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We'll be starting in just a few moments.....

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Making measurement science work!

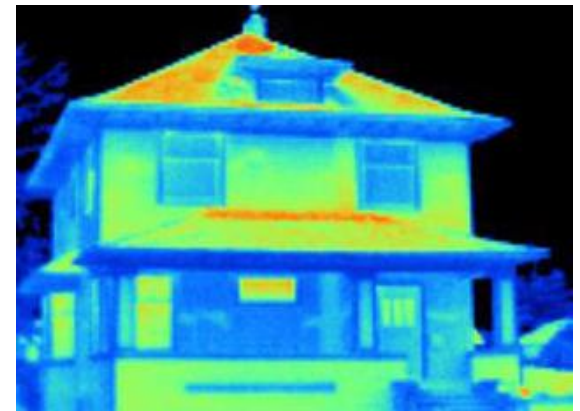
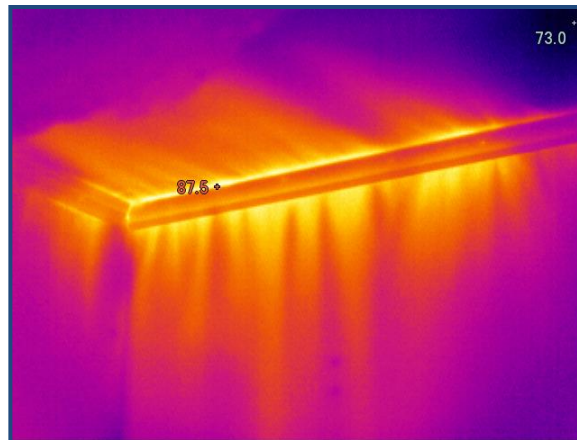
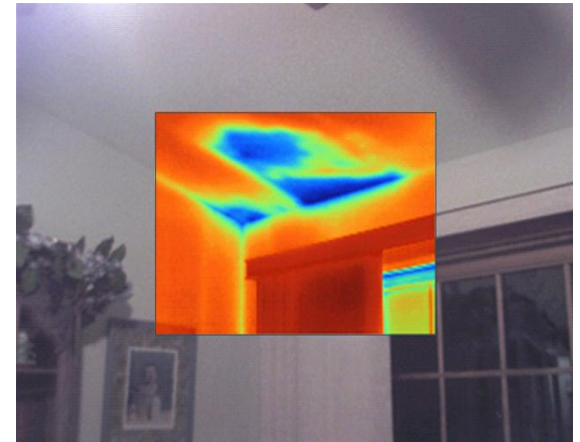
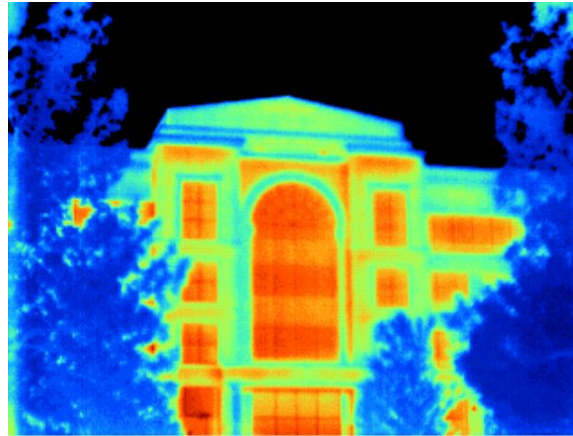
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TruTech Tools
and
Proactive Maintenance Consultants
Presents:



Thermography 101



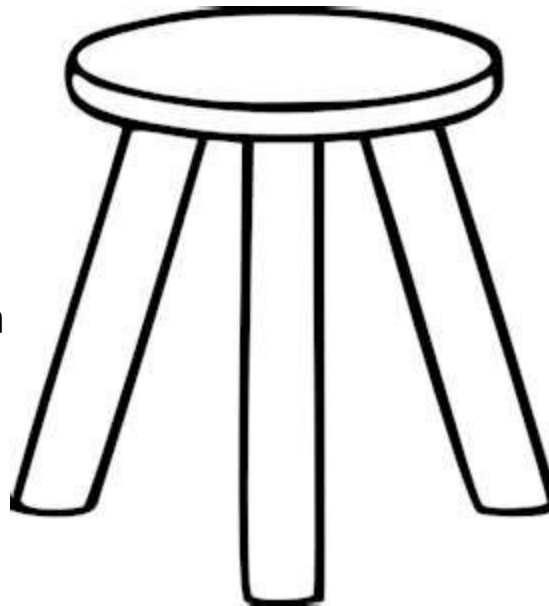
Agenda

- What is infrared
- What is thermal imaging and where is it used?
- Thermography Considerations
- Common Inspection Scenarios
- Choosing a Thermal Imager
- Summary

An effective infrared scanning program

- Analogous to a three legged stool

Know your camera



Program/process for
effective thermal
imaging

Understand the science of infrared

Today we are going to touch on the science of infrared

Understanding Thermography



UNLIKE GLASS....the Germanium lens...

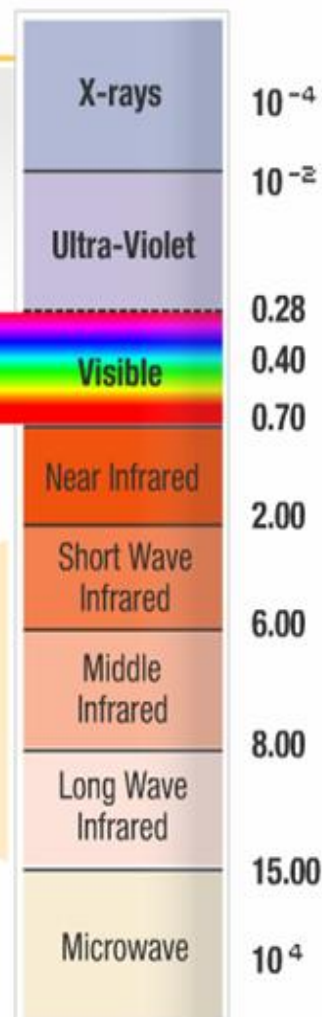
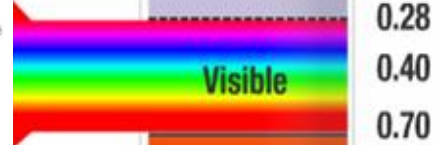
- Will transmit infrared radiation
- Influences image quality
- Can be easily scratched
- Is the single most expensive component on an infrared camera
- Is replaceable, modular on higher-end cameras (with software mapping or re-calibration)
- Can be protected (germanium protection glass)



What is infrared?

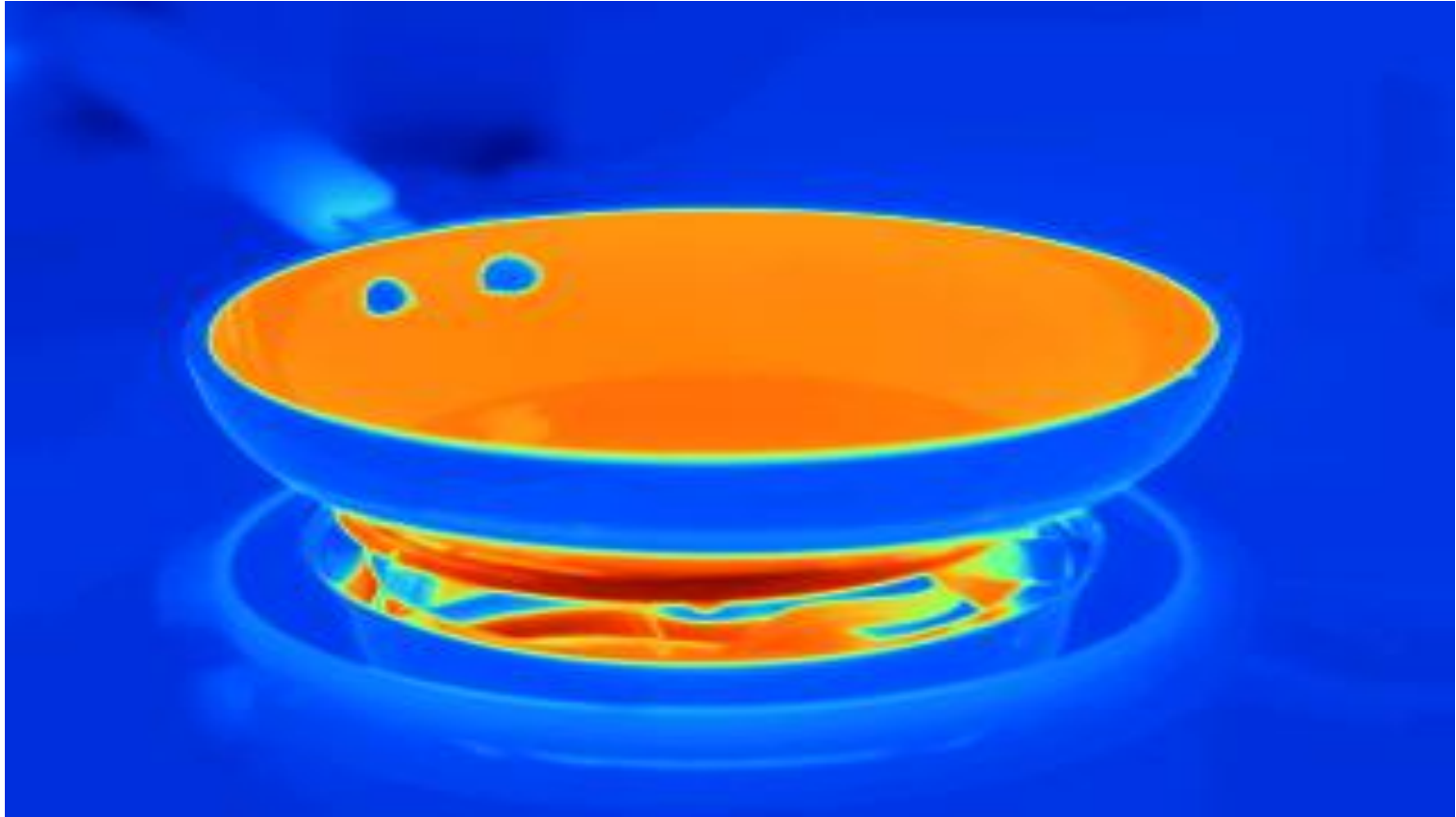
The Electromagnetic Spectrum

- Infrared radiation is radiated heat that cannot be seen by our eyes but can be sensed by our skin
- All objects, whatever their temperature, emit infrared radiation
- The intensity of infrared radiation depends on the temperature and a surface property termed “emissivity”.



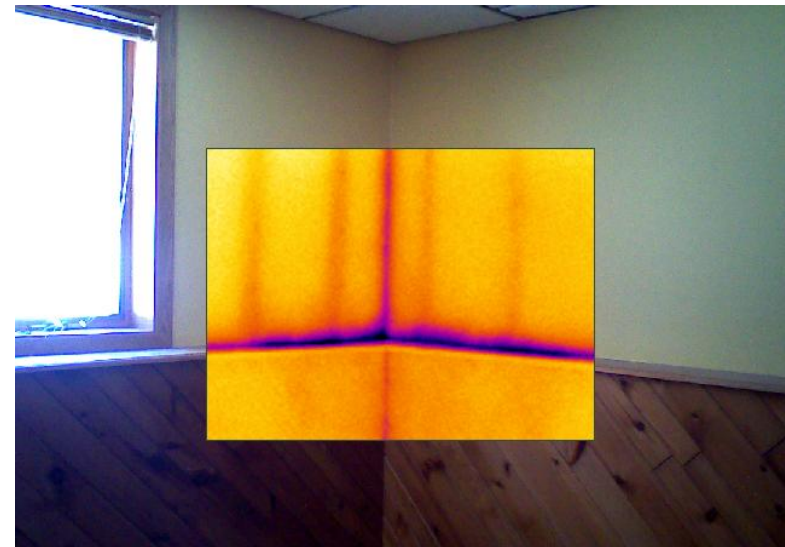
Wavelength in Microns (μm)

What you see “thermally” is what you can feel....



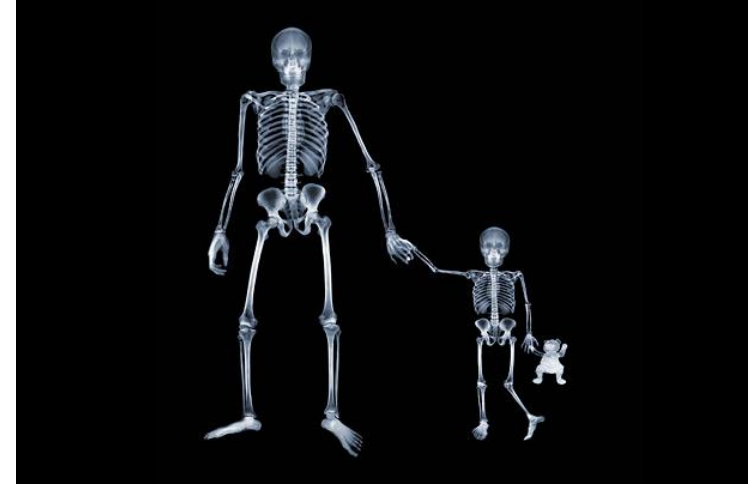
What Does a Thermal Imager Do?

- Displays the thermal patterns on a given surface by converting the radiated energy to a digital image
- Provides visual verification and documentation of problems, before and after
- Reduces liability, improves efficiency, adds revenue stream



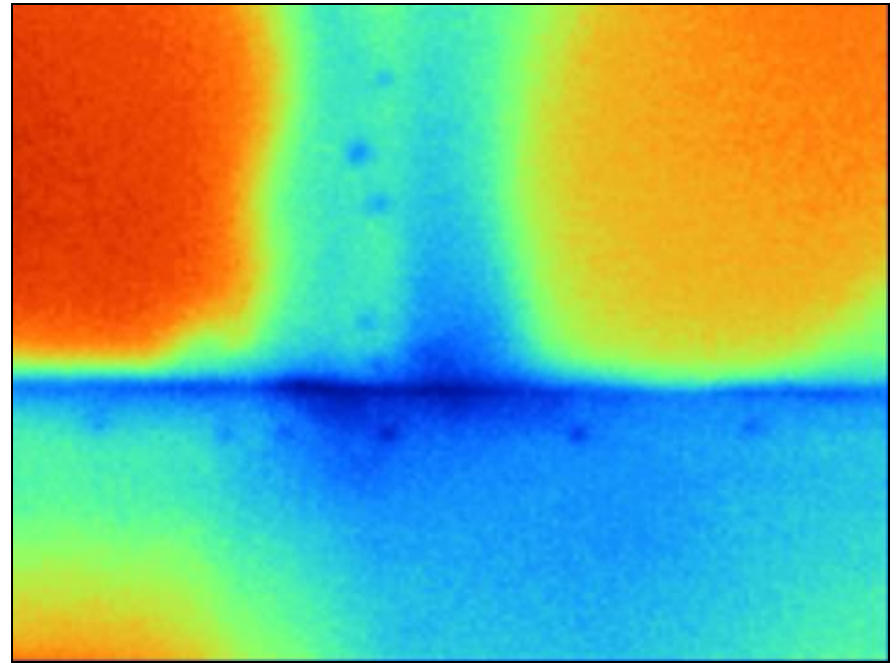
What a Thermal Imager *Does NOT* Do.

