One Inspector's Journey Into

INFRARED THERMOGRAPHY

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Four years ago at InspectionWorld, I wistfully looked at the fascinating technology of infrared thermography that offered the potential to expand my practice into new areas. But with infrared (IR) cameras costing more than $15,000, I couldn't see how to recover my investment, much less make a profit. I decided to leave infrared thermography to the multi-inspector companies and to the more adventurous early-adopters.

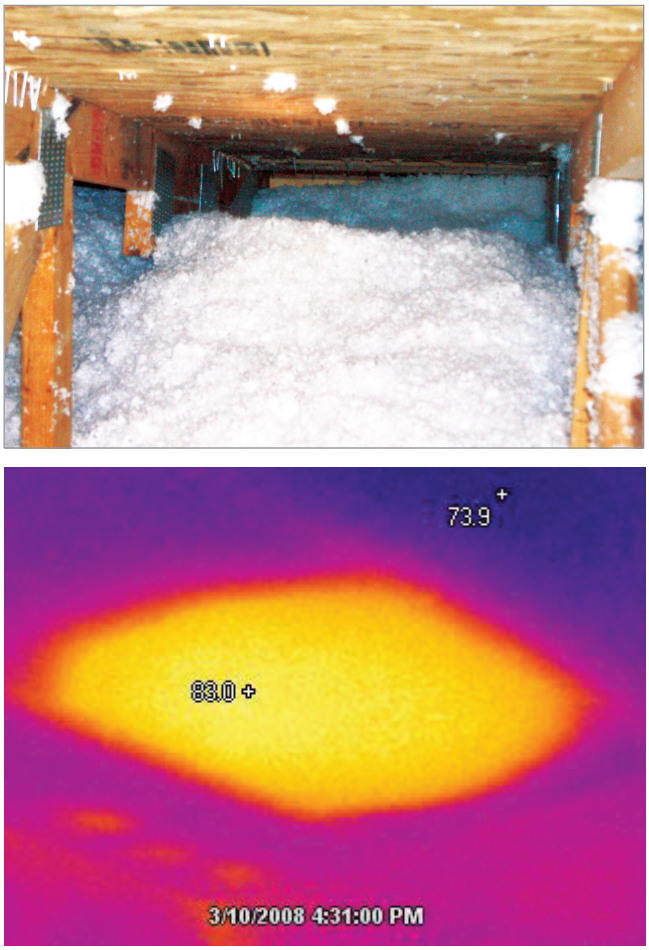
This year at the ASHI conference, I found the price for a basic IR camera had dropped below $5,000. At this price, I might actually be able to make a profit with it. I suspect other inspectors are considering making the same investment. My experiences taking IR camera training and my initial experiences using the camera may interest them.

It helps to know the basics about the technology before buying an IR camera — how it works, what features are important and factors to consider before using it in your practice.

Introduction to infrared thermography

IR cameras see IR radiation produced by heat energy. All matter above absolute zero contains heat energy, and IR cameras see the IR radiation produced by heat energy. IR radiation is electromagnetic radiation, which exists below visible light and above microwaves on the electromagnetic spectrum. IR cameras are similar to visible light cameras in that both detect and record electromagnetic radiation. But because IR radiation behaves differently from visible light radiation, it is possible to detect situations in IR that you cannot detect in visible light.

IR cameras see IR radiation only at the surface of a target object. They are not X-ray cameras; therefore, they do not see the object's interior. Two conditions must be present to see what might be under the object's surface: 1) The material under the surface has more or less heat energy than is present at the object's surface, and 2) A heat-transfer mechanism has been operating long enough to conduct the interior heat energy to the object's surface. In other words, the interior and the surface of the object must be at different temperatures before an IR camera can detect what is beneath the object's surface. ▸▸▸



Top photo shows insualtion disturbed at roof vent. Bottom photo is an Infrared image of the top photo.

Infrared Camera **Features**

IR cameras have their own complex and confusing language Here are some terms and features I found to be important when selecting and using an IR camera.

TEMPERATURE RANGE: High and low temperature limits that the camera can detect.

Entry-level cameras have a range between 0˚ and 212˚F. Better cameras have a wider temperature range, particularly for higher temperatures. The range on entry-level cameras is adequate for most home inspection work. A broader range is recommended for commercial and industrial inspections.

TEMPERATURE ACCURACY: Margin of error in measuring the temperature.

Camera temperature-measuring accuracy is more important in quantitative inspections and when measuring high temperatures than when doing standard home inspection work.

THERMAL SENSITIVITY: Ability to detect small temperature differences between areas of the target object.

