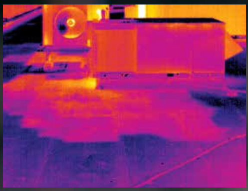
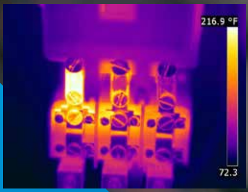
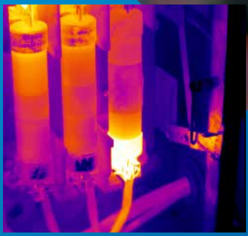
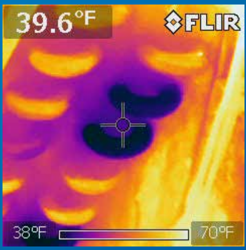


THERMAL IMAGING GUIDEBOOK FOR FACILITIES MAINTENANCE

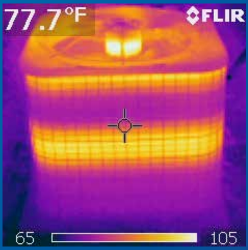


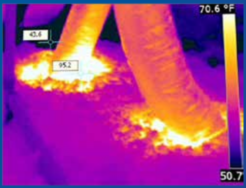




Preventative Maintenance for:

- HVAC
- Electrical
- Plumbing
- Building Envelope





FLIR®

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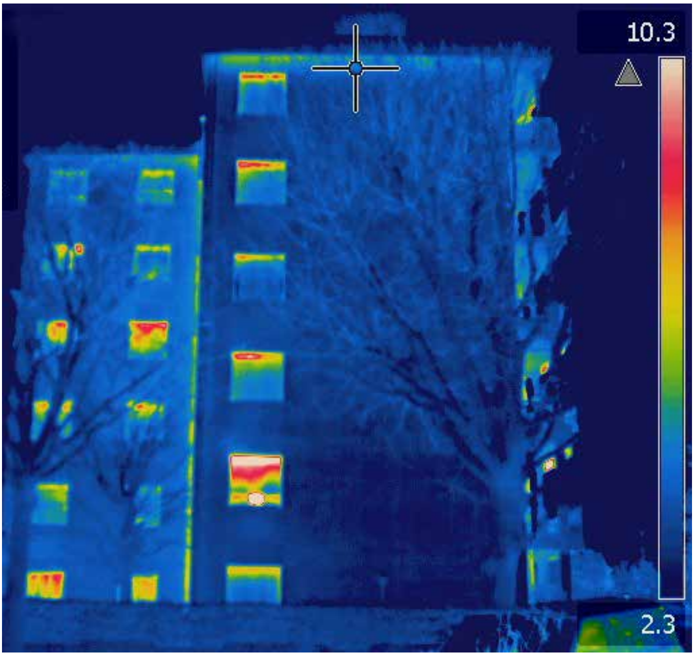


Introduction

The first commercial thermal imaging camera was sold in 1965 for high voltage power line inspections by what would later become FLIR Systems. Since then, one of the most important market segments for FLIR has been preventative maintenance applications for a wide variety of industries. In response to this market's needs, FLIR focused on designing compact systems that look and work like consumer digital cameras, with intuitive controls and the ability to generate crisp, real-time, high-resolution images.

As FLIR's thermal imaging technology has improved, so has the reliance on infrared as a diagnostic tool for facilities maintenance. The applications cover a broad range, from HVAC maintenance to electrical inspection and building envelope surveys. Electrical and mechanical systems tend to get hot before they fail; air duct leaks and excess moisture are often colder than their surroundings. By detecting these temperature anomalies, thermal imaging allows facilities maintenance crews to take corrective action and avoid costly maintenance and repair.

Another advantage of thermal imaging is it can pinpoint energy losses in a building without any destructive testing methods. Pairing the thermal imaging camera with methods such as 'Blower Door' systems can speed up inspections immensely. The camera is a reliable non-contact instrument that can scan and visualize the temperature distribution of entire surfaces quickly and accurately. Thermography programs have contributed to substantial cost savings around the world.

This booklet is an in-depth guide to predictive maintenance inspections using a thermal imaging camera. There are many details that require attention when carrying out such an inspection. Not only do technicians need to understand how the thermal imaging camera works and how to take images, they also must understand the physics behind the system they're inspecting and how it is constructed. All of these elements must be considered in order to interpret thermal images correctly.

It is impossible, however, to cover all principles and concepts for facilities maintenance applications in this guidebook. We therefore cooperate with the Infrared Training Center (ITC) to organize regular training courses specifically designed for facilities maintenance applications.

FLIR Systems has always been a thermal imaging pioneer, bringing the most advanced thermal imaging cameras to the market for more than 50 years.

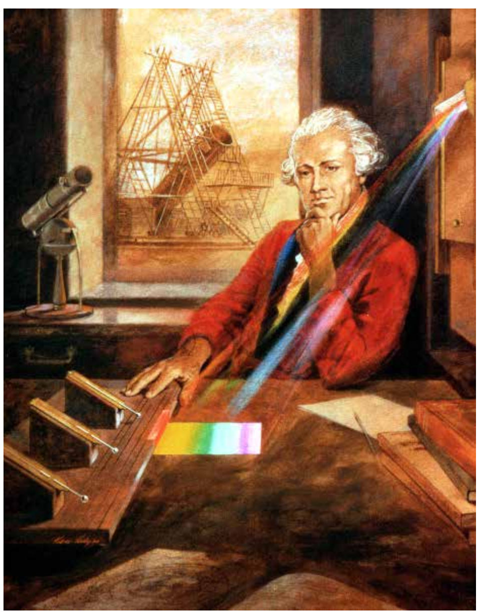
[1] How thermal imaging cameras work

A thermal imaging camera records the intensity of radiation from the infrared band of the electromagnetic spectrum and converts it into a visible image. This image depicts infrared variations across an object or the scene.

What is infrared?

