ROOF LEAKAGE DECEPTION

Exterior Walls May Be the Culprit

By Pam Jergenson, CCS, CCCA

Introduction

For some, an elusive building leak strikes a chord of terror. For others it is the frustration of another exhausting, unending problem. A building owner or maintenance crew dreads a recurring leak because all the phone calling, head scratching, floor swabbing, ladder climbing, and ceiling tile replacement become futile efforts. Left unresolved, leaks might go beyond the "bucket-will-catch-it" approach. They can take on a new meaning with the four-letter "M" word – MOLD – which invokes even a deeper sense of fear. A despairing mental image begins to appear – a vision of dark spots with more spores than bleu cheese. Add to that staff complaints about vague, ongoing physical symptoms of illness and the (heaven-forbid!) legal side of this damp coin.

For the roofer who has been called again on a rainy day to see that same drip, drip, drip, the evasive leak is the frustrating challenge that another roof patch or repair did not work. But believe it or not, this kind of leak justifies the thoughts of those people involved or affected. The building occupants' complaints are valid. Symptoms are not all in their heads. The facilities people have a legitimate fear of not getting the awful problem fixed. The roofer is vindicated because it is not a roof issue anymore. For a small group of people, however, another challenge presents itself. What else exists in the building envelope that could be the source of the persistent leak?

Think about the exterior walls. Do not let components like brick veneer fool you. Today's complex wall systems rely more on the engineered details of through-wall flashing than the historic counterpart of solid wall construction with multiple masonry layers. Leaks in the complexity of today's exterior wall systems are the 1,000-piece puzzle for the small group of people who solve building envelope issues. Even this group of people – engineers and industrial hygienists – are right about an unsolvable leak accompanied by mold: it is a formidable challenge.

Photo 1 (above) - Brick, stone, stucco, and a tile roof grace this nine-year old city hall.

Photo 2 - The ballasted, EPDM roof eventually proved innocent.

Photo 3 - A closer look at all the windows was warranted.

Photo 4 - The diamond-shaped windows were suspect in the investigation.

Case Study – City Hall

What was thought to be roof leakage had plagued a nine-year-old city hall for several years. Unbeknownst to the city, a mid-sized suburb of Minneapolis, Minnesota, the brick veneer over a steel stud wall was the real culprit, not the continually accused EPDM roof. City hall was a two-story, brick masonry building with stone and stucco features, diamond-shaped windows at the second floor, ballasted EPDM roof, and steep-slope concrete tile roof (*Photos 1-4*). The building owner had a proactive stance with a roof management program incorporating periodic visual observation of all municipal building roofs, including city hall, by a roof consultant. Nevertheless, although one of the last visual observations for the city hall roof did not reveal any deficiencies, leaks were still reported. They appeared below the base flashings of the low-slope roof section at the connection of the upper walls. The roof consultant concluded that the leaks weren't from the roof anymore, and that eventually proved correct.

Survey and Investigation

The building owner logically turned to the next building envelope feature: the brick veneer exterior walls. Like the game show Jeopardy, a series of clues leading to answers in question form evolved. This continued for almost two years, starting with a preliminary exterior wall survey. The survey observations included potential through-wall flashing deficiencies (*Photo 5*) that were more than what spot tuckpointing could mend. This resulted in an investigation with a series of inspection openings performed at key hot spots for through-wall flashing deficiencies. Those hot spot locations included:

- Roof-to-wall transition.
- Between the window and roof-to-wall transition (*Photo 6*).
- Roof parapet intersection with the wall.

That investigation revealed two potential options for the building owner to explore. One option was a litigious effort to pursue the architect and general contractor for exterior wall design and construction deficiencies to recover some of the mounting costs relative to the pending repair before the statute of limitations expired. The other avenue was the link between the exterior wall deficiencies and the ongoing mold abatement that had been started a few months earlier when building occupants complained of symptoms similar to those from Sick Building Syndrome. Until this point, the mold abatement and indoor air

THROUGH-WALL FLASHING KEY CHARACTERISTICS

- **Continuity of flashing**
- **Top edge termination**
- **Extension through the wall**
- **End dams for terminations**
- **Unobstructed weeps**

Check the Brick Industry Association website (http://www.brickinfo.org/) or the Masonry Society website (http://www.masonrysociety.org/) for more information and details on through-wall flashing.

