



Refrigerated Facility Design

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Objectives

- ▶ What is Cold Chain and Its Elements
- ▶ Understanding of Refrigerated Facility
- ▶ Applicable Cods and Standards
- ▶ URS(*User Required Specifications*)
- ▶ Building Design Consideration
- ▶ Specialized Storage Facilities
- ▶ Construction Methods
- ▶ Refrigeration Load Calculation
- ▶ Refrigeration Systems
- ▶ Conclusion / Projects

What is Cold Chain Logistics?



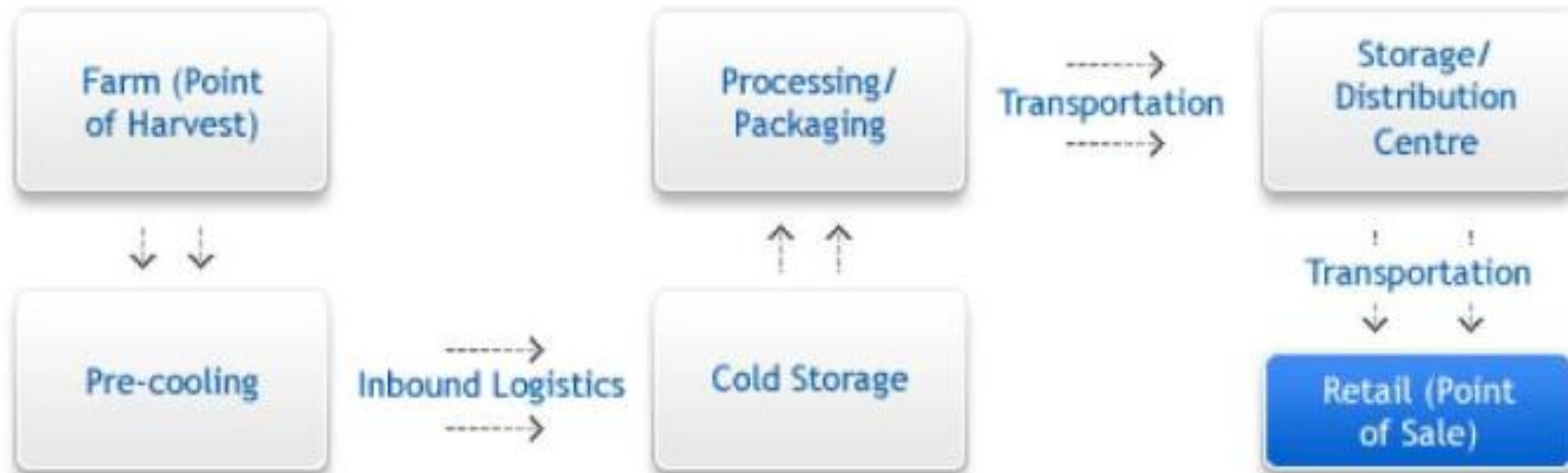
Major Sectors : Food and Beverages, Bio-Pharmaceutical

The Cold chain logistics infrastructure



Our Area Of Discussion Today

Cold chain in Food Sector



Industry Temperature Standards

Banana
13 C

Chill
2 C

Frozen
-18 C

Deep Frozen
-29 C

Understanding of Refrigerated Facility

- ▶ Refrigerated Facility is any building or section of a building that Achieves & Maintain controlled storage conditions using Refrigeration.

ASHRAE Categorized 5 main Types of cold storage facilities.

- ▶ 1- Controlled Atmosphere (CA) Cold Rooms for long term storage.
- ▶ 2- Coolers at temp. of 32F and above.
- ▶ 3- High-temp. freezers at 27 to 28F.
- ▶ 4- Low-temp. storage rooms for general frozen products.
usually maintained at -10 to -20F
- ▶ 5- Low-temp. storages at -10F / -20F & below with a surplus of Refrigeration for freezing products received above 0F

COOLERS

Application
For Vegetables , Fruits, Dairy
etc.

