National Centre for Cold-chain Development
[A Govt. of India initiative]

**The technical team of NCCD was requested to take part in stakeholder meetings in Punjab. These meetings including site visits to five operational facilities and was conducted in May 2014 over a period of 3 days. The agenda of this interactive visit was to present options that could be developed into specific solutions to upgrade existing cold stores in Punjab. Engineers from the National Productivity Council also participated in this program.**

## Report: Meeting, Site Visits, Observations and Recommendations on assessing scope for Modernisation / Up-gradation of cold stores in Punjab

## I) Executive Summary of Observations:

1. All Cold storage visited are Brick and Mortar construction.
2. The thermal insulation was varied, with Rice Husk or Expanded polystyrene.
3. The refrigeration plants were all using ammonia as refrigerant gas.
4. The compressors were Open type Reciprocating compressors.
5. The condensers were universally of Atmospheric type.
6. The evaporators observed were both Bunker coils (open tube system) and Diffuser type system.
7. The storage of potatoes is on the wooden grated floors and on wooden Mezzanine levels. Mezzanine levels were supported by steel framed structure.
8. The loading and unloading of the products are done by manual labour and little or no material handling equipment was observed.
9. It is observed that basic building structure is strong without any noticeable cracks in the walls or in the inside ceiling.
10. Non-insulated wooden doors were seen in use and gaps are found at sealing surfaces.
11. The temperatures variance in mezzanine levels was observed, the relative humidity levels are low and low rate of circulation cold air. The temperature monitoring was done with instruments which were reportedly not calibrated.
12. There was no ammonia ventilation system found in the plant room.
13. A fresh air ventilation system for replenishing oxygen levels evacuating expired $CO_2$ from cold room chambers was not found to be installed.
14. The electrical control panel, wiring, cable support, routing and termination are done without standard electrical panel manufacturing and installation procedures.
15. The electrical consumption is reported to be very high in most of the cold storages.

16. During the visit to the Punjab Agro Juice Ltd, we noticed the capacity of the screw compressors was on the high side than actually required for 1000 MT cold storage . The part load power consumption of screw compressor is high and will lead to increase in electricity consumption. The frozen cold room with 1000 MT is also supported with a dedicated single stage screw compressor which can consume very high power in part load operation.

## II) Technical Inputs for Possible Solutions and Recommendations:

### 1) Modernization/Up-gradation of Existing Refrigeration System along with Temperature monitoring system with PLC controls:

Modernisation/Up-gradation of Refrigeration system along with Programmable Logic Controls to improve the quality of bulk storage in existing cold stores for table potatoes and to accommodate low sugar potatoes, onions and ginger for maintaining recommended temperature, relative humidity and ventilation system. The technical recommendations are:

- Replacement of existing compressors with new energy efficient compressors with water cooled head cooling arrangement and oil cooling arrangement. However to decide the refrigeration capacity of the compressor the effectiveness of insulation has to be checked. The effectiveness of thermal insulation is required to calculate the capacity of the compressor.
- For the atmospheric type condenser cooling system, the spray header nozzles needs to be checked for chocking of orifice and if required to be changed. The water quality also needs to be checked.
- The Bunker type cooling coil needs to be changed to Forced draft evaporators with Fin coil arrangement which delivers more air volume and static pressure to distribute the cold air uniformly to all levels. This will ensure the penetration of cold air into all the produce stacked in bags.
- Replacement of the bunker coil system will increase the space occupancy of the products. The uniform temperature management and increase in Relative Humidity up to 90% will help to improve the quality of shelf life during the storage period and reduce the weight losses.
- Replacement of refrigeration flow control valves, pressure regulating valves, stop valves, solenoid valves, expansion valves, check valves and safety valves. The valves are required to improve the performance and safety operation of

refrigeration plant and to maintain multi temperatures to store different products.

- Ventilation system with fans and ducting system for Fresh air circulation and Carbon dioxide removal.
- PLC System to monitor, record temperatures in the cold chambers in all the levels, management of compressor and defrosting operations.

