
# REFRIGERATION REVIEW

## Cold Storage (PRW) v. Dry Storage

**The primary difference between cold storage and dry storage is that the refrigerated rooms have to be constructed in a manner so that they are encapsulated in a total vapor barrier, not unlike a balloon. The dry storage industry likes to use the term "vapor retardant", but a vapor retardant would not suffice for refrigerated rooms. The dynamics in a cold room, particularly a freezer, are such that cold air is heavier than warm air, and the cold air in a room is always applying a negative pressure at the wall/roof juncture. Even if it is the size of a pinhole, if air is admitted in any form, it will form frost at the wall/roof juncture as well as on the floor, on the racks, on the product, etc. The vapor barrier must be placed on the warm side of the insulated structure whether it's an insulated metal panel (IMP) or a roofing system, such as a TPO roof. In addition to the continuity of the vapor barrier on the outside walls, there needs to be a continuity of vapor barrier on the inside walls as well (i.e., the walls between coolers and freezers). Infiltration, water vapor, is the tail that wags the dog. It takes**

**1000 BTUs/lb to condense water out of the air and is generally the largest single load in a refrigeration system.**

**The second major difference between refrigerated structures and dry facilities is that adjacent rooms with a 10° or more temperature difference need to have their own independent steel systems. Unlike dry facilities that can use common steel beams, in adjacent rooms, refrigerated facilities require a separate steel system for each component, (i.e., freezers, coolers, dock, office, and machinery room). Each must be an independent steel system with its own bracing, etc. There have been several cases where steel-penetrated wall systems unknowingly rusted out, and the owner came in one morning to find the steel system laying on top of the storage racks. Noteworthy is that we avoid the use of tubular steel columns in a refrigerated building, and have found over the years pre-engineered systems are much more cost effective in first costs and are much more flexible in changing room configurations at the last minute.**

**The third difference of refrigerated buildings is that when they are pulled down to operating temperatures, all the components contract. Allowances must be made for that contraction. A freezer floor will contract approximately ½"/100 feet of floor. Special isolation joints are provided at doorways and in aisles to protect the edges of the concrete after they open up. There are numerous miscellaneous details that are unique to refrigerated buildings such as column bases must be placed on insulated isolation blocks; piers and footings are unique on columns at the perimeter**

**of the building to prevent interference with the IMP wall panels.**

**With large facilities, the geometry of the building needs to be considered to complement such things as the refrigerant pipe slope, the location of the air units, and the distribution of the air inside the rooms. The key component in plant layout is determining space utilization so that the steel design can be provided on a timely basis. While room layouts can be changed and modified in the development phase before cost can be determined the steel framing layout needs to be fixed. Other amenities unique to refrigerated buildings include underfloor heating systems for freezers as well as heat in key areas where moisture and ice can pose a challenge. While some would try to construct a box-in-a-box, an enclosure with IMP walls and an IMP ceiling, this construction technique is self-defeating. If not done properly, and thoroughly sealed, all of the panel joints, in time, will absorb moisture which turns to ice, and the ceiling will have a finite life of approximately 20 years. Also, when this is done, amenities such as sprinkler systems have to be installed above the ceiling and below the ceiling, and all the penetrations require a tight vapor barrier seal.**

**Generally, the costs for a refrigerated facility are made of three components: 50% is general construction; 25% is the thermal insulation and roof system; 25% is the refrigeration system. In PRW (public refrigerated warehousing), the two costs which are quite often of similar magnitude are labor and power costs. While power costs have been improved with technology, labor is a function of the activity and type of**