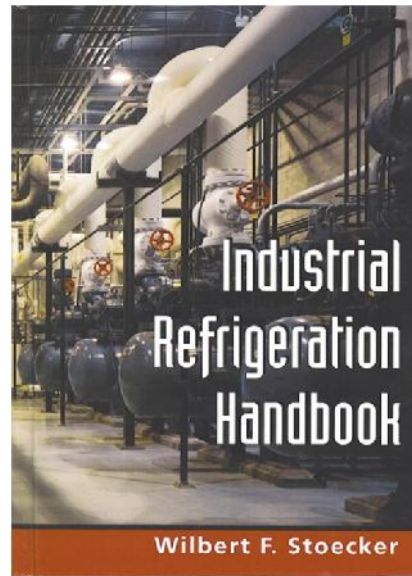
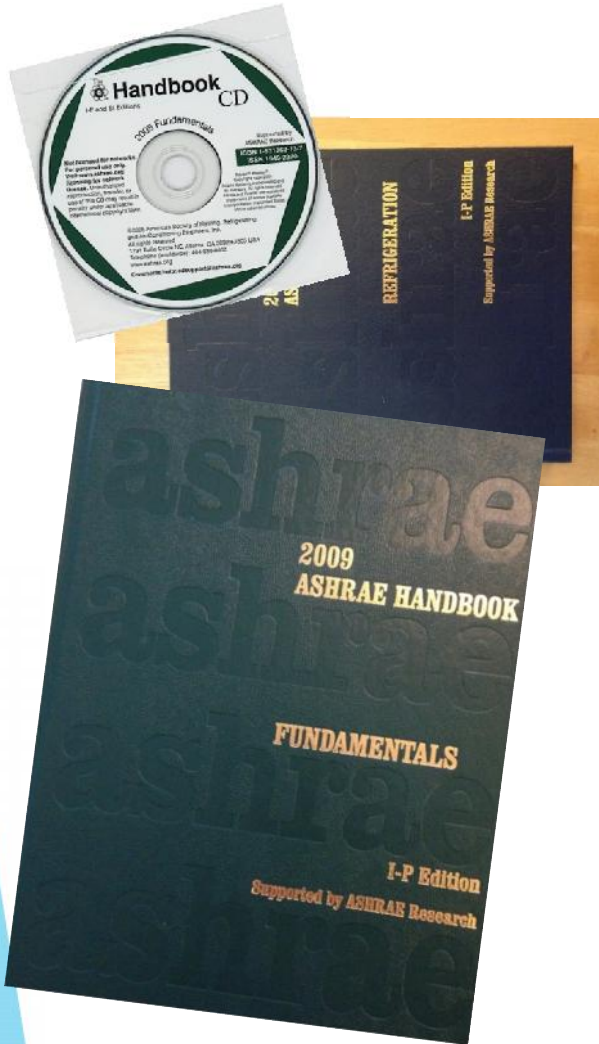


FREEZERS

Application
For Meat, Fish , Frozen Food
Items



Sources of Data / Information / Codes / Standards



Sources of Data / Information / Cods / Standards



For Example: In the United States The U.S. Public Health Services Food & Drug Administration, developed the Food Code Which consists of model requirements for safeguarding public health and ensuring that food is unadulterated.



United States Department of Agriculture
National Institute of Food and Agriculture

URS

(User required Specification)

- 1- Understanding the client objectives; Nature of business activity.
- 2- Making product understanding ; life cycle, storage and handling requirements.
- 3-Place and Location
- 4-Required parameters; e.g Temp., humidity, Odor, oxygen . Nitrogen, CO2.
- 5- Product incoming and final Temperature.
- 6-Product freezing time.
- 7-Understading the Supply chain of the process.
- 8- Trafficking
- 9- Docking and dispensing
- 10- Type of Refrigeration system
- 11- ROI (Rate of return and other commercial aspects)