Photo 5 - Repair to through-wall flashing deficiencies needed more than joint sealant or spot tuckpointing.

quality issues had been dealt with independently of the exterior wall work. Despite the initial mold abatement, building occupants were still experiencing symptoms.

Legal Investigation

A large-scale investigation was scheduled. It began with water testing and an additional series of inspection openings, both coordinated with the city's industrial hygienist. All of this took place with the guidance of the city's legal counsel, to execute claims within the 10-year window established by applicable statutes for legal claims.

Water testing occurred at the roof-level walls, spraying at the through-wall flashing and the diamond-shaped windows. This testing, intended to simulate wind-driven rain, demonstrated that the through-wall flashing had deficiencies that contributed to the leakage (*Photo 7*). The diamond-shaped windows also leaked. The roof membrane was blameless.

Photo 6 - Test opening performed between the diamond-shaped window and roof-to-wall transition.

The expanded series of inspection openings included shelf angles, columns, and windowsills. It also included window and balcony heads at roof and grade level. The openings revealed fractured through-wall flashing membrane, no end dams, no flashing extension beyond the brick face, improper laps and seals, rusted shelf angles, and unsecured top termination (*Photo 8*). The correlation of the through-wall deficiencies, the mold locations, and the indoor air quality became apparent at this point. The industrial hygienist reported higher mold counts from contact samples that were taken at the base of first floor

Photo 7 - Leak testing simulates wind-driven rain.

walls at the building perimeter and in spaces below the low roof connection to the upper walls.[1] The investigation became the basis for a pending suit against the original architect and general contractor.

PVC Analysis

As an offshoot of the through-wall deficiencies, the through-wall flashing membrane, made of 20-mil polyvinyl chloride (PVC), had failed within nine years of construction. This material failure became another critical point of the legal case and required additional testing. The failure of the PVC membrane was crucial to the argument that use of this flashing material is not consistent with a structure built with brick and mortar and intended to last 50 years or more. The additional testing of the PVC membrane included a subjective rating of the brittleness of several pieces of through-wall flashing taken during the repairs from various locations and exposures. This was followed by an infrared and chemical analysis to determine plasticizer loss of the vertical and horizontal portions of the same flashing. The subjective rating of the brittleness was a scale of 1 to 5, with 1 being flexible and 5 being brittle and cracked, as determined by touch and visual observation (*Photo 9*). Solvent extraction and gas chromatography served as the chemical analysis methods used in the testing.

The outcome was twofold: the horizontal portion was almost always more brittle than the vertical portion in the subjective rating, and the PVC membrane installed within the past nine years had a plasticizer loss of up to 57% more in the horizontal portion than the vertical portion.[2] The plasticizer loss meant the PVC membrane was not nearly as flexible as when it was first installed and had actually become brittle and subject to fracture.

Photo 8 - Test openings revealed numerous deficiencies.

The following findings demonstrated that PVC was a poor material to choose as a through-wall flashing material – especially for a municipal building that current standards would have expected to stand proud for 50+ years:

- Material failure seen *in situ.*
- Plasticizer loss found during chemical testing.
- Visually observed brittleness.

Repairs

The legal battle proceeded, but timely repairs were still needed to stop the leakage, abate the mold, improve indoor air quality, and prevent further building occupant complaints and absenteeism related to physical symptoms. In a building plagued with improperly-installed, unsuitable through-wall flashing material, leaky windows, and mold needing abatement, these repairs became a large project that touched every building elevation and element, inside and out.