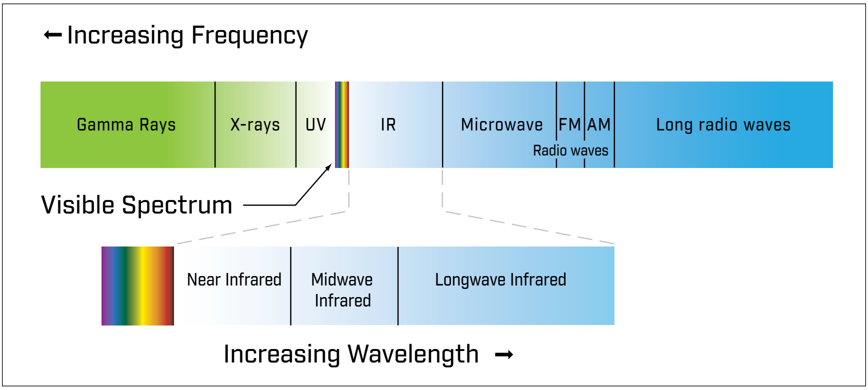
Our eyes are detectors designed to sense electromagnetic radiation in the visible light spectrum. All other forms of electromagnetic radiation, such as infrared, are invisible to the human eye.

The existence of infrared was discovered in 1800 by astronomer Sir Frederick William Herschel. Curious about the thermal difference between the various colors of light, he directed sunlight through a glass prism to create a spectrum and then measured the temperature of each color. He found that the temperatures of the colors increased from the violet to the red part of the spectrum.

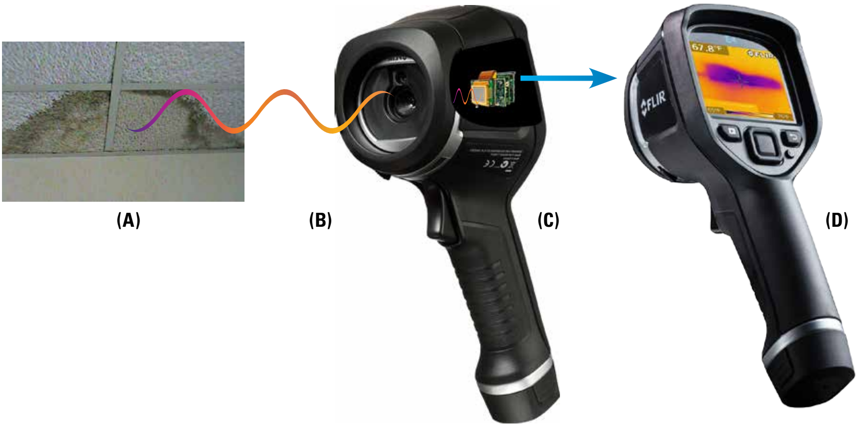


Sir William Herschel discovered infrared radiation in 1800

After noticing this pattern, Herschel decided to measure the temperature just beyond the red portion of the spectrum in a region where no sunlight was visible. To his surprise, he found that this region had the highest temperature of all.



Infrared radiation lies between the visible and microwave portions of the electromagnetic spectrum. The primary source of infrared radiation is heat or thermal radiation. Any object that has a temperature above absolute zero (-273.15°C or 0 Kelvin) emits radiation in the infrared region. Even objects that we think of as being very cold, such as ice cubes, emit infrared radiation. Since we can't see it, the infrared radiation we experience every day is the heat we feel from sunlight, wall heaters, and other sources. The warmer the object, the more infrared radiation it emits.



Infrared energy (A) coming from an object is focused by the optics (B) onto an infrared detector (C). The detector sends the information to sensor electronics for image processing. The electronics translate the data coming from the detector into an image (D) that can be viewed on the LCD screen.

Infrared thermography is the art of transforming an infrared image into a radiometric one, which allows temperature values to be read from the image. Every pixel in the radiometric image is converted into a temperature measurement via complex algorithms incorporated in the camera's software. A properly calibrated IR camera can provide accurate non-contact temperature measurements of the objects it records.

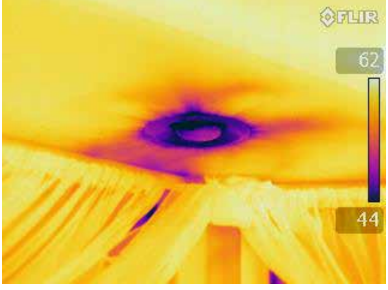
[2] Why you should use thermal imaging

Being in charge of facilities maintenance means you wear many hats and carry a great deal of responsibility. If you could only see when systems are clogged, leaking, or about to fail, you could accurately determine the best way to take corrective action. Unfortunately the worst problems remain hidden until it is too late.

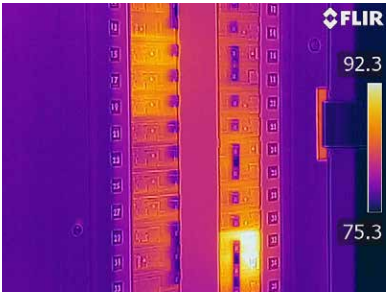
Thermal imaging cameras are powerful, non-contact tools for monitoring and diagnosing the condition of HVAC, electrical systems, plumbing, and building envelopes. These cameras help you identify problems early, document them immediately, and correct them quickly. The longer system faults are ignored, the more serious and costly they are to repair.

