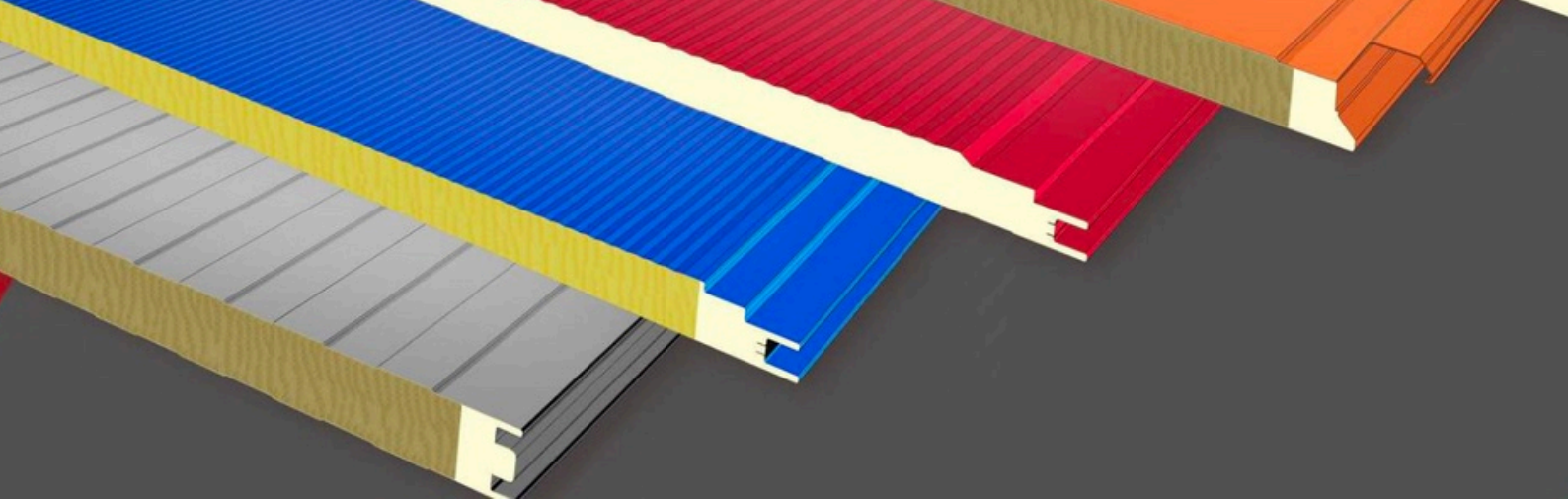
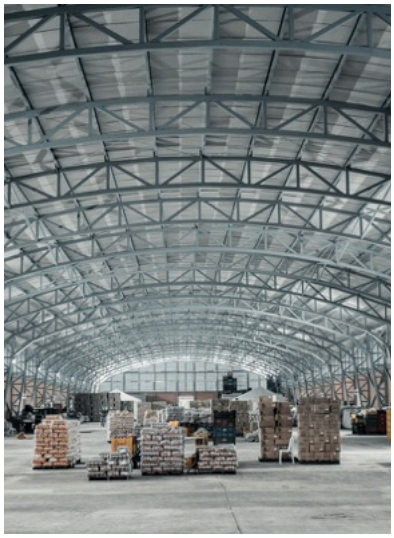
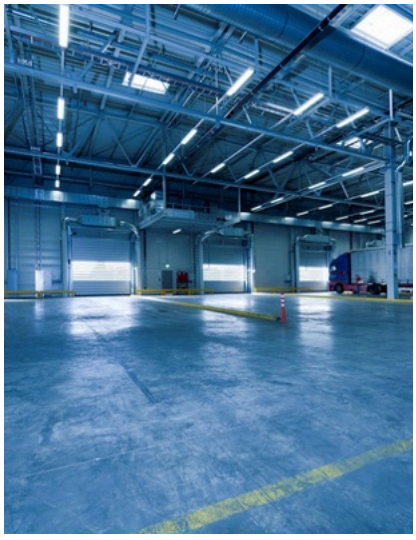
Wedge India