Building Design Consideration

- 1- Type of Building e.g New and Old, Civil or Prefab.
- 2- Shipping and Receiving Docks.
- 3-Utility Space.
- 4-Double or single story Configuration.
- 5- Road Access
- 6- Building orientation. E.g East, west, south , North
- 7- Sanitation , Utility and other consideration.
- 8- Fire fighting feasibility.
- 9- Plant Room

Construction Methods

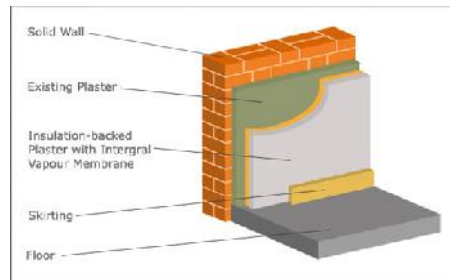
Cold storages; more than construction, it requires correct design, quality materials, good workmanship, and close supervision.

- 1-Insulated Structural panels. (PU sandwich Panels)
- 2-Mechanical Applied Insulation. (Insulated Board Fixing)
- 3-Adhesive or spray-applied foam. (PU-Spray)

1



2



3



Types Of Insulation

13.12

1998 ASHRAE Refrigeration Handbook

Table 2 Recommended Insulation R-Values

Type of Facility	Temperature Range, °F	Thermal Resistance R , °F·ft ² ·h/Btu		
		Floors	Walls/Suspended Ceilings	Roofs
Cooler ^a	40 to 50	Perimeter insulation only	25	30 to 35
Chill cooler ^a	25 to 35	20	24 to 32	35 to 40
Holding freezer	-10 to -20	27 to 32	35 to 40	45 to 50
Blast freezer ^b	-40 to -50	30 to 40	45 to 50	50 to 60

Note: Because of the wide range in the cost of energy and the cost of insulation materials based on thermal performance, a recommended R-value is given as a guide in each of the respective areas of construction. For more exact values, consult a designer and/or insulation supplier.

^aIf a cooler has the possibility of being converted to a freezer in the future, the owner should consider insulating the facility with the higher R-values from the freezer section.

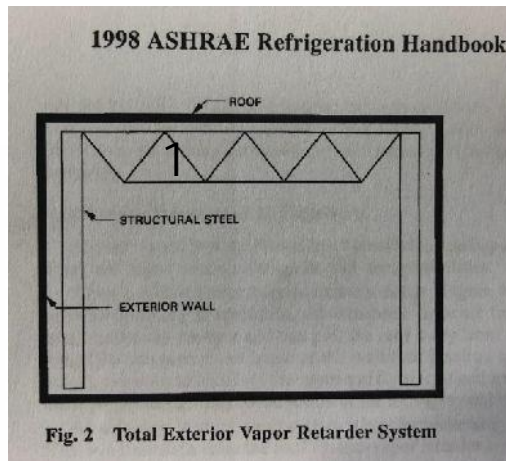
^bR-values shown are for a blast freezer built within an unconditioned space. If the blast freezer is built within a cooler or freezer, consult a designer and/or insulation supplier.

- 1-Rigid Insulations
- 2-Panel Insulations
- 3-Foam-In Place Insulations
- 4-Precast Concrete Insulation Panels

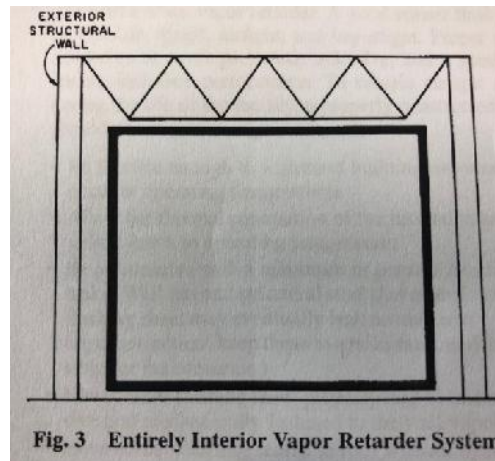
Construction Methods

Types of creating perfect Insulated / Vapor Retardant Envelop.
Ref: ASHRAE Refrigeration Book