**2) Modernizing / Up-gradation of Thermal Insulation**

Modernisation/ Up-gradation of thermal insulation for walls, ceiling, floor and replacement of doors to reduce electricity bills and thus improving operational revenue of existing cold storages. This will result in lowering the carbon foot print.

- For the old cold storages, we have found the effectiveness of thermal resistance value for existing walls and ceiling is almost become zero. The thermal property value of expanded polystyrene reduces every year due to moisture absorption with maximum life of 10 years. In Absence of effective thermal insulation leads to more conductive heat transfer into the chamber through walls and ceiling. As the cold room chambers cannot hold the room temperature, the temperature of the room rises quickly. The number of hours of compressor operation per day will increase substantially even if the products are pulled down to room temperature after completion of one month of loading.
- The effectiveness of water vapour barrier of the walls and ceiling has also reduced to zero resulting in transfer of humidity from inside to outside the chamber. The products will lose its weight during storage time in absence of desired Relative humidity levels and commercial market value of the product.
- The existing insulation of the building cannot be removed completely due to the structural damage that may happen to the building walls and ceiling. Strengthening of thermal insulation will ensure optimal heat transfer rate of 8 to 10W per sqm of wall / ceiling surface area into the chambers. The possible solutions includes spraying of PUF insulation on the outside walls or fixing the prefabricated sand witched insulated panels with one side pre painted GI sheet cladding . These panels can be screwed from outside the building wall surface with application of necessary glues. The ceiling walls are generally sprayed with PUF insulation and finished with water proofing. Application of outside insulation protects the heat conduction and eliminates the accumulated heat in the walls to radiate into the room during the night time.

3) **Conversion of Existing cold stores to multipurpose chambers and addition of Pre-cooling rooms and packaging areas to link Farmers to the market (to serve as distribution centres for whole sale and retail market)**

- The cold storages which has been built recently (less than 5 years old) for potatoes can be converted to multipurpose cold storage by replacing the Bunker coil system with Forced Draft Fin coil evaporators and replacing refrigeration pressure regulation valves, solenoid and stop valves to maintain different temperature in the cold room chambers.

- Addition of precooling rooms with suitable capacity including condensing units, pre-coolers, controls, electrical systems and insulated panel room. The precooling capacity could be 5 to 6 MT per batch.

- Staging Cold rooms with capacity of 30 to 50 MT storage capacities constructed with insulated PUF panel room and refrigeration equipment including dedicated Condensing Unit and Evaporators.

The technical solution in detail for modernisation / Up gradation, conversion to multi chamber cold storage design support will be taken up by NCCD once state team discuss with cold storage owners for further information required and owners interest for the investment.

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**CEO's COMMENTS:**

The teams visit highlights following logical sequence of events, in consonance with support options under MIDH Operational Guidelines. Basis these inputs comments are as follows:

a. First step to plan replacing of insulation of cold storages. Insulation changes will redefine the thermal dynamics and only then can the upgradation to compressor capacities be assessed. For eg-

- Paddy husk has thermal conductivity of 0.035 to 0.04 W/(m.°C) in comparison to more modern insulation material with 0.02 W/(m.°C). This means that for each square meter of rice husk insulation at 100mm thickness, the heat infiltration is 140watts per hours vis 900watts per hour for the same thickness with modern insulating material (when maintaining 2°C inside with outside at 42°C). In effect, a cold store with 2000 sq meters of surface area keeping seed potato will suffer heat transfer from walls to the extent of 95,000 BTUs every hour when walls are insulated with 100mm paddy husk. Conversely, using 100mm of polyurethane as insulation, the total heat transfer will

be only 55,000 BTUs per hour, reducing the cooling requirement by 75%.