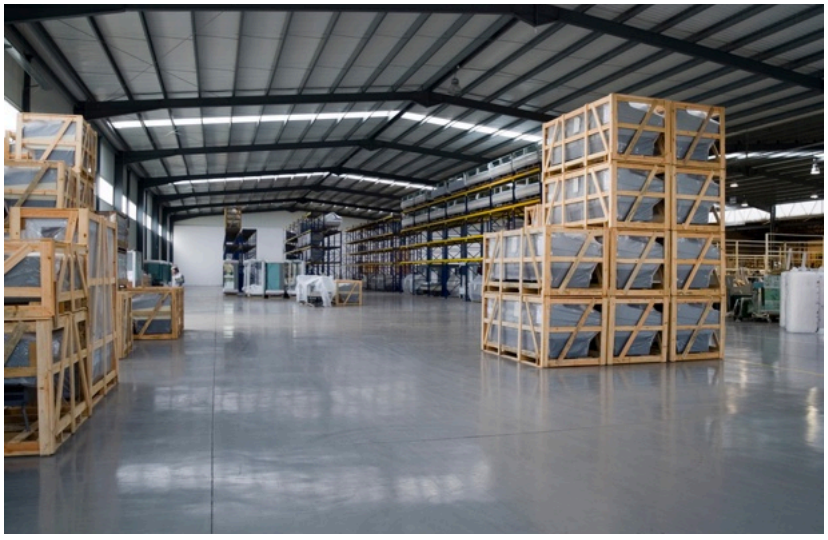
Cold Storage | EPC

- BULK COLD STORAGE
- REFRIGERATED WAREHOUSES
- MULTI-COMMODITY COLD ROOMS
- RIPENING CHAMBERS
- PHARMA COLD STORAGE
- REEFER VANS / MOBILE COLD STORAGE
- MODULAR COLD ROOMS









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Why is Cold Storage Needed?

Cold storage refers to temperature-controlled environments used to store perishable products. These include specialized rooms, containers, or warehouses where the temperature is kept low (chilled or frozen) to prevent spoilage or degradation. Cold storage plays a crucial role in preserving perishable goods like fruits, vegetables, dairy, meat, seafood, and pharmaceuticals. The cold chain industry has grown rapidly due to rising demand in food processing, retail, and logistics.

Here are the main reasons cold storage is essential:

1. Preservation of Perishable Goods

- Many items like fruits, vegetables, meat, dairy, seafood, and flowers spoil quickly at room temperature.
- Cold storage slows down bacterial growth and enzymatic reactions.

2. Extended Shelf Life

- Increases the lifespan of products significantly.
- Reduces waste and losses during transport and storage.

3. Safe Storage of Pharmaceuticals

- Vaccines, insulin, and other temperature-sensitive medicines require specific storage conditions (e.g., 2°C to 8°C or even sub-zero).

4. Year-Round Availability

- Helps store seasonal produce like mangoes, apples, or potatoes so they can be sold off-season.

5. Support for Food Supply Chains

- Cold storage enables transportation of frozen/chilled items across cities or countries without damage.
- Essential for modern retail, online grocery, and food delivery services.

6. Compliance with Safety Standards

- Food and pharmaceutical industries must follow strict regulations regarding temperature-controlled storage.

Types of Cold Storage

Type	Used For
Cold Rooms	Small scale (restaurants, labs)
Cold Storage Warehouses	Large scale (industrial, commercial)
Refrigerated Containers	For transport via truck, ship, rail
Blast Freezers	Quick freezing of products
Pharma Cold Storage	For medicines and vaccines

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EPC | Engineering, Procurement, Construction

Wedge offers EPC contracting services for large cold storage facilities globally. Wedge group has established technology and manufacturing collaboration with most economic high quality manufactures of cold store components in India and China. Wedge group engaged in manufacturing, sourcing, and supplying high performance insulation panels, steel structures, and refrigeration systems for cold storages. The EPC (Engineering, Procurement, and Construction) approach for Cold Storage facility involves a turnkey solution where a single contractor manages the entire project from design to commissioning.