Most thermal imaging cameras for facilities maintenance:

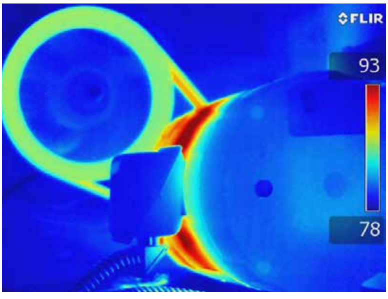
- Are as easy to use as a camcorder or a digital camera
- Provide a full view of the situation
- Identify and isolate the problem
- Measure temperatures
- Store information
- Clarify what needs to be fixed
- Discover minor faults before they grow into big ones
- Save you valuable time and money



Air infiltration through recessed lighting



Overheating fuse in electrical panel



Hot spot on HVAC fan motor

The advantage of thermal imaging cameras

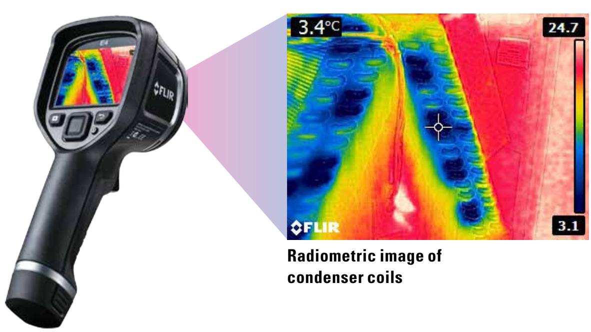
Why would you choose a thermal imaging camera over other non-contact temperature measurement technology? Let's compare infrared cameras to a common, inexpensive alternative: the infrared thermometer.

Infrared (IR) thermometers can be reliable and useful for single-spot temperature readings. However, when you consider all the systems and equipment that must be surveyed for facilities maintenance, single-spot readings won't cut it. It's too easy to miss critical faults such as air leakage, insufficient insulation, and water intrusion when surveying with a spot IR thermometer.

With a thermal imaging camera, you can quickly and efficiently scan entire building, electrical, and HVAC installations. You'll never miss a potential problem area, no matter how small it is.

IR thermometer:
temperature measurement
in one spot

FLIR E4:
temperature measurement
in 4,800 spots

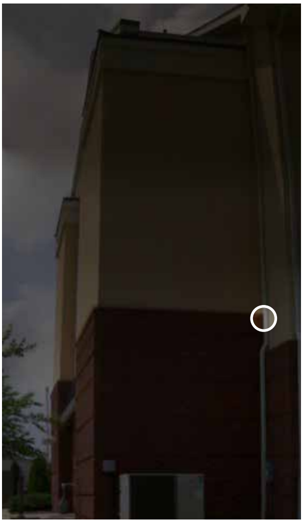
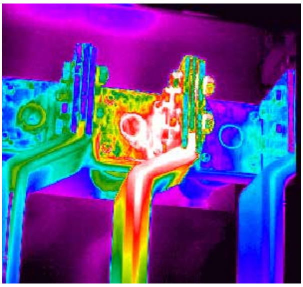


Radiometric image of condenser coils

Find problems faster, easier, and more accurately

Thermal imaging cameras provide a complete view of the situation and instant diagnostic insights. You'll see more than just a cold spot or hot fuse: you'll be able to diagnose the entire extent of the problem.

With an IR thermometer, each reading provides the temperature measurement for one single spot. In contrast, thermal imaging cameras offer thousands of temperature measurements for every image you record. For example, the FLIR E4 Thermal Camera has a resolution of 80 x 60, for a total of 4800 pixels per image. Each pixel provides a temperature measurement – meaning one E4 image is equivalent to using 4,800 IR thermometers at the same time. If we look at the FLIR T1K with its image resolution of 1024 x 768, the equivalency increases to more than 786,000 pixels – or 786,000 IR thermometers all taking readings together.

What an IR Thermometer "sees"	What a thermal imaging camera sees
	
	

[3] Thermal imaging for HVAC inspections

Heating, Ventilation, and Air-Conditioning (HVAC) systems are critical to indoor air quality and comfort, so they need to be well maintained. Unfortunately, these systems can be compromised by mechanical failures, while poor construction and installation can lead to air leaks, dripping water, and loose ductwork. You need a way to catch these problems before they lead to higher energy costs and lower air quality.

When you survey HVAC systems armed with a thermal imaging camera, you gain a whole new understanding of the building's heating and cooling issues. You'll be able to see problems such as misaligned ductwork and electrical faults, and then make decisions about corrective actions.

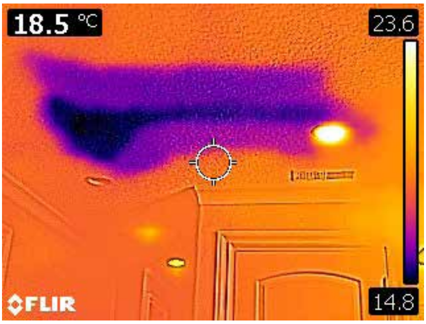
HVAC inspection with a thermal imaging camera can help you:

- Locate misrouted and leaking ducts
- See electrical or mechanical HVAC system faults
- Confirm the source of energy losses
- Find missing insulation
- Discover AC condensate leaks

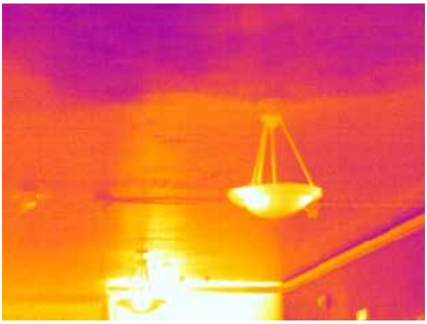
In a typical facility there are hundreds of points along the walls, ceilings, floors, and even roof that could require monitoring. Surveying an HVAC system with an IR thermometer or a contact-measurement tool is like walking around blindfolded: you can only find trouble spots through trial and error. This method takes time and carries the risk of missing a small fault that's affecting the entire system.

AC condensate leaks

A thermal imaging camera can quickly guide you to the source of water leaks from an AC system. The process of evaporation has a cooling effect on wet ceilings, walls, and floors, so the AC condensate leak will appear cold in relation to the rest of the room.



HVAC condensate overflow soaks a ceiling



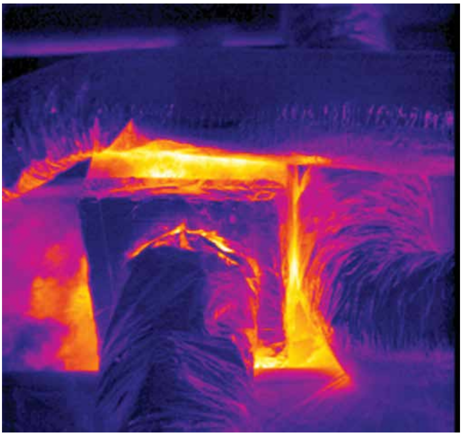
Leak in ceiling is nearly dry

Once the source is identified and remediation begins, you can monitor the drying process with your thermal imaging camera. The cold spot caused by evaporating water will disappear as the area dries.