- See through walls or materials
 - A few exceptions:
 - Thin plastics
 - The Atmosphere
 - And of course the lens of your camera
- Distinguish moisture issues from thermal or apparent temperature issues
- Measure temperature
- Give answers that need no interpretation

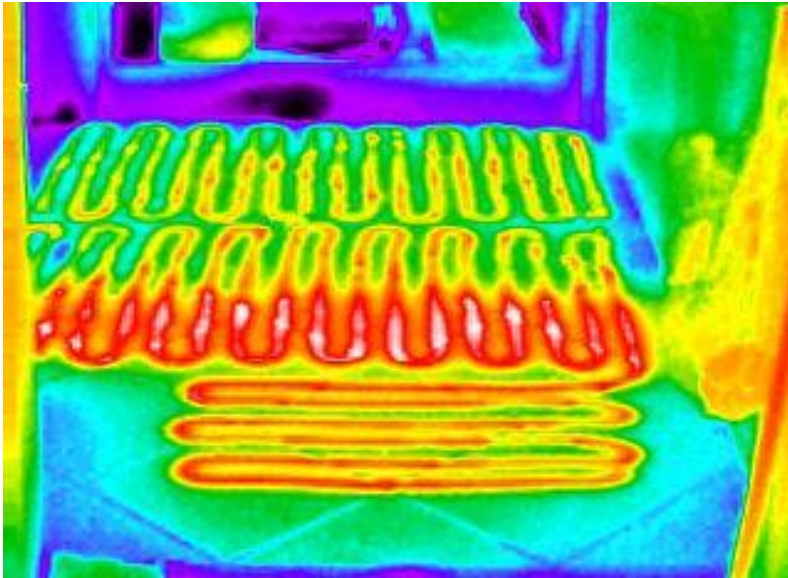


Thermal Imaging....

... is the non-contact detection and measurement of radiation coming from a surface.

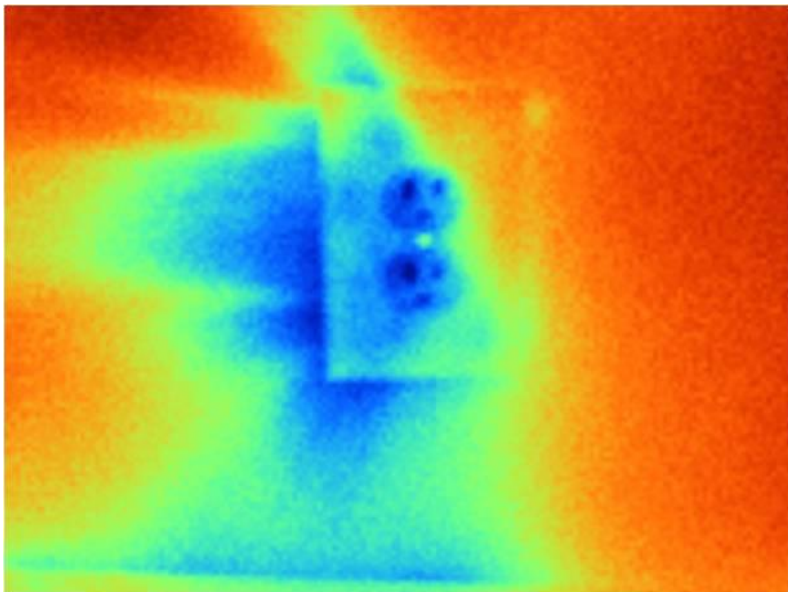


Where can we use a Thermal Imager?

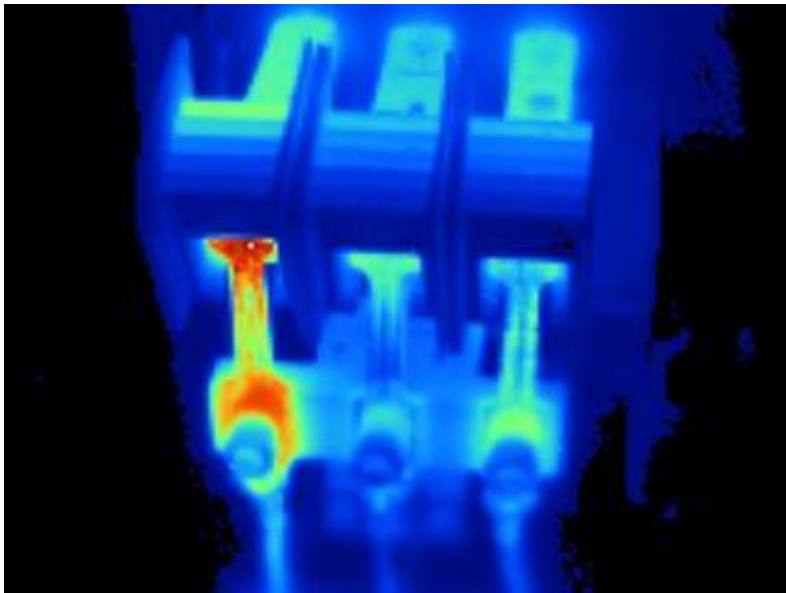


Thermal imagers allow you to easily inspect:

- Building Envelope
 - Building commissioning
 - Energy auditing
 - Weatherization
 - Home inspections



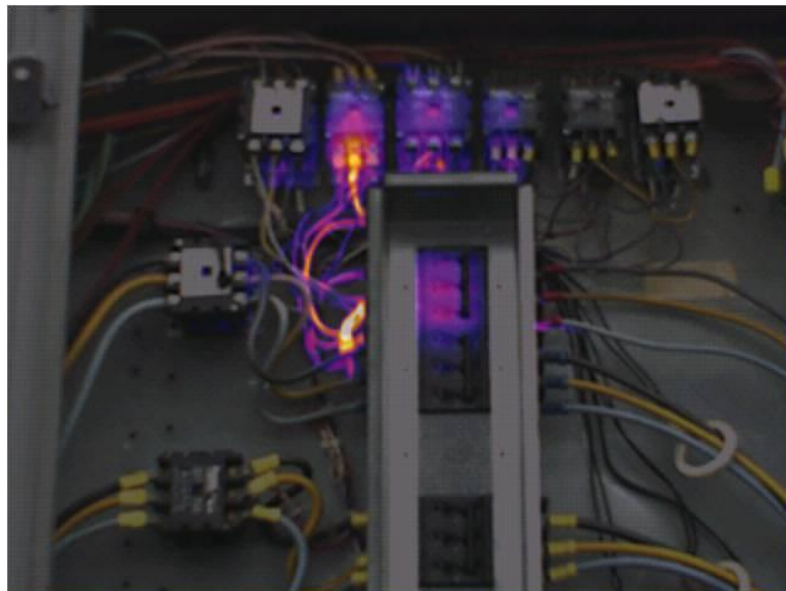
Additional applications for a Thermal Imager?



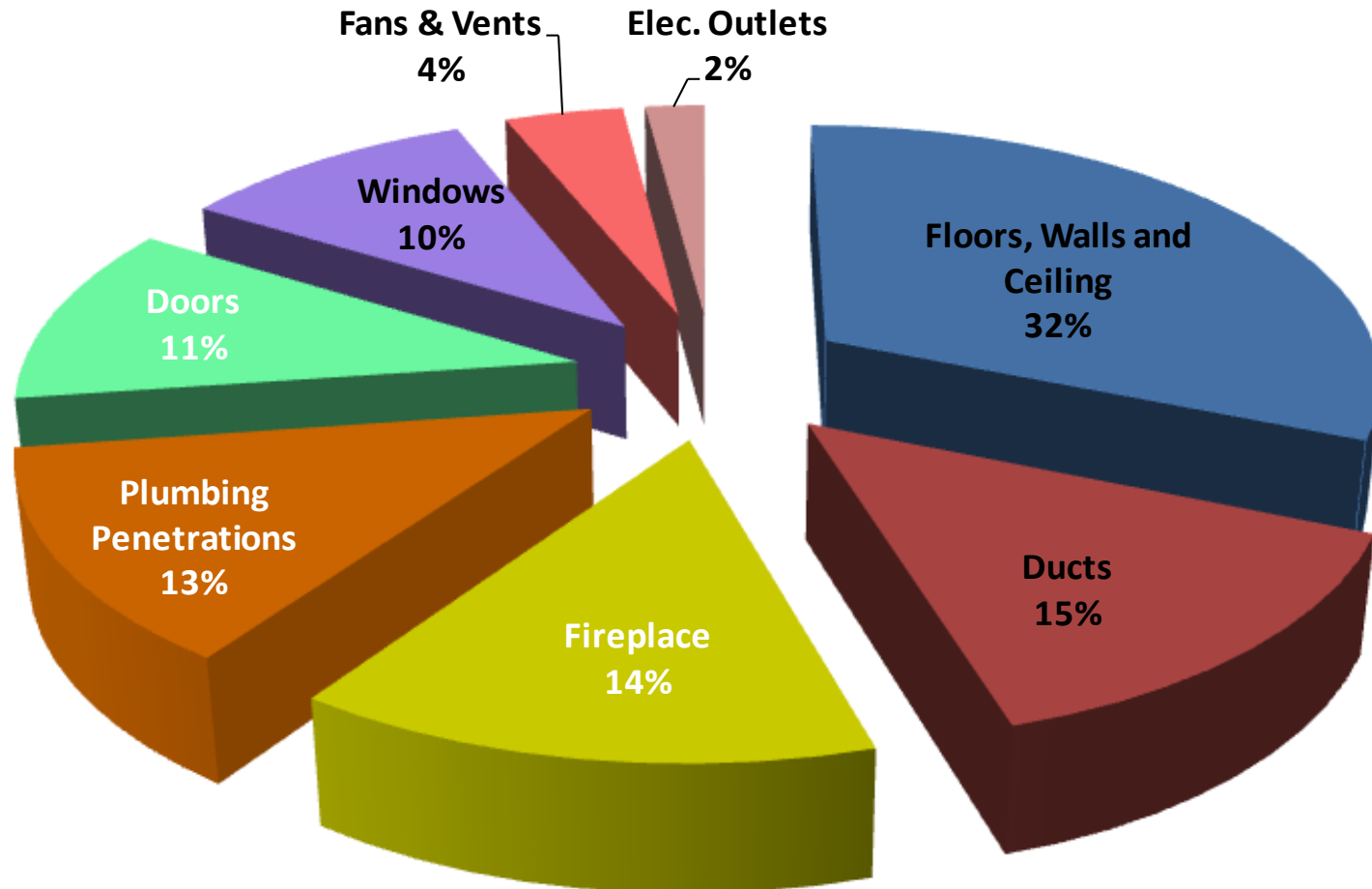
Beyond the building inspection applications,

Infrared can be used in...

- Electrical Equipment
- Electrical Circuits
- Mechanical Equipment
- Heating / Cooling Equipment
- Industrial low slope roofs
- Human health
- Animal health
- Many others....



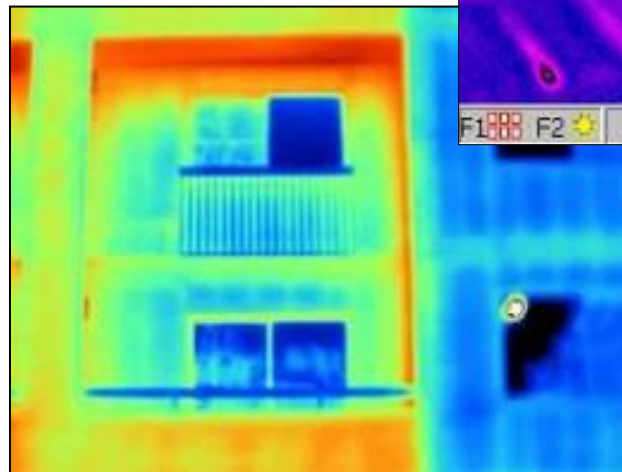
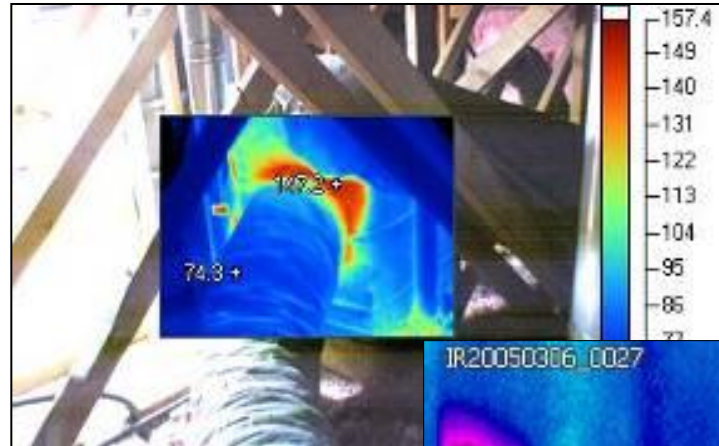
Common Air Leak Sources



Source: DOE - http://www1.eere.energy.gov/consumer/tips/air_leaks.html Date Accessed: 4/20/2009

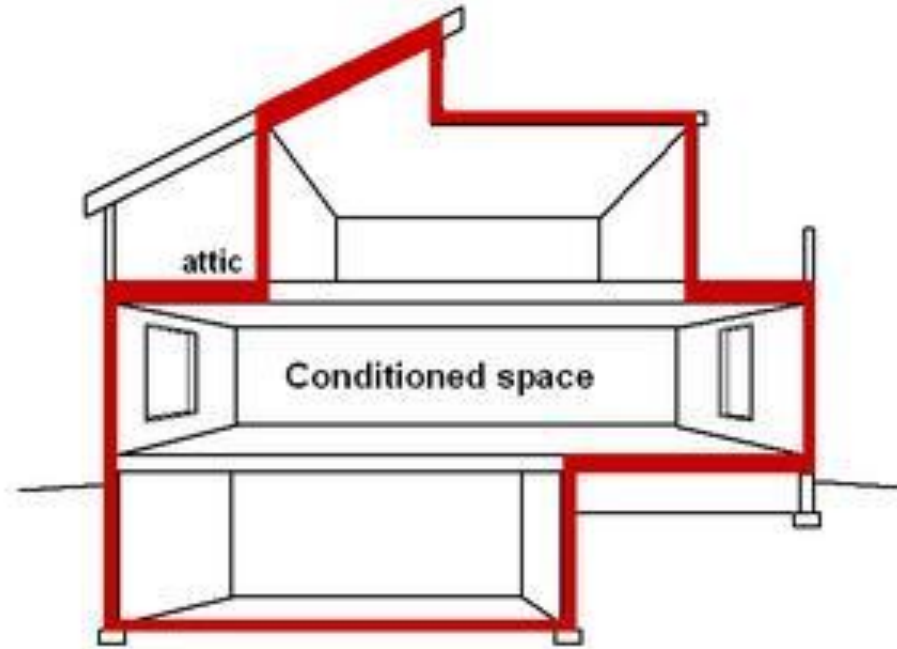
What Do We Look For?

