II F (2°C – 5°C)

Sl. No.	Products	Temp	Humidity	Holding Time
1	cranberry	2-5°C	90-95%	8-16 weeks
2	Tangerine	3-6°C	85 - 90%	2-4 weeks
3	Pomegrenate	5°C	90-95%	2-3 months

TYPE- III F (5°C – 10°C)

<i>Sl. No.</i>	<i>Products</i>	<i>Temp</i>	<i>Humidity</i>	<i>Holding Time</i>
1	Guava	5 - 10°C	90%	2 - 3 weeks
2	Melons	5-10°C	85-90%	2-3 weeks
3	Avocado	5-8° C	85-90%	2-4 weeks
4	Papaya	7-13°C	85-90%	1-3 weeks
5	Dragon Fruit	4-10°C	90-95%	2-3 weeks
6	Pineapples	7-13° C	85-90%	2-4 weeks

TYPE- IV F (above 10°C)

<i>Sl. No.</i>	<i>Products</i>	<i>Temp</i>	<i>Humidity</i>	<i>Holding Time</i>
1	Passion fruit	10	85-90%	3-4 weeks
2	Rambutan	12	90-95%	1-3 weeks
3	Mango	12 - 13°C	85 - 90%	14 - 21 days
4	Banana	12 - 15°C	80 - 95%	14 - 21 days
5	Custard Apple	13°C	90-95%	2-4 weeks
6	Jackfruit	13°	85-90%	2-4 weeks

VEGETABLE

TYPE- I Vg (upto 2°C)

<i>Sl. No.</i>	<i>Products</i>	<i>Temp</i>	<i>Humidity</i>	<i>Holding Time</i>
1	carrot (Bunched)	0°C	98-100%	10-14 days
2	carrot (Topped)	0°C	98-100%	3-6 Months
3	cauliflower	0°C	95-98%	3-4 weeks
4	Corn	0°C	95-98%	5-8 days
5	Garlic	0°C	65-70%	6-7 months
6	Mint	0°C	95-100%	2-3 weeks
7	Lettuce	0°C	98-100%	2-3 weeks

8	Mushroom	0°C	90%	7-14 days
9	Radish	0°C	95-100%	1-2 months
10	Spinach	0°C	95-100%	10-14 days
11	Sprouts	0°C	95-100%	5-7 days
12	Turnip Root	0°C	95%	4-5 months
13	Beet (Bunched)	0°C	98-100%	10-14 days
14	Beet (Topped)	0°C	98-100%	4 Months
15	Broccoli	0°C	95-100%	10-14 days
16	Cabbage (early)	0°C	95-100%	3-6 weeks
17	Cabbage (late)	0°C	95-100%	5-6 months
18	Peas	0-1°C	90-98%	1-2 weeks
19	Shallot	0-2°C	65-70%	1-2 weeks
20	Water Chestnut	1-2°C	85-90%	2-4 months
21	Onion	1-3°C	60-65%	4-6 months

TYPE- II Vg (2°C – 5°C)

Sl. No.	Products	Temp	Humidity	Holding Time
1	Oregano	0-5°C	90-95%	1-2 weeks
2	Tamarind	2-7°C	92-95%	3-4 weeks
3	Tomato	3-4°C	85-95%	10 weeks
4	Beans	4-7°C	95%	7-10 days
5	Potato (some varieties)	2-4°C	90-95%	5-10 Months

TYPE- III Vg (5°C – 10°C)

Sl. No.	Products	Temp	Humidity	Holding Time
1	Potato (late)	4-12°C	90-95%	5-10 Months
2	Potato (early)	10-15°C	90-95%	10-14 days
3	Chilli	5-10°C	85-95%	2-3 weeks

4	Olives	5-10°C	85-90%	4-6 weeks
5	Okra	7-10°C	90-95%	7-10 days
6	Squash (courgette)	7-10°C	95%	1-2 weeks

TYPE- IV Vg (Above 10°C)

<i>Sl. No.</i>	<i>Products</i>	<i>Temp</i>	<i>Humidity</i>	<i>Holding Time</i>
1	Bitter Gourd	10-12°C	85-90%	2-3 weeks
2	Cucumber	10-12°C	85-90%	10-14 days
3	Eggplant	10-12°C	90-95%	1-2 weeks
4	Lemon	10-13°C	85-90%	1-6 months
5	Watermelon	10-15°C	90%	2-3 weeks
6	Pumpkin	12-15°C	50-70%	2-3 months
7	Squash (calabash)	12-15°C	50-70%	2-3 months
8	Ginger	13°C	65%	6 months
9	Sweet Potato	13-15°C	85-95%	4-7 months
10	Onion	25-29°C	60-65%	4-6 months