- It is reported that wooden doors are installed with poor thermal seals. Upgrading of insulation shall include modernizing the door and access openings.

b. After planning the change insulation, keeping the same product load, the refrigeration upgradation can be designed, where feasible. Alternately, the saved capacity can be utilised for other loads.

c. Creating smaller compartments for handling of fresh fruits and vegetables can be taken up as expansion of project to make it capable for handling other perishable products. It is recommended that to handle greens and fruits, locally grown, a pack-house facility with precooler should be integrated as backward linkage. In cases where the cold storage is within feasible range of such production area, the pack-house facility can be built at the cold store itself as a new project.

d. The visit report indicates no automation is deployed for control of refrigeration equipment. The MIDH operational guidelines allows support as an add-on technology for both old and new cold stores. As a standalone option, this alone will add to optimising the operational efficiency of the refrigeration plant. This upgradation should include controls for Outdoor Unit (ODU), Indoor Unit (IDU) and sensors including temperature and humidity in the chambers.

e. Cold stores with large roof top surface areas can also take advantage of add-on options of Solar PV array as grid interactive or for captive use.

f. Option to locate pack-house with precoolers at each cold store is a good option. Specially as the cold store itself will serve as the necessary pre-transit store. Optionally the cold store owner can expand into other locations with pack-houses.

It is noted that this visit by NCCD technical team was introductory in nature and time in field was minimal. It is recommended that the technical team from assess individual existing projects in detail so that the options can be further refinement.

The support for upgradation under MIDH are as follows, subsidy @ 35%:

1. Modernise insulation where insulation is more than 15 years old or material is being modernised – cost norm of max Rs. 1 crore (approximately 5200sqm of 100mm PU based insulation)

2. Modernise refrigeration - cost norm of max Rs. 1 crore (depending on design and type of refrigeration).

3. Automation through PLC - cost norm of max Rs. 10 lakh (sufficient for automating operations for 20 to 25 chambers).

4. Alternate technology (Solar PV array) - cost norm of max Rs. 35 lakh (approximately 50 KW array, generating 550KWs every day in 11 hours of sunlight).

5. Pack-house with precooler- cost norm of Rs. 75 lakh for throughput of 15 tons per day. Additionally where deploying a packing line, additional cost norm of Rs 15 lakh is applicable.

## III) Visit summary with Minutes of Meeting in the Office of Secretary Agriculture, Punjab on 19th May:

Date of Meeting: 19th May'2014

Date of Site Visit: 19th to 21st May'2014

Venue: Punjab Agro Industries, Chandigarh,

### Attendees

1. Mr. K.S. Pannu , IAS, M.D Punjab Agro Industries Corporation, Secretary Agriculture (Punjab)
2. Mr. Gurkanwal Singh, Mission Director, SHM, Punjab
3. Mr. Pardeep Sharma, General Manager, PAGREXCO
4. Mr. Krishan Gopal Malik, Nodal Officer, Cool Chain Development, Punjab, Jalandhar
5. Dr. B.V.C.Mahajan, Professor, PHPTC, Punjab Agriculture University (PAU)
6. Dr. Mahesh Kumar, Professor, PHPTC/PFE, PAU
7. Dr. T.Chand, Extension Engineer, Department of Processing and Food Engg, PAU
8. Dr. Jaswinder Singh, Nodal Officer-Cold Chain, Punjab Horticulture Department
9. Mr. Maheshwar, Pioneer- Banana Ripening Chamber, Chandigarh
10. Mr. Nakul, Assistant Director, National Productivity Council
11. Mr. Rishabh Agrawal, Assistant Director, National Productivity Council
12. Mr. Rajagopal Sivakumar, Technical Advisor, NCCD, New Delhi
13. Mr. Aman Bhatnagar, Executive Manager, NCCD, New Delhi
14. Mr. Vanshaj Kaul, Executive Manager, NCCD, New Delhi

1. NCCD engineering team accompanied by Engineers from National Productivity Council, State Cold Chain Nodal Officer and State Technical team visited and made observations on 5 cold storages (3 cold storages near Jalandhar, one cold storage near Hoshiarpur, one cold storage near Nawan Shaher), two Centre of Excellence-one in Katarpur and other in

Hoshiarpur set up in Collaboration with Israeli Government and Cold and Freezer Storage room for Punjab Agriculture Juice Ltd.