Air leaks

Temperature differences can also point you to problems with insulation, weatherization, and ductwork. When ducts and insulation aren't installed correctly they can leak, allowing cold air to seep in or warm air to escape the building. In the summertime, these leaks allow chilled air to escape. The result is always the same: higher energy costs.

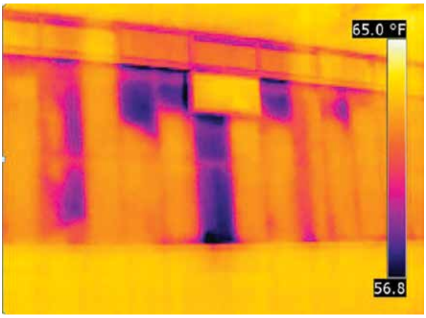
Thermal imaging cameras are an excellent tool for locating misaligned ductwork. In the example below, the HVAC duct is not properly connected. Warm air escaping from the fittings appears bright yellow, while the cooler air around it is displayed in purple and black. Instead of just warming the rooms below, this HVAC duct is also helping to heat up the attic.



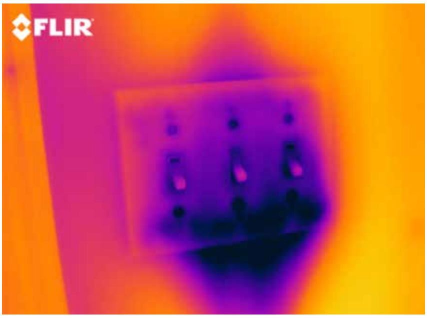
Poorly fit HVAC duct leaks warm air

Poorly installed insulation and building cracks are additional sources of air leaks. The cracks are quite often found around windows, doors, and vents; insulation gaps can happen anywhere in a structure. The drafts these problems create cause noticeable temperature differences, especially when cold air seeps into a warm room through window seals that aren't air-tight.

In some cases, precise temperature and air pressure control is needed in order to visualize air leaks with thermal imaging cameras. The process usually involves a blower door. We will discuss how they work later in this guidebook.



Missing insulation allows in cold air

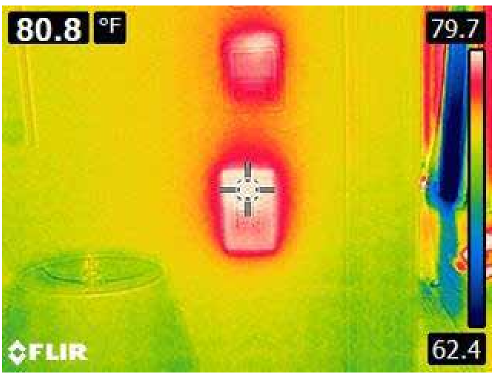


Air leak around a wall switch

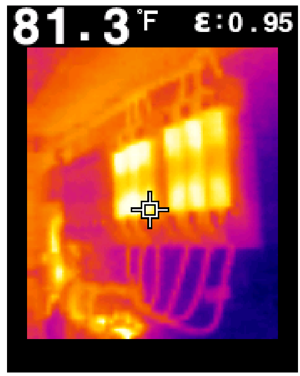
HVAC equipment inspections

There are many electrical and mechanical elements to an HVAC system, and all of them must be inspected regularly in order to avoid breakdowns. Thermostats must be installed correctly and functioning properly in order to regulate the temperature. Gas heaters and boilers need to be maintained, as do air handling systems and AC condensers.

A quick scan with a thermal imaging camera can tell you a lot about the health of these systems. Since things tend to heat up as they begin to fail, you can use a thermal imaging camera to look for worn belts and motors, check electric circuits, and see if the system is overheating. Hot circuits and fuses could indicate a potential electrical short. If a scan of the air handling system shows that it's running hot, that could indicate a clogged air filter.



Thermostat reads a higher room temperature because of heat from the light switch below



TG165 thermal image of HVAC compressor fuses

You can even find mistakes like the one pictured below. A city government installed a high efficiency HVAC system in their building but wasn't seeing any benefits. In fact, the power bills tripled over a year. A quick scan with a thermal imaging camera revealed that the heating system was sending warm air into the room at the same time that the AC system was sending in cool air. Once this installation mistake was corrected, the systems ran efficiently.

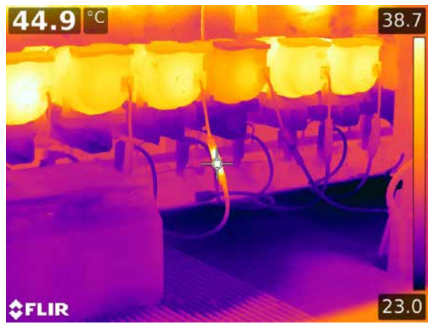
Companies expect and building standards often require HVAC systems to be energy and cost efficient. With thermal imaging cameras in hand, facilities maintenance pros can readily uncover the source of HVAC faults and determine the best way to stop energy loss.

Thermal image shows hot air (yellow) coming from heating vent and cool air (black) coming from AC vent near the wall.

[4] Thermal imaging for electrical and plumbing inspections

The electrical and plumbing systems that crisscross each facility must be inspected regularly for good preventative maintenance. If left unchecked, plumbing problems can lead to leaks and mold growth, while electrical faults can cause outages, melt connections, and start fires.

Warm electrical breaker at normal load



Failing electrical connector on a motor

A thermal imaging camera has the potential to catch plumbing and electrical problems before they cause major damage. As we've already discussed, it's easy to visualize water leaks with a thermal imaging camera. Finding electrical faults can be easy, too: even low voltage systems give off excessive heat when they break down.

