

## **ABSTRACT**

The purpose of this article is to explore some of the proactive milestones for infrared thermography in the roofing industry that greatly benefit building decision makers and provide rewarding careers for thermographers. Building upon IECC 2009 code and 2009 US Army Corps of Engineers mandates, we'll discuss the infrared capabilities, the need for Building Owners to become much more involved in demanding thermal integrity to their roofing system installations, and the time-sensitive optimal opportunities for infrared thermography benefits. Regretfully, conventional wisdom only utilizes roofing infrared scans when the sale of the facility is pending, and when the roofing system nears the end of its satisfactory service life. With higher thermal resistance requirements cited in IECC 2009 and the common sense merits of sustainable construction and shepherding resources, we'll explore many more opportunities for roofing infrared scans to offer valuable, real-time, non-destructive information to benefit building decision makers throughout the building service life.

## **ROOFING INFRARED MILESTONES**

Roofing installation milestones where infrared detection of problematic thermal patterns can benefit the most include building commissioning such as identifying deficiencies with installation work in progress, puncture damage by other trades trafficking on the roofing membrane, substantial completion prior to the installer leaving the project, near the termination of the installer's warranty, weather events and storm damage, before and after the roof's use as a work platform during mechanical work or cladding work affecting the roofing system performance, the intended sale of the facility, building changes affecting roofing system watertight integrity, the need to determine the extent of warranty, or other repairs, or even to determine the need for replacement for a leaking roofing system and prior to the termination of the membrane manufacturer's warranty coverage. In this age of über sophisticated energy controls, delivery systems and feedback circuitry, one of the most beneficial milestones but underutilized opportunities includes when the roofing system nears the end of its satisfactory service life and is being considered for cost saving recover roofing, or the much more costly removal and replacement.

The knowledgeable thermographer needs to know and convey to their customers what they can reasonably accomplish with a professional qualitative infrared roofing scan, and based upon the conditions below what they may not be able to accomplish. Non-destructive infrared capabilities are limited to detecting thermal patterns that indicate probable concealed moisture and should not be stated to include identifying leak sources. Infrared scan results need to be confirmed by knowledgeable roofing consultants and roofing contractors via destructive means such as roofing system moisture probes and roofing cores. The infrared scan of the roofing system including flashings is only a snapshot or moment in time where the infrared camera detects radiated heat. The quantity of solar gain contributing to radiated heat is related to the insolation. Infrared roof scan results are dependent upon ambient conditions such as cloud cover, temperature and wind speed. Additionally, the following roofing system conditions can greatly affect successful roofing scans.

Qualitative scan results may be skewed with the type of roofing system including but not limited to the method of installation and the reflectivity of the membrane, type of insulation, recent weather events, heavy applications of mopping bitumen or cold process adhesive, loss of granules or gravel, significant granule or gravel deposits resulting from loss of granules or gravel, deposits of dirt and airborne debris resulting from poor drainage, presence of a brilliantly reflective, snow blinding coating, a weathered reflective coating on a repair patch where the coating still presents aspects of reflectivity and possibly emissivity impeding an accurate infrared scan, ice, frost or dew on the roof mat, slight to heavy ponding water, rooftop unit condensate runoff onto the roof mat and heat signature or thermal pattern radiating off of adjoining walls. Obviously, the thermographer may detect several contributors to thermal patterns and concealed moisture may not be among those.

With the certainty of ever increasing energy costs and threats of penalties for energy use, Building Owners, particularly facility managers, need to be better informed of the importance of thermal performance relating to their roofing systems and flashings. To better manage and protect the building asset base, to be good stewards Building Owners and facility managers need to become much more involved in demanding thermal integrity to their roofing system installations from design through

installation and during the service life of the systems. The consequences of compromised insulating value or greatly reduced thermal resistance from moisture intrusion need to be clear to the decision makers in dollars and cents. For sustainable building operation, energy conscious decision makers need to identify, document, quantify and manage all of the potential moisture intrusion issues including free air movement, or air wash through the roofing system, robbing their facility energy. It costs a lot of money to heat and cool the Great Outdoors!

Above we cited several time-sensitive optimal opportunities for infrared thermography to benefit Building Owners and property managers. However, everyone involved with the design, construction, operation, maintenance, insurance and finances of a building can benefit from timely, knowledgeable infrared thermography to identify and remedy thermal problems before they worsen or to verify watertight roofing system performance. Installers, General Contractors, Insurers and Financiers benefit from accurate roofing infrared scans to facilitate entities accountable for correcting deficiencies to act in a timely manner before conditions get worse, before consequential damages occur, and before the cost of remediation climbs exponentially. Expanding upon roofing infrared scan opportunities cited above, roofing installation milestones where infrared detection of problematic thermal patterns can benefit decision makers the most include the following scenarios.