This feature is important when, for example, the temperature difference between the inside and outside of a building is small. A more thermally sensitive camera will show more subtle temperature differences and may help you detect a problem in some situations. This feature is sometimes called the NETD. More is better for all types of IR work, so get the most thermally sensitive camera you can afford.

IMAGE RESOLUTION: Number of collection points (pixels) in the camera's IR detector.

A greater number of pixels provides a clearer IR picture and can help you detect temperature differences between nearby areas of the target object. More is better for all types of IR work, so get the best image resolution you can afford.

CAMERA DISPLAY SIZE/RESOLUTION: Size and clarity of the camera's display screen.

A larger camera display screen makes the camera easier to use in the field. A higher display resolution (more pixels per square inch) makes the display image clearer. More is better for all types of IR work, so get the largest display with the highest number of pixels you can afford. Don't be confused between display resolution and image resolution. Image resolution refers to the IR detector in the camera and display resolution refers to the camera display screen.

CAMERA ADJUSTMENTS: Ability to adjust the camera to account for temperature distortions (such as reflected IR radiation) caused by characteristics of the target object and characteristics of the environment around the object.

Accurately measuring temperatures during the inspection requires, at a minimum, the ability to adjust the camera for the object's emissivity and for reflected IR radiation (RAT). You can usually make these adjustments later in the image-processing software available with the camera, but if you need to accurately measure temperature on site, you need to enter these adjustments in the camera. The ability to make these adjustments on the camera is a good-to-have feature for home inspection work. It is a necessary feature for most quantitative inspections.

FUSION PICTURES: Ability to display an IR picture inside a visible light picture.

This helps you and the client locate the area of concern using visual cues. This is a good-to-have feature for all types of IR work. You can usually convert an IR picture to a fusion picture in the software that comes with the camera.

ARTICULATING LENS: Ability to rotate the camera lens independently from the camera's display.

Another good-to-have feature if you do a lot of IR work because your outstretched arm can get tired holding a 2-3 pound camera. This feature is available only on more expensive cameras.

EXTRA LENSES: Ability to add lenses such as optical zoom lens and wide angle lenses.

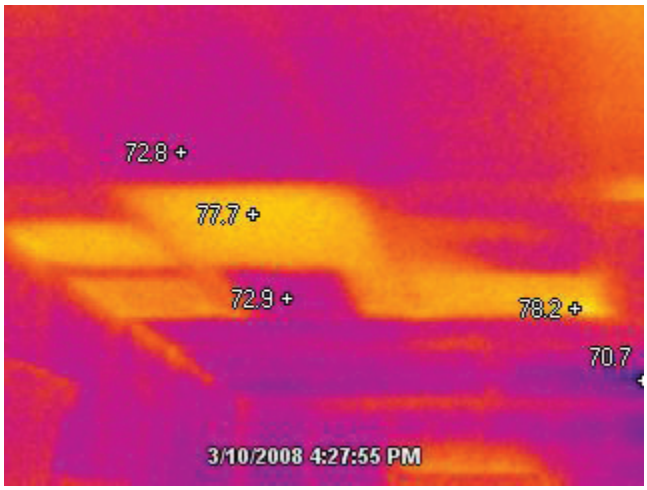
Extra lenses may be useful when measuring temperature from a distance and when measuring the temperature of a small object. A wide-angle lens may be useful when taking a picture of a large object. Better cameras allow you to change lenses, while entry-level cameras do not. Extra lenses are not usually necessary for home inspection work.

BATTERY: Hard-wired or replaceable.

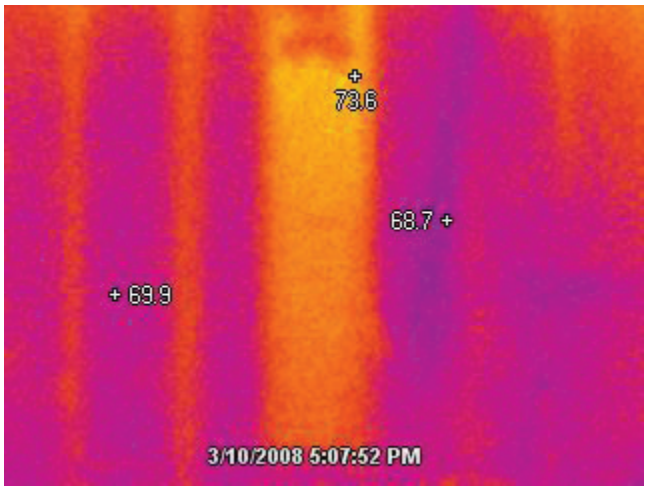
Users cannot replace batteries hard-wired into the IR camera. Other IR cameras have a battery that the user can replace. Without a replaceable battery, you must stop work to recharge the battery when it runs out of power, and you must send the camera back to the factory when the battery dies. A replaceable battery is a good-to-have feature.