1. Engineering (Design & Planning)

Site Assessment: Soil testing, land suitability, and environmental studies.
Capacity Planning: Determining storage capacity (e.g., 1000 MT, 5000 MT, etc.).

Cold Storage Design:

Insulation: Polyurethane (PUF) panels for walls and ceilings.
Cooling System: Ammonia or Freon-based refrigeration.
Humidity & Ventilation Control: To prevent sprouting and rotting.
Racking System: For efficient stacking of potato sacks.
Automation: Temperature and humidity monitoring systems (IoT-based).

2. Procurement & Manufacturing

Refrigeration Units: Compressors, condensers, evaporators.
Insulation Materials: PUF panels, vapor barriers.
Electrical Systems: Backup generators, HVAC, control panels.
Construction Materials: Steel structures, flooring (epoxy-coated for hygiene).
Safety Equipment: Fire suppression systems, gas detectors.

3. Construction

Civil Work: Foundation, walls, roofing.
Installation: Refrigeration units, insulation, electrical systems.
Testing & Commissioning: Ensuring temperature stability (2-4°C for potatoes) and humidity (~85-90% RH).
Compliance: Meeting food safety standards (FSSAI, ISO) and local regulations.

Key Considerations for Cold Storage EPC

Energy Efficiency: Use of inverter compressors to reduce power costs.
Shelf-Life Extension: Proper airflow design to minimize spoilage.
Scalability: Modular design for future expansion.
Maintenance Access: Easy servicing of refrigeration units.

Estimated Costs (India & Global)

Capacity (Metric Tonnes)	Estimated Cost (INR)	Estimated Cost (USD)
500 MT	₹1 - ₹2 Cr	~180,000–180,000–240,000
1000 MT	₹2 - ₹3 Cr	~300,000–300,000–420,000
5000 MT	₹5 - ₹10 Cr	~960,000–960,000–1.4M

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Main Components of a Large Cold Storage

Building Structure

- Usually PEB (Pre-Engineered Building)
- Well-insulated walls and roofing using PUF panels (60–100 mm thick)
- Flooring: Anti-slip concrete with vapor barrier and insulation layer
- Waterproofing and pest control treatment

Refrigeration System

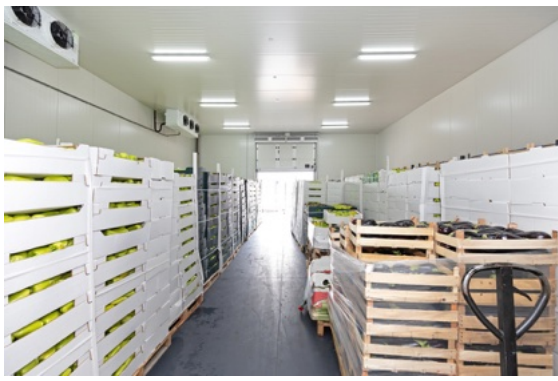
- Compressor units (Reciprocating or Screw type)
- Evaporator coils for cooling air inside storage
- Condensers (air-cooled or water-cooled)
- Refrigerants: Typically Ammonia (NH_3) or Freon (R404a)
- Multiple compressors for load sharing and backup

Temperature and Humidity Control

- Ideal storage temp for potatoes: 4°C to 6°C
- Humidity control system: RH maintained at 85–90%
- Dehumidifiers or humidifiers as needed

Ventilation System (Air Circulation)

- Large-capacity axial fans/blowers
- Uniform airflow to prevent hotspots
- Ducting system to distribute air evenly across all levels



Insulated Doors

- PUF-filled sliding doors or swing doors
- Air-tight sealing to prevent cold loss
- Equipped with safety lock, heater wires (anti-freezing), sensors