TYPE- S (4°- 10°C)

<i>Sl. No.</i>	<i>Products</i>	<i>Temp</i>	<i>Humidity</i>	<i>Holding Time</i>
1	Dry Spices	4-7° C	65-75%	8-9 months
2	Raisins	4-10° C	75-85%	6-12 months

LIST II

CONVERSION FACTORS

For standardization purposes, MIDH/NHB guidelines established the following conversion factor:

- **1 MT (Metric Ton) of storage capacity = 3.4 m³ (cubic meter) or 120 ft³ (cubic feet)** of temperature-controlled space, irrespective of the product stored when using mezzanine, boxes and crates.
- **1 MT (Metric Ton) of storage capacity = 5.0 m³ (cubic meter) or 176 ft³ (cubic feet)** of temperature-controlled space, irrespective of the product stored when using racks, shuttle racks, double deep racks & palletization.
- **1 MT (Metric Ton) of storage capacity = 4.4 m³ (cubic meter) or 155 ft³ (cubic feet)** of temperature-controlled space for storing apples. (applicable in CA stores)
- **1 MT (Metric Ton) of storage capacity = 4.0 m³ (cubic meter) or 141 ft³ (cubic feet)** of temperature-controlled space for Dry Spices/raisins.
- **1 MT (Metric Ton) of storage capacity = 11 m³ (cubic meter) or 390 ft³ (cubic feet)** of temperature-controlled space for Ripening chambers.
- **1 MT (Metric Ton) of storage capacity = 20 m³ (cubic meter) or 710 ft³ (cubic feet)** of temperature-controlled space for pre-coolers.

NOTE: The storage capacity, type of stores and other specification are to be taken from the detailed standards against each category.

National Centre for Cold-chain Development

LIST III

STANDARDS/ BIS CODES

Electrical: Bureau of Indian Standards (BIS)

#	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 earthing	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 650V	IS 732-1963
15.	Code of practice for electrical wiring installation (system voltage exceeding 650V)	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 & control gear	IS 10118
27.	National Electrical Codes	SP: 30

Mechanical: Bureau of Indian Standards (BIS)

#	Title	Reference
1.	Safety codes for Mechanical Refrigeration	IS 660
2.	Code of practice for thermal insulation of cold storages	IS 661
3.	Code of practice for application of polyurethane insulation by in-situ pouring method	IS 13205
4.	Rigid phenolic foams for thermal insulation	IS 13204
5.	Application for spray applied insulation code of practice – Polyurethane / Poly-isocyanurate	IS 12432 Part-III
6.	Specifications for preformed rigid polyurethane (PUR) and poly isocyanurate (PIR) foams for thermal insulation	IS 12436
7.	Expanded polystyrene for thermal insulation	IS 4671
8.	Code for practice for fire safety of industrial buildings: General Storage and warehousing including cold storage	IS 3594
9.	Anhydrous ammonia	IS 662
10.	Industrial Bitumen	IS 702
11.	Gunmetal gate, globe and check valve for general purpose	IS 778
12.	Ball Valves including floats for water supply purposes	IS 1703
13.	Mild Steel Tubes, tubular and other wrought steel pipes fittings	IS 1239
14.	Steel Plates for pressure vessels used at moderate and low temperature	IS 2041
15.	Color code for identification of pipe lines	IS 2379
16.	V-belts for industrial purposes	IS 2494
17.	Hot dip galvanizing of iron and steel	IS 2629
18.	Code for unfired pressure vessels	IS 2825
19.	Glossary of terms for safety and relief valves	IS 3233
20.	Steel for pressure vessels and welded structures	IS 3503
21.	Steel tubes for mechanical and general engineering purposes	IS 3601
22.	Steel for general structural purposes	IS 2062
23.	Steel tubes for structural purposes	IS 1161
24.	Specifications for steel doors, windows and ventilators	IS 1038
25.	Code of practice for design loads (other than earthquake) for building and structures	IS 875 Part I to V
26.	Criteria for earthquake resistant design of Structures	IS 1893
27.	Specifications for cold formed light gauge structural steel sections	IS 811
28.	Code of practice for use of Steel Tubes in general building construction	IS 806
29.	Code of practice for use of cold form light gauge steel structural members in general building construction	IS 801
30.	Code of practice for general construction in steel	IS 800
31.	Glossary of terms used in refrigeration and air-conditioning	IS 3615
32.	Pressure and vacuum gauges	IS 3624
33.	Safety Codes for scaffolds and ladders	IS 3696
34.	Formed ends for tanks and pressure vessels	IS 4049
35.	Shell an tube type heat exchangers	IS 4503
36.	Code of safety for ammonia	IS 4544
37.	Expanded polystyrene for thermal insulation purposes	IS 4671