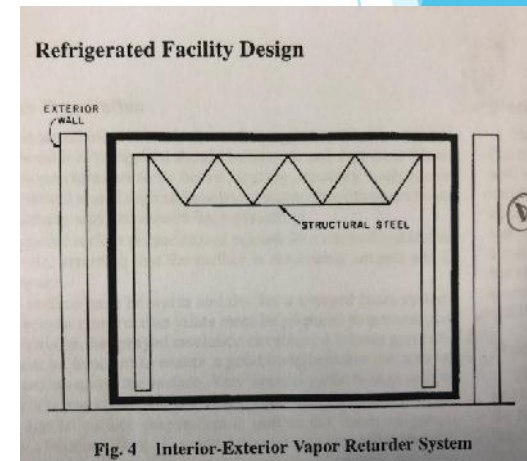
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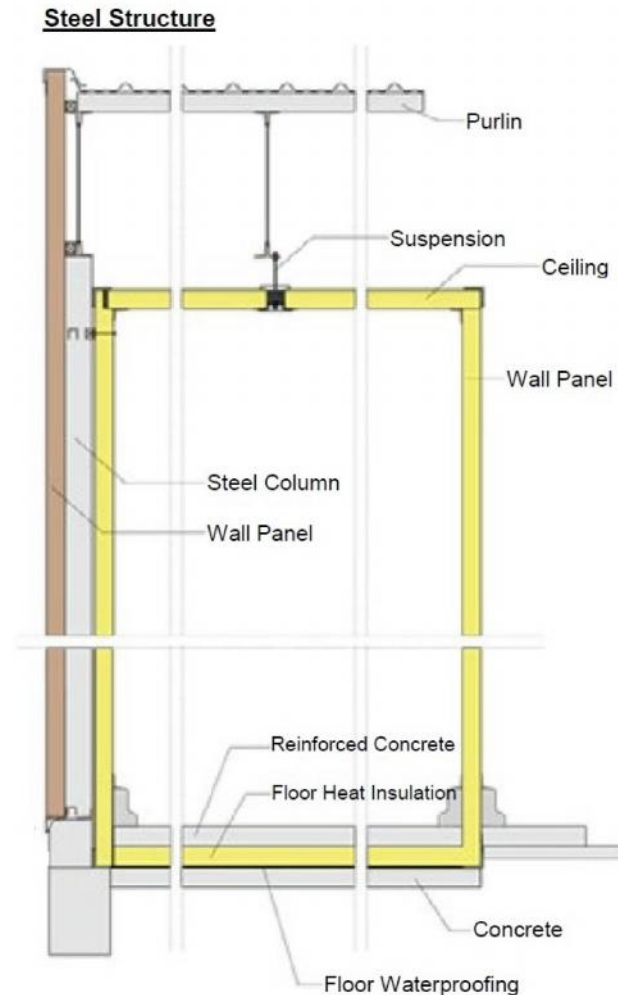