Storage Racks or Bins

- Steel racking systems or wooden crates
- Crate size: Often ~20–25 kg per crate for ventilation
- Ensures airflow between layers and reduces rot

Control Panel and Automation

- PLC-based automation system
- Sensors for temperature, humidity, CO_2 levels
- Remote monitoring and alarms for deviation
- Backup power integration

Electrical & Backup Systems

- Three-phase electrical supply
- DG Set (Generator) for power backup
- Battery backup or UPS for control systems
- Surge protectors and stabilizers

Fire Safety & Safety Features

- Fire alarms and extinguishers
- Emergency exits and lighting
- Gas leak detectors (if using Ammonia)
- Personal protective equipment (PPE)

Optional (Advanced Cold Stores)

- CO_2 scrubbers: To maintain air quality
- Ozone generators: For bacterial/fungal control
- Automated material handling systems (conveyors, forklifts)

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PEB | Pre-Engineered Building Structure

PEB (Pre-Engineered Building) structure is an excellent choice for cold storage construction. It's fast to build, cost-effective, durable, and can be customized for precise temperature control.

What is a PEB Structure for Cold Storage?

A PEB cold storage is a steel-framed building that is pre-designed and manufactured in a factory, then assembled on-site. It includes:

- Insulated panels for walls and roofing (usually PUF or PIR)
- Steel frame structure (columns, rafters, beams)
- Refrigeration systems (customized to temperature zones)
- Floor insulation (to prevent thermal leakage)

Basic Structural Components

- Primary Frame: Rigid steel frames (columns and rafters)
- Secondary Members: Purlins, girts, braces
- Roof & Wall Panels: Insulated sandwich panels (PUF or PIR)
- Flooring: RCC floor with vapor barrier + insulation
- Doors: Industrial-grade insulated sliding doors or swing doors
- Cooling Systems: Air coolers, compressors, evaporators

Why Use PEB for Cold Storage?

Benefit	Description
Fast construction	Fabrication and erection are much faster than RCC buildings
Custom design	Temperature zones, loading docks, and racking systems can be tailored
Thermal efficiency	Excellent insulation with PUF/PIR panels
Durability	Withstands humidity, chemicals, and temperature fluctuations
Low maintenance	Galvanized steel resists rust and corrosion
Cost-effective	Lower cost per square foot than traditional buildings

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PUF, PIR, EPS, VIP | Wall and Roof Insulation Panel

The best insulation panels for a cold storage must provide high thermal efficiency, moisture resistance, durability, and hygiene. Best cost effective choice for Potato Cold Storage:

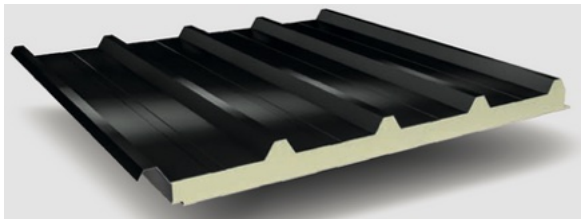
PUF Panels (100mm-150mm thickness)

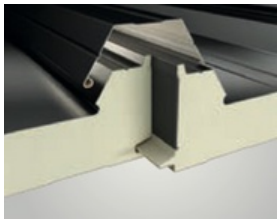
- Moisture Barrier: Ensure panels have aluminum foil or vapor-proof coating to prevent condensation.
- Joint Sealing: Use PU foam sealant to avoid thermal leaks.
- Hygiene: Smooth surface (avoid fibrous insulation like rockwool).
- Fire Safety: Check B2/B1 fire rating (especially if using PUF).

