



## **SPRI ADVISORY BULLETIN**

### **CONSTRUCTION-GENERATED MOISTURE AND ITS EFFECT ON ROOFING SYSTEMS**

Roofing system assemblies are typically designed to accommodate occupancy-generated moisture based on building usage and function. Buildings with relatively small amounts of occupancy-generated moisture (office buildings, retail buildings, etc.) can be designed differently from buildings with large amounts of occupancy-generated moisture (swimming pools, paper mills, etc.).

However, moisture generated during the construction phase of a building is rarely recognized and seldom addressed by roof designers. In moderate climate regions (ASHRAE Zones 1-3), construction-generated moisture may go unnoticed until musty air is detected or mold growth is discovered.

In colder climate regions (ASHRAE Zones 4-7), construction-generated moisture may be detected in the form of drips inside the building after the first freeze/thaw cycle. These drips are often misinterpreted as a roof leak. For this reason, it is vitally important that projects with elevated levels of construction-generated moisture be engineered to accommodate, dissipate or avoid this moisture load.

#### **Sources of construction generated moisture**

Moisture associated with construction can be generated by various trades. According to *The Manual of Low Slope Roofing Systems* (Griffin & Fricklas, pp 112):

- A 4" thick concrete floor slab poured in an enclosed building generates 1 ton of water per 1000 square feet of concrete.
- The use of propane heaters (to provide more comfortable working conditions or to help "dry" the construction) also generates large quantities of moisture. For each 200-pound tank of propane burned, 30 gallons of water are produced.
- Oil-burning heaters produce 1 gallon of water for every 1 gallon of oil burned.
- Paint, plaster, drywall and other water-based construction materials also contribute to construction-generated moisture and potential accumulation in the roofing system assembly.

## **Moisture migration**

When proper measures are not taken, construction-generated moisture can contribute to high levels of relative humidity inside the structure. When the outside temperature drops, condensation can begin to form.

This condensation can appear on any cold surface (with a temperature at or below the dew point), including the underside of skylight domes, uninsulated portions of decks, roof insulation or the underside of the roofing membrane.

Warm, moisture-laden air migrating upward can infiltrate or “intrude” into the roofing system assembly through deck-to-wall joints, gaps around penetrations, or voids in the deck. The intruded air is then trapped within the roofing system assembly because of the air-impermeable roof cover.

As the air cools condensation occurs and liquid moisture will collect on colder surfaces, turning to frost and ice at temperatures below freezing. The higher the level of interior relative humidity and the greater the temperature differential between the interior and the exterior of the building, the more moisture will collect.

In extreme cases, and especially with the use of a single layer of insulation, ice build-up, due to condensation, can be noticed by a “cracking” sound when walking on the membrane. Also, heavy ice formation along insulation joints can generate expansion forces that push laterally, causing insulation joints to widen. Condensation within the roof insulation may cause permanent damage, loss of R-value and loss of wind uplift resistance.

As the outside temperature rises and the roofing system assembly warms up, frozen moisture begins to thaw, resulting in drips inside the building. The drips are not associated with rainfall or snow accumulation on the roof. In fact, drips are more likely to occur on sunny days when temperatures warm to above freezing.

The intensity of the drips is directly related to the amount of moisture that has intruded into and condensed within the roofing system assembly. The concentration of drips, however, is more likely to be seen around the perimeter and at deck end-laps.

## **Controlling construction-generated moisture**

Roofing professionals need to identify and plan for construction-generated moisture during the design process. In order to reduce the probability of condensation, buildings under construction should be adequately ventilated during concrete hydration and other high moisture-related construction activities.

Temporary, high-volume ventilation systems are commercially available and should be used during construction. These high-volume air-handling systems include dehumidification that is essential to remove large amounts of moisture from the air.

HVAC systems designed for temperature control of finished buildings are not sufficient to remove construction-generated moisture.

### **Additional cold climate design recommendations**

In cold climate regions (ASHRAE Zones 5-8), the following design recommendations should be considered as a matter of general practice. These recommendations are intended to supplement the measures taken to control construction-generated moisture.

- Use a vapor retarder to prevent moisture accumulation caused by air intrusion. The vapor retarder must be positioned within the roofing system assembly so that its temperature is always warmer than the dew point temperature. This prevents the warm, moist air from reaching the dew point, thereby eliminating condensation. Consult a roofing design professional or the roofing materials manufacturer/supplier to ensure that the proper amount of insulation (R-value) is used to keep the vapor retarder “warm.”
- Use multiple layers of insulation (minimum of two) with staggered joints to help retard warm, moist airflow from the interior of a building up into the roofing system assembly.
- Seal deck-to-wall joints and gaps around roof penetrations to further limit air infiltration into the roofing system assembly.
- Avoid, where possible, the use of wet materials or materials with an excessive moisture content.

### **Remedies for existing conditions**

In buildings where drips are frequently experienced, the interior relative humidity should be measured. If the interior humidity exceeds the outdoor humidity, a condensation problem may exist. The building should be adequately ventilated and dehumidified to remove excess moisture. Additionally, the following recommendations may help eliminate drips.

- Verify that the design operating temperature of the facility not been exceeded. The warmer the air, the more moisture it can hold.
- Provide air circulation using mechanical or electrical fans during the winter months to mix warmer and colder air, preventing moisture-laden air from accumulating beneath the roof deck.
- Check to ensure that the deck-to-wall joints and joints between the deck and roof penetrations have been sealed from the underside to prevent warm air intrusion from inside the building.

### **Conclusion**

All buildings should be designed to accommodate occupancy-generated moisture. In addition, construction-generated moisture must also be controlled. Buildings under

construction should be adequately ventilated during concrete hydration and other high-moisture related construction activities. All roofing system assemblies should be designed to accommodate the anticipated occupancy-generated moisture based on building usage and function. In cold climate areas the use of a vapor retarder should be considered as determined by a roofing design professional. Eliminating moisture intrusion into the roofing system assembly will improve the performance and life expectancy of the assembly, a benefit to the entire building industry.

### ASHRAE Climate Zones Map