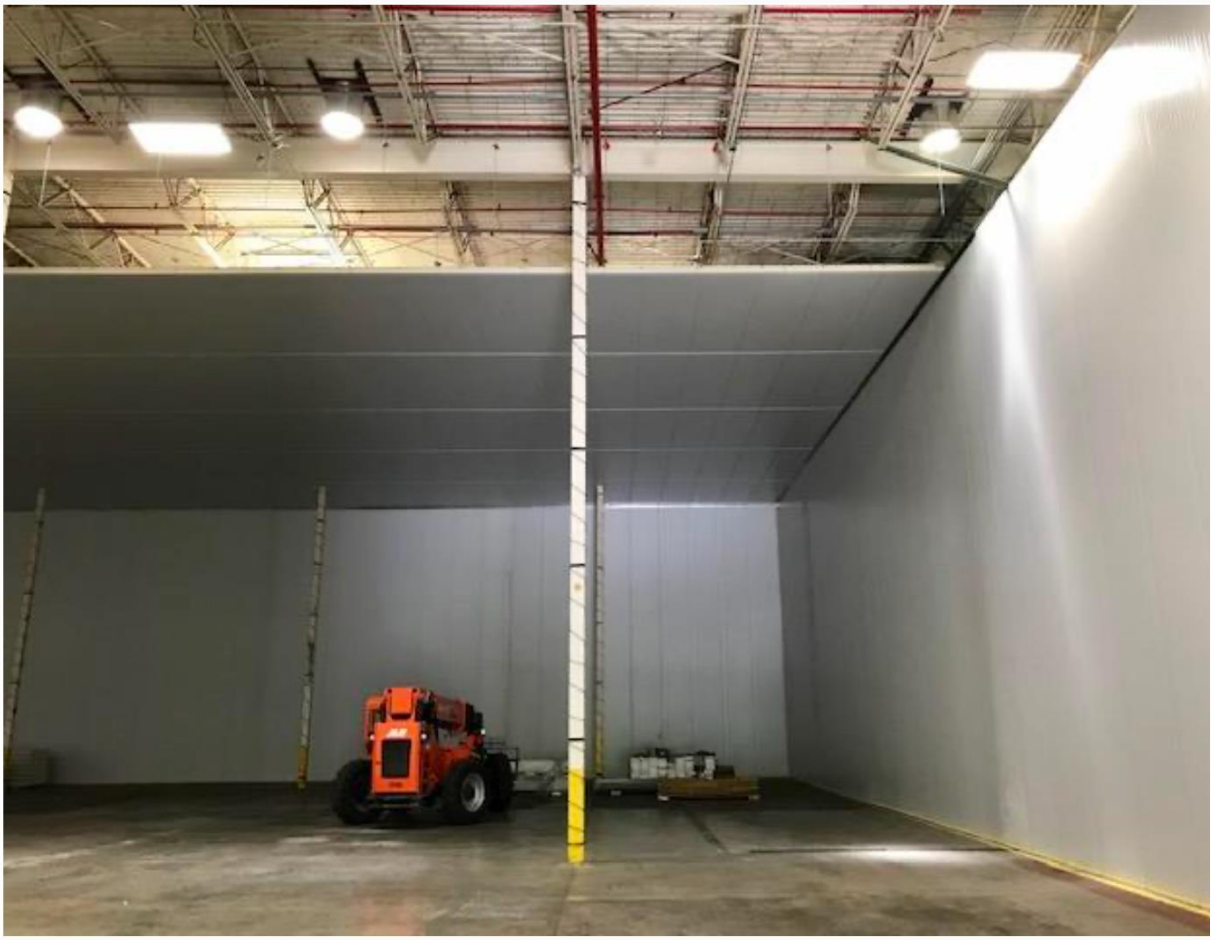
**operation supported (i.e., long term production or high turnover distribution). Power costs have traditionally been in the range of 2 kWh/cubic foot/year. Today's technology, assuming a well-designed facility, has driven that down as low as .25 kWh/cubic foot/year. Another aspect of PRW that is significantly unique compared to dry warehousing is the use of battery-operated fork trucks and pallet jacks. Because the facilities are tightly sealed, propane-powered fork trucks cannot be used. This also affects the type of doors and seals as well as dock levelers used for refrigerated docks. The fork truck drivers would use insulated clothing and would have warm up rooms where they can go periodically. Typically, warehouses will handle half their cubic feet in pounds-per-day and truck doors would be in the range of 200,000 lbs/day, whereas dock freezer doors may handle as much as 500,000 lbs/day. This varies widely depending on the type of operation.**

**The state-of-the-art refrigeration systems employ green refrigerants such as ammonia and carbon dioxide ($CO_2$), and eliminate the use of "freon". There are some systems being touted as efficient as two-stage systems which are, to say the least, false claims and are promoting the use of "freon" single-stage with multiple compressors and multiple air-cooled condenser fans. – all of which, in turn, will require high maintenance costs and come under the scrutiny of the scheduled bans of all "freons".**

**In refrigerated buildings, automation for order picking has been tried on several occasions. Some of the larger chain stores have decided not to use**

**them in the future because of the complexity and lack of flexibility in the operation of equipment like stacker cranes and rail systems. The trend is for fork trucks operating from the floor, with single- or double-deep racks; more and more, mole systems are being used, which use an independent carriage that will place pallets 20-22 feet deep in a dense configuration; again, being operated via a fork truck in an open aisle layout.**

**Generally, the parking of tractor trailers and movement will be largely a function of the type of activity of the building. The activities of over-the-road tractor trailers v. containers would influence space allocation, but 20% to 30% of the building area would be typical for tractor trailer activity. Refrigerated facilities, unlike dry facilities, are constructed with dock heights of 52" in lieu of 48". Depending on the type of operation, edge-of-dock levelers and/or vertical hydraulic levelers would provide adequate movement of product in minimizing the time spent loading and unloading tractor trailers.**



**Dry Warehouse Conversion to Box-in-a-Box**

**Ceiling Panels Ready to Be Installed**