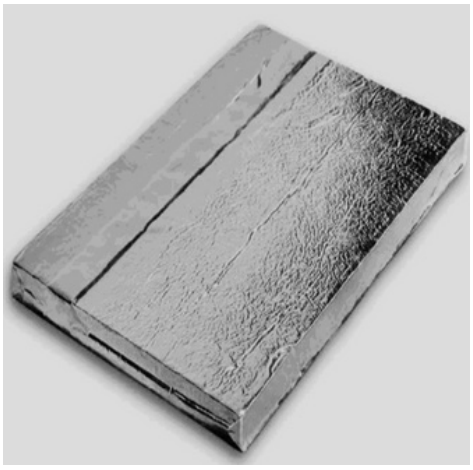
The other options are EPS, PIR, PUF, and VIP insulation panels for potato cold storage, covering thermal efficiency, cost, durability, moisture resistance, and suitability.

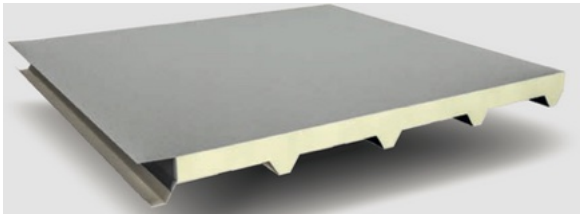
Insulation Panels Comparison Summary

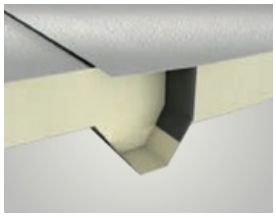
Parameter	Wedge PIR ☀️	PUF 👍	Wedge VIP 💎	EPS 💸
Insulation (R-value)	Best (6-7)	Very Good (5.5-6.5)	Ultra (10-15)	Poor (3.5-4)
Moisture Resistance	Excellent	Excellent	Excellent	Poor
Fire Safety	Best (B1/A2)	Good (B2/B1)	Varies	Flammable
Cost	High	Medium	Very High	Low
Durability	25–30 yrs	20–25 yrs	15–20 yrs	10–15 yrs
Best For	Large, fire-safe	Standard	Premium, compact	Low Budget
Thermal Conductivity	0.022 - 0.025 W/m·K	0.023 - 0.028 W/m·K	0.004 - 0.008 W/m·K	0.033 - 0.038 W/m·K
Energy Saving	High	Medium	Very High > 50%	Low











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R22, R404A, R290, R744, R717 | Refrigerants

The refrigerant in a potato cold storage system plays a critical role in maintaining the optimal temperature (typically 2–4°C) and humidity (85–90% RH) required to preserve potato quality, prevent spoilage, and extend shelf life.

Best Choice for Potato Cold Storage

✅ Recommended Refrigerants

1. R717 (Ammonia) – Best for large-scale storage (high efficiency, zero GWP).
2. R290 (Propane) – Best for small/medium modular units (eco-friendly, efficient).
3. R744 (CO_2) – Good for medium systems in temperate climates.
4. R448A (Alternative to R404A) – For retrofitting old systems.

❌ Avoid: R22 (Banned) & R404A (Phasing out due to high GWP).

Key Considerations When Choosing a Refrigerant

1. Temperature Stability – Must maintain 2–4°C without fluctuations.
2. Energy Efficiency – Impacts electricity bills (e.g., ammonia is 30% more efficient than HFCs).
3. Environmental Laws – Avoid phased-out refrigerants (e.g., R22 illegal globally).
4. Safety – Ammonia requires leak detectors; hydrocarbons (R290) need explosion-proof systems.
5. Total Cost – Include retrofitting penalties for banned refrigerants.

Energy Efficiency: R717 > R290 > R22 > R404A > R744 (for 2–4°C).
Eco-Friendliness: R717/R744/R290 > R404A > R22.
Safety: R404A/R744 > R22 > R717 > R290.
Cost-Effectiveness: R290 (small) > R717 (large) > R744 > R404A.

Future Trends

- Natural refrigerants (NH_3, CO_2, hydrocarbons) are gaining popularity due to sustainability mandates.
- IoT-based monitoring helps optimize refrigerant performance and detect leaks.

