RRJ INSIGHT™

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A technical newsletter by Raths, Raths & Johnson, Inc. for the construction industry.

**"Insight: to see into and understand; an item of knowledge gained by this power."**

In this issue of *RRJ Insight*, we explore humidity and condensation problems on the exterior building envelope by using the Case Study of a Computer Center. Special building occupancies may require controlled interior relative humidity levels which are higher than normal office or commercial levels. For example, hospitals are humidified to assist patients with respiratory ailments and to reduce static electricity; libraries and archives are humidified to control the moisture content of paper and valuable artifacts; computer centers are humidified to reduce the potential for static electricity which may damage electronic components. Some occupancies such a pools, green houses and manufacturing plants generate their own high levels of interior humidity. In locations with cold winters, the walls of these buildings must be designed to limit condensation and to purge condensate which may occur under severe conditions. The use of a vapor retarder to limit diffusion through the wall materials is well known and understood. Equally important is controlling air movements with an air barrier so that warm humidified interior air does not freely reach the cold internal surfaces of the wall. Both a vapor retarder and an air barrier are needed for proper control of condensation, and the absence of one defeats the function of the other. Read on to learn about *Diagnosing the Problem* and *The Repair* involving a *Case Study of Wall Condensation Problems — Computer Center.*

*INSIDE*



*Computer center with exterior envelope condensation problems.*

# Project Profile

## Case Study of Humidified Computer Center – Diagnosing the Problem

A humidified computer center in the upper Midwest exhibited symptoms of condensation problems including wall weeping and water discharge in cold weather, at times when there was no precipitation to account for the water. In addition, water and frost built up on the inside surfaces of window framing and glass, even though the windows were glazed with insulated glass units. The original wall design incorporated three distinct vapor retarders: foil-backed drywall, plastic sheeting and foil-faced insulation batts. Clearly, diffusion was considered in the original design, and a steady-state analysis indicated that at least two of the three vapor retarders were needed to control diffusion. Unfortunately, the way the wall was designed and assembled permitted interior humidified air to flow around the interior wall finishes and the vapor retarders, and to reach the cold back side of the exterior granite cladding. An initial assessment of the problem indicated that control of air flow into the wall was inadequate, and an air barrier was needed.

To verify the initial assessment, instruments were implanted in the wall to monitor behavior over several winter months. A computer-controlled data acquisition system took hourly readings of temperature, relative humidity and differential air pressure at several layers through the wall profile. In addition to monitoring an as-built section of wall, two trial repairs where installed and monitored. One repair involved the complete removal of all interior finishes and insulation, and the complete reconstruction of the wall from the interior. The other repair involved upgrading the existing construction to improve control of air movements using sheet metal closures, sealants and expanding spray foams, thereby making maximum use of existing building components. Complete removal and reconstruction of the entire wall was not a viable alternative because of the nature of the occupancy and the critical mission of the building operations.

The most difficult part of the test program was isolating the test areas from the rest of the wall so that measurements would not be contaminated by moisture migrating from outside the test area. Some of the problems encountered while isolating the test areas, such as the idiosyncrasies of expanding spray foam and the internal drainage patterns of the wall, were quite instructive in developing final repair details. In situations like this, ordinary materials are being used in unusual ways, and conventional wisdom about material properties is not always adequate. For example, the small amount of shrinkage in expanding spray foam could create breaches in the air barrier we were trying to create, and it was necessary to use a knife-grade elastomeric around penetrations to supplement the foam.

The instrumentation program verified that movement of interior humidified air into the wall was the cause of the condensation problem. The program also indicated that the first repair alternative involving complete reconstruction of the wall from the interior side provided better condensation control than the second repair alternative involving upgrading the air barrier. The monitoring program made it possible to determine that the differences in behavior between complete reconstruction and simply upgrading the air barrier were small and would occur only under the most severe climatic conditions. It was also determined that the differences in behavior were temporary, and would not damage the wall.

