

Conducting thermal investigations for moisture in building envelopes

Application Note

Testing Functions Case Study

By Regan Brown and David Brown for Fluke



Using infrared cameras (thermal imagers) to detect moisture and building failures is a new, rapidly growing business. Hurricanes, flooding, and subsequent mold growth have escalated the need for fast and accurate moisture investigations.

In the past, infrared has been successfully used to detect roof failures and in the fire and water restoration industry. As infrared cameras become more readily available, they are quickly being introduced into what is often referred to as “fire and water repairs”, “building forensics investigations” or loosely as “construction insurance work”.

This article describes how building industry contractors can combine thermal imaging with their building inspection skills to make useful assessments.

Water damage

Many insurance carriers have now accepted the use of thermal imaging to identify moisture in the interior walls. With infrared images, insurance companies can better detect water damage, thus reducing unforeseen conditions and later requests for more abatement. A thermal imager shows the Evaporative Moisture Cooling effect (EMC) that occurs when the studs, insulation and other interior wall components are damaged from water.

Tool: Fluke FlexCam Thermal Imager

Operator: Regan Brown, Principal, G.B. Group General Contractors

Inspections: Interior wall components, roofs, electrical, plumbing, HVAC, exterior components.

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New

Building forensic investigations

Forensic investigations may simply mean “to discover building failures” or it can also be attached to litigation as builders, homeowners or multiple family associations engage in lawsuits for construction defects. Typical areas of recognized defects include sloped roofs, electrical problems, plumbing or HVAC failures, insulation failures or water intrusion from any number of failing exterior components. Because there are so many components, infrared alone cannot answer all of the questions to building failure or moisture problems but it can serve as a powerful tool eliminating hours of traditional investigative methods.

An example of this would be a homeowner who notices water on the carpet near a window. **(See photos below)**

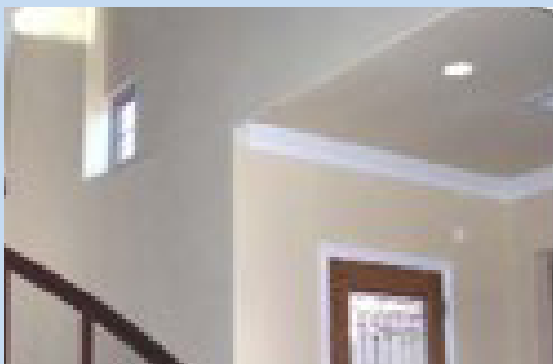
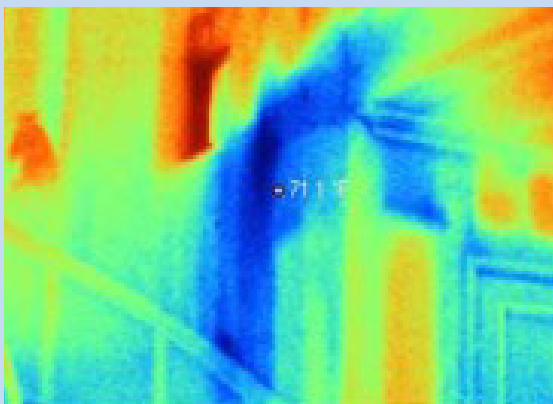
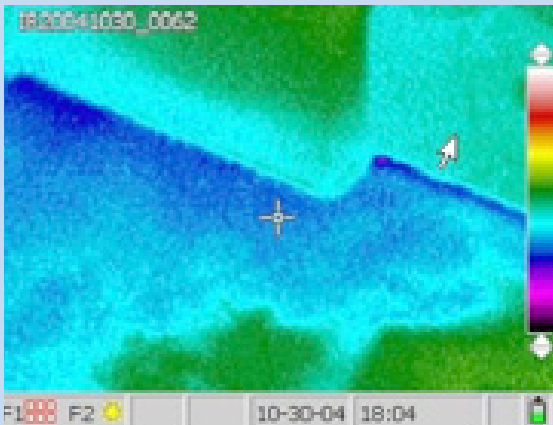
Traditional investigative methods might include “tracking” with either an invasive moisture meter or a newer non-invasive moisture meter. This method would try to determine

if the water is coming through the wall, from the window, or running down the wall cavity from some other penetration location.