DIGITAL ZOOM: Increases pixel size for better viewing of distant and small objects.

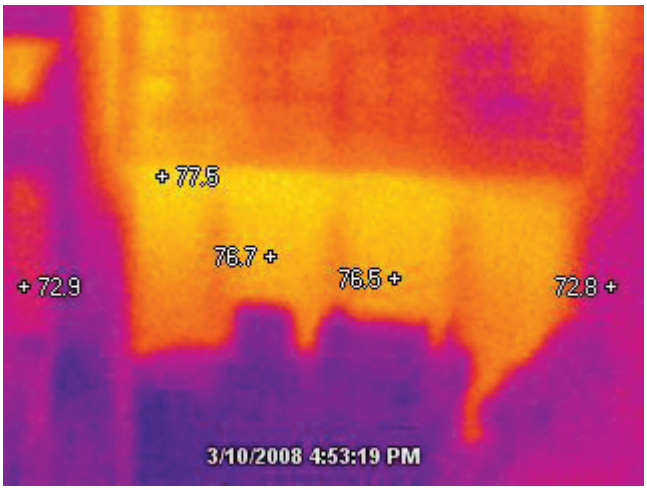
It does not help when measuring temperature of distant and small objects. Digital zoom can make the image fuzzier and may not be particularly useful in many home inspection applications.



IR image of batt insualtion not in contact with drywall.



IR image of batt insualtion missing in wall cavity.



Infrared image of insulation missing under window.

All photos for this article courtesy of Bruce Barker.

For example, water absorbs and releases heat at a different rate compared to solid construction materials. Water under fiberglass shingles makes shingles heated by the sun appear hotter after sunset compared to surrounding shingles with dry sheathing underneath. This is because the water retains heat longer than the shingles do. Water in insulation behind drywall usually makes the drywall appear colder compared to surrounding drywall with dry insulation underneath. This is because water does not absorb heat as rapidly as drywall.

IR cameras see all IR radiation at the surface of a target object. This includes the IR radiation caused by the object's actual heat energy, plus any IR radiation from other sources that may be transmitted through the object, plus any IR radiation from other sources that may be reflected off the object. IR radiation transmitted through an opaque object is usually unimportant. IR radiation reflected off the object can be extremely important when measuring the object's actual temperature. IR radiation reflected off the object is sometimes called reflected apparent temperature (RAT). Reflected IR radiation can come from any surrounding objects, including the person operating the camera. Objects that easily reflect IR radiation can produce extremely inaccurate temperature readings.

A simple, but not always accurate, way to think about reflected IR radiation is that the more visible light an object reflects, the more IR radiation the object may reflect. A dull surface, such as an object painted with flat paint, will usually reflect less IR radiation. A shiny surface, such as unpainted metal, will usually reflect more IR radiation Therefore, there can be a significant difference between the actual temperature of a shiny object and the temperature registering on an IR camera or on an IR "laser" thermometer.

Because of reflected IR radiation, being able to correct for an object's emissivity is important when selecting and using an IR camera. An easy way to think about emissivity is that it indicates whether there is a need to correct for distortions caused by reflected IR radiation in order to detect the actual temperature of an object. Emissivity is expressed as a number between 0 and 1. An object with a dull surface will usually have a high emissivity, near 1, and will usually require little or no correction to determine the object's actual temperature. An object with a shiny surface will usually have a low emissivity, and will usually require extra steps to determine its actual temperature.

Some basic IR cameras do not allow you to correct for an object's emissivity or to account for reflected IR radiation. It is difficult to take accurate temperature measurements from low emissivity objects without these two capabilities. Although usually not a problem for standard home inspections, the lack of these capabilities would be a problem for some IR inspections.

Infrared inspections

IR inspections are qualitative or quantitative. For the most part, building inspectors perform qualitative IR inspections, which measure the temperature differences between nearby objects. IR inspections to detect moisture intrusion behind

walls and ceilings and under roof coverings are qualitative. So are inspections to detect missing and improperly installed insulation. IR cameras can detect air leaks around building envelope penetrations such as windows, recessed lights and electrical receptacles. In some cases, they can even detect the heat from pest nests such as ants and termites. Under some conditions, they can detect the presence or absence of structural elements such as headers and structural steel. The actual temperature of the target object is less important in qualitative inspections. The difference between the temperatures of nearby objects conveys the important information. Any good IR camera can perform qualitative inspections.