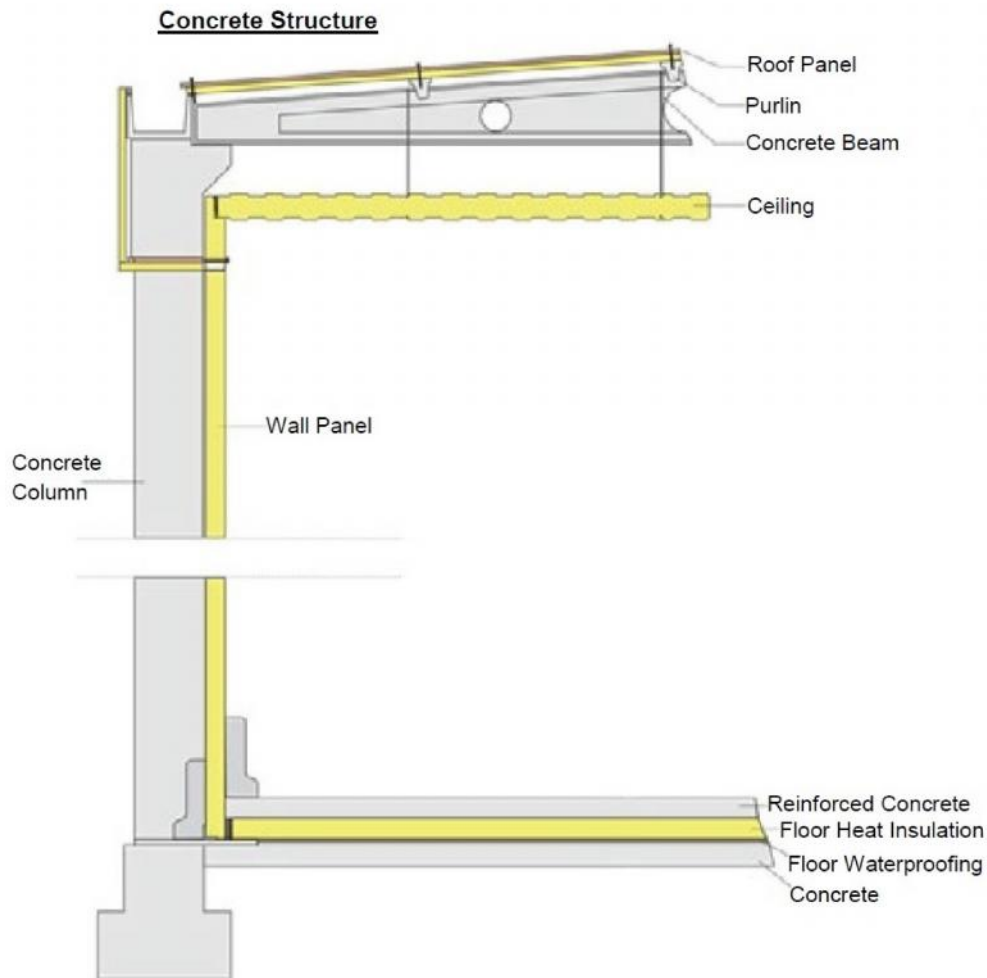
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Construction Methods