Unfortunately, there are many factors adversely affecting the watertight integrity of roofing system installation work in progress. We define a leak as moisture intrusion into the roofing system or wall system, and certainly moisture intrusion into the interior. In many building trade magazines, via seminars and other venues building scientists are more frequently citing the damages caused by lingering construction moisture intrusion, and the need to avoid construction moisture entry. Leakage can occur because of sudden and unexpected precipitation. Leakage can occur because of an improper work stoppage or nightly tie-off that permits water entry. Too often objectionable moisture intrusion is concealed and causing damage undetected. Specific to many types of multi-ply, built-up bitumen roofing systems, trapped moisture can cause significant moisture blisters that pull apart field and flashing seams. Moisture may be trapped between plies or in porous open cell types of insulation. Moisture may be trapped in board joints between non-porous, almost closed cell insulation boards. The skilled thermographer can often distinguish between 1.) suspected concealed moisture trapped between the top ply or finish ply, and underlying plies from 2.) moisture under the roof mat and trapped on top of an almost closed cell insulation 3.) in porous open cell insulation boards or 4.) in joints between almost closed-cell insulation board.

Unfortunately, in too many instances roofing installations are used as work stations both during new construction and remedial work on adjoining walls and glazing. Serious abrasion and puncture damage by other trades working and trafficking on the unprotected roofing membrane can cause significant water entry into the roofing system and even into the interior. To make matters worse, often the damage is nearly imperceptible to the naked eye. In the hands of a professional thermographer infrared thermography is an ideal non-destructive tool to detect thermal patterns indicating probable concealed moisture entering the roofing system through damage to the roofing membrane. With water entry into porous insulation or trapped under the finish ply or trapped between closed cell insulation board joints, retained solar heat gain from probable concealed moisture can be detected and marked on the roof mat by the knowledgeable thermographer. With the timely infrared survey validated by a professional roofing consultant or roofing contractor, water entry may be stopped and deficiencies corrected.

Particularly when a new construction roofing installation has been inadequately protected and the roofing membrane used as a work station or subjected to trafficking that damages the membrane, an infrared scan of the suspected problem areas or the entire roof area prior to substantial completion can be very cost effective. Probable moisture intrusion problems detected, marked and verified may be corrected in the best interest of every entity involved with the construction, and especially in the Building Owner's best interest. Rather than hoping the roof mat wasn't damaged to the extent it would permit objectionable water entry, the proactive risk management decision is to utilize non-destructive infrared thermography to better ensure continued watertight roofing system performance. With the roof infrared scan performed prior to substantial completion, deficiencies may be corrected by the installer to protect the long-term

interests of the membrane manufacturer offering their long-term warranty coverage and the General Contractor desiring to protect their good name in the very competitive construction industry.

Another proactive time to plan, authorize and conduct a roof infrared scan is near the termination of the installer's warranty. Historically the roofing installer offers the facility Owner a one-year warranty or guarantee to correct defective material and workmanship on their installation.

Following weather events and known or possible storm damage are two milestones for obtaining an accurate roof infrared scan to detect thermal patterns indicative of objectionable probable concealed moisture. Scan results can prove invaluable by assisting to identify weather event and storm damage in a timely manner to facilitate correcting moisture intrusion problems before they increase and become even more costly to properly address. While interpretation of a roof scan by a knowledgeable experienced roofing consultant or roofing contractor is recommended for every roof scan, it is particularly wise to have scan results scrutinized following weather events and possible storm damage. The purpose of the roof infrared scan is to detect, document and report thermal patterns indicating probable concealed moisture. The purpose of the scan is not to identify leak sources. With the Building Owner's interests, probably a property insurance company's and the membrane manufacturer's interests at stake, great skill is involved for an accurate scan interpretation. Many variables apply to interpreting such scan results including interpreting possible hail damage puncturing different roofing membrane systems or not, and possible membrane damage resulting from metal objects cartwheeling ahead of the wind. Prompt remedial scopes of work to extend satisfactory roofing service life may be established and implemented based upon the accurately interpreted scan results.

Roofing system infrared scans can prove very beneficial to potential purchasers prior to their closing or negotiating final funding details for an intended purchase of the facility. An accurate roof infrared scan properly conducted and reported can benefit the potential purchaser by detecting thermal patterns indicative of probable concealed moisture that could cost many thousands of dollars to repair the roofing system; or cost many hundreds of thousands of dollars necessary to recover or replace a problematic roofing system. In many instances, more than a visual roofing condition observation survey of many types of roofing systems, an accurate roof infrared scan can quickly and in a non-destructive manner detect the thermal patterns characteristic of problematic concealed moisture into the roofing system. This expedient real-time information from professional interpretation of an accurate roof infrared scan by a knowledgeable thermographer can obviously make or break a potential transaction depending upon the results. The professional thermographer may be a hero or a heel depending upon the scan results and the entities affected, but it is safe to say both sides of the potential transaction will remember the thermographer's professionalism and the results delivered.

There are a myriad of building changes possibly affecting the roofing system's watertight integrity or the need for ensuring continued satisfactory watertight performance. A roof infrared scan can prove beneficial to the Building Owner, the General Contractor making the changes, the roofing installer, the cladding installer and the new building tenant to name just five such entities. Building changes affecting the roofing system can involve trafficking on the unprotected roofing membrane and using the roof mat as a work station. These conditions are discussed above. Further, an accurate roof infrared scan can detect if there is probable moisture intrusion or not along an added wall or the opposite, a demolished perimeter to better establish innocence or guilt of different tradesmen working on the building change. The scan results can speak for themselves and may defuse a possible false claim for roof damage and funds withheld; or the scan may conclusively indicate probable concealed roofing system moisture and the party that caused the problem may be properly held accountable.

