

Using IR to Diagnose Building Conditions

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Infrared (IR) thermographic inspection is a powerful and noninvasive means of monitoring and diagnosing the condition of buildings. IR cameras provide immediate documentation of as-built or post-restoration quality, post-casualty cause and origin data, plumbing and building envelope water leakage, post-flood and fire water-damaged material assessment, energy use inefficiency, and electrical problems.

ADVANTAGES OF IR FOR BUILDING DIAGNOSIS

- Trace hard-to-find moisture sources quickly and easily.
- Inspect with minimal building disassembly.
- Minimize disturbance of tenants.
- Capture thermographic images instantly.
- Output full-motion infrared video records in real-time
- Create reports of inspection results in seconds.
- Select agencies and trades for restoration and repair with speed and assurance.
- Protect against frivolous complaints.
- Provide the basis for fair settlements.

Moisture and Mold

Moisture in building materials can destroy structural integrity and nurture mold and insect infestations. IR cameras distinguish between wet and dry materials by exploiting the thermal characteristic of wet materials to store heat very well and warm up or cool down more slowly than dry materials. Grades of water can vary from clear to black-river water (see table).

The thermogram (right) clearly shows a leaking bedroom ceiling (visible, left). The leak was assumed by the owner to originate in an upstairs marble-paneled bathroom in the \$3 million home. The estimated cost to rip out and replace the marble to access the plumbing was estimated at \$80,000! Further IR investigation absolved the bathroom and traced the source of the leak to a clogged weep hole under the threshold of a door leading to an upstairs porch.



GRADES OF WATER

1. Clear
 2. Gray-contains bacteria and other microbial growth
 3. Black-river water, flooding, herbicide content, microbial content
- For the first 72 hours, Clear grade water loss remains "Clear", but after that, it can become "Gray" with growth of bacteria and fungus. If untreated for several more days, it can downgrade to black water
 - Moisture must be evaluated on a daily basis, and no less than every 2 days until dry. Last IR thermograph must show NO thermal anomalies.
 - Wet drywall has been found to be about 6°F cooler than dry drywall due to evaporative cooling.

Mold in particular is a growing concern for lenders, developers, producers of building materials, and building owners and investors because of the growing number of filings of health-related tort claims. In a nutshell, all mold is bad; some mold is worse (see table). Certain molds can cause a variety of adverse human health effects. Mold requires moisture to grow. It stops growing when dry, but health issues remain. The actual presence and identification of specific types of mold requires further investigation beyond thermography, including visual inspection and laboratory cultures.

DIFFERENT TYPES OF MOLD AND THEIR ASSOCIATED MOISTURE REGIMES

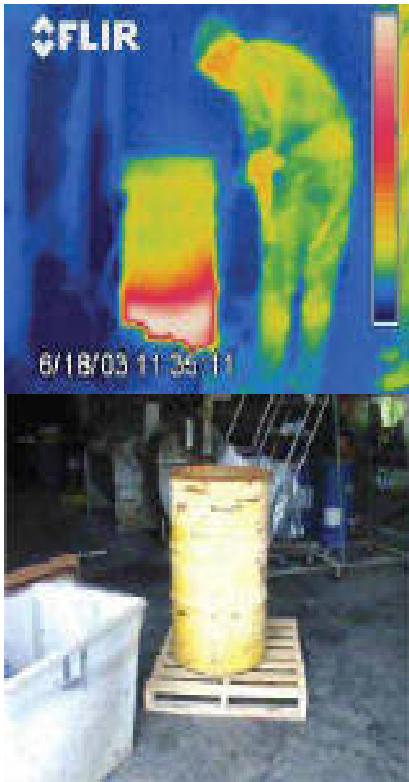
- Black mold, *Stachybotrys chartarum* (atra) is a toxic fungus that occurs widely in North America, but is uncommon in homes. It can cause pulmonary hemorrhage (PH). It requires water-soaked cellulose (wood, paper, and cotton products) to grow -- typically from flooding, serious plumbing problems, or roof leaks -- and takes about two weeks to start amplifying. While wet it looks black and slimy perhaps with white edges; when dry it looks less shiny.
- *Penicillium* grows in damp, but not wet conditions. Some species produce toxins and may render food inedible or even dangerous. It is a good practice to discard foods showing the development of any mold. On the other hand some species of *Penicillium* are beneficial to humans. Cheeses such as Roquefort, Brie, Camembert, Stilton, etc. are ripened with species of *Penicillium* and are quite safe to eat. The drug penicillin is produced by *Penicillium chrysogenum*, a commonly occurring mold in most homes.
- *Aspergillus* refers to a group of mold fungi which are found world-wide and are especially known for decaying fruit and vegetables. They are very common in the autumn and winter in the Northern hemisphere. Only a few of these molds can cause illness in humans and animals, and fortunately most healthy people are naturally immune to its effects. The most problematic varieties are *Aspergillus fumigatus*, *Aspergillus niger*, *Aspergillus terreus*, and *Aspergillus flavus*. The mold can cause allergic reactions in the bronchia and lungs, grow in the lungs and sinuses, and become invasive in immunosuppressed people. However, most healthy people do not develop disease caused by *Aspergillus*.

