REFRIGERATION REVIEW

Hank's Rules of Thumb

Over the years, I have developed some Rules of Thumb for different aspects of refrigerated facilities and refrigeration systems. The following are some Rules of Thumb that are typical for PRWs, while the actual values need to be determined, if possible. Quite often the owner of the warehouse will not know for sure what the values will be (i.e., the product movement in and out of the facility).

RULE OF THUMB #1: PRODUCT POUNDS PER DAY = 1/2 CuFt of PRW. Typically it has been our observation over the years that product movement in and out of a freezer room will be, in pounds, half of the cubic feet of the room. While this will vary widely for the location of the facility, whether it's a production storage or distribution storage, it is generally indicative of the product movement into and out of the facility. Typically, the product load is considered to have a 20° drop.

RULE OF THUMB #2: Product Lb/CuFt - 6-7 lb/CuFt for storage rooms. The pounds of product stored in a freezer typically will be in the range of 6 to 7 pounds per cubic foot. Of course this varies, depending on the racking system, for instance 2-deep, single-deep, or high density systems like the mole system, and the type of product, whether it's butter versus bread or potatoes.

RULE OF THUMB #3: 5TR per door for docks. While the actual heatload for dock areas needs to be calculated, a good check on the TR required for a dock is 5TR per door. This is assuming a 40° dock area equipped with insulated tight-fitting doors. While dock pits are no longer used for refrigerated dock areas, if an existing dock has dock pits, you can easily expect a 30-40% higher refrigeration load on the dock. Typically, today, docks would use vertical levelers or edge-of-dock levelers. Some facilities use "back-into" door openings where the doorway is larger than the unloaded height of the truck, and wider than the 8 foot width of the truck. These openings would require 20-30% more refrigeration, where a typical door with cushions would be 7'-6" wide x 8'-6" high, and would be more tightly sealed.

RULE OF THUMB #4: Dock room height minimum of 25'. While most dock ceiling heights are no longer in the 14' range, the benefits of a minimum of 25' high dock ceilings will not only add equity to a facility, but functionally will provide better performance. The dock doors are where moisture laden air enters at the top of the door and rolls immediately up to the ceiling of the dock. When dock ceilings are low, this humid air will condense on the under side of the (normally metal) deck and eventually the ceiling will be black from mold.

Depending on the configuration of the dock air units and their design, docks in the order of 25' high can provide dehumidified air that will be mixed with the humid air coming in over the doors, and lower the air's dew point to where it will no longer condense on the under side of the dock ceiling or roof. There are several ways to configure air units and/or provide re-heat to help minimize condensation. In addition, the 25' high dock will permit the truck doors to raise vertically straight up and not require roll back into the dock area. This also makes for a tighter fitting truck door.

Since it is far more desirable and cost effective to extract moisture out of infiltration air at dock temperatures, every effort should be made to keep the dock air unit coil actively extracting moisture. This is to say that when temperatures are satisfied on the dock, cycle the fans off but leave the coil active

so it can continue to dehumidify the infiltration air. At the same time, the freezer air unit fans should run continuously to provide even air circulation and to counter any stratification of warm air near the ceilings.

RULE OF THUMB #5: Dock floor height of 52". Refrigerated dock floor heights are typically 52", whereas dry warehouse dock heights would be 48". This is due to the fact that reefers have insulated floors and the floor is higher than on dry trucks. In addition, containers tend to vary in height, and a convenient way to handle this is with a vertical leveler or a Load Hog adjustable dock board.

RULE OF THUMB #6: Normal RH of rooms is 70%. Typically the air unit design conditions will permit the humidity to be in the range of 70%. While the refrigeration load on a dock will vary from 100 to 0 depending on the geographic location, generally an operating temperature difference (TD) of 15° would provide 70% humidity in the dock area. Freezer designs would be a 10° TD between the coil, air, and the average refrigerant temperature, which would be a reasonable compromise for energy conservation as well as for humidity. While most products are sealed today, in some areas of the world product is open, and a higher TD would provide a lower humidity in a freezer, which would be undesirable from a "frostbite" perspective, and degrade the product in storage.

RULE OF THUMB #7: Normal temperature drop of air unit air = ~1/3 design temperature. While we design rooms at certain temperatures, in reality the air temperature after it leaves the air units will pick up heat to bring back to the air unit. Typically, that rise in temperature will be 1/3 of the TD for which the coil is operating. So, for example, if it's desirable to have the dock temperature at 40° and the coil design is 15°, the air temperature could be expected to be 40°+/- 2 1/2°.

RULE OF THUMB #8: Location of air handling units. Where possible, in small rooms, we would typically blow air at the doors. While in some larger rooms, where location of pipelines, say, are above a dock, you can blow away from the doors, but not down the aisles. While the location of the air handlers

will vary with the room size and configuration, air units can blow air as far as 300', if designed properly. Long distances may require the use of centrifugal fans with high velocity bi-directional louvers for discharging air. The use of duct work should be avoided. In addition, design heights need to provide a minimum of 30" above the top of the product for air distribution. I would generally prefer blowing air over the tops of the rack and the product as opposed to down the aisles for a more even distribution. The top of the product quite often provides a plateau that air allows air to move significant distances by rolling across the top of the product.