2. Secretary Agriculture (Punjab) welcomed team NCCD and told that PAIC is actively supporting modernisation/up gradation of cold storages and young entrepreneurs. He also introduced Team NCCD to the recently nominated professionals two from Punjab Agriculture University, one from Department of Processing and Food Engineering, and one from Punjab Horticulture Department who along with Punjab Nodal Cold-chain Officer shall assist and interact with NCCD.
3. He focussed on the failure of cold storages and the requirement of entrepreneurs to catalyse the development in this sector of farming. He highlighted that cold storage shall become entrepreneurs from rent seekers. The requirement of middle-man can only be met through development in cold-chain.
4. Seminars with cold-storage owners, banks and with entrepreneurs shall be held after obtaining inputs from NCCD.
5. In Punjab 5% of 19 million tonnes of produce is lost due to design constraints of cold-storages. One has to now focus on 'Cold-chain' revolution and Punjab shall be the leading state.
6. He added that within 2 years Punjab would need 100 new cold storages including modernisation of as many existing cold stores with multi-commodity storage and at economical cost. This shall enhance employment.
7. Discussed that few CA cold storage were built in Punjab that were of no use and had a huge construction cost. Also discussed that one of the cold storage of capacity 4000 ton was built with no humidifier and when asked to add these, another Rs 3 crore was demanded. Companies like Blue star, Frick India are only selling their products at higher price without giving proper service.
8. Stated that Punjab does not store apples, hence no requirement of CA cold stores.
9. He also communicated to newly appointed professionals from Punjab Agriculture University, Department of Processing and Food Engineering, and Punjab Horticulture Department that NCCD shall support them in getting technical training.
10. He emphasised on pre-cooling, multi-commodity storage, proper marketing and modernisation of cold-storages. Multi-commodity gives linkage to backward community for forward market. Policies shall be guided by Government and not by companies.
11. Secretary Agriculture Punjab also focussed on the following:

- Referred to Ms. Veena Sinha's statement of use of solar energy in cold store in Bihar during NCCD conclave and expressed his desire to replicate the same in Punjab where availability of solar energy is for 7-8 months.
- Use of automation in cold-storages.
- Target consumer and then in turn target producer.
- Study of market trend and its prices.
- What shall be the economical size of cold storage and how farmer be approached the cold store.

12. Secretary introduced Mr. Maheshwar, one of the pioneers in banana supply chain industry. Mr. Maheshwar told that Punjab Agro Industries helped him in providing all the relevant data in 1996 which helped him to establish banana ripening chambers for banana ripening. He has also insisted potential of creating similar supply chain for guava. He stated that Punjab Agro needs following inputs from NCCD:
    - Proper consultancy required to convert cold-storage to cold-chain.
    - Optimal Design to convert existing cold store to modern cold store.
    - Needs Realistic cost for relevant hardware.
    - Subsidy provided.
13. Mr. Gurkanwal Singh stated that PAGRO would need guidance on setting up packaging line for vegetables and citrus. He also stated that PAGRO would need technical assistance on small solar powered onsite cold rooms.
14. He stated that he was also helped by United States Agriculture Department. Banana has only ten days period from harvesting to consumption. He also stated capsicum is a success in Punjab now due to protected cultivation.
15. Mr. Pradeep Sharma (GM-Admin, Punjab Agro) stated that Punjab requires a workable technology without compromising the efficiency.
16. Mr. Siva stated that NCCD will extend the technical support for modernisation and up gradation of the existing cold storages in the state in a phase wise manner

## IV) Observations and Discussions during visit to Cold Storages:

1. The following observations are made during the visit to the cold storages
    - Building construction type, design and material used in construction.
    - Type of Insulation materials used for walls, ceiling, floor and doors.
    - Storage systems, staking pattern, access to the stocks etc.
    - Refrigeration technology, compressors, type of evaporators, piping and controls.
    - Temperature monitoring and control systems.