The first step in mold remediation is to quickly and accurately locate and remove all sources of moisture. IR cameras can instantly image entire rooms, inspect places that can't be physically reached with moisture meters, reveal wet conditions behind surfaces such as enameled walls and wallpaper that don't readily water stain, track

leaks to their source, monitor the drying process, and confirm when a structure is dry.

Post-disaster “Cause and Origin” investigations

To a building owner or an insurance company involved in a property damage settlement, clear images of normally invisible diagnostic evidence can be invaluable for planning the restoration effort and rationalizing settlements. After fires, IR cameras can quickly locate remnant hot spots, providing potentially valuable data for insurance companies’ Cause and Origin investigations — and assure that a fire is truly extinguished. For catastrophic storm water intrusion and plumbing failures, IR thermography can trace the influx of moisture to find the ultimate source of the incursion with little or no physical disassembly of the premises and minimal disturbance of inhabitants.



This thermogram dramatically reveals the general manager of a garment dying facility leaning toward a 32 gallon drum demonstrating a dramatic level of heat being generated by the exothermic reaction of sodium hydrosulfite and water. The property manager immediately summoned an industrial hygienist, who summoned the authorities.

During remediation and restoration, IR thermography can evaluate the progress of the drying process per accepted standards. The availability of authoritative thermographic records can reduce or even eliminate the need for insurance representatives to make personal on-site inspections, and the thermographic record of the remediated property can protect against future frivolous claims.

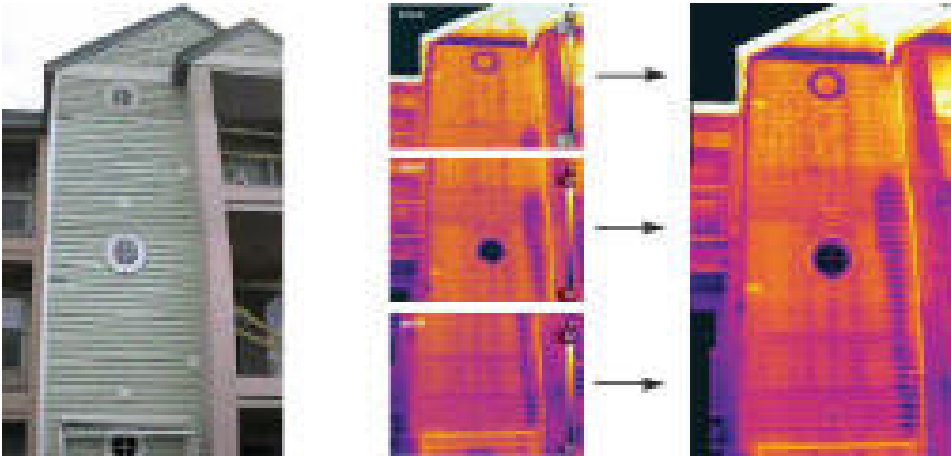
Energy efficiency

IR thermography is a well-accepted method of imaging and evaluating the state of electrical wiring, the thermal efficiency of building insulation, doors, windows and other penetrations, and the efficiency and condition of heating and cooling systems. Temperature anomalies revealing problems are rendered visible, enabling needed repairs to be made with confidence.

Cameras and software for building inspections

IR cameras used for building inspections should provide both still and full-motion video thermographic images. Especially in flood and post-fire situations, infrared video is a real timesaver, as walk-through inspections in inhospitable environments can be done quickly and the results thoroughly and conveniently analyzed later. To handle video, the IR camera must have fast (60 Hz is good) scanning speed and standard video output. Interchangeable lenses are highly desirable to accommodate all the working distances and target sizes you will encounter. Wide-angle is great for fast scanning and close-up situations; longer-focus may be necessary to accommodate small spot size targets at greater distances.

The thermogram of this vinyl-sided 3-floor apartment house clearly shows the path of a serious leak from a washing machine on the third floor, which is completely hidden within the wall. The thermographer used FLIR's Image Builder software to automatically "stitch" the three individual thermographs into one fully radiometric collage.



Software is key to generate reports quickly. Images in standard file formats such as .jpg and .gif can be inserted into Microsoft® Word. But dedicated software timesavers can shorten the report-generation process. Image mosaicing or stitching software uniquely knit multiple thermographic images together to create a single composite image that can facilitate diagnosis and repair.