- Air infiltration
 - Energy use
 - Comfort
 - Health issues
- Insulation or installation issues
- Moisture
- Construction problems



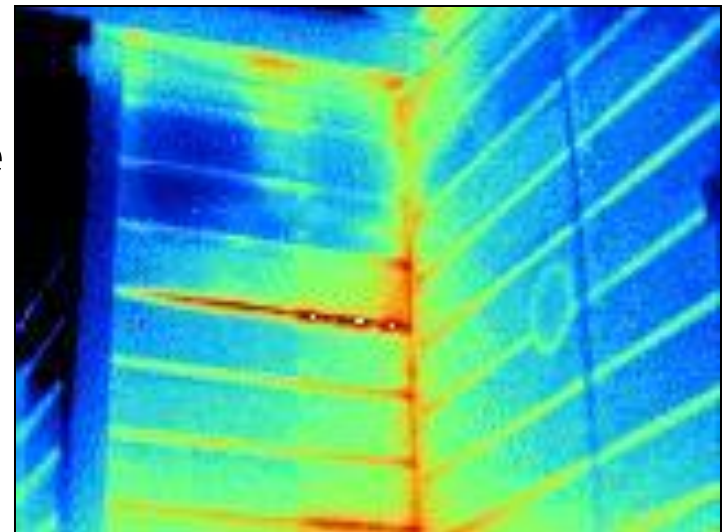
Where do we look?

- Viewing conditioned vs. unconditioned space
- Indoor
 - Walls
 - Floors
 - Ceilings
 - Ducts
- Exterior
 - Thermal bridging
 - Windows & doors
 - Construction joints
- Roofs
- HVAC/R
- Electrical and Mechanical Systems

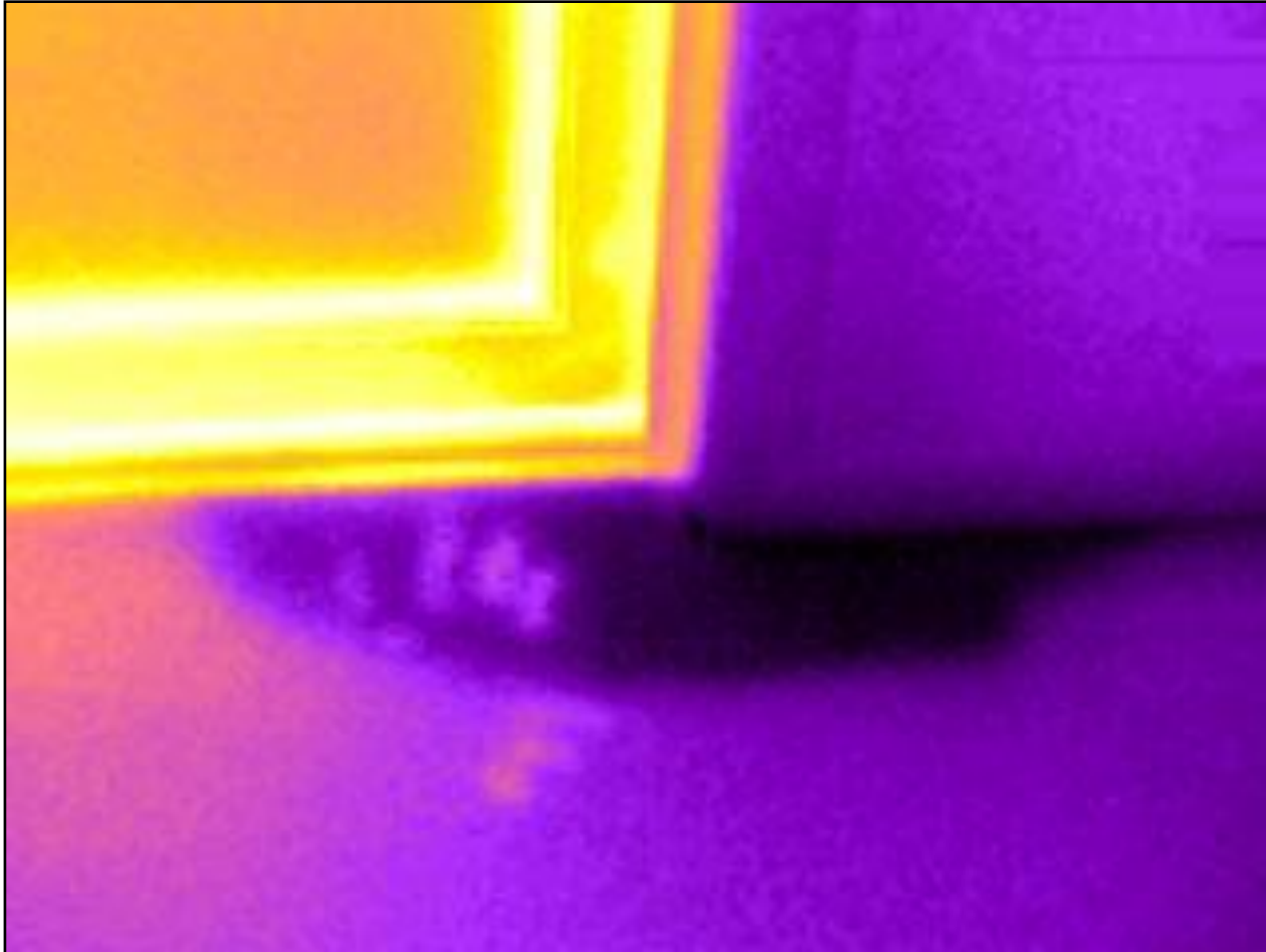


Thermography Benefits

- Measurements are:
 - Very sensitive to problem characteristics
 - Can scan large areas quickly
 - Identifies specific location
 - Non-contact
 - Obtained without disturbing structure
 - Detect problem before significant damage

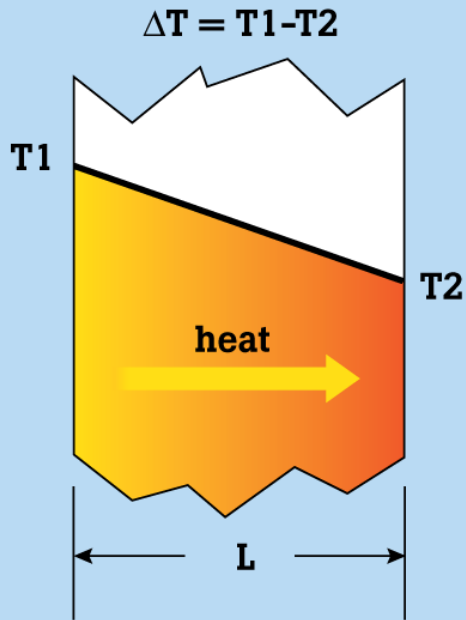


A little of the science of infrared...



Three Modes of Heat Transfer

Conduction

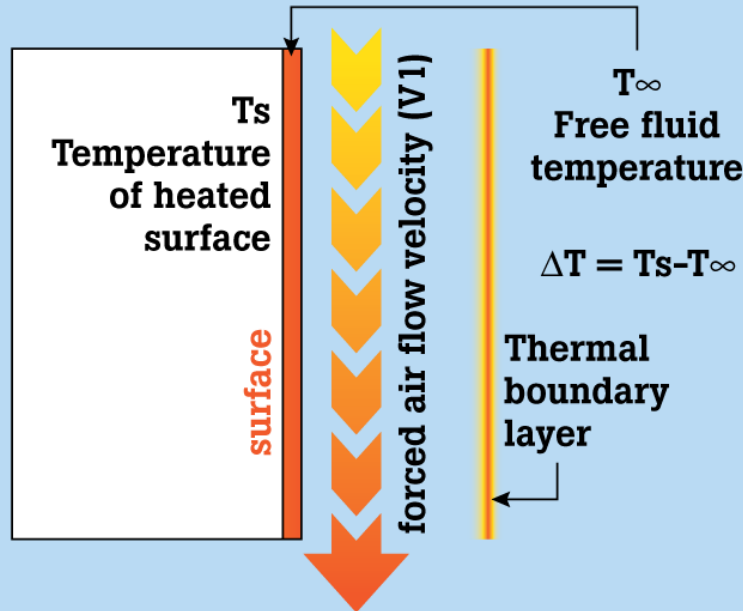


Conductive Heat Flow:

*** Solids ***

And sometimes in fluids &
gasses

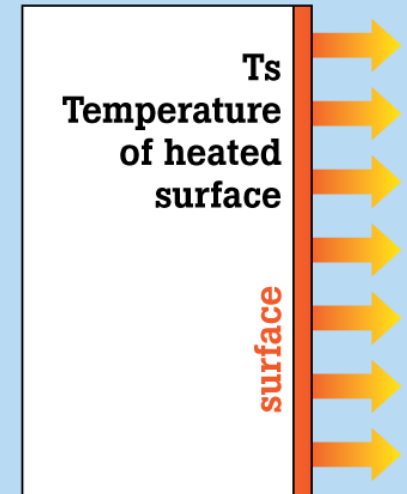
Convection



Convective Heat Flow:

*** Fluids & Gasses ***

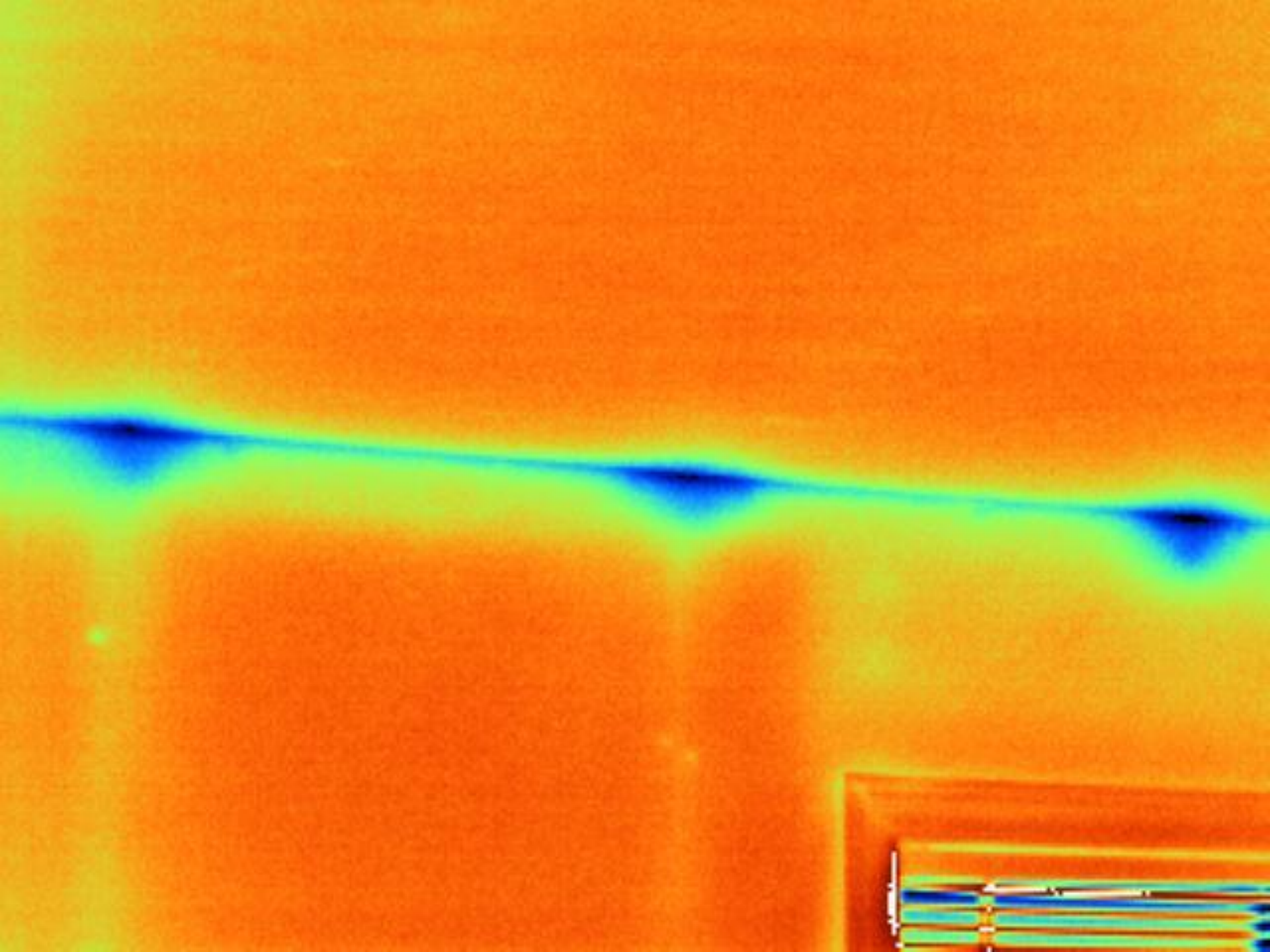
Radiation



Radiation Heat Flow:

**Electromagnetic
Waves**





Thermography Considerations

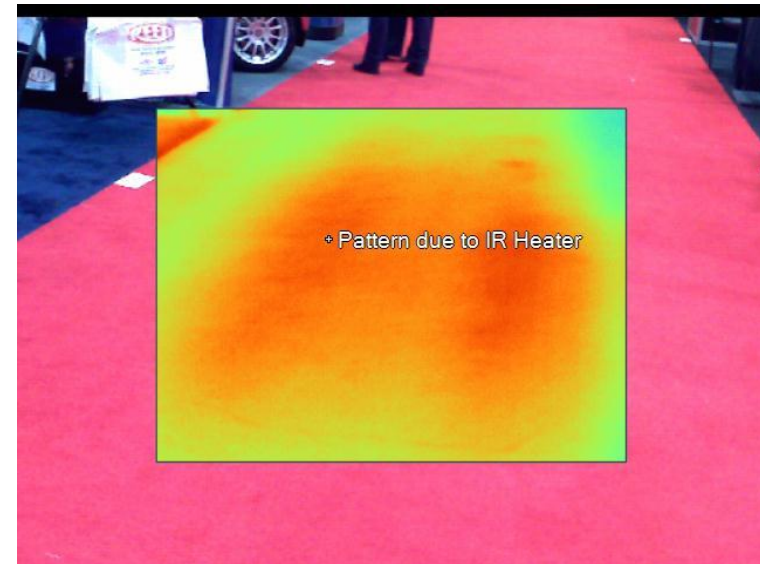
- A thermal gradient exists from the inside to the outside
- The primary factors influencing this are:
 - Conduction
 - Thermal capacitance
 - Convection
 - Load on the system
 - Emissivity of the surface
 - State change on the surface
 - Wind Effects
 - Angular Variations
 - Your Surroundings
 - Reflective Surfaces





There are some basic conditions that must be met in order to perform most inspections:

- Direct View
- As perpendicular to target as possible
- Understand environmental conditions
 - Sun
 - Wind
- Make a plan – follow a plan



Types of Measurements

Qualitative

Qualitative inspections focus on temperature differences as opposed to actual temperatures