Electrical and plumbing inspections with a thermal imaging camera can help you:

- Locate hot or loose connections
- Find overloaded circuits, motors, and wires
- Trace water leaks to their source
- Determine the size of moisture buildup
- Monitor drying, verify cleanup

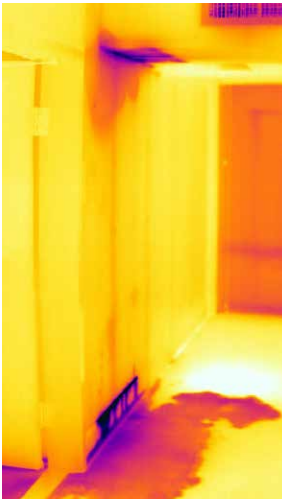
Electrical current naturally creates some heat as it flows through a circuit. You can see this when you point a thermal imaging camera at circuits or fuse connections: they appear brighter, or hotter, than their surroundings.

The problem comes when there is too much resistance in the circuit or a high current flow. This is often an indication of an impending failure. Loose connections, load imbalances, and corrosion can also increase resistance – making the circuit heat up. This heat is often noticeable long before the circuit fails, so regular inspections with a thermal imaging camera can detect such faults at an early stage. This will help prevent costly damages and avoid dangerous situations.

Other electrical failures that can be visualized with thermal imaging cameras include internal fuse damage, circuit breaker faults, and potential short circuits.

Plumbing

Thermal imaging is a perfect tool to detect blocked or broken pipes and other plumbing relates issues. You can use the camera to find leaks before they're visible to the naked eye and then trace them back to the source.

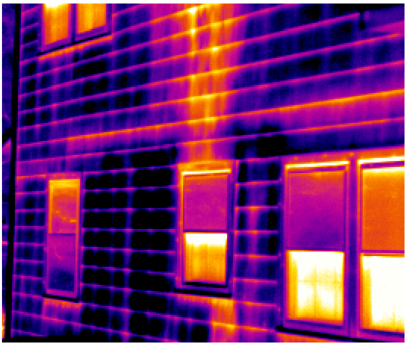


Water leak evident in a hallway

Even if the pipes are laid under the floor or inside a wall it can be possible to determine the exact location of the problem. Sending hot water through the pipes will allow heat to radiate through the area. The problem will quickly become visible to a thermal imaging camera.

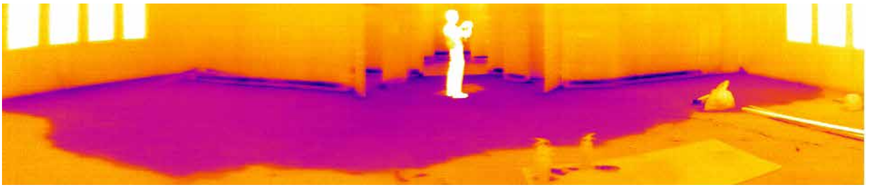
Plumbing leaks and water intrusion can also affect the building envelope, but in order to visualizing these leaks you will need to take advantage of solar loading. During the day the sun warms the exterior walls and the moisture trapped inside. The walls cool down again after sunset, but the moisture holds its temperature longer. Your thermal imaging camera will detect the temperature difference between the dry walls and the wet areas, pinpointing the location of the water leak.

You can use a similar principal to locate water leaks indoors. The water continuously evaporates as it soaks walls and pools under the flooring. This evaporation has a cooling effect, making the leak appear cold against the warmer walls and floor. Once you find these leaks you can begin repairs and remediation immediately – avoiding mold and its impact on building air quality. You can also use the camera to visualize mold, which typically generates heat. Finally, use your thermal imaging camera to monitor the drying process and demonstrate that the leak was fixed.



Water leak evident from outside the building

Monitor the drying process



[5] Thermal imaging for building envelope inspections

Thermal imaging cameras can provide a powerful and non-invasive means of monitoring and diagnosing the condition of buildings. Camera users can identify problems early, giving them the opportunity to document and correct issues before they become more serious and more costly to repair.

A building inspection with a thermal imaging camera can help:

- Visualize cracks that cause energy loss
- Detect missing or defective insulation
- Find moisture trapped in insulation, walls, and roofs
- Locate thermal bridges
- Find disruptions in district heating supply lines
- Locate water infiltration in flat roofs
- Detect construction failures

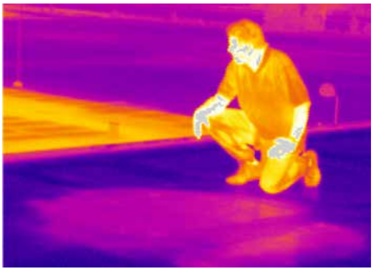
It's important to understand that you can't just scan a building at any time of day and draw conclusions from your images. For accurate results, you must choose the hours when temperature differences are most noticeable. For example, many thermal imaging cameras need a 10°C of temperature difference between the building's interior and exterior in order to detect missing insulation or energy losses. High image resolution, high thermal sensitivity cameras can detect temperature differences that are much smaller, but these cameras are often expensive.

In order to reach this temperature difference, buildings located in cold climates are often inspected during winter time. In hotter climates, the summer months can be ideal for surveying a building's insulation to determine whether chilled air is escaping.

Moisture intrusion around electrical circuit

Moisture Detection

Moisture damage is the most common form of deterioration in a building. Air leakage can cause condensation to form within walls, floors, or ceilings. Wet insulation takes a long time to dry and becomes a prime location for mold and fungi.



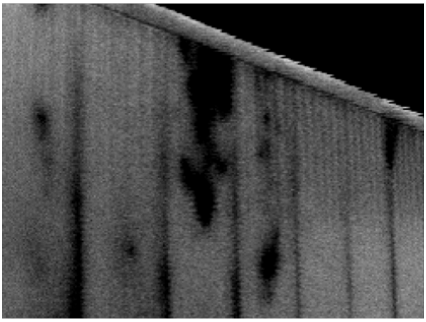
Water infiltration on a flat roof appears warmer than the surrounding area

The real problem is that while one might smell the presence of mold, it's hard to tell where it is forming. A thermal survey will help you find the moist areas where mold could grow and lead to serious health issues.