- Electrical System and wiring.
- Safety Systems adopted for ammonia and fire safety.
- Power consumption during peak and lean periods.

2. The thermal insulation of the building is completely lost in all the old cold storages. Non-insulated wooden doors are used and gaps are found in between the walls and periphery of the doors thus leading to infiltration of hot air. Due to in effective insulation and hot air infiltration from outside the refrigeration compressors are running for more operating hours. This is evident by the higher electricity bills paid by the cold storage owners.

3. The Refrigeration plant was assembled by local contractors without proper system, design practices and safety aspects. Due to Bunker coil type evaporators, the temperatures in mezzanine levels are different, the relative humidity levels are low and low rate of circulation cold air. This leads to weight loss of the products substantially during storage period of about six months. The temperature monitoring was done with measuring instruments without calibration. The ammonia ventilation system was also not found in the plant room.

4. The stacking of the gunny bags without leaving space hinders the cold air movement from the top to bottom and the return air to the top. As potatoes respire during storage, the released carbon dioxide needs to be ventilated periodically and fresh air is taken inside. The ventilation system important for storage of potatoes is not found.

5. The electrical control panel, wiring, cable support, routing and termination are done without standard electrical panel manufacturing and installation procedures.

6. The electrical consumption is very high in most of the cold storages. The average capacity utilisation is less than 70% of the full load capacity.

7. Due to increased competition and higher operating expenses, the cold storage owner wants to store low sugar potatoes, onion and ginger. They would like to modernize to store these products as bulk for longer period of time.

8. One of the cold storage owners would like to create vegetable supply chain and would like to link the farm to the market using his storage with addition of pre-cooing and packing rooms.

9. During the visit to the Punjab Agro Juice Ltd, we have noticed the capacity of the screw compressors was on the high side than actually required for 1000 MT cold storage . Due to part load power consumption of screw compressor is high leading to increase in electricity consumption. The frozen cold room with 1000 MT is also supported with a

dedicated single stage screw compressor which consumes high power due to part load operation.

After the visit, the team discussed with the cold storage owners about the present problems, utilization capacities, future plans and their interests for modernization and expansion.

NCCD team has explained to them about the present MIDH schemes and subsidies and NCCD's role on supporting the SHM for Technical assistance and Training on capacity building.

**Details of site visits.**

**1) M/S Sandhu Cold store and Ice Factory:**

| | | |
|---|---|---|
| Year of construction | 1977 | |
| Products stored | Table and seed potato | |
| Storage Capacity | 1250 MT | |
| No of chambers | 1 chamber with three mezzanine levels. | |
| Size of each chamber | 80' x 60' x 40' | Total Volume=5436.84 $m^3$ |
| Building Construction | It has brick wall construction with wooden grated floor supported by steel structures for storage of goods in multi levels. |  |
| Type of Insulation | Use of paddy husk as insulation.<br>Due to the aging of the insulation , the characteristics of the rice husk has been completely deterioted which is evident from the electricity bill paid every month |  |

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|---|---|---|
| Door Type | Wooden hinged doors of size 4' x 7'. The insulation is not found. |  |
| Flooring Type | Wooden grated flooring supported on steel structures. |  |
| Refrigerant Plant | Ammonia Refrigeration system gravity flooded type consisting of open reciprocating compressors connected with slippering induction motors, atmospheric type condensers, ammonia receiver and diffuser type air coolers mounted in the ground floor and air is distributed from bottom to the top through ducts. |  |
| Compressors | 2 nos. of Open Type Reciprocating compressors connected with 30 kw Motor each. |  |