1. Temperature differences are sufficient to indicate most abnormalities in electrical and mechanical equipment

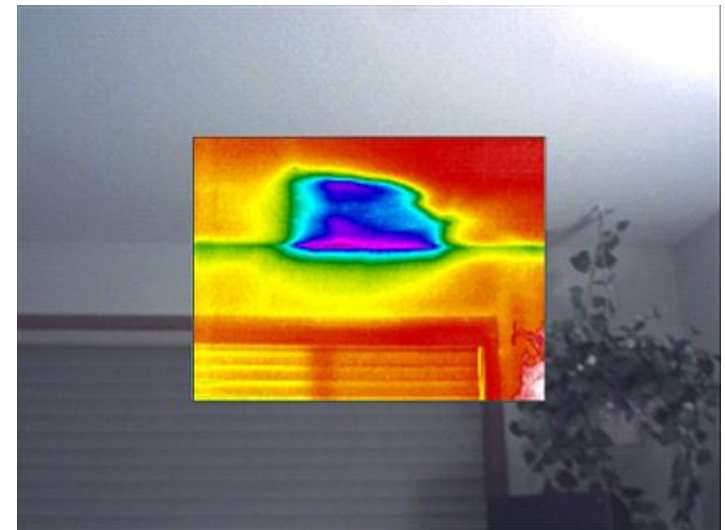
Quantitative

Precise temperature or temperature distribution measurement

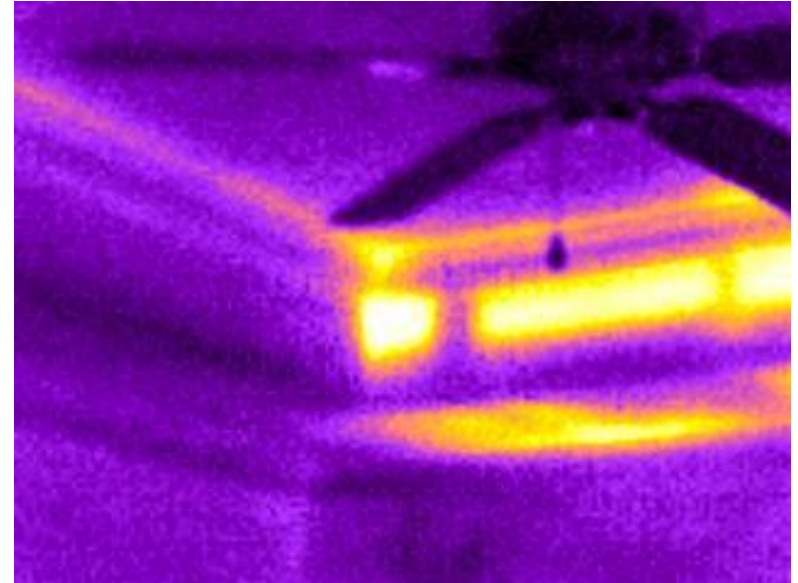
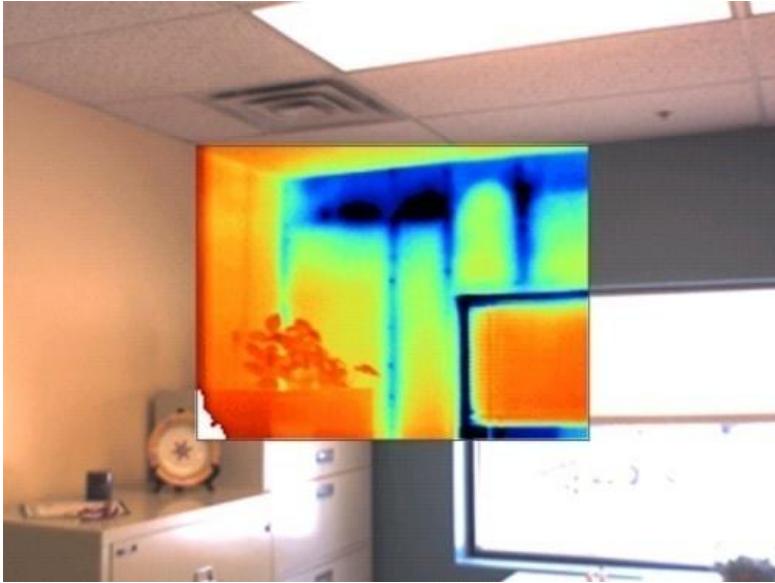
1. Slight variations caused by changes in material properties, atmospheric conditions and other factors could distort the readings

What You Need to Know

- How buildings work & how they are built
- Heat transfer basics
- Thermal imager operation
- Organizations are developing standards
 - RESNET & BPI
- Level I training & certification requirements
 - ASNT SNT-TC-1A



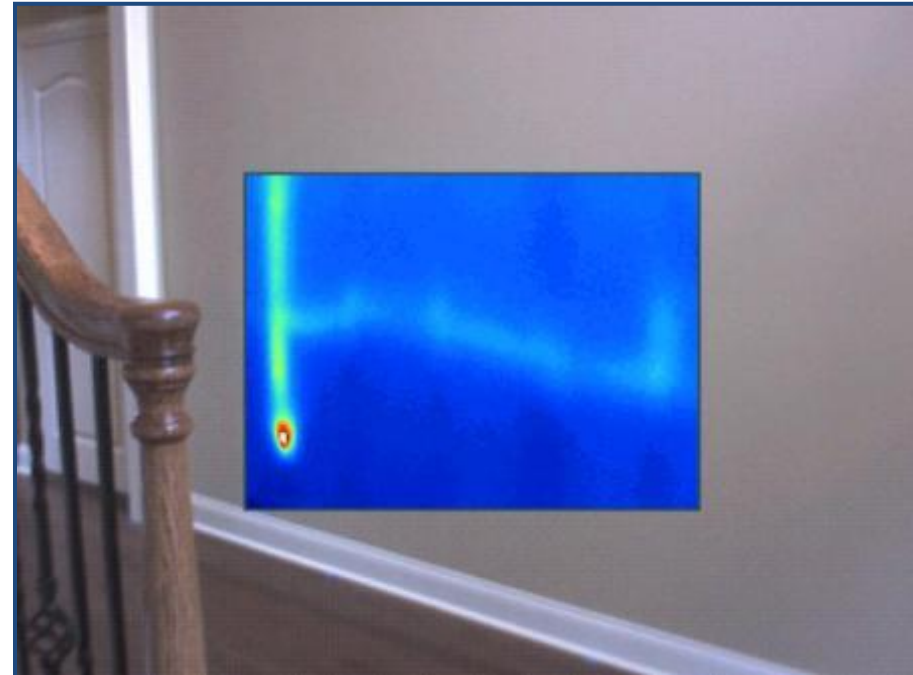
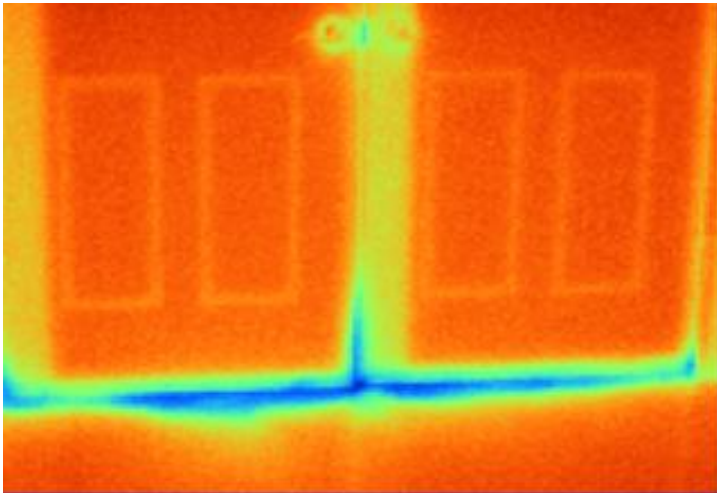
Successful IR Audit



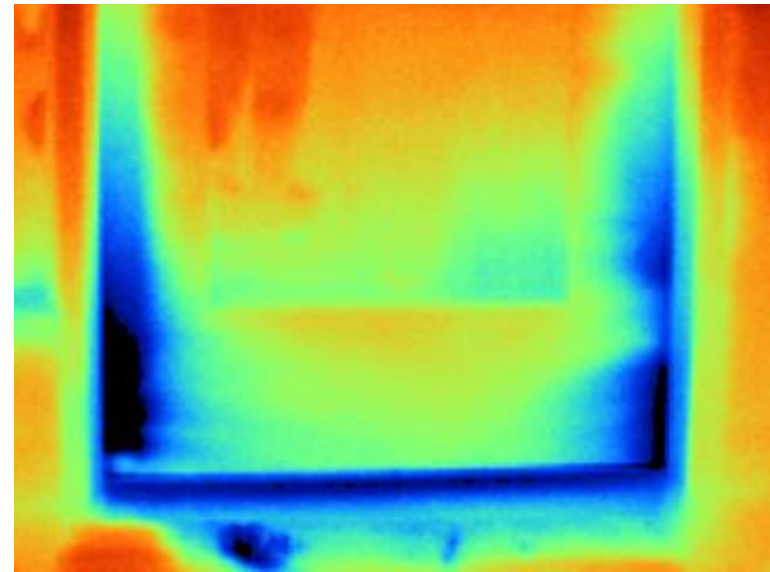
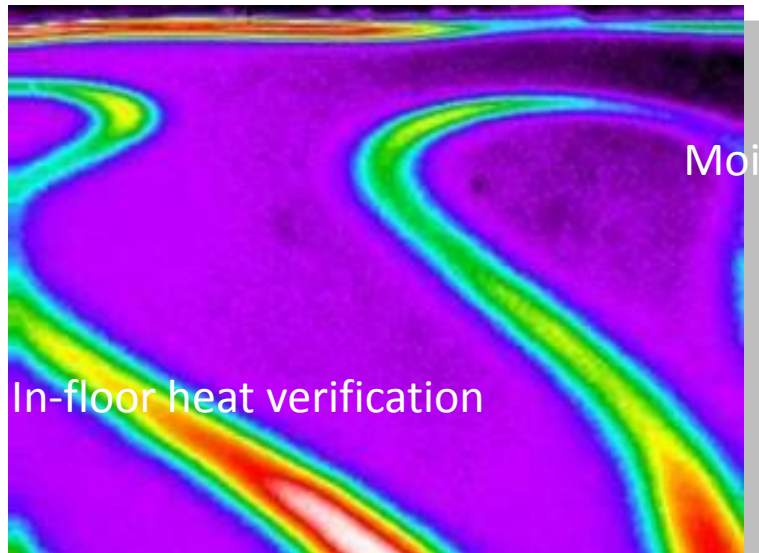
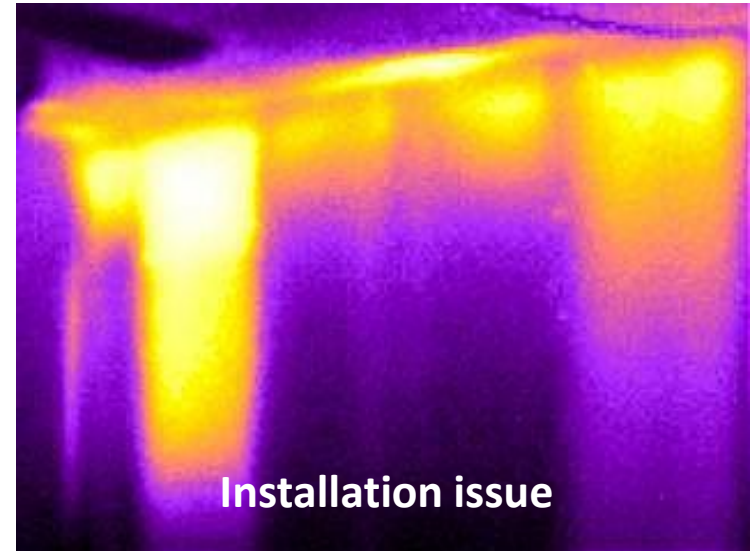
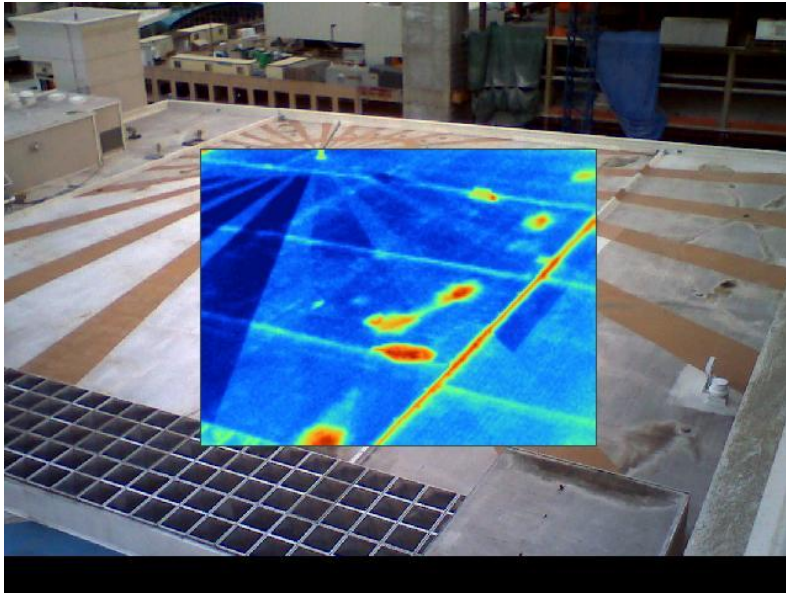
- Air Leaks – ASTM E-1186
 - ΔT of 3°F for Air Leak Inspection
- Insulation – ASTM C-1060
 - ΔT of 18°F for Insulation Inspection (* better cameras narrow ΔT)
- Solar Loading & Wind can mask problems
- Focus!