Best Refrigerants for Modern Potato Cold Storage

Refrigerant	Initial Cost	Operating Cost	Retrofit Cost	Compliance
R22	Low	High (Banned)	❌ Illegal	❌ Obsolete
R404A	Medium	High (GWP taxes)	❌ Phasing out	❌ Short-term
R290	Medium	Low	✅ Compatible	✅ Long-term
R744	High	Medium	High	✅ Long-term
R717	High	Very Low	High	✅ Long-term

Refrigerant	Efficiency (COP)	Operating Pressure	Temp Suitability	Oil Type
R22	Moderate	Medium	Good for +10°C to -40°C	Mineral Oil
R404A	Low-Medium	High	Best for -50°C to +10°C	POE Oil
R290	High	Medium	Excellent for 0°C to -40°C	AB Oil
R744	Low	Very High	Best for sub-zero	PAG Oil
R717	Very High	Low-Medium	Best for large cold stores	Mineral Oil

Air or Water | Condensing Unit

The choice between air-cooled and water-cooled condensing units depends on efficiency, cost, climate, and water availability.

Air-Cooled Condensing Units

- Lower upfront cost (no cooling towers/pipes required).
- Easier installation & maintenance (no water treatment needed).
- Suitable for water-scarce regions.
- No risk of freezing in cold climates.
- Less efficient (higher energy consumption in hot climates).
- Louder operation (fans generate noise).
- Shorter lifespan (exposed to outdoor elements).

Ideal For Small-to-medium cold storage, dry climates, low-maintenance setups.

- Small potato storages (≤500 MT)
- Temperate/dry climates (ambient temp <35°C)
- Budget-conscious projects

Water-Cooled Condensing Units

- Higher energy efficiency (better heat transfer than air).
- Quieter operation (no large fans).
- Longer lifespan (protected from outdoor weather).
- Better performance in high ambient temps (>35°C).
- Higher initial cost (cooling towers, pumps, piping).
- Water dependency (not suitable for drought-prone areas).
- Maintenance-heavy (water treatment, scaling risk).
- Risk of Legionella (if not properly treated).

Ideal For Large cold storage, hot climates, high-efficiency needs.

- Large potato storages (≥1000 MT)
- Hot/humid climates
- High-efficiency industrial setups

Screw Compressor Units

For large potato cold storage (1,000+ MT), air coolers (evaporative condensers) are a cost-effective and energy-efficient alternative to traditional cooling systems. They work best in hot & dry climates and help maintain 2–4°C with 85–90% RH. Below are the top recommendations, features, and selection criteria.

Why Use Air Coolers for Potato Storage?

- Lower energy costs (30–50% savings vs. water-cooled systems).
- No water scarcity issues (unlike water-cooled condensers).
- Eco-friendly (no harmful refrigerants like R404A).
- Better humidity control (helps maintain 85–90% RH).

Best For: Large potato storages (1,000–10,000 MT)

- Hot & dry climates (India, Middle East, Africa)
- Regions with water shortages

Key Selection Criteria

- Cooling Capacity: 1 TR ≈ 3.5 kW cooling. For 1,000 MT potatoes, you need ~50–100 TR (depends on insulation & climate).
- Climate Suitability: Best in dry climates (humidity <60%). Less effective in humid areas (use hybrid cooling).
- Energy Efficiency: Look for EC (Electronically Commutated) fans (saves 30% energy). Variable Speed Drives (VSD) adjust cooling as per load.
- Water Consumption: Closed-loop systems (water recycling) reduce wastage. Scale-resistant materials (for hard water areas).

Air Coolers (Evaporative Condensers)

Potato cold storage requires precise temperature (2–4°C) and humidity (90–95% RH) control to prevent spoilage, sprouting, and dehydration. Evaporative condensers are an excellent choice for such applications due to their energy efficiency, water savings, and ability to maintain stable cooling conditions.

Why Use Evaporative Condensers for Potato Storage?