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| Evaporators | Diffuser type mounted in the ground floor and air distribution using ducts to upper levels. The surge drum and the suction line are not insulated and frost formation is noticed. The water collected in the drain pan was bad quality and does not have provision to drain the water out. |  |
| Condenser | Atmospheric type condenser with spray headers mounted in the top with water circulation pumps. |  |
| Control Panel | Electrical cables are without conduits and proper terminations are not provided. |  |
| Fire and Safety | Only one sand filled fire bucket seen. No adequate fire safety precautions have been taken. |  |

**2) M/s Haricold Storage and Ice Factory, Bajwara, Hoshirapur.**

| | | |
|---|---|---|
| Year of construction | 1981 | |
| Products stored | Potato, apple, grapes | |
| Cooling System | Bunker System | |
| Storage Capacity | 4500 MT | |
| No of chambers | 3 | |
| Size of each chamber | 85' x 55' x 40'<br>Per chamber | Volume=5295.25$m^3$<br>per chamber |
| Building Construction | It has brick wall construction with wooden grated floor supported by steel structures for storage of goods in multi levels. |  |
| Type of Insulation | Use of expanded Polystyrene as insulation material. In many places the insulation is peeling out of the walls. |  |
| Door Type | Wooden hinged doors of size 7' x 3.5'. The doors have not been properly fixed in the wall which leads to the infiltration of hot air into the cold chamber. |  |
| Flooring Type | Wooden grated flooring provided. |  |

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|---|---|---|
| Refrigerant Plant | Ammonia Refrigeration system with open reciprocating compressor connected with atmospheric type condensers and Bunker type coils provided in the top floor |  |
| Compressor | 3 no's of Reciprocating Compressor connected with each 75 kw Motors. | |
| Evaporator | Bunker type coil mounted on the top floor. The ice formation indicates humidity loss from the products. |  |
| Condenser | Atmospheric type. |  |

**3) M/S Guru Hargobind Cold storage and Agro Farm:**

| | | |
|---|---|---|
| Year of construction | 2012 | |
| Products stored | Seed potato | |
| Cooling System | Fin Coil System | |
| Storage Capacity | 4225 MT | |
| No of chambers | 4 | |
| Size of each chamber | 72.8' x 54.7' x 42.4' – 2 no's<br>55.5' x 35.1' x 43.2 '– 2nos. | Volume=14328.29$m^3$ |

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|---|---|---|
| Building Construction | It has brick wall construction with wooden grated flooring. The thermal insulation for walls and ceiling is with Expanded polystyrene. |  |
| Type of Insulation | Use of Expanded Polystyrene as insulation material with applied paint. The quality of the finish was good. |  |
| Door Type | Wooden hinged doors of size 7' x 3'. |  |
| Flooring Type | Wooden grated flooring provided. Sap formation due to storage of onions in one of the chambers seen. |  |

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| Refrigerant Plant | The Refrigeration plant uses ammonia as refrigerant with pumped liquid recirculation system consisting of open reciprocating type compressors, atmospheric type condensers and Fin coil type evaporators. |  |
| Liquid Recirculation system | Ammonia recirculation system consists of horizontal low pressure vessel with liquid ammonia pumps and control panels. |  |
| Compressor | Open reciprocating type. | |
| Evaporator | Finned coil evaporators |  |

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|---|---|---|
| Condenser | Atmospheric type |  |
| Control Panel | The Main MCC and Refrigeration panel are provided. |  |

**4) Name of Cold Store M/s Dahiya Cold Storage**

| | | |
|---|---|---|
| Year of construction | 2011 | |
| Products stored | Seed potato | |
| Storage Capacity | 5254.13 MT | |
| No of chambers | 4 | |
| Size of each chamber | 79' x 49' x41'<br>Per chamber | Volume=4494.20m$^3$ per chamber |
| Building Construction | It has brick wall construction and wooden grated flooring. The insulation is with Expanded Polystyrene insulation. |  |
| Type of Insulation | Use of Expanded polystyrene as insulation material. |  |