Inspecting with IR

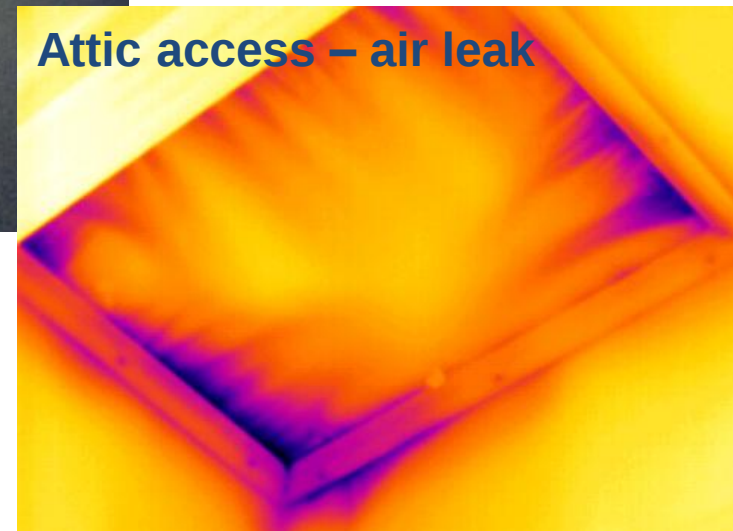
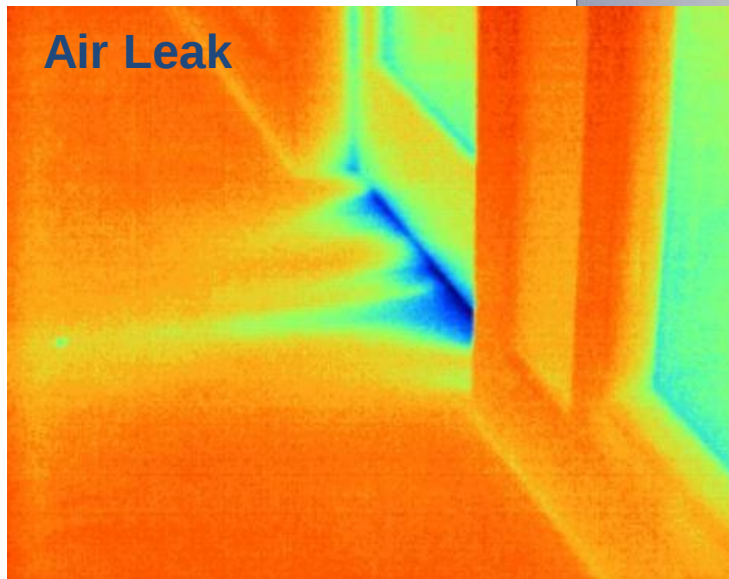
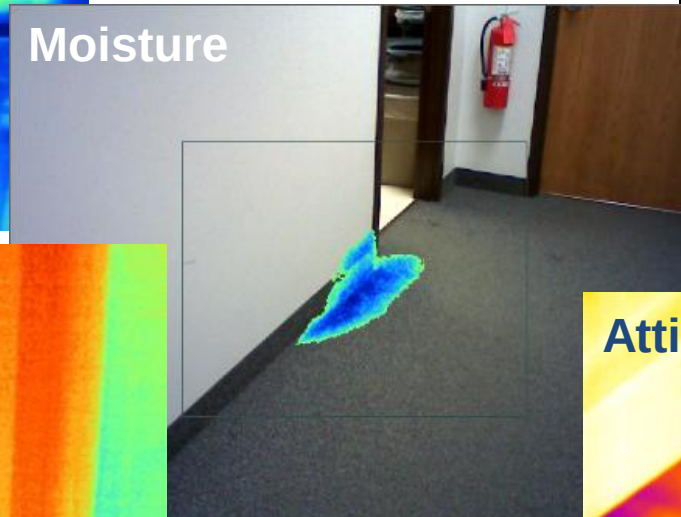
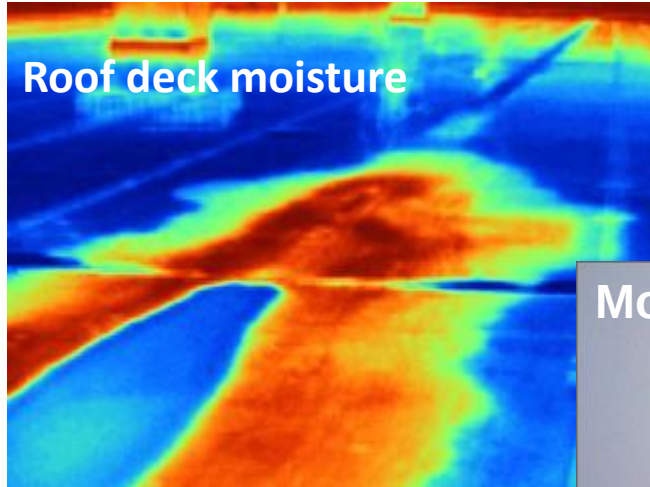
- Stabilize home
- Turn HVAC off 10-15 min – before scan
- Perform visual inspection of building envelope
- Work systematically – follow route
- IR image appears hot or cold depending on climate
- Inspect from both inside and outside
- Validate findings with other tools

