Vapor retarders for cold-storage buildings

by Jack Robinson, RRC

Q: On a freezer building, where is the proper place to install a vapor retarder in the roof assembly?

A: Vapor retarders (i.e., systems that slow but don’t prevent vapor migration) and vapor barriers (i.e., systems that must prevent vapor migration) always should be placed as close as possible to the warm, humid side of any low-slope roof assembly. If a building has a constant interior temperature of about 32 F (0 C) or less, the assembly’s warmest side will be the exterior side, under most conditions.

Hot, humid weather on the exterior and cool, dry conditions on the interior will create a strong vapor pressure drive from exterior to interior. In this case, the vapor retarder is the roof membrane itself. So, on freezer and cooler buildings, the roof membrane is, in fact, a vapor barrier, and its proper location is on top of the insulation.

The other components of the building envelope (i.e., the walls and floor) also should have vapor retarders. The building’s most critical construction details for controlling moisture and preventing condensation are those that address joining the vapor retarders at roof-wall and floor-wall intersections.

To prevent condensation problems at roof-wall junctions, air leakage must be prevented. To accomplish this, the walls’ vapor retarders must be joined continuously to the roof assembly’s vapor barrier.

However, such a task always has been a difficult design problem—and the problem has been exacerbated in recent years with the trend of constructing the walls of cold-storage and freezer buildings with insulated metal panels. When this type of construction is used, the wall’s vapor barrier generally is the panel’s outer metal skin. The task of joining the roof’s vapor barrier (i.e., roof membrane) to that of the wall (i.e., outer metal skin) becomes even more difficult; creating airtight seals between roof membranes and metal components can be challenging.

There are additional moisture-control factors that should be considered when designing cold-storage or freezer buildings, such as the method of attaching the insulation to the roof deck, which can be critical to successful design.

For example, when the roof deck is steel and the insulation must be mechanically attached, it is best to attach the first layer of insulation and fully adhere the overlying courses to achieve the desired thermal resistance. (Avoiding fasteners that penetrate the entire insulation thickness will reduce thermal bridging.) Also, staggering or offsetting the joints of the insulation’s upper layers from those below will reduce the potential for air leakage and improve thermal efficiency.

The type of membrane used also can affect how successfully the vapor drive is controlled from the exterior to interior; membranes differ in permeance (i.e., the ability to resist water vapor’s movement), which is rated in units called perms. A perm is defined as follows: A rating of 1 perm means a membrane will allow one grain of water vapor to pass through 1 square foot (0.09 m²) of material in one hour for each inch (2.54 mm) of mercury pressure differential.

It is important to note that a membrane’s permeability changes with temperature. According to a symposium paper written by Rene Dupuis, president of Structural Research Inc., Middleton, Wis., some membranes will have low perm ratings at low temperatures (e.g., 70 F [21 C]) but significantly higher permeance at higher temperatures.

For example, a 45-mil (1.1-mm), black EPDM membrane has a perm rating of 0.017 at 40 F (4 C), but its permeance increases to 0.519 at 158 F (70 C). Some thermoplastic single-ply membranes have perm ratings between 0.003 and 0.3 at 90 F (32 C). Built-up roof membranes have reported perm ratings of 0 at broad temperature ranges. To be an effective vapor barrier, a membrane should have a perm rating of less than 0.5 (preferably approaching 0) at 90 F (32 C).

A membrane’s permeability changes with temperature.

During hot weather, roof membranes can reach temperatures greater than 158 F (70 C). Under these conditions, a cold-storage or freezer building experiences the greatest exterior-to-interior vapor drive. If the permeance of the membrane (which is functioning as the vapor barrier) increases significantly (to greater than 0.5), the membrane may no longer be an effective vapor barrier.

Before selecting a roof membrane for a cold-storage or freezer building, designers should contact membrane manufacturers and obtain information about the perm ratings of their membranes at elevated temperatures. The proper membrane will prevent possible condensation problems.


Each month in this column, one of NRCA’s technical services staff members will answer readers’ technical questions. If you have a specific question you would like answered in this column, send it to Professional Roofing magazine, 10255 W. Higgins Road, Suite 600, Rosemont, Ill. 60018-5607.

44 Professional Roofing August 1997