Types of creating perfect Insulated / Vapor Retardant Envelop.

Ref: ASHRAE Refrigeration Book



Construction Methods

Floor Construction
Surface Preparation
Finishes
Ceiling Panels Fixing
Floor Drainage system
Electric wiring
Tracking
Cold Storage Doors
Hardware
Refrigerated Docks / Docking systems

Refrigeration Load Calculations

Load Factors To be Consider

- 1-Heat Transmission Through Insulated enclosures
- 2-Heat & Vapor infiltration load from warm air passing into refrigerated space and improper air balance.
- 3-Internal heat generation; Fan motors , Defrosting heaters etc.
- 4-Heat Removed from product from lowering their temp. from entering to final storage temp.
- 5-Heat removed from product while freezing / when received Unfrozen.
- 6-Heat produced by product while stored.
- 7-Internal machine producing heat. E.g Lifters / lights etc
- 8-Blast freezing. (Quick cooling)

Refrigeration Load Calculations

Basic Heat Gain Equation

$$Q = U \times A \times \Delta t$$

Where:

Q = Heat Gain Btu/h

U = Overall heat transfer coefficient

Btu/h • ft² • °F (1/R)

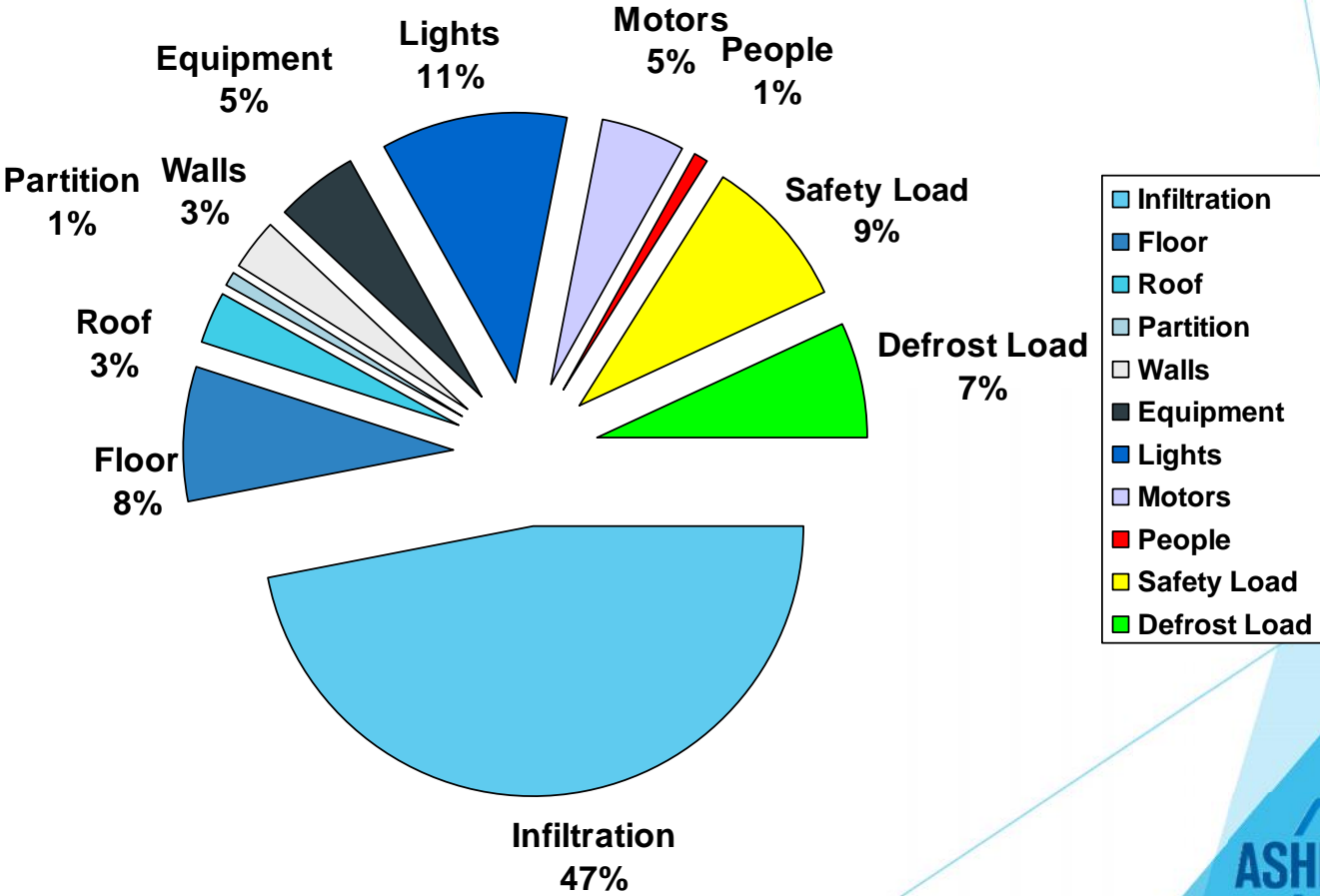
A = Outside area of section ft²

Δt = Temperature difference between
outside and inside of space °F

*Note: Alternatively Many software and Easy calculations sheets are available which can help in Load Calculations - **ASHRAE REF. Chapter 12 (Refrigeration)***

Refrigeration Load Calculations

Load Distribution Example



Commonly Use refrigeration Systems

Freon (HCFC) Based systems
e.G Air or Water Cooled packaged or split systems



Evaporator Unit Coolers; used with Freon systems;
normally Coils are made of Copper Tubes and
Aluminum Fins