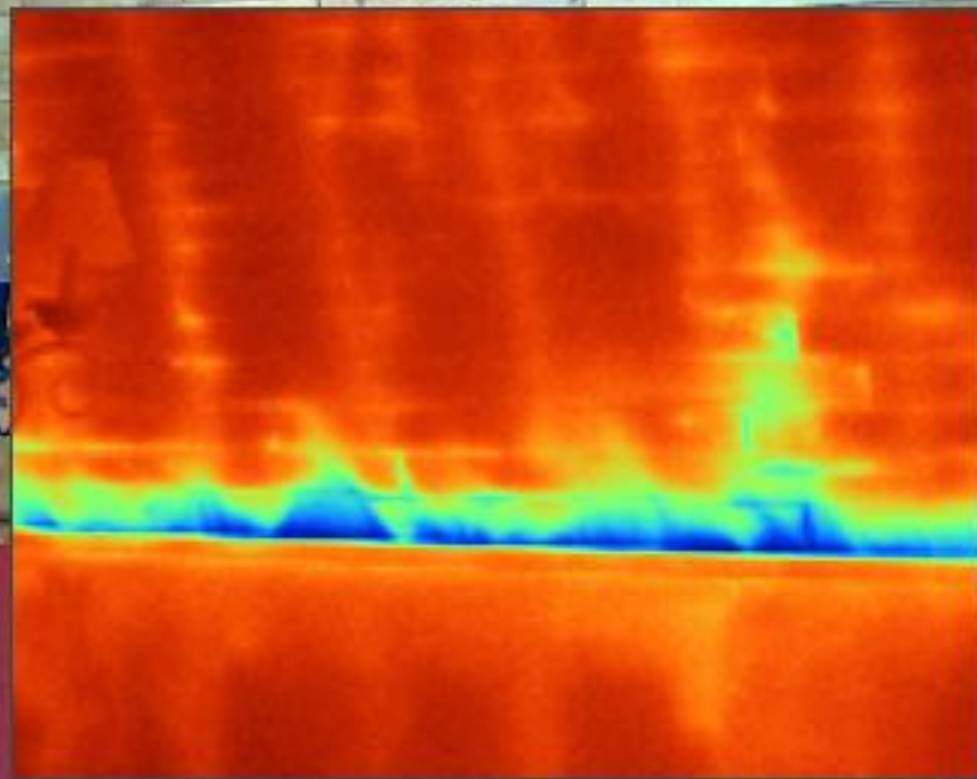


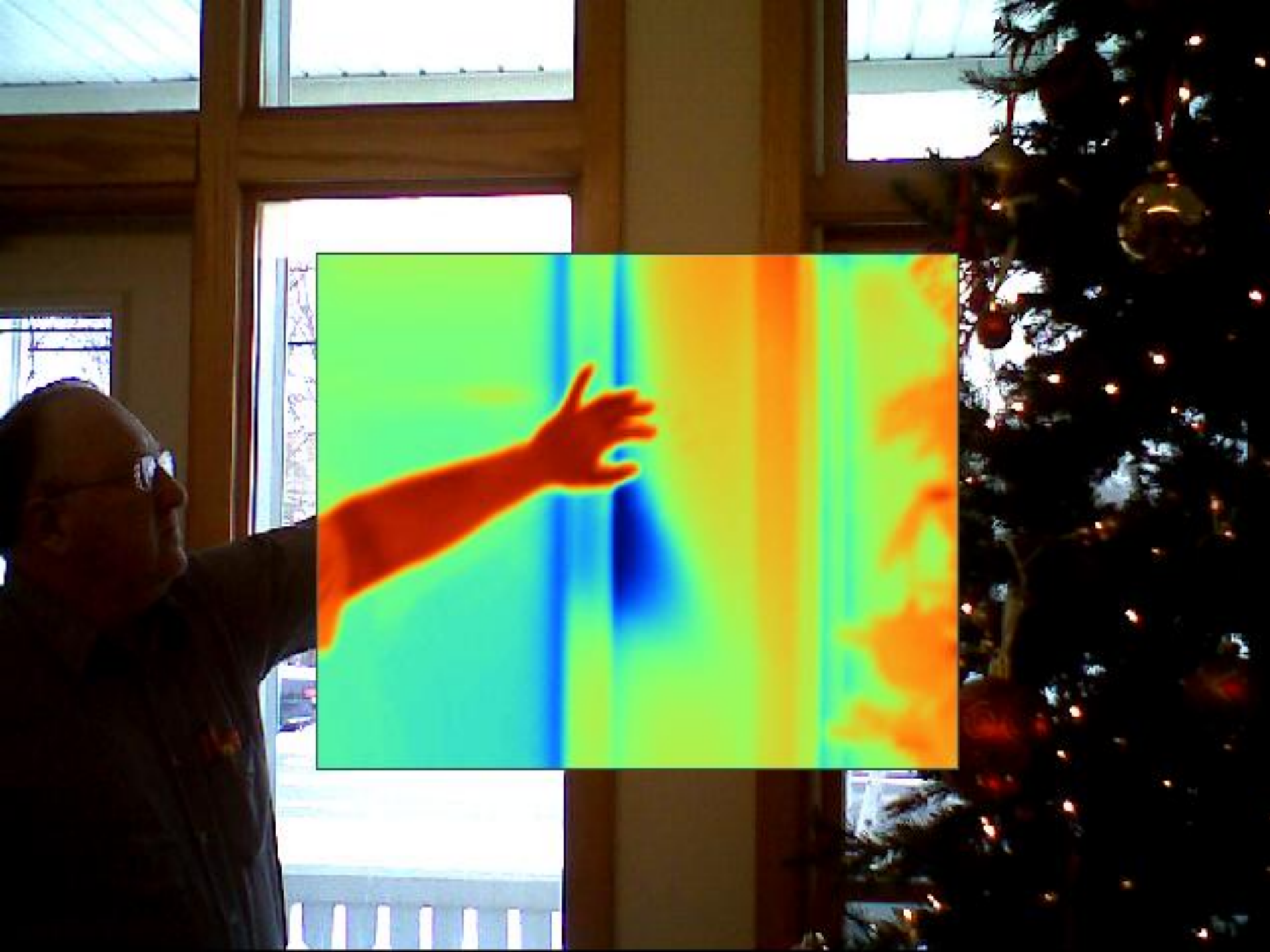
Building Inspection & Energy Auditing

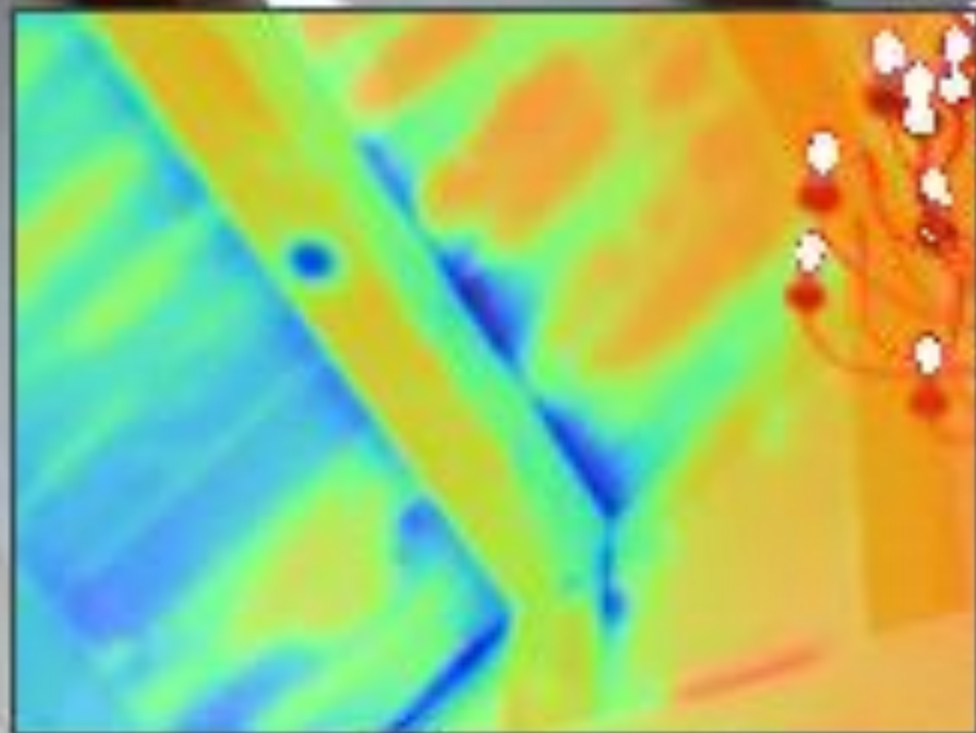


Building Inspection & Energy Auditing



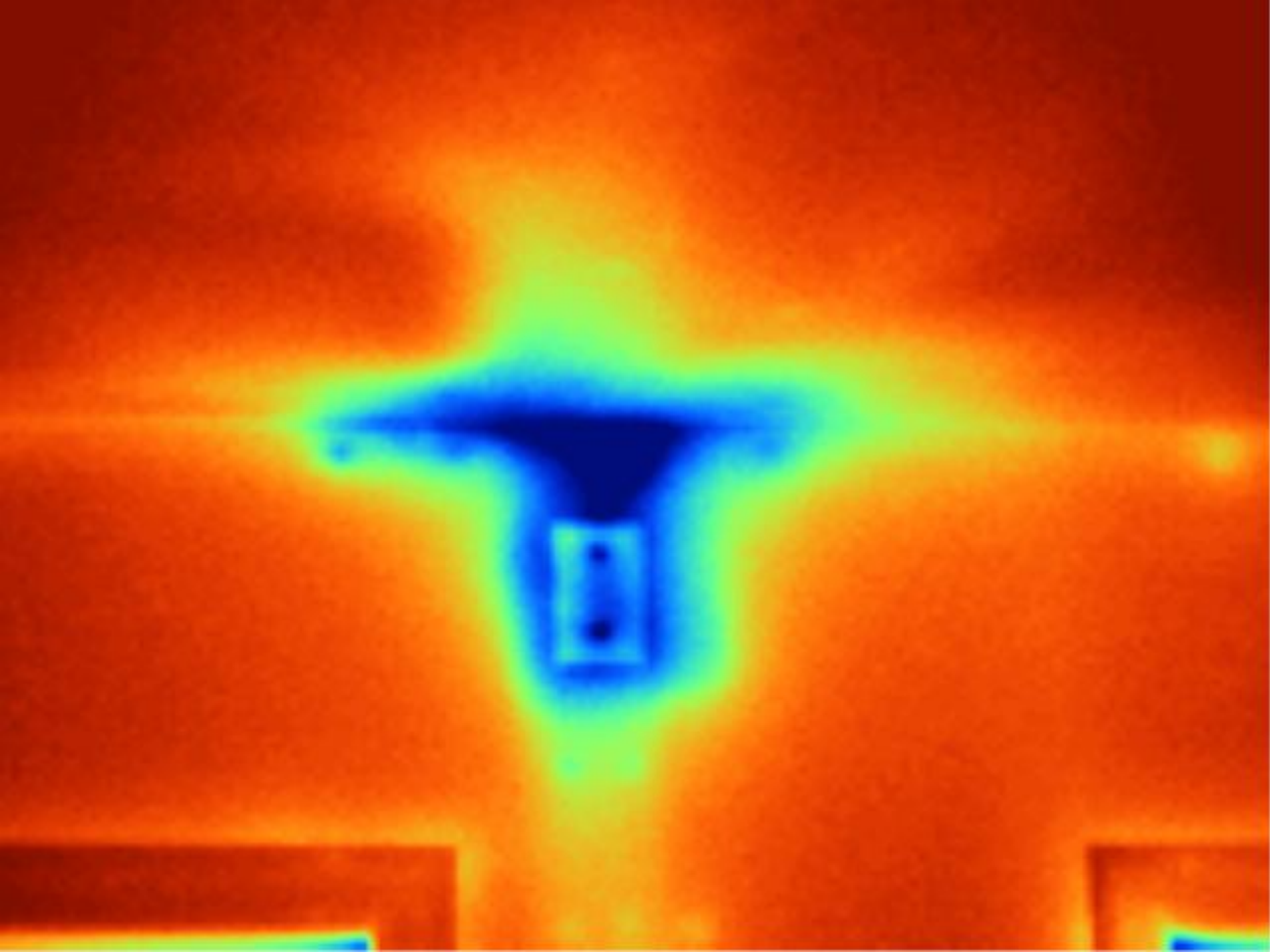


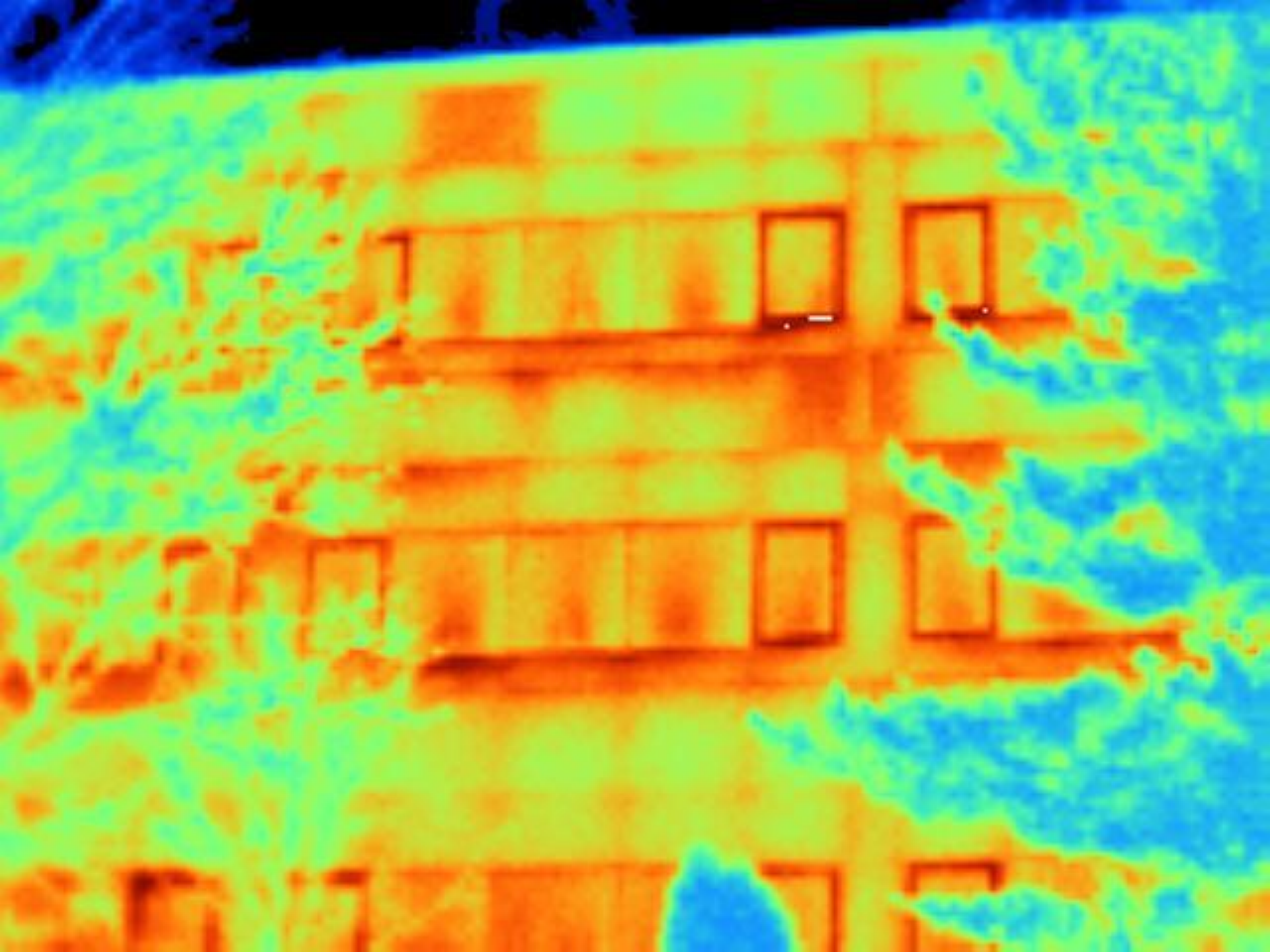


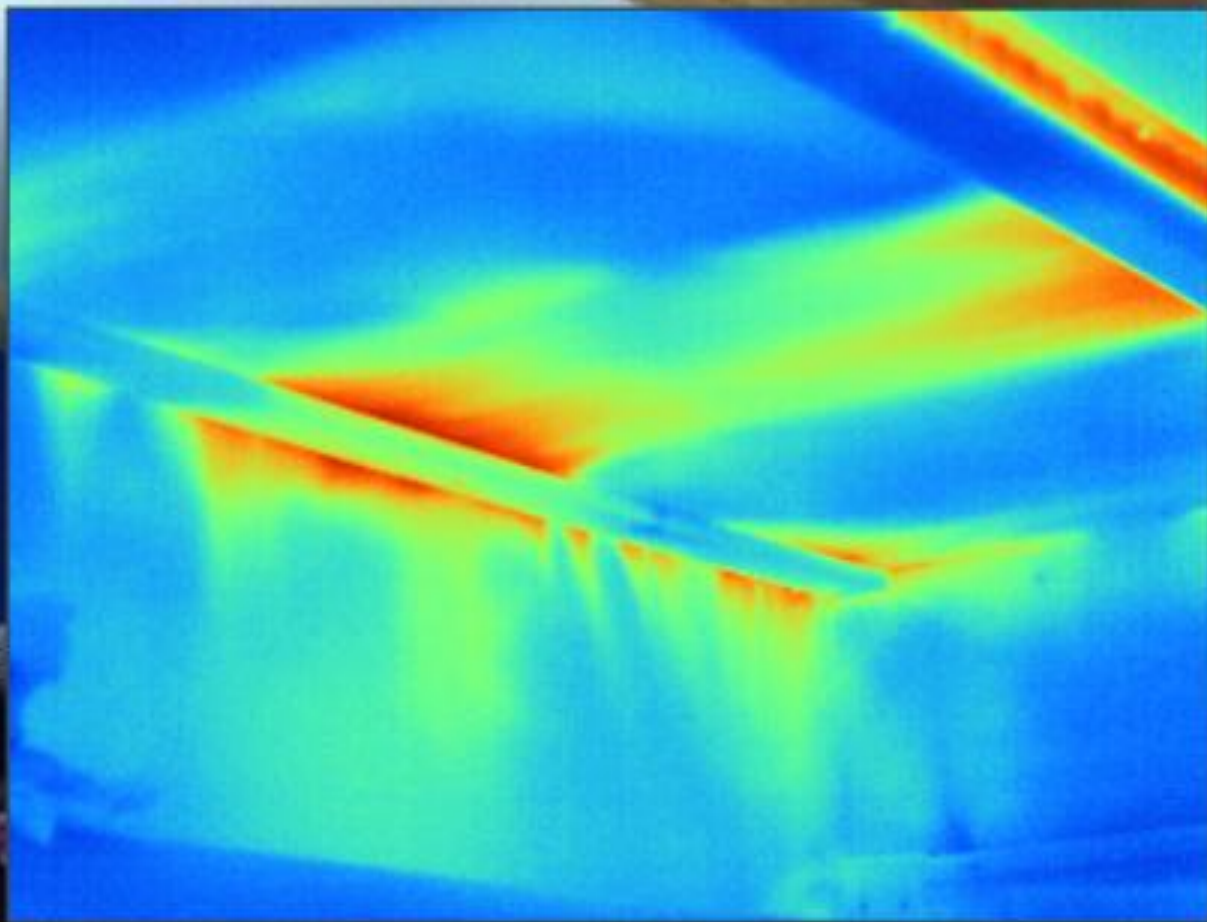




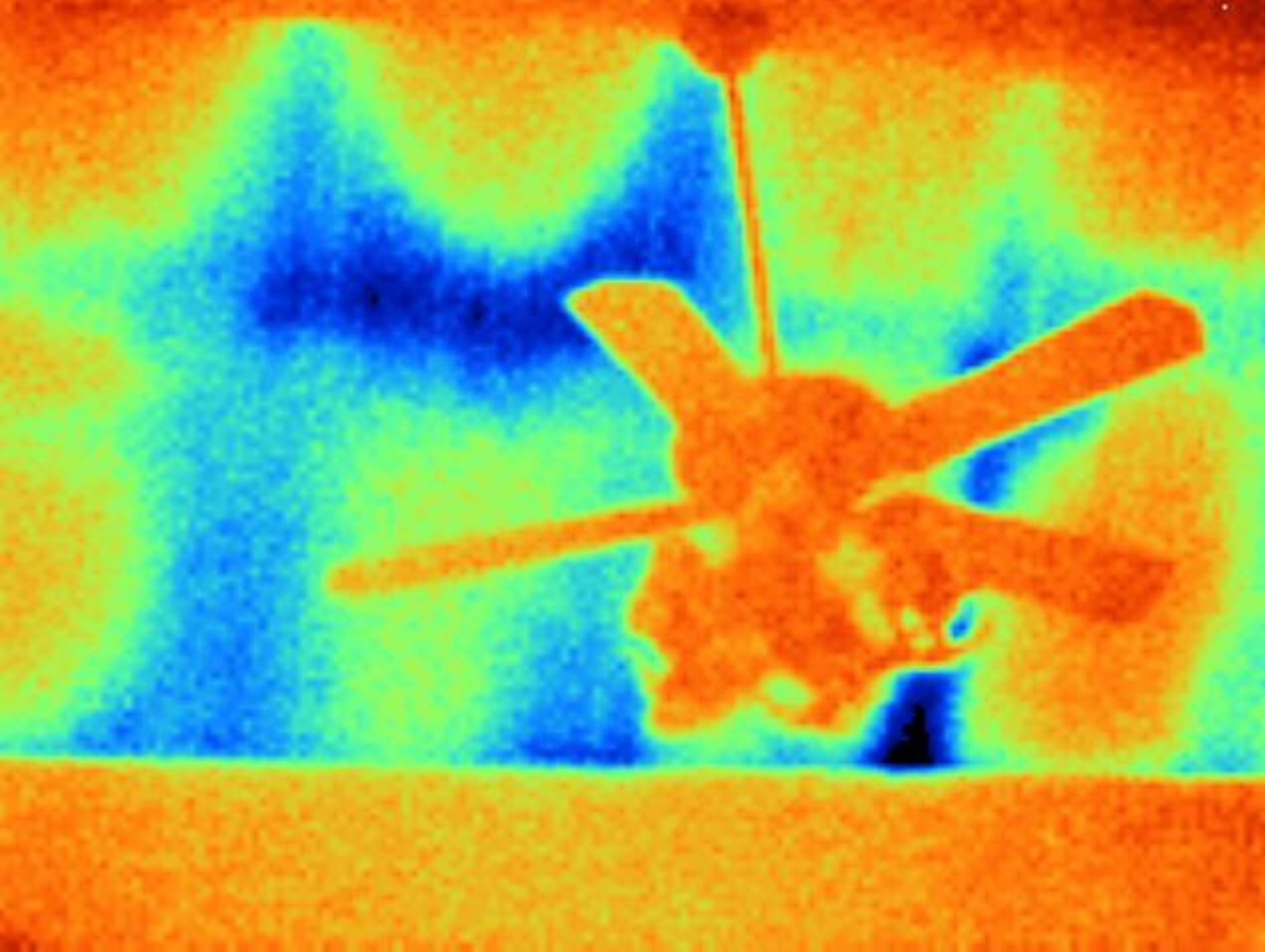








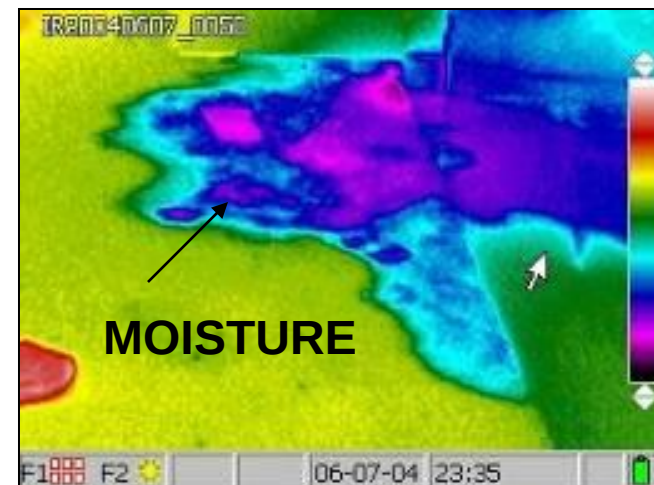
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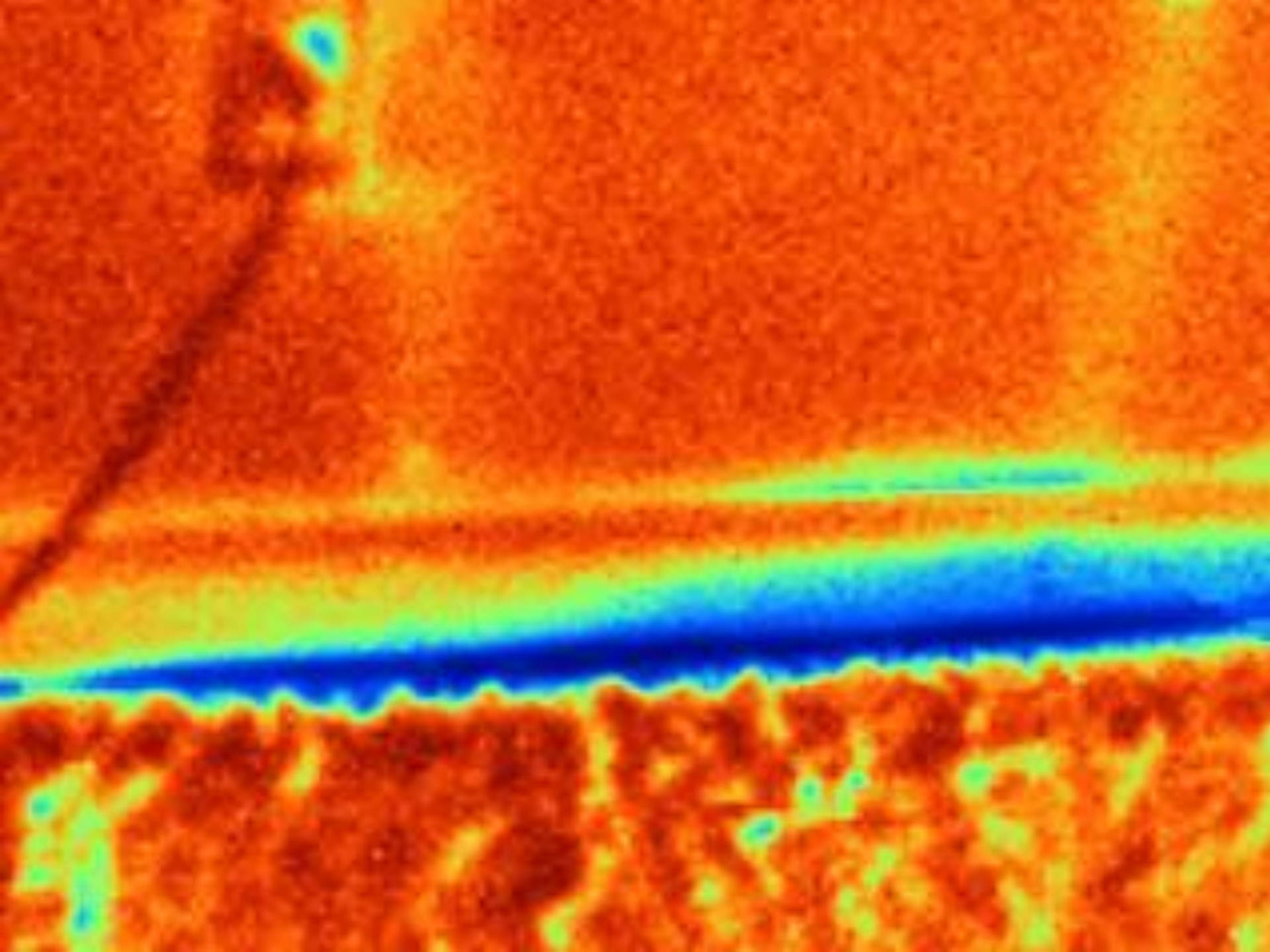