38.	Hot-dip Zinc coating on steel tubes	IS 4736
39.	Units and symbol for refrigeration	IS 4831
40.	HDPE pipes for potable water supplies, sewage and industrial effluents	IS 4984
41.	Gauge glasses	IS 5428
42.	Specification for sprayed aluminum and zinc coating on iron and steel surfaces	IS 5905
43.	Steel Pipe flanges	IS 6392
44.	Injection molded HDPE fittings for portable water supplies	IS 8008
45.	Vertical steel ladders	IS 8172
46.	Treatment of water for industrial cooling systems	IS 8188
47.	Nominal sizes of valves	IS 9520
48.	Selection, use and maintenance of respiratory protective devices	IS 9623
49.	Polythene floats for ball valves	IS 9762
50.	General purpose ball valves	IS 9890
51.	SI units	IS 10005
52.	Recommendations for general pipeline welding	IS 10234
53.	Ammonia valves	IS 11132
54.	Finned type heat exchanger for room air conditioner	IS 11329
55.	Refrigeration oil separators	IS 11330
56.	MS tubes for vertical condenser	BS 3059
57.	Specification for metal air duct	IS 655
58.	Specification for galvanized steel sheet	IS 227
59.	Specifications for Performed Rigid Polyurethane	IS 12436 -1988
60.	Glossary of Terms used in Refrigeration& Air conditioning	IS 3615: 2007
61.	Code of Practice for Fire Safety of Ware housing including cold storages	As per Relevant IS specification
62.	Food Hygiene – General Principle – Code of Practice	IS 2491-1998
63.	Self-blasted lamps for general lighting service	IS 15111 Part 1 and 2
64.	Fruits and vegetables - Principles and techniques of the controlled atmosphere method of storage	ISO 6949 : 1988 (E)

Publication by International Societies and Associations in relation to Building works

#	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

LIST IV

STAKEHOLDERS INVOLVED

A. Govt. Organisations

Sl No.	Government Organisation
1	Bureau of Energy Efficiency – BEE
2	Ministry of Renewable Energy – MNRE
3	National Horticulture Board – NHB
4	Bureau of Indian Standards - BIS
5	Department of Fisheries
6	APEDA
7	Directorate of Horticulture - Andhra Pradesh
8	Directorate of Horticulture - Arunachal Pradesh
9	Directorate of Horticulture - Bihar
10	Directorate of Horticulture - Goa
11	Directorate of Horticulture - Assam
12	Directorate of Horticulture - Chhattisgarh
13	Directorate of Horticulture - Gujarat
14	Directorate of Horticulture - Haryana
15	Directorate of Horticulture - Himachal Pradesh
16	Directorate of Horticulture - Jharkhand
17	Directorate of Horticulture - Karnataka
18	Directorate of Horticulture - Kerala
19	Directorate of Horticulture - Madhya Pradesh
20	Directorate of Horticulture - Maharashtra
21	Directorate of Horticulture - Manipur
22	Directorate of Horticulture - Meghalaya
23	Directorate of Horticulture - Mizoram
24	Directorate of Horticulture - Nagaland
25	Directorate of Horticulture - Odisha
26	Directorate of Horticulture - Punjab
27	Directorate of Horticulture - Rajasthan
28	Directorate of Horticulture - Sikkim
29	Directorate of Horticulture - Tamil Nadu
30	Directorate of Horticulture - Telangana
31	Directorate of Horticulture - Tripura
32	Directorate of Horticulture - Uttar Pradesh
33	Directorate of Horticulture - Uttarakhand
34	Directorate of Horticulture - West Bengal
35	Directorate of Horticulture - Andaman & Nicobar
36	Directorate of Horticulture - Delhi
37	Directorate of Horticulture - Lakshadweep