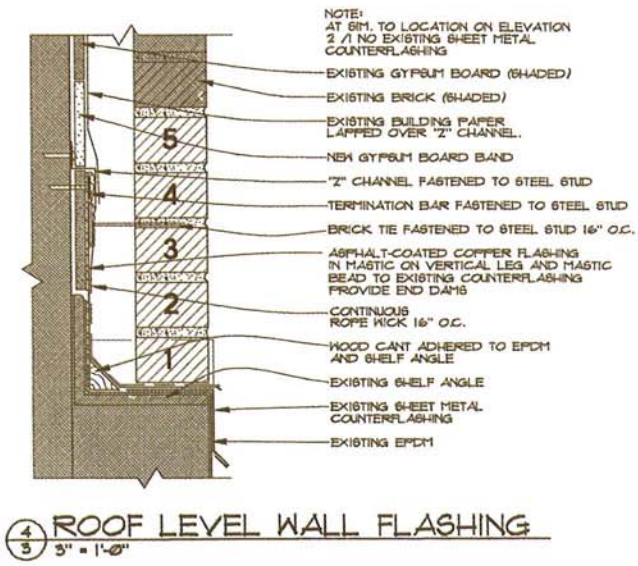
The through-wall flashing was replaced at grade (*Photo 10*), below windowsills and louvers, above window heads, at low roof connections to upper walls (*detail*), shelf angles, and under parapet coping stones. When the through-wall flashing was replaced, water-damaged exterior gypsum sheathing and batt insulation were replaced and rusted steel studs were cleaned and painted (*Photo 11*). To properly design and specify such a repair project, coordination and communication between the engineer and industrial hygienist were imperative to create a complete set of detailed construction documents that would not invite change orders.

Photo 9 - Brittle PVC sample tested by chemical analysis to show level of plasticizer loss on PVC through-wall flashing membrane.

Photo 10 - Through-wall flashing was replaced at grade, window sills, louvers, shelf angles, and other areas.

As with any project involving unforeseen conditions, the best assumptions were made as to the type and quantity of repairs, based on the inspection openings done prior to construction document development. These assumptions were written as allowances, with the accompanying unit price for items such as exterior gypsum and batt insulation replacement. To ensure adherence to quality and schedule, the engineer and industrial hygienist were involved in the daily construction observation and weekly progress meetings. The repairs and abatement were completed. This eventually led to clearance testing with approved results by the industrial hygienist.

Photo 11 - Water-damaged exterior gypsum sheathing and batt insulation were replaced while rust was removed from existing metal components.



Detail 1 – Roof level wall flashing.

end, the building owner, the building occupants, the roofer, and the building envelope team – an engineer and industrial hygienist – all received validation of their viewpoints. By resolving the dreaded leak, the building owner expects to eliminate the phone calling and head scratching. The building occupants expect to work in an environment where they do not succumb to non-descript physical symptoms. The roofer expects no more weary requests to look at the same drip, drip, drip.

Think again about that irritating leak in your or a client's building. It may not be the hastily accused roof, but instead the unassuming exterior walls.

References

1. For further perspectives from the industrial hygienist on this project, see: Lewis, Todd. "Project, Risk Managers Should Know Their Roles," *Indoor Environment Connections*, January 2005.
2. For more information on the PVC membrane testing, see: Jaffe, Rochelle, and Rebel, Bill. "Analysis of Polyvinyl Chloride Through-Wall Flashing," *Proceedings of the Ninth North American Masonry Conference*, June 2003.

Conclusion

The intricate web of building envelope issues produced by that frustrating leak created a great challenge for many involved. This challenge was not only to help prepare the legal case, but more importantly to investigate and prepare the construction documents for the sought-after long-term performance and successful repairs of a city hall that deserves to live a long life. In the

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NRCA Establishes Hurricane Relief Fund

The National Roofing Contractors Association (NRCA) has established the Hurricane Katrina Roof Relief Fund with its charity partner, Rebuilding Together, a volunteer organization that rehabilitates the houses of low-income, elderly, and disabled homeowners. The fund will be used to provide new roofs in the regions affected by Hurricane Katrina.

Contributions to the fund can be made to the National Roofing Foundation (NRF). Donations are tax-deductible, and contributions will be used exclusively to fund relief efforts. NRCA and NRF will cover all general and administrative costs.

Checks may be mailed to the NRF, 10255 W. Higgins Road, Suite 600, Rosemont, IL, 60018. Donations may be made with a credit card by filling out a form on NRCA's website, **www.nrca.net.**