Energy Efficiency – Lower condensing temperatures reduce compressor workload, saving electricity.
Humidity Control – Unlike dry air-cooled condensers, evaporative systems help maintain high humidity levels.
Water Efficiency – Uses less water than traditional cooling towers.
Space Savings – Compact compared to cooling tower + condenser setups.
Better Performance in Hot Climates – More effective than air-cooled units in high ambient temperatures.

System Design Considerations

A. Cooling Load Calculation

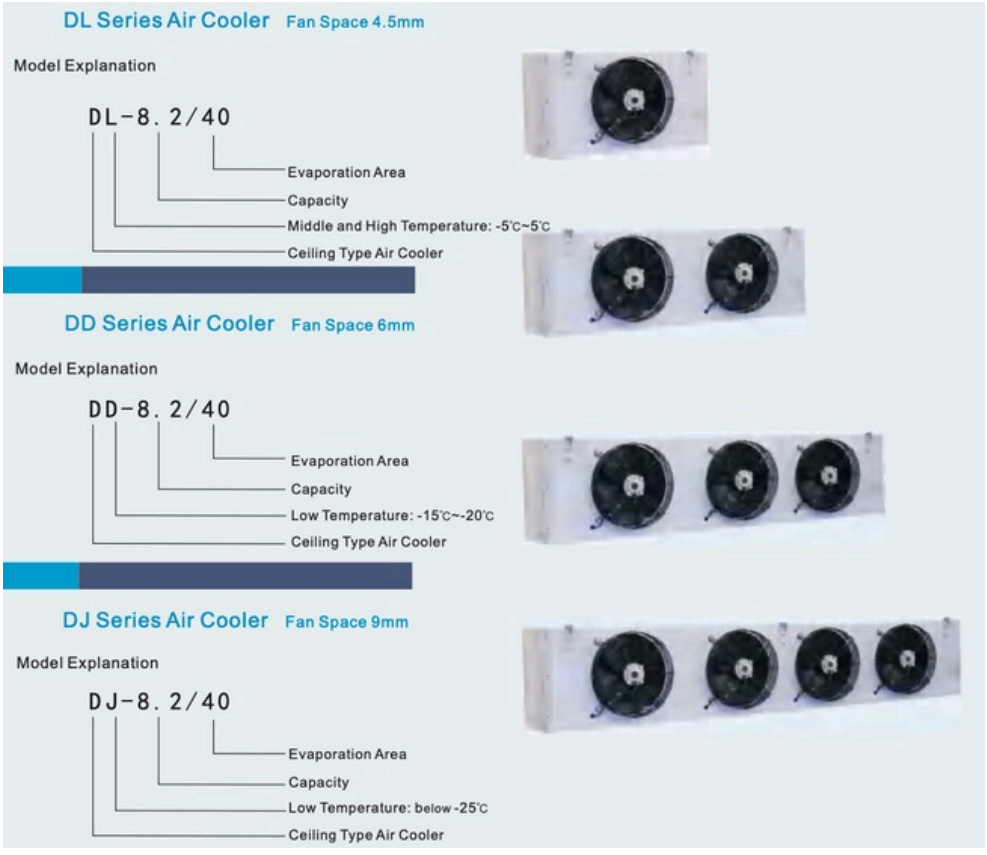
- Potato storage cooling load depends on:
  - Storage capacity (tons of potatoes)
  - Initial cooling (field heat removal)
  - Respiration heat (potatoes generate heat over time)
  - Insulation quality of the cold room
- Typical cooling requirement: 0.5–1.5 kW per ton of potatoes (varies based on climate and storage conditions).

B. Evaporative Condenser Sizing

- Must match the refrigeration compressor capacity (e.g., for a 100 TR system, select a condenser rated for ~120 TR to account for peak loads).
- Airflow & Water Flow Rates should be optimized for humidity control.

C. Refrigerant Selection

- Common refrigerants: Ammonia (NH_3) or CO_2 (for larger systems), R404A/R507 (for smaller systems).
- Ammonia is often preferred for large potato storage due to high efficiency and low cost.



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