38	Directorate of Horticulture - Puducherry
39	Directorate of Horticulture - Dadar & Nagar Haveli
40	Directorate of Horticulture - Daman Diu
41	Directorate of Horticulture - Jammu
42	Directorate of Horticulture - Kashmir
43	Directorate of Horticulture - Ladakh

B. Agricultural Universities

SI No.	Agriculture University
1	Punjab Agriculture University, Ludhiana
2	ICAR-IIVR VARANASI
3	Dr. YS Parmar University, Nauni
4	SKUAST Kashmir
5	G.B. Pant University of Agriculture and Technology, Pantnagar

C. Private Organisations

SI No.	Private Organisation
1	Kirloskar Pneumatic Co. Ltd
2	Carrier
3	Carrier Transicold India
4	Bitzer
5	Infra Cool Pvt Ltd
6	Jindal Mechtech
7	Panasonic Life Solutions India Pvt Ltd
8	Metaflex
9	ISHRAE
10	Jaikon Refrigeration
11	CII – FACE
12	IIHM
13	Godrej
14	Snowman Logistics
15	Suraksha Transport
16	Amazon
17	Gandhi Automation
18	Llyod Insulation
19	Bombay Ammonia
20	Jaikon
21	Manik Engineers
22	Dixell
23	Danfoss
24	Copeland

25	Preservation Technology
26	Baby Marine
27	Palogix IG
28	Standard Refrigeration
29	ACR Project Consultant- Pune
30	Shaheen Agro Fresh Pvt. Ltd.
31	Daikin
32	New Leaf Technologies
33	Agri Value Chain Services Private Limited
34	Blue Cold
35	BIEJER REF
36	ANS Temp Control Engineers Pvt. Ltd.
37	Envirotech Engineering Pvt. Ltd.
38	PricewaterhouseCoopers - PWC
39	Shakti Sustainable Energy Foundation
40	PHD Chamber of Commerce
41	Inficold India Pvt. Ltd.
42	Ecozen Solutions Pvt. Ltd.

D. Cold Storage/ Farmer Associations & Cold Storage Owner

SI No.	Cold Storage/ Farmer Associations & Cold Storage Owners
1	J&K Board for development of kisans
2	Federation of Cold Storage Associations of India - FCAOI
3	JKPICCA
4	Jolly Ice & Cold Storage

SUB-COMMITTEES CONSTITUTED FOR THE REVISION PROCESS:

SI No.	Sub-Committee
1	Cold Storage Design & Material Handling
2	Commodities Specification
3	Insulating Materials & Refrigeration Systems
4	CA Room Components & Safety
5	Alternate Energy & Packaging
6	Reefer Vehicles, Logistics & Supply Chain
7	Automation & Electricals

The constituted committees offered recommendations for various aspects of the cold chain. The Steering Committee, chaired by the Joint Secretary of Horticulture, oversaw the overall progress of the revision process.

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

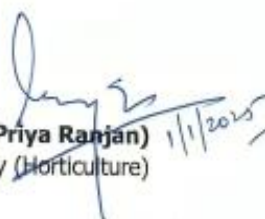
Krishi Bhawan, New Delhi

Subject: Guidelines and Minimum System Standards for Implementation in Cold Chain Components - Reg.

The Guidelines and Minimum System Standards for Implementation in Cold Chain Components/interventions prepared by National Centre for Cold Chain Development (NCCD), in consultation with various Government agencies and industry stakeholders are enclosed for circulation and dissemination.

These System Standards lay down the minimum requirements for development of cold chain infrastructure and supersede the technical standards for cold chain issued by this Department vide letter of even number dated May 15, 2015.

These standards are also available on websites of this Department, <https://midh.gov.in>; <https://nccd.gov.in>; and <https://nhb.gov.in>.


(Priya Ranjan)
Joint Secretary (Horticulture)

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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, Nashik
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 Bhawan, New Delhi
13. Joint Secretary (Marketing), Krishi Bhawan, New Delhi
14. Joint Secretary, Ministry of Food Processing Industries, August Kranti Marg, New Delhi
15. Horticulture Commissioner, DAC, New Delhi
16. Implementing Agencies/NLA's

Copy to:

PPS to Secretary (A&C)/Additional Secretary/JS (MIDH)



National Centre for Cold-chain Development



Authored & compiled by:

NCCD

Edition 2025



National Centre for Cold-chain Development

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National Centre for Cold-chain Development

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