Air and water Cooled Condensing Units



Central Refrigeration Rack units



Condensing unit

Piston Bitzer Unit

-25C ~25C

Horse Power: 2HP~40HP

Refrigerant; R22 & R44



Parallel condensing unit

-25C ~25C

water cool & air cool

Horse power: 20HP~200HP

2-Stage blast freezer unit

-25C~-45C

water cool & air cool

Horse power: 20~300HP



Maineurope Scrol unit

-25~25C

Horse power:2HP~40HP



Scrol copeland refrigerator

-25C~25C

open box type

Horse power: 2HP~10HP

Box type unit

-25~25C

Horse power: 2HP~10HP



Ammonia Based Refrigeration Systems

Applied systems or Ammonia refrigeration based systems e.g; Industrial Refrigeration; involved Field Piping and is tailored made as per process demand.

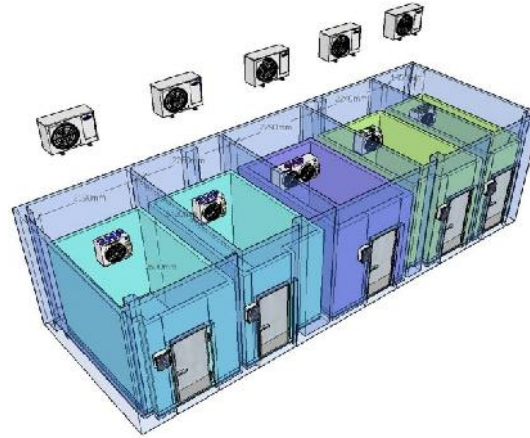


Controlled Atmosphere Cold Rooms

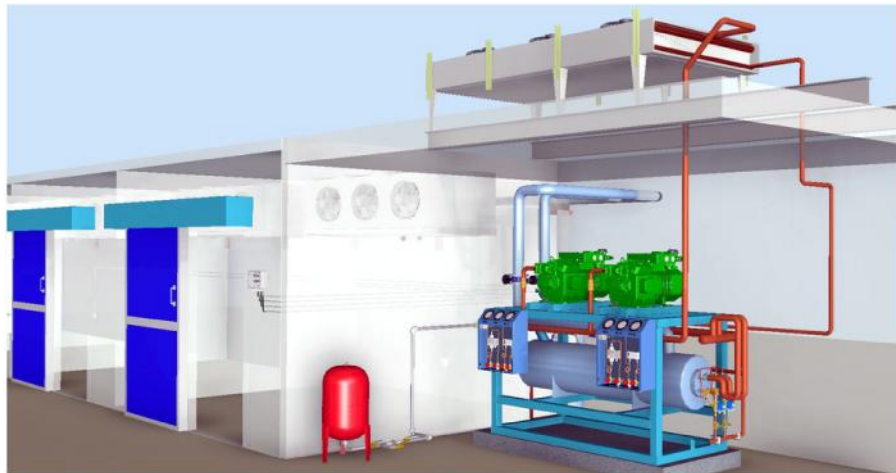
A controlled atmosphere Cold Rooms is an [agricultural](#) storage method in which the concentrations of [oxygen](#), [carbon dioxide](#) and [nitrogen](#), as well as the [temperature](#) and [humidity](#) of a storage room are regulated. Both dry commodities and fresh fruit and vegetables can be stored in controlled atmospheres.