An inexpensive, accurate infrared roof scan near the termination of the membrane manufacturer's warranty coverage makes a lot of sense. It is a lot less costly to spend a membrane manufacturer's money remedying moisture intrusion deficiencies under warranty leak coverage than spending scarce capital resources. This concept is true particularly on roofing installations of any size, but certainly on roofing installations twenty-five thousand (25,000) square feet and larger. Because the roofing industry has moved from bonded roof installations to correct defective workmanship and materials to warranty

coverage triggered solely by leaks, prudent roofing decision makers contract with professional thermographers to scan roofing installations prior to termination of warranty coverage.

When many facility professionals think of infrared roofing scans they are thinking of scans to identify concealed suspected moisture when the roofing system nears the end of its satisfactory service life and the roofing system is being considered for cost saving recover roofing or the much more costly removal and replacement. Granted, scans for this purpose are tremendous tools for possibly saving Building Owners valuable time and money with the discovery that there is little to no trapped moisture in an aged and weathered roof and new recover roofing is a valid option. Additionally, an infrared roofing scan can detect thermal patterns from contiguous areas of suspected moisture that may be economically removed, dry fill insulation installed to restore a suitable roofing substrate and new recover roofing insulation and roofing system installed. Whenever recover roofing is feasible the Owner saves time compared with the time needed for complete roofing removal and replacement. Also, with less expensive recover roofing the Owner avoids most of the damaging water entry risk associated with roofing replacement when roofing is removed, and decking and new roofing components are exposed prior to completed new roofing and flashing installation.

Further, when an infrared roof scan detects thermal patterns characteristic of widespread concealed moisture the decision to bear the cost of complete roofing system removal and replacement is fairly straight forward without mystery. This need for roofing removal and replacement is true whether the suspected moisture detected appears as widespread mottled or stippled thermal patterns, or if the heat signature is roughly for over thirty percent (30%) of the roof area with widespread numerous, distinct, well-defined suspected moisture areas. With less than thirty percent (30%) suspected moisture indicated in a contiguous well-defined area the economy of removal and replacement of suspected wet area, dry fill insulation and recover roofing is significant enough to weight the decision in favor of recover roofing. When thermal patterns are not limited to roughly thirty percent (30%), and when thermal patterns are widespread roofing and flashing, removal and replacement are prudent.

## **SUMMARY**

In closing, bidding or negotiating, budgeting and implementing infrared roofing scans in an attempt to identify suspected concealed moisture can prove beneficial to all entities responsible for roofing decisions during all phases of a roofing system's service life. Many roofing milestones occur early in the life of a roofing installation that may facilitate cost effective decisions to promptly remedy moisture intrusion issues, to avoid or greatly limit consequential damages, to obtain remedies from installers or membrane manufacturers under guarantee and warranty coverage respectfully, to reduce maintenance and greatly extend satisfactory service life. All of these options constitute and augment true sustainability by optimizing existing insulation thermal resistance, continuing satisfactory service and reducing debris going to landfills. Accurate roof infrared scan results need to be interpreted and validated by professional roofing consultants and roofing contractors. We've discussed infrared roof scan capabilities. We've explored some of the proactive, time-sensitive milestones for infrared thermography in the life of a building's roofing that greatly benefit building decision makers and provide rewarding careers for thermographers.

## **ABOUT THE AUTHOR**

Ben T. Hixson, RCI, CCCA, CCS

Mr. Hixson formed Hixson Consultants, Inc. (an applied technical resource consulting company) to provide expert roofing, architectural sheet metal, glazing, wall system and waterproofing consulting services. He has over 33 years of experience in roof, wall and waterproofing condition analysis, life-cycle cost analysis, budgeting, design specification writing, CAD detailing management, and component selection and systems which are designed to remedy building moisture problems. Investigative surveys for new and existing facility projects have included both flat and sloped roofing installations, non-destructive infrared thermography, nuclear density gauge and dielectric capacitance technologies. Services have included surveys, condition reporting, remedial/replacement recommendations and quality assurance monitoring for below-grade waterproofing, plazas, masonry, precast, tilt wall, split-face brick

and block, metal wall panels, terra cotta, stucco, DEFS, EIFS, balconies, terraces, parking decks, pools, fountains and most types of roofing. Mr. Hixson has considerable experience in architectural sheet metal, metal panel and single ply roofing, roof-coating systems, cold process, peel and stick and self adhered modified bitumen roofing and coal tar pitch roofing systems. He received a B.A. in Chemistry from Vanderbilt University in 1973 and is uniquely able to correlate product chemistry to predictable field performance. He is a roofing, wall systems & waterproofing expert and is the Technical Director for [www.RoofScanIR.com](http://www.RoofScanIR.com)