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|---|---|---|
| Door Type | Insulated hinged doors of size 7' x 3.5' |  |
| Flooring Type | Wooden grating flooring is provided. |  |
| Refrigeration Plant | Comprises of open Reciprocating compressors, | Atmospheric type condensers and Fin coil type evaporators |
| Compressor | Open Reciprocating type | |
| Evaporators | Forced Draft Fin coil type Evaporator provided in the top level mounted on the floor. |  |
| Electrical plant | Electrical panel for Refrigeration panel with cables. |  |

**5) Name of Cold Store M/s Bal Cold Storage**

| | | |
|---|---|---|
| Year of construction | 2010 | |
| Products stored | Seed potato | |
| Cooling System | Bunker Coil System | |
| No of chambers | 4 chamber | |
| Size of each chamber | 62' x 84' x 43' per chamber | Volume=6341.39$m^3$ per chamber |
| Building Construction | It has brick wall construction with wooden grating. |  |
| Type of Insulation | Expanded Polystyrene slabs | |
| Door Type | Wooden hinged doors |  |
| Flooring Type | Wooden crated flooring provided. |  |
| Refrigeration plant | The Refrigeration plant is with ammonia refrigeration with open reciprocating compressors, | Atmospheric condensers and with Bunker coil. |

## 6) Name of Cold Store M/s Punjab Agro Juices Ltd

| | | |
|---|---|---|
| Year of construction | 2007 | |
| Products stored | Freezer used for storage of Butter. Cold storage proposed to store kinnow, pear, water melon, mango, carrot, tomato, amla. | |
| Cooling System | Fin Coil System | |
| Storage Capacity | 1000MT for cold room and 1000 MT for freezer. | Total 2000MT |
| No of chambers | 2 (1 for freezer room and 1 for cold store) | |
| Size of each chamber | 160' x 80' x 17' | Volume=6161.75m3<br>Capacity 1026 MT in pallets per chamber |
| Building Construction | It has brick wall construction with cement concrete flooring having thermocol insulation. |  |
| Type of Insulation | Prefabricated Insulated PUF panel with both sides cladded with GI sheets for cold and Freezer rooms. |  |
| Door Type | Insulated sliding doors |  |

| | | |
|---|---|---|
| Flooring Type | Cement concrete flooring. |  |
| Refrigerant Plant | Ammonia screw liquid recirculation system |  |
| Compressor | Screw Compressor |  |
| Evaporator | Fin coil evaporator |  |

| | | |
|---|---|---|
| LP Receiver | Low pressure ammonia liquid receiver with pumps mounted on the steel frame. |   |
| Electrical plant | Consists of starters for compressors, condensers, and water circulation pump motors and evaporator fan motors. |  |

## V) Observations and Discussions during visit to Centre of Excellences:

During visit to Centre of Excellence for Citrus products in Khanuva, Hoshiarpur & Centre of Excellence for Vegetables at Katarpur.

The team met the project officers in charge and understood the planned process for the the integrated pack house which is in the construction stage

- Washing, cleaning and drying.
- Waxing (only for citrus products)
- Mechanical Sorting and grading line.
- Packing in cartons.
- Precooling and
- Cold rooms
- Retail outlet ( only for vegetables)

The NCCD team discussed in detail with project officers & the State technical team about the process design and technology adopted for the pack house suitable of Citrus products & vegetables.

The state team requested NCCD to support for process design and recommend list of equipment suppliers.

### 1) Centre of Excellence for fruits-CITRUS

| | | |
|---|---|---|
| Year of construction | 2014 | |
| Products | The centre of Excellence comprises of an integrated pack house to wash clean, sort, grade, and Pack and Precool Citrus products grown in the local areas... |  |
| Process line | 3 MT per Hr Capacity | |
| Building Construction | PEB construction covered with steel sheet on roof and all the walls. | |
| Process Machines & precooling rooms | In the planning stage | |

### 8) Centre of Excellence for fruits-Vegetables

| | | |
|---|---|---|
| Year of construction | 2014 |  |
| Products stored | Packing, sorting, Grading, packing and precooling of locally grown vegetables (tomato, capsicum, peas etc.). |  |