Thermal imaging is also used to detect water infiltration in flat roofs. Wait until the roof has cooled down in the evening, and you'll be able to see the water with your thermal imaging camera. Again, this is because water changes temperature more slowly than the roof materials. Your company can save a tremendous amount of money by repairing wet areas instead of replacing the entire roof.

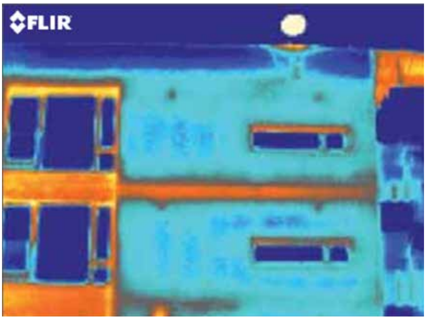
Thermal bridges

Thermal bridges indicate spots in a building where energy is being wasted. A thermal bridge is an area where the building envelope has a lower thermal resistance, usually caused by poor construction. The cracks and gaps create a path of least resistance for heat to follow out the building.

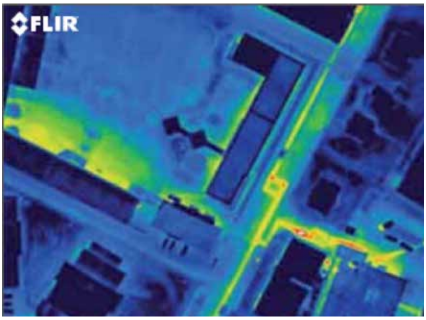


Air leaks visible in poorly finished sandwich-construction wall

The thermal image shows thermal bridges between the roof beams and adjacent walls



The image shows a thermal bridge at one of the floors



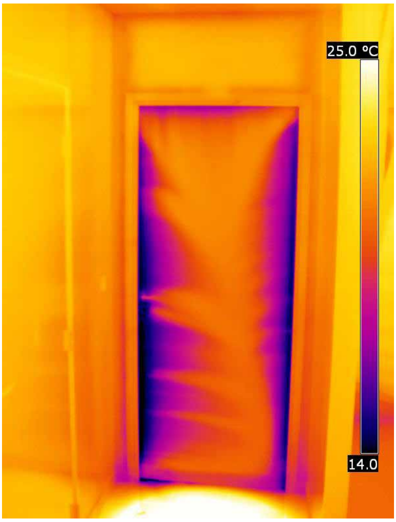
A thermal image, taken from the air, identifies leaks or insulation failure in the district heating system

Typical effects of thermal bridges are:

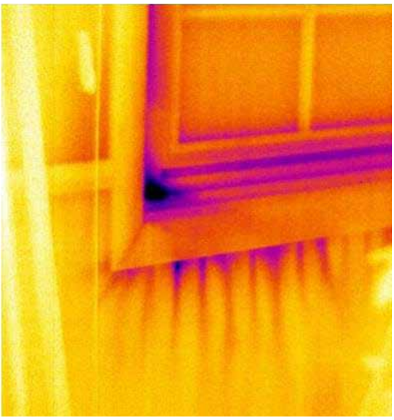
- Decreased interior surface temperatures; in the worst cases this can result in condensation, particularly in corners
- Significantly increased heat losses
- Cold areas in buildings

Supply lines and district heating

In cold climates, pavements and parking areas are sometimes heated. District heating systems distribute heat generated from a centralized location for residential and commercial heating requirements. A thermographic survey can easily detect defects in pipes or tubes of any underground heating system. A thermal imaging camera can help to identify the exact location of the defect so that repair works can be minimized.



Blower door set up to check for air leaks


Air leakage around a window during blower door test

Detection of air leaks

Air leakage can account for up to half of the energy consumed for heating purposes. A thermal imaging camera allows you to detect the characteristic patterns that occur when cold air seeps in through a leak in the construction, goes along a surface, and cools the surface down. However, both a temperature difference and pressure difference are needed in order to detect these leaks.

Air leak inspections should always take place on the side of the construction with negative pressure. This negative pressure can be exaggerated with the help of the pressurization method often referred to as the 'Blower Door Test'.

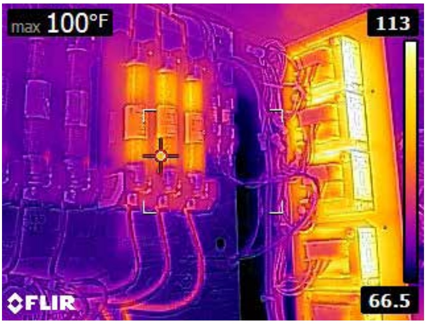
A blower door system is made up of three components: a calibrated fan, a door panel system, and a device to measure fan flow and building pressure. The blower door fan is temporarily sealed into an exterior doorway using the door panel system. The fan blows air into or out of the building, which creates a pressure difference of about 50 Pascal between the inside of the building and the outside air pressure.

Using the example of a building in a cold climate, the door would be set up to blow air out of the building. This creates a pressure difference that forces outside air to rush into the room through existing cracks. The colder outside air will cool down the crack, making a temperature difference that clearly shows up in a thermal image. The operator can use the cold areas of the image to accurately locate and map the air infiltration pathway.

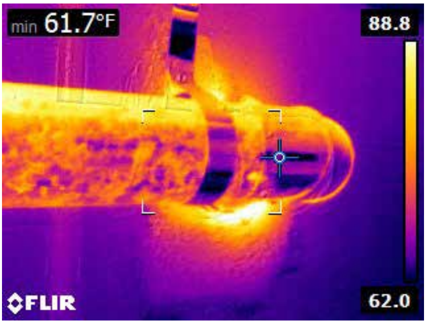
Quality assurance

Thermal imaging technology is also useful for monitoring the quality of work during renovations or expansion. You can check new electrical wiring, look for plumbing leaks, and ensure that insulation is installed correctly.