Measuring the actual temperature of the target object is a quantitative IR inspection. Inspections to detect overheated circuit breakers and wires are common quantitative inspections. So are inspections to detect overheated pumps and motors. Determining the actual temperature of a device is important in quantitative inspections because the threshold between proper and improper operation usually occurs at a specific temperature. Failure to account for distortions caused by reflected IR radiation and other factors can make the difference between a correct and an incorrect call. Correcting for reflected IR radiation is far easier if you can adjust the camera for emissivity and for reflected IR radiation, rather than making the corrections in the IR image processing software.

Infrared camera training

My advice about IR camera training is simple: If you can't afford the training, don't buy the camera. An IR camera is not a fancy and expensive optical camera. Proper use of an IR camera and accurate interpretation of IR images require training. In my opinion, the potential liability involved with IR cameras is too great to assume without training.

The tuition for a Level I Thermographer course is around $1,700. Travel expenses are extra. I took the Level I course offered by Infrared Training Center (ITC) and was well satisfied. ITC is part of FLIR, one of the major camera manufacturers. There are, no doubt, other good training options available.

Viewpoint on using infrared cameras in home inspections

ASHI's Standards of Practice (SOP) states that home inspections are visual inspections; therefore, I do not recommend bundling IR inspections with a visual home inspection. Doing so may increase the liability of the inspector using an IR camera and, potentially, for all inspectors.

IR inspections take time. I expect to be compensated for my time, investment and training. My time includes planning the inspection, performing it using proper IR inspection techniques, analyzing the results and reporting my findings and recommendations. Perhaps most important, I take time to educate my client about the objectives and limitations of IR inspections. This education includes a separate written IR inspection agreement.

Conclusion

I am glad I began the journey to IR thermography. I'm still working IR into my practice, so it has not generated much revenue yet. I believe it will as clients learn about its benefits, particularly in the energy conservation area. In any event, it has been an interesting and educational experience.■

Bruce Barker is the founder and president of Dream Home Consultants, a consulting and inspection division of B.A. Barker & Associates, Inc. (www.DreamHome Consultants.com) and the author of Everybody's Building Code, written to help home inspectors understand the International Residential Code.

He has been building and inspecting homes since 1987 and is licensed by the State of Arizona as a residential contractor, licensed by the State of Florida as a residential contractor, certified by the International Code Council as a Residential Combination Inspector, certified by the State of Arizona as a home inspector, and is a member of the Independent Home Inspectors of North America.

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Features of Selected Infrared Cameras Marketed to Building Inspectors

Company/ Camera	Temp. Range	Temp. Accuracy	Thermal Sensitivity	Image Resolution	Display Size/ Resolution	Camera Adjust[1]	Fusion Pictures	Articulate Lens	Extra Lens	Replace Battery	Price[2]
FLIR/ BCAM	+14 to +212° F	2° C or 2%	.15° C at 25° C	120x120	3.5 in./ 240x240	EM RAT	NO	NO	NO	YES	$5,750
FLIR/ BCAM SD	+14 to +212° F	2° C or 2%	.10° C at 25° C	120x120	3.5 in./ 240x240	EM RAT	NO	NO	NO	YES	$6,750
FLIR/ THERMACAM B2	-4 to +212° F	2° C or 2%	.10° C at 25° C	160x120	2.5 in./ 320x240	EM RAT	NO	NO	YES	YES	$8,450
FLIR/ B360	-4 to +248° F	2° C or 2%	.07° C at 30° C	320x240	3.5 in./ 320x240	EM RAT	YES	YES	YES	YES	$15,950
FLUKE/ TiR	-4 to +212° F	5° C or 5%	.10° C at 30° C	160x120	3.6 in./ 640x480	NO	YES	NO	NO	NO	$4,495
FLUKE/ TiR1	-4 to +212° F	2° C or 2%	.07° C at 30° C	160x120	3.6 in./ 640x480	EM	YES	NO	NO	NO	$6,995
FLUKE/ Ti25	-4 to +662° F	2° C or 2%	.10° C at 30° C	160x120	3.6 in./ 640x480	EM	YES	NO	NO	NO	$7,495
FLUKE/ TiR2FT-20	-4 to +212° F	2° C or 2%	.07° C at 30° C	160x120	5 in./ 320x240	EM	YES	YES	YES	NO	$12,495

1 EM = can adjust emissivity in camera, RAT = can adjust reflected apparent temperature in camera
2 FLIR prices from Professional Equipment Spring 2008 catalog. Fluke manufacturer's list prices courtesy of Home Inspector Essentials. Contact your dealer for current pricing, including possible discounts from list prices.