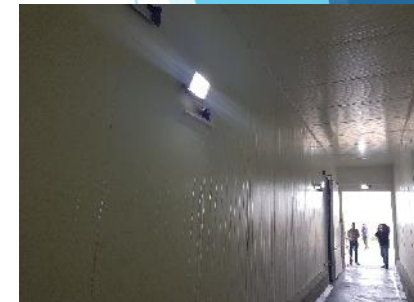
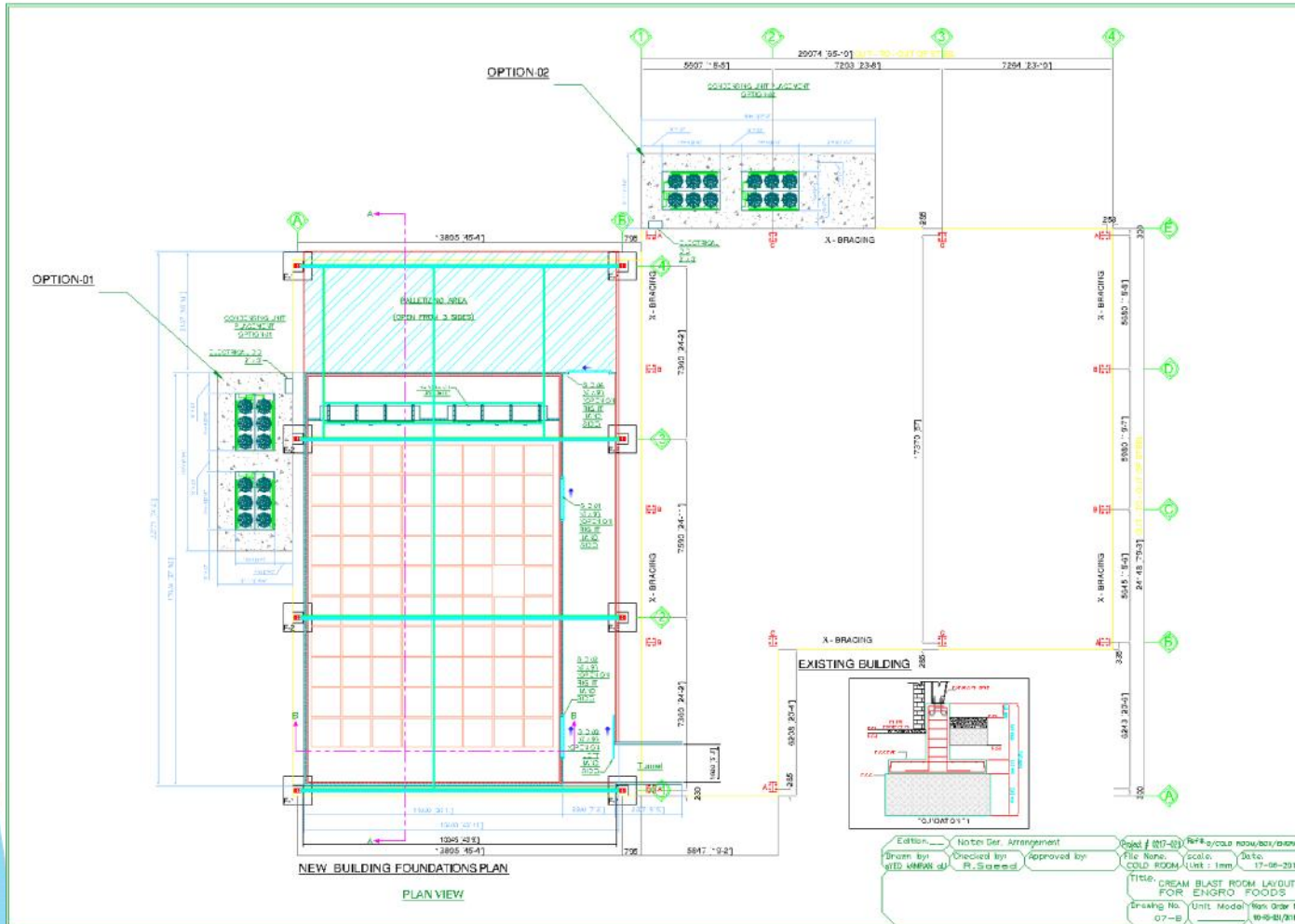
Typical Example Of Refrigerated Facilities



Typical Example Of Refrigerated Facilities



Cream Blasting (Refrigerated Facility) Engro Foods



Discussion