IR Moisture Detection

Evaporative Moisture Cooling (EMC)

- Wet materials evaporating water will reduce the surface temperature in a controlled environment until equilibrium is reached (dry)
- EMC causes thermal anomaly on surface, even when surface is dry
- Temperature difference can be $>0.1^{\circ}\text{F}$





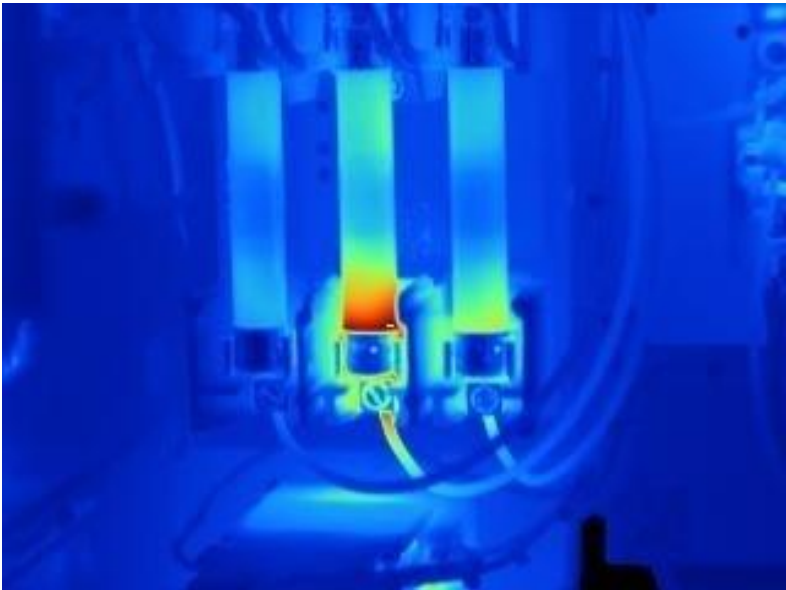
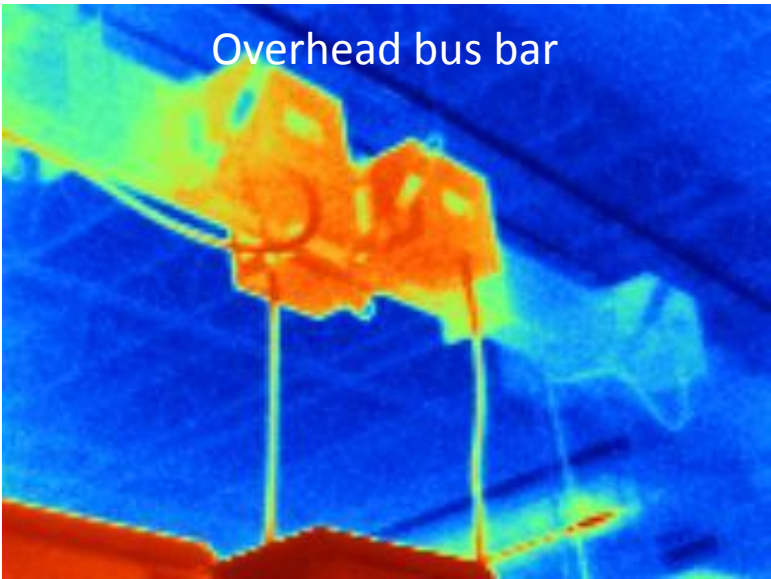
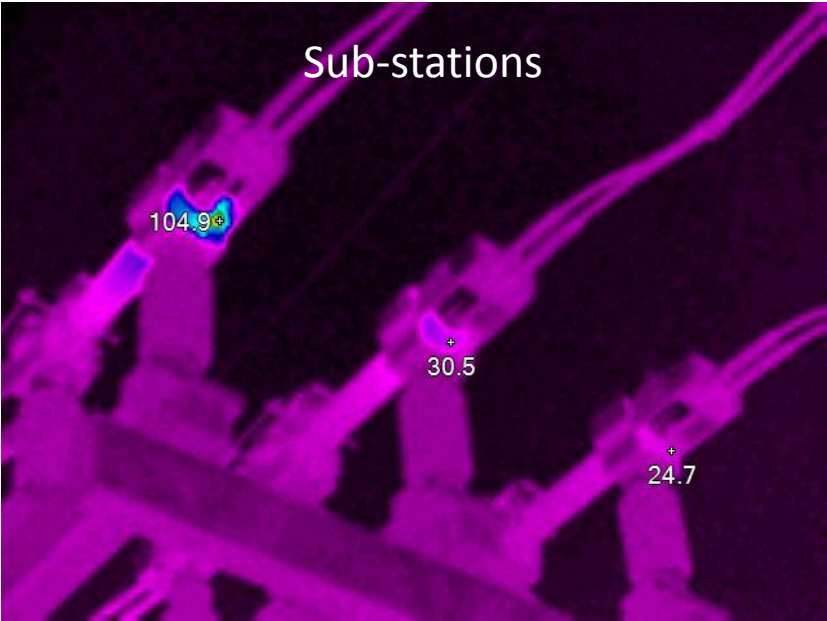
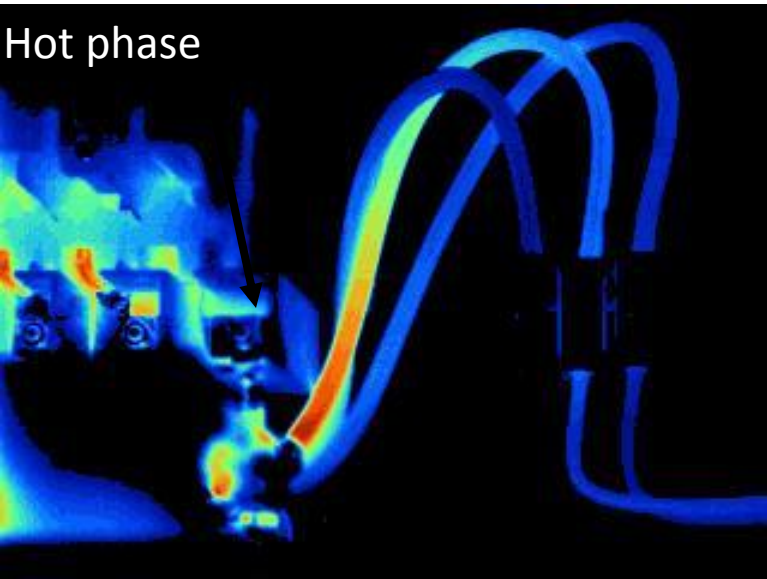


Thermography – Uses and Users

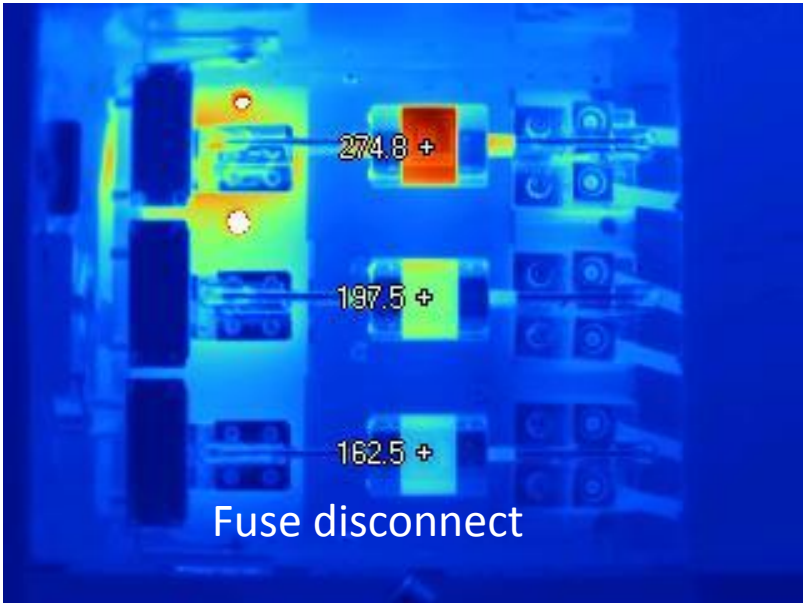
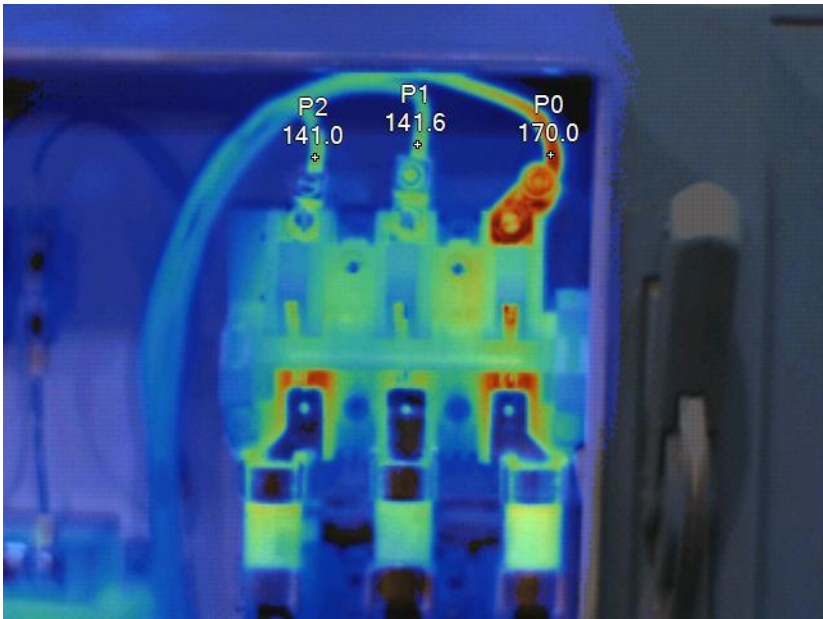
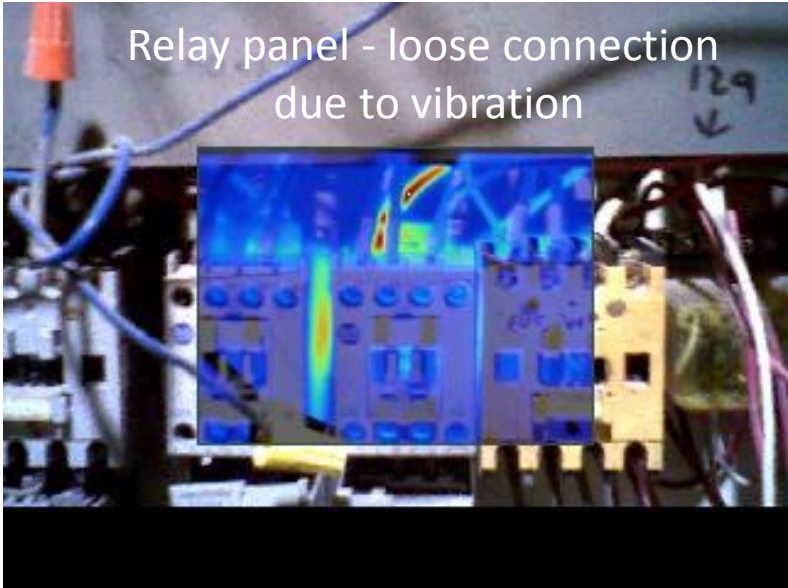
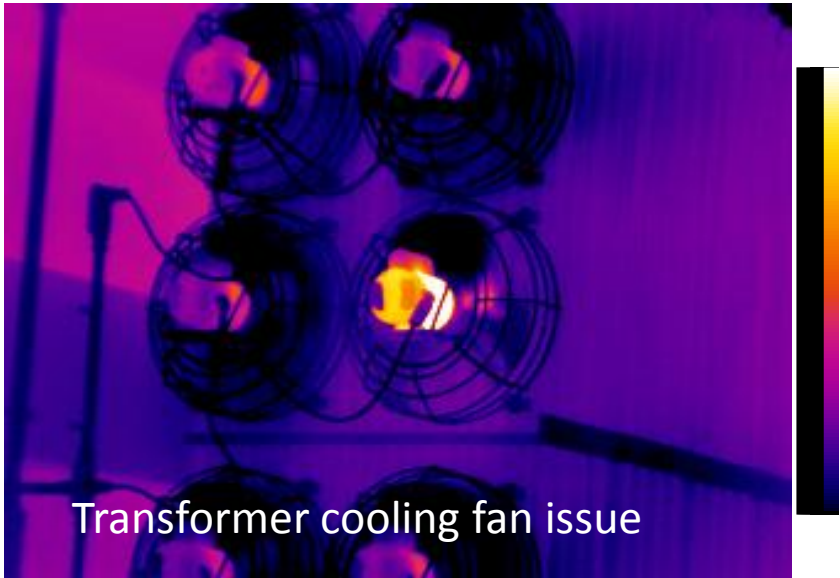
Where is Thermography Used

Vertical markets	Equipment Applications	Building Diagnostics	Medical
Industrial	Engines	Furnaces	Human Health
Utilities	Drives	HVAC	Animal Health
Local & State Government	Motors	Roofs	Chiropractic
Petroleum/Gas	Electric Motor Bearings	Building envelopes	Acupuncture
Construction/Restoration	Electric Motor Windings	Water Restoration	
Paper & Pulp Mills	Belts and drive shafts	Mold Remediation	
Data Centers	Electrical panels	Pest Control	
R & D	Switchgear		
Human & Animal Medical	Power lines		
Automotive	UPS systems		