During construction-drying, thermal imaging makes it possible to determine the progress of the drying procedures. If the drying is going slowly, measures can be taken to speed up the process. Once the construction is totally dry – confirmed by thermal imaging – normal work can resume in the facility.



Check newly-installed electrical wiring



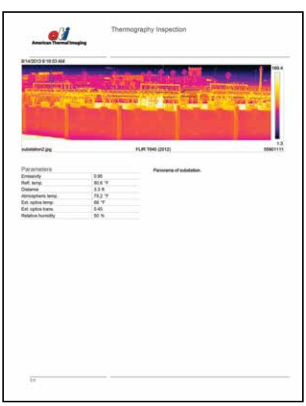
Look for plumbing leaks

[6] Choosing the right tool for the job

Thermal imaging cameras are versatile, affordable tools that can help you ensure the safety of your facility and the people who work there. To get the most out of your camera, make sure to choose a brand and model that fits your needs – from features to service and support.

Your job keeps you on the move all day, taking you up ladders, into crawl-spaces, and through a rugged work environment. A good thermal imaging camera should offer you:

- **Ruggedness –** This camera is a tool, just like everything else in your toolbag. It needs to be rugged enough to withstand a drop from one or two meters up. It should also be easy to carry in one hand, with user-friendly buttons and menus.
- **Resolution –** Thermal imaging that is impossible to interpret won't do you any good. Choose a camera with enough resolution to create clear, crisp images that you can enlarge if needed. For example, FLIR cameras offer Multi Spectral Dynamic Imaging (MSX®), which embosses visual details onto the full resolution thermal image. MSX® adds perspective to the scene and allows you to read text and labels.
- **Reporting –** Once you've surveyed a problem area, you need to generate a report so repair plans can be made. FLIR pairs its cameras with FLIR Tools+, an image editing and reporting software. You can use this program to instantly generate reports with information on the problem type, location, and steps needed to resolve it.



There are a lot of cameras that fit these needs available on the market. Which camera brand should you choose?

A well-established brand should be able to offer you:

- **Variety –** Different users have different needs. It is therefore very important that the manufacturer can offer you a full range of thermal imaging cameras, from affordable entry models to advanced high end models, so that you can choose the one that best fits your needs.

- **Accessibility –** Whatever your application, you will need to be able to easily view and share thermal images, and have the software to analyze and report your findings. Choose a thermal imaging camera that can be combined with the correct software for your application.
- **Service –** While most thermal imaging cameras for facilities maintenance applications are as good as maintenance free, accidents can happen. Your camera may also need occasional recalibration. Rather than having to send your camera half-way around the world, make sure the manufacturer offers a local repair center. That way, you'll get the camera fixed and back at work as fast as possible.
- **Accessories –** Make sure you have a system that can grow with your needs. The manufacturer you choose should be able to offer different types of lenses, displays, and other accessories.
- **Training –** There is more to the world of thermal imaging than just knowing how to handle the camera. Select a manufacturer that offers good training and application support when needed.

[7] Thermal physics for facilities maintenance applications

In order to interpret the thermal images correctly, you must understand how different materials and circumstances influence temperature readings. Some of the most important factors that can influence thermal measurements are:

1. Thermal conductivity

Different materials have different thermal properties. Insulation tends to warm up slowly while metals warm up quickly. This is called thermal conductivity. When two materials with different thermal conductivities are imaged at the same time, there may be a large gap in their temperature readings. This can be an advantage – for example, when you are looking for a water leak or missing insulation. However, in some cases it can lead to misinterpretation of images.

2. Emissivity

Emissivity is the most important factor in taking a correct thermal measurement. The emissivity of an object tells you how efficiently it emits infrared radiation. Objects with a high emissivity are very efficient emitters, while objects that do not emit infrared radition very well have a low emissivity.

If you look at the thermal image you might think that the gold paint is colder than the mug surface. In reality they have exactly the same temperature. The gold paint has a lower emissivity than the rest of the mug. This difference in intensity of infrared radiation makes it appear cold.

It is extremely important to set the right emissivity in the camera or the temperature measurements will be incorrect. Many thermal imaging cameras offer a menu with a list of emissivities based on material. Other materials can be found in an online emissivity table.

3. Reflection

Some materials reflect thermal radiation just like a mirror reflects visible light. Reflections can lead to misinterpretation of the thermal image. In addition, thermal radiation reflected from your body and room around you can also cause false temperature readings. There are steps you can take to reduce the impact of both reflection problems.

If the object you're trying to measure is metal and/or has a low emissivity, one solution is to put a piece of electrical tape on the shiny surface. A more permanent solution is to paint the surface. The paint or the tape will provide an area of higher emissivity that you can measure from.

When an object has a low emissivity and there is a large difference between the object temperature and the temperature of the room around you, the reflection of incident radiation – either from your body or from other warm objects in the area – will influence the temperature readings. One quick solution is to pay attention to the angle at which you're pointing the camera. You may need to try a few different angles in order to avoid reflections. Also, be careful about including windows in the scene, as windows reflect thermal radiation.

The window reflects thermal radiation, so to a thermal imaging camera the window acts as a mirror.

Finally, your camera menu may include an option to set the apparent reflected temperature. This will ensure the reflected heat won't affect your thermal camera readings.

4. Indoor and outdoor temperatures

To detect missing, damaged, or deficient insulation using thermal imaging cameras there needs to be a noticeable difference between inside and outside temperatures – usually, around 10°C.

Such inspections are typically done from both inside and outside the building. If the insulation is damaged or even missing, the void will stand out clearly. Before beginning an inspection, make certain you know the indoor and outdoor temperatures, as well as whether there have been any large temperature shifts within the past 24 hours.

5. Building material influences

It probably goes without saying that direct sunlight can influence thermal readings, but sunlight can have long lasting effects as well. Direct sunlight and shadows might even influence the thermal pattern on a surface many hours after the exposure to sunlight has ended.

