**Building Envelopes: Focus on Energy**  
*By Eric J. Seaverson, P.E.*

**It is Important to Identify Common Air-Leak Paths**

New and existing buildings are notorious for leaks. Moisture within the building envelope can migrate to the interior of the system, damage components, and reduce insulating values. In terms of air leaks, openings in the building envelope result in direct energy loss.

Implementing an inspection and maintenance program that incorporates infrared diagnostic tools to prevent and reduce leaks can provide significant savings for commercial and institutional facilities.

A range of issues, including air leaks, wet insulation, and thermal bridging, typically account for energy loss in building envelopes. Using infrared technology can help technicians identify and prevent these three issues, as well as improve energy efficiency.

**Air Leaks**  
To prevent un-tempered, exterior air from entering interior spaces, technicians typically balance mechanical systems to create a positive pressure, where more air is supplied to the interior rather than exhausted, pushing air out through openings in the building envelope.

Although this is a common practice in commercial and institutional buildings, openings in the envelope can allow significant amounts of air to exit the building, drastically increasing heating and cooling loads.

Common air-leak paths through the building envelope include around and through windows and doors; gaps at transitions between walls and floor or roof levels; transitions in wall-system types; and structural penetrations through the wall system.

**Wet Insulation Decreases a Building's R-Value, Thermal Efficiency**  
Moisture within building-envelope components, such as insulation, leads to premature deterioration of the material. It also decreases the R-value and thermal efficiency of the overall building. Moisture can reach building-envelope components in many ways, including condensation and direct water leaks through the building envelope.

Due to budget constraints and the out-of-sight, out-of-mind mentality many organizations possess, roofs are one of the most commonly neglected envelope components. But roofs are important for thermal efficiency and preventing moisture from entering the building.

Moisture in insulation significantly decreases the roof’s R-value. Condensation within the roof section or bulk water migrating below the membrane can be the cause of the moisture. Some roofs leak due to age and lack of maintenance, but improper or unreliable detailing typically leads to the majority of water migrating below the membrane.

**Infrared Cameras Can Detect Thermal Bridging, Air Leaks, Wet Insulation**  
Although air movement transports cold air into a building and forces warm air out, thermal bridging through the wall system also can increase the load on the mechanical system. Thermal bridging consists of temperature gradients through components, such as cold, exterior air cooling a window frame, which then cools interior air.

The wall system also can contribute to heat losses and gains from thermal bridging. Many facilities use fiberglass batts in the wall cavity between steel studs to insulate the wall. But the insulation is inserted between the steel studs, breaking the continuity of the insulation. Thermal bridging occurs because the steel studs extend from the exterior — cold — side of the wall to the interior — warm — side of the wall.

**Identifying Energy Loss**  
Infrared scanning technologies can help technicians identify energy loss in building envelopes. Infrared scans can identify air leaks, wet insulation in a roof and some wall systems, and significant thermal bridging.

While using infrared diagnostic tools might look easy on the surface, scanning does not mean technicians are merely looking through a camera. Trained thermographers, infrared camera technicians and knowledgeable building envelope professionals must interpret the thermal images to determine the scans’ findings. For example, reflections of apparent heat loss on a surface might provide a false-positive.

Infrared scanning is limited to specific types of systems and components, mostly barrier-type systems that do not include a cavity between the exterior shell and the back-up wall system, such as brick veneer. Air leaks can dissipate behind the face shell and veneer with a cavity system, so technicians might not be able to identify the leak with an infrared camera.

Secondary techniques for identifying air leaks include visual surveys, pressurization of the building, and the use of smoke pencils. In some instances, openings in the building envelope are very obvious. After locating large air-leak paths, technicians can use smoke pencils to identify smaller paths. Although infrared scanning and smoke pencils can identify leak areas, they cannot identify the cause of the leak. Technicians need to evaluate and investigate further to determine the cause.

For example, an infrared scan might indicate wet insulation, but it will not determine the reason the insulation is wet. Also, infrared scanning or smoke pencils can identify air leaks, but they do not indicate the breach in the air-barrier system. Making that determination might require destructive testing and exploratory openings to examine concealed components.

**Building Envelope: A Maintenance Checklist**  
Before managers can develop a maintenance program for the building envelope, they must ensure the system is as functional as possible. Ensuring the building envelope is functional could require a year’s worth of maintenance or an extensive capital investment. A capital project could include a roof replacement, sealing significant amounts of openings in the back-up wall construction, and replacing windows.

Once managers have established a functional and relatively efficient building envelope, they can develop a maintenance plan. A typical plan includes:

* visual surveys of deterioration and openings in roofs
* annual repairs of detected deterioration
* infrared surveys of roofs every five years
* visual survey of wall-system components annually
* sealants in wall systems and window perimeters
* window glazing gaskets
* cracks and openings in wall-system components
* interior survey of openings in wall systems above the ceiling
* infrared survey of wall components every five years.

**Replacing Windows Improves Building Envelope Efficiency**  
While technicians can conduct a range of maintenance tasks to improve the performance of building envelopes, replacing windows is another strategy for improving the system’s efficiency. Technology advances have significantly increased the R-value of windows, but the overall R-value remains low, compared to an average wall system.

Some recent advances include bar-type thermal breaks and warm-edge, insulated-glass units. Manufacturers have improved the performance of solid-plastic thermal breaks in frames by using two plastic bars separated by an air gap. The air gap is less conductive than the solid plastic. Although insulated-glass units generally are efficient, most of the thermal loss is due to the metal spacer. Manufacturers have helped reduce thermal bridging with composite and plastic spacers.

In some cases, such as single-pane window systems, the energy savings from replacing windows are obvious. But the energy savings and corresponding payback period of replacing existing windows with insulated-glass units are not as obvious. Technicians should perform a system analysis, including an assessment of air leaks, to make those determinations.

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