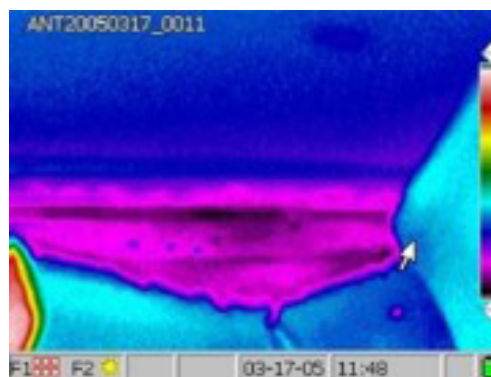
Eventually this would require some means of invasive investigation: cutting open drywall to try and find the leak; opening exterior envelopes to look at flashing detail, (etc.) and then adding water in order to duplicate the behavior.

With an infrared camera, you can quickly and non-invasively zero in on the probable area, because the anomalies created by evaporative moisture cooling are easily identifiable. In the carpet example above, if the water was coming from the roofline or some other ceiling transition area, you would see the anomaly either in multiple locations or as a continuous anomaly from ceiling to floor.

Ultimately the leak investigation may still require invasive action, but the IR gets us to that location much quicker and with less intrusion to the building envelope.



Examples of water damage



By the location and pattern of moisture, visible on the thermal imager as a change in temperature, the inspector can determine where the water is coming from —the window, in this case, vs. the ceiling or floor.



Framing an investigation

Often the request for infrared inspection is well past the opportunity to see the problem at its optimal condition, due to scheduling restraints, litigation protocols, or simply delays in the request by the resident. So in this case, we may need to reintroduce water to the probable affected area. At this point the inspectors may be asked the following questions:

- What if the leak dries before you are scheduled?
- Can you only conduct IR investigations after it rains?
- Can it see through anything? (concrete, stucco, siding)
- How long does it take?
- How much does it cost?

The questions the technician should ask are:*

1. How old is the building? (This gives us an idea of the type of failure.)
2. When did you first notice a problem? Was it during a rainstorm? Was it a hard rain? Do you only notice the problem after many days of rain?
3. If it is an exterior wall, and rain is not involved, is the landscaping running against the same wall? Is there exterior staining from sprinklers?
4. Is this a multiple-story unit? Is it directly below a bathroom or kitchen?
5. What kind of access is around the effected area? (Meaning, is this a 3-4 story building?)
6. Does it have extensive landscaping?
7. Have you conducted any repairs recently? (i.e. reroofing, painting, HVAC etc.)

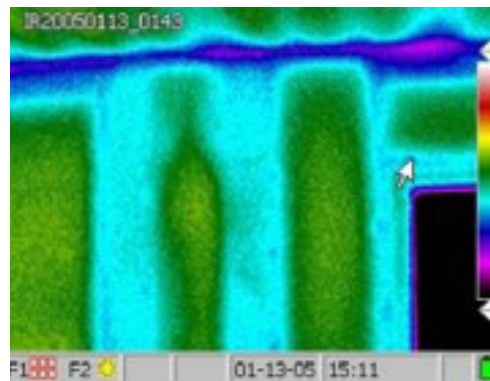
* For this example, this is not a home with litigation issues, just water intrusion problems. The location of the complaint is very important; it provides the first clue to the type of problem the residents may be experiencing. However; water will follow the path of least resistance, so prepare for it to travel along a 2x 4, a metal RC track, a tape joint, and so forth.

The history you learn about the building will direct you to the area where you will start your water test. Often regardless of who eventually hires you to do the investigation, you must speak with the actual resident and, in some cases, neighbors above or adjacent as well.