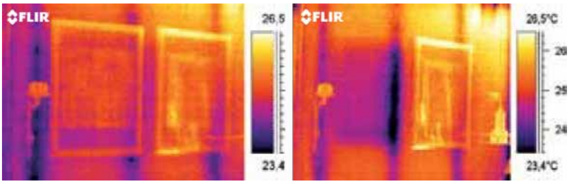
Differences in thermal conductivity can also cause differences in thermal patterns. Brick changes temperature much slower than wood, for example. Wind and rain can also influence the thermal data because they both cool down the surface materials. Even after the rain has stopped the evaporation of the water continues to cool surfaces.

6. Heating and ventilation systems

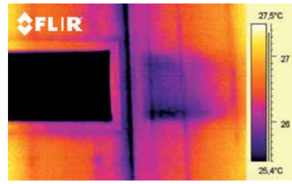
External influences on surface temperatures can also be found indoors. The temperature of the room will have an effect on the object surface temperature. In addition, HVAC systems cause temperature differences that can cause misleading thermal patterns, either creating warm air pockets in the winter, or cool zones near ventilators and air-conditioning vents.

7. Influences on the inside of the building

Bookshelves, cabinets, and hanging pictures can also influence the thermal pattern in a room by having an insulating effect. Once these things are moved away from the wall, the area behind them will appear colder than the rest of the wall. This might be confused for missing insulation. For that reason, it is advisable to remove items from the wall at least six hours before inspection.



These two thermal images show the same wall, recorded when the outside temperature was colder than the room. The image to the right shows a cold spot where a hanging picture insulated the wall, giving the incorrect impression of missing insulation.



The image shows thermal reflections on an inner wall (to the right) caused by the window to the left.

8. Reflections from the surroundings

When scanning reflective targets, you may need to change your angle to minimize the reflections on the image. The reflection could be from your body heat, a piece of machinery, light bulb, or some other heat source in the area. Reflections can affect the data in the thermal image, and if not understood, cause an incorrect temperature reading.

9. Type of materials used in the construction

Some materials, such as concrete, are “thermally slow,” or change temperature very slowly. Other materials, such as most metals, change temperature quickly. In order to interpret the results correctly, the thermographer needs to know whether there have been any large temperature changes inside or outside the building prior to the inspection.

10. How the building was constructed

Sometimes outer walls are built with an air gap between the outer skin and the rest of the construction. This type of construction is not suitable for control from the outside. Any framework in the wall construction looks colder when seen from the inside (provided it’s warmer inside). In contrast, the framework will look warmer than the rest of the wall when seen from the outside. These are actually characteristic patterns, and should not be considered errors.

[8] Steps for a successful thermal inspection

Once you have your thermal imaging camera in hand, where do you begin your inspections? In this section of the guidebook, we will present some thermal imaging methods to help get you started.

1. Define the task

Start the assignment by considering the conditions of your facility. For instance: has there been a recent increase in energy usage? Is it cold inside? Is there a noticeable draft? Then determine both the inside and outside temperature and make sure that the temperature difference is sufficient for building inspections (a difference of at least 10°C is advisable).

2. Start from the outside

Start the thermographic inspection from the outside. Missing insulation or cold bridges can quickly be located from the outside. Be sure to include images from areas where nothing appears to be wrong. This gives you an opportunity to compare areas with faults to the “good” areas, so you can better evaluate the extent of the problem.

3. Continue inside

The next step is looking at the situation from the inside. This requires thorough preparation, however. To prepare for the interior thermal scan, the inspector should take steps to ensure an accurate result, such as moving furniture away from exterior walls and removing hanging pictures at least six hours before the inspection. This will prevent false readings in areas that have been insulated by the furniture and pictures. Just as with outside scans, the requirement for accurate thermographic inspections is a large temperature difference (at least 10°C) between the inside and outside air temperatures.

When these conditions are met the inspector can start scanning every room in the building with the thermal imaging camera. In doing so the inspector should make sure to take accurate notes of where each thermal image was taken, perhaps by marking the location with arrows on a floor plan to show exactly from which angle the thermal images have been taken.

4. Scan your systems

Now take a closer look at the interior systems. Check the HVAC system for loose electrical connections, misaligned ducts, and air leaks. Check for clogged air filters and leaking condensation. Scan the thermostat, too, to make sure its readings aren't being affected by a light switch or other warm connection nearby. Next, inspect the building's electrical systems, starting with the breaker box. Look for overheating, overloaded circuits, and loose connections. You can also scan smoke and carbon monoxide alarms to make sure they're active. Finally, use your thermal imaging camera to scan near plumbing lines, bathrooms, and along walls for evidence of water leaks.

5. Set up an air tightness test

If the building continues to lose energy after resolving any HVAC issues, then there may be small cracks and crevices causing a draft. Air leakage can account for up to half of the energy consumed for heating purposes. A blower door test will make even the smallest cracks visible (For an explanation of blower door tests, please see Chapter 5).

6. Analysis and reporting

When all rooms have been inspected it is time to return to the office to do the analysis of the images and to summarize the findings in a report.

Many thermal imaging camera manufacturers pair their cameras with reporting software. These programs allow inspectors to quickly and efficiently draw up comprehensive building inspection reports.

FLIR products for facilities maintenance

FLIR TG165

FLIR TG130

FLIR C2

FLIR MR 160

FLIR Ex and Exx Series

FLIR Tools Mobile App

FLIR Tools+

FLIR Tools+ software helps to analyze the thermal images and quantify problems such as air infiltration, insulation defects, and moisture problems in a professional report. The program offers image editing tools, advanced analysis, and options such as a Panorama tool to stitch several images together. The software includes Rapid Report, a one-click option that generates reports based on your custom template.

Don’t worry about being tied to your desk in order to take advantage of FLIR Tools. FLIR leads the way with forward-thinking Wi-Fi connectivity to Apple and Android mobile devices. Just download the FLIR Tools Mobile app from the App Store, Google Play or the Amazon Appstore for Android and you’re ready to capture live, streaming video and still images from select FLIR IR cameras.

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