*— Robert J. Kudder, S.E.*

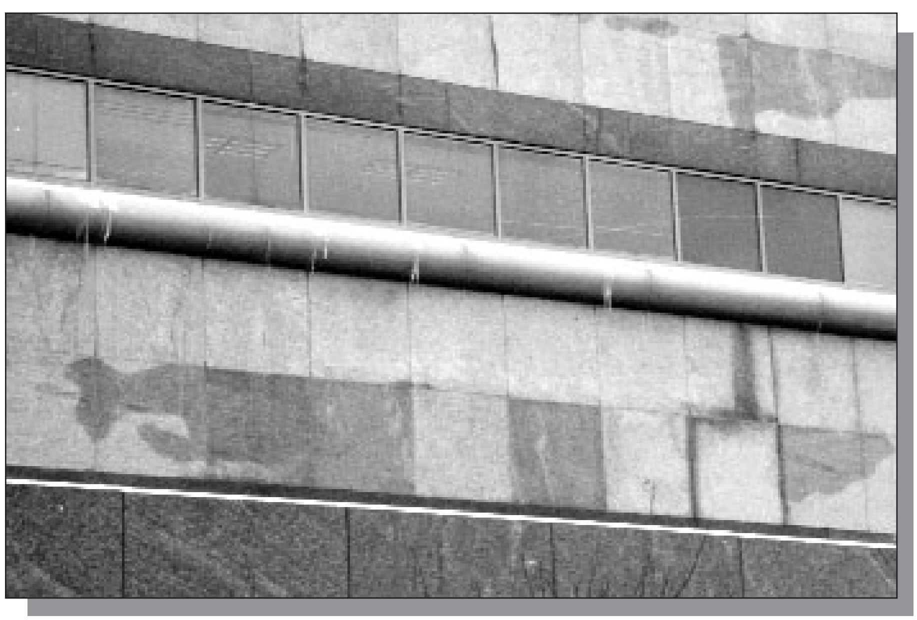

*Figure 1 – Weeping and icicles on the exterior due to condensation.*

# Tech Tip

## Case Study of Humidified Computer Center – The Repair

Selection of a repair involved intensive collaboration with the Owner. The relative merits of each approach were considered and discussed in detail. The computer center is an occupied and sophisticated building which must remain in operation. The relative disruption, cost and duration of each repair alternative was explored and weighed against the relative advantages and disadvantages. Upgrading the air barrier was selected as the repair approach. The development and evaluation of repair alternatives, and close collaboration with the Owner, are essential parts of our engineering services. The optimal repair is not necessarily the most complete and costly repair, nor is it necessarily the cheapest or the quickest repair. An informed decision can only be made with information gathered during a thorough problem evaluation program, including testing of alternative repairs when appropriate.

Most of the existing drywall and the existing triple vapor retarder were incorporated into a full air barrier. Strips of drywall around window penetrations were removed so that the existing vapor retarders could be tied together and sealed to the window frames. At the top and bottom of the wall, sheet metal closure strips were used to close gaps. A lip on the closure strips accepted sealant to complete the barrier. The drywall enclosure around exterior columns terminated at the level of the drop ceiling, creating exceptionally large air paths into the wall. The metal framing of the enclosures was extended to the underside of the slab above and additional drywall installed before the sheet metal closure detail could be applied. Penetrations through the drywall for exterior panel anchors, pipe penetrations and diagonal braces posed a special problem. A sheet metal collar was developed for installation around the penetration, and the space within the collar was filled with expanding foam. The foam was then trimmed and sealed. The parapets were opened from the roof side and sealed with expanding spray foam and an elasto-meric. Mini-vents were installed in the exterior sealant joints to ventilate the space behind the granite panels.

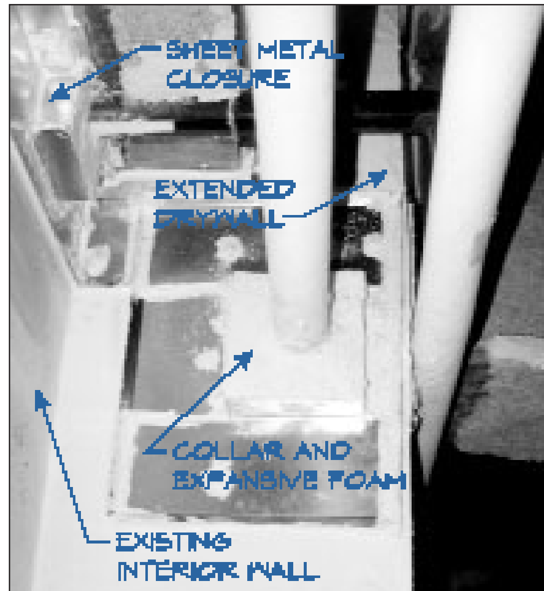


*Figure 2 — Use of sheet metal collars and strip, sealants, and spray foam to upgrade the air barrier.*

Frost and water accumulation on the windows was a separate problem not solved by up-grading the wall air barrier. The repairs considered were: replacement with units that had a sufficient *Condensation Resistance Factor* (CRF) for the high interior humidity; or, an interior insulated glass unit (IGU) supplementary sash. Tests were conducted in an environmental chamber to verify that the combined original and supplementary sashes would have an adequate CRF. The tests revealed that the windows would control condensation on the glass, but that the heavy extruded window trim sections were still too cold because they partially communicated with the exterior. Creating a conventional thermal break, such as a plastic insert, was not practical. After studying the shape of the aluminum extrusions and determining the conduction paths, we tried a very simple and inexpensive repair while the units were still installed in the test chamber. Reasoning that the low temperature of the interior trim resulted from conduction through the aluminum, we sawed intermittent slots in the trim to interrupt the conduction path. This is a technique borrowed from conventional thermal stud technology, and it worked well.

This repair has been in place for several years now, and is performing within the expectations of RRJ and the Owners. It was particularly satisfying to apply unusual and cost-effective repairs, verified through testing, rather than immediately condemning the entire wall construction, demolishing everything, and starting all over. The project was enhanced by the Owner's willingness to explore alternatives, and by the contractors, who grasped the concepts behind the repairs and contributed their knowledge and experience to achieve the repair objectives.

*— Robert J. Kudder, S.E.*

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