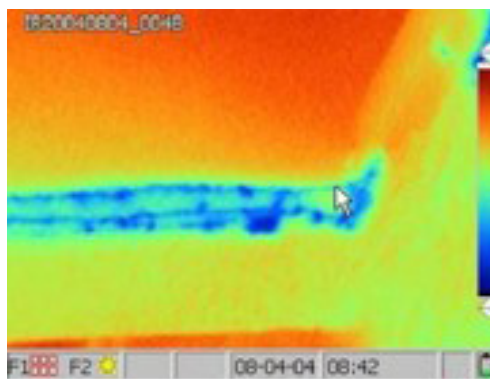
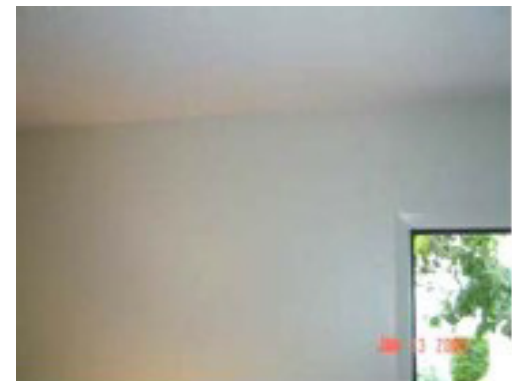
Beginning the investigation and water test

Next, prepare the interior to minimize any further damage and document the affected area in its existing "before test" condition. Documentation includes digital and thermal photographs and a brief description.

To reintroduce water to an affected area, always start at the bottom and work your way up unless evidence from your preliminary investigation shows moisture coming from above; i.e. the roof and ceiling are the affected area. **(see stucco photos below).**



Tracing the path of moisture at wall/ceiling joints.



Cold water emerging through stucco.



Always document the start and stop times and move the water to each new location in eight to ten minute increments. You should not have to exceed 30–45 minutes of water testing on one specific area. Once you have duplicated the leak, stop testing in that location. However, continue up the exterior wall to confirm there are not multiple locations.

Take notes or voice record the steps you are taking and a brief description of every thermal photo. This is important, as the digital photographs are usually easily identifiable, yet the thermal photos may later not make sense without the notes. (Fluke thermal imagers offer IR-Fusion® dual digital-thermal pictures on screen, to take care of this problem, and some allow you to attach voice recordings to saved images.)

Tips for success

The greater the span in temperature from outside to inside the building envelope, the better the thermal results. To ensure a successful thermal test, schedule your investigation according to the weather.



For example, if the weather is very cold outside, manipulate the temperatures of the building's interior temperature by turning up the heat. The warm/hot climate of the western states is excellent for thermal investigations with air conditioning cooling the building interior. The water used in testing also tends to be cooler, creating greater variance in temperature and therefore generating better thermal images.

Exteriors such as stucco are more porous, absorbing and retaining moisture, providing better exterior shots than siding, which hides water behind the thick planks. You can also use hot water on a cold exterior, but it is more difficult apply enough to locate the problem.

Where building industry experience counts

Anomalies in building envelopes may appear fairly easily, but if you don't have construction experience consider teaming up with a construction expert to help interpret the results. Refrain from speaking in absolutes until you verify each location. Save your comments for your report. Comments can easily be misinterpreted by the lay person or homeowner resulting in problems later. Lastly, don't forget to leave the residence in the same or better condition when leaving.

Tools useful for conducting a water test:

- Thermal imager
- Moisture meter for confirmation of results
- Flashlight
- Digital or 35 mm camera
- Small notepad and pen for taking notes
- A paint brush to move away dirt and debris from window and door tracts etc.
- A dust mask to prevent inhaling dirt and dust in confined spaces such as attics.
- Booties to cover shoes when repeated entrance and exits into residences is necessary.
- Ladders that can extend to the necessary building height.
- Water hose with spray nozzle or calibrated spray rack.
- Duct tape and plumbers putty for sealing up holes during testing.
- Caulking and caulking gun for temporary repairs if necessary.

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