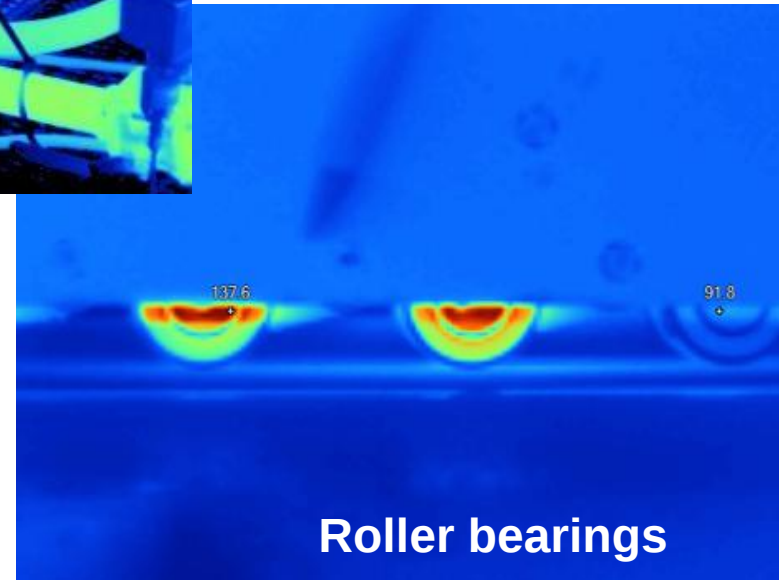
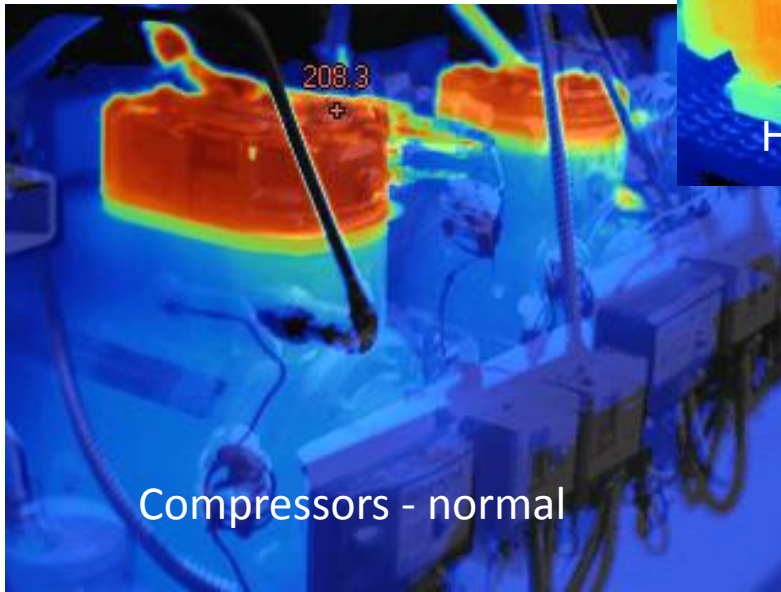
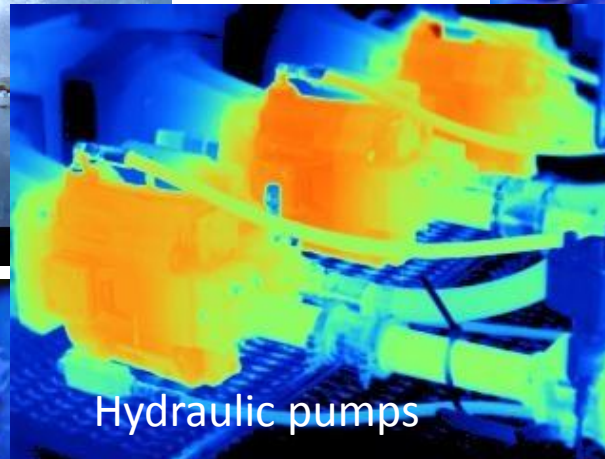
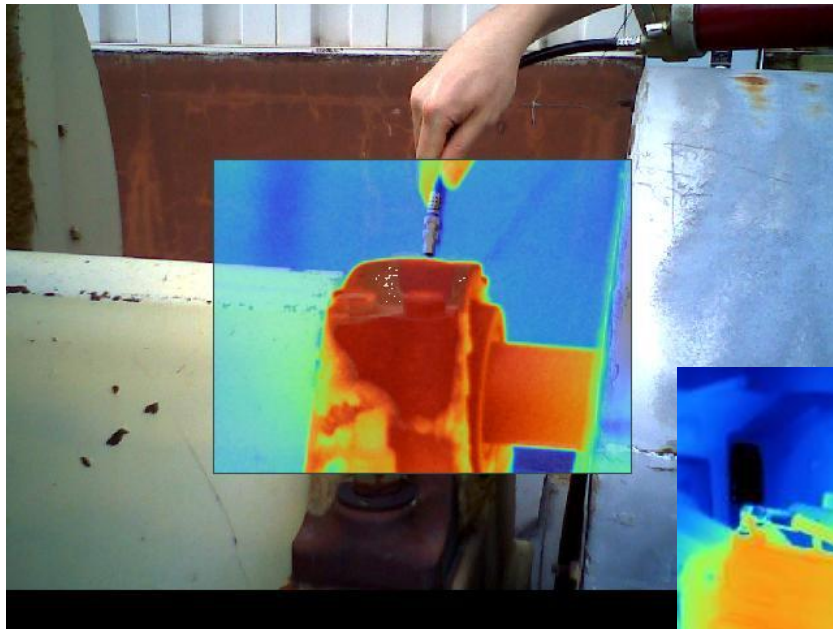
Electrical Applications



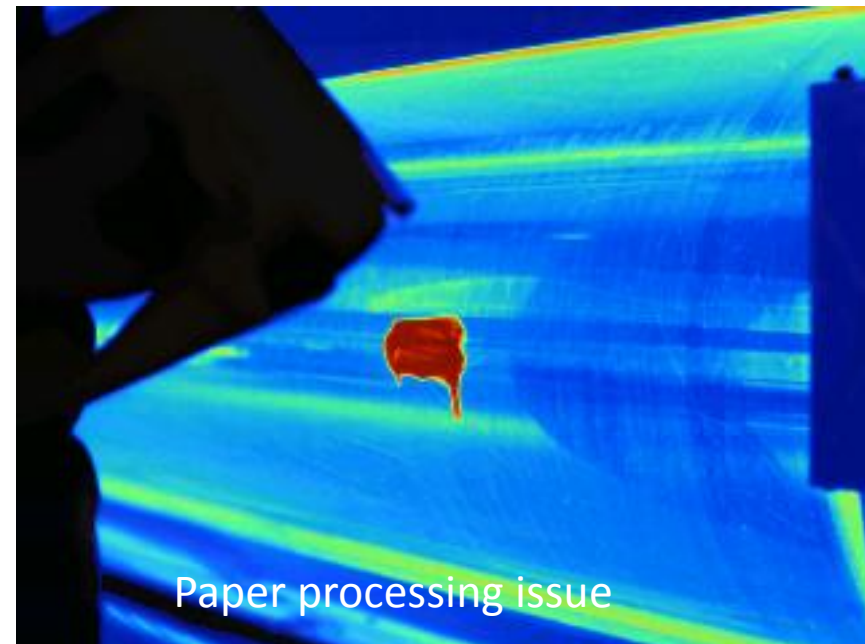
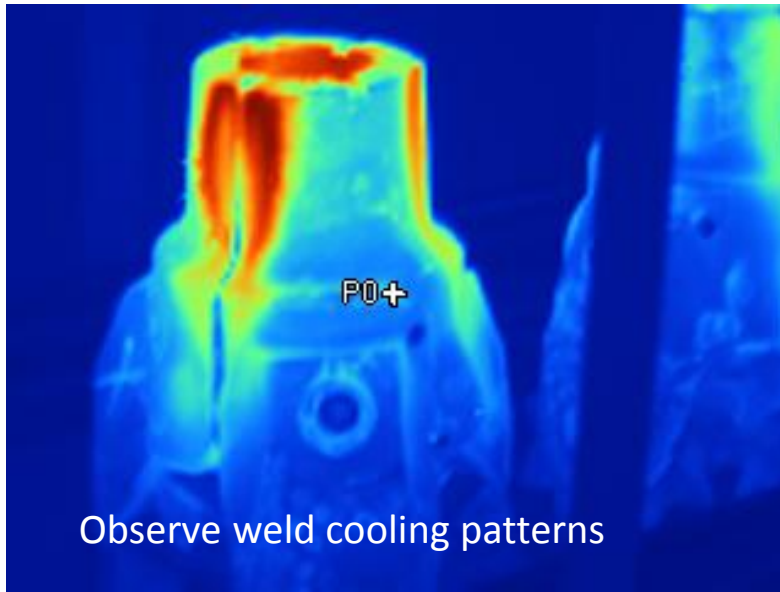
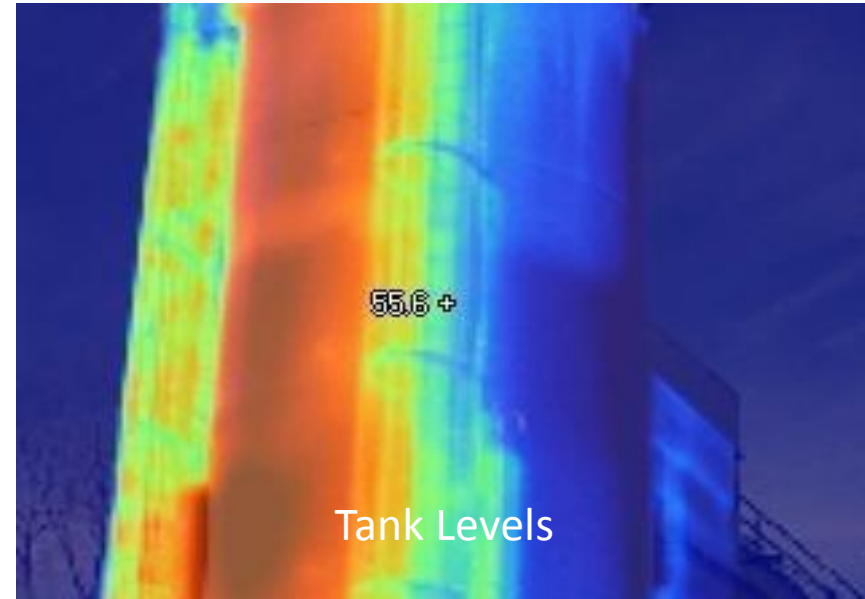
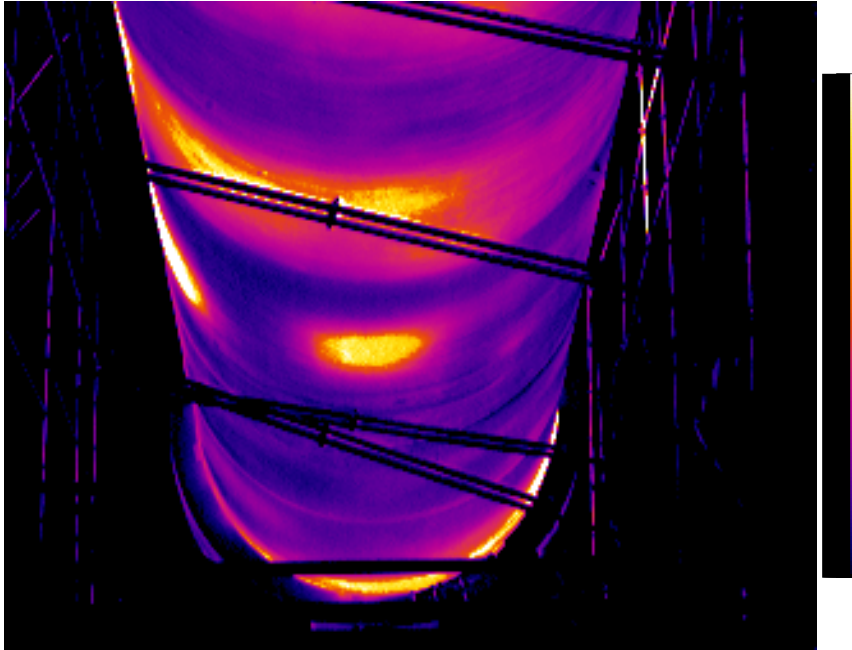
Electrical Applications



Electromechanical & Mechanical



Process and Product Development



Common mistakes

- Focus!!!
 - You cannot correct for poor focus with software!
- Assuming the temperatures presented in the image are correct
- Miss-interpreting moisture for cold air infiltration
- Not accounting for environmental concerns
 - The sun
 - The wind
 - The temperature
- Not accounting for the reflective properties of the materials being viewed
- Miss-stating the problem observed
- Not setting the stage to capture the best images
 - Framing the image
 - Steady state vs. transient
- Understanding basic construction and construction materials

Choosing an imager

- A few thoughts to consider in selecting an imager!

Choosing an imager

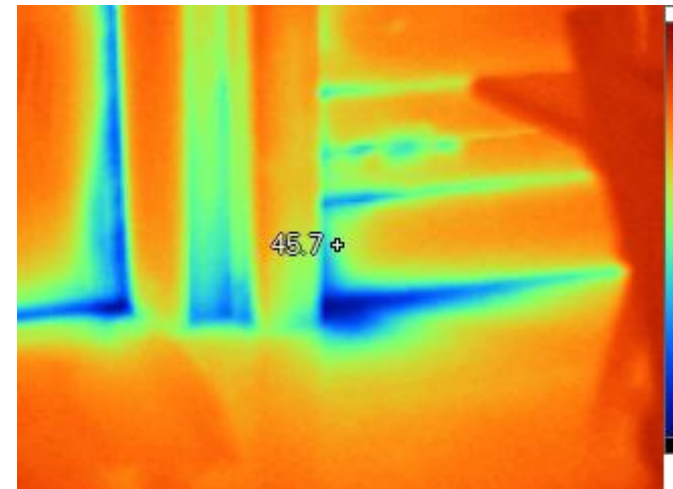
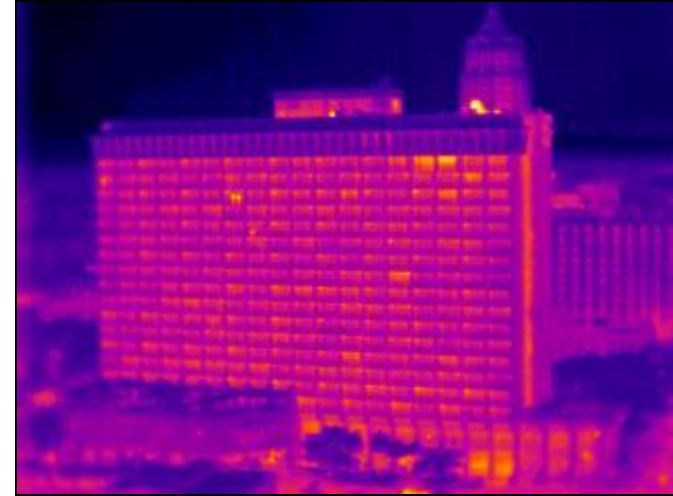
- Know your application
- **Arguably the most important specification for the Building Diagnostic applications –**
- **Thermal sensitivity**
 - **The Noise Equivalent Temperature Difference (NETD)**
 - **RESNET states must be less than or equal to 0.10 °C at 30 °C (0.18 °F at 86 °F).**

Detailed Specifications	Building Diagnostics
IR resolution (FPA size)	160 x 120 FPA Uncooled Microbolometer
Spectral band	7.5 µm to 14 µm (long wave)
Capture or refresh rate	9 Hz
NETD (thermal sensitivity)	≤ 0.08 °C at 30 °C target temp (80 mK)
FOV (Field of view)	22.5 °H x 31 °V

Resolution	60 x 60 pixels	100 x 100 pixels	140 x 140 pixels
Total Pixels	3,600	10,000	19,600
Thermal Sensitivity	< 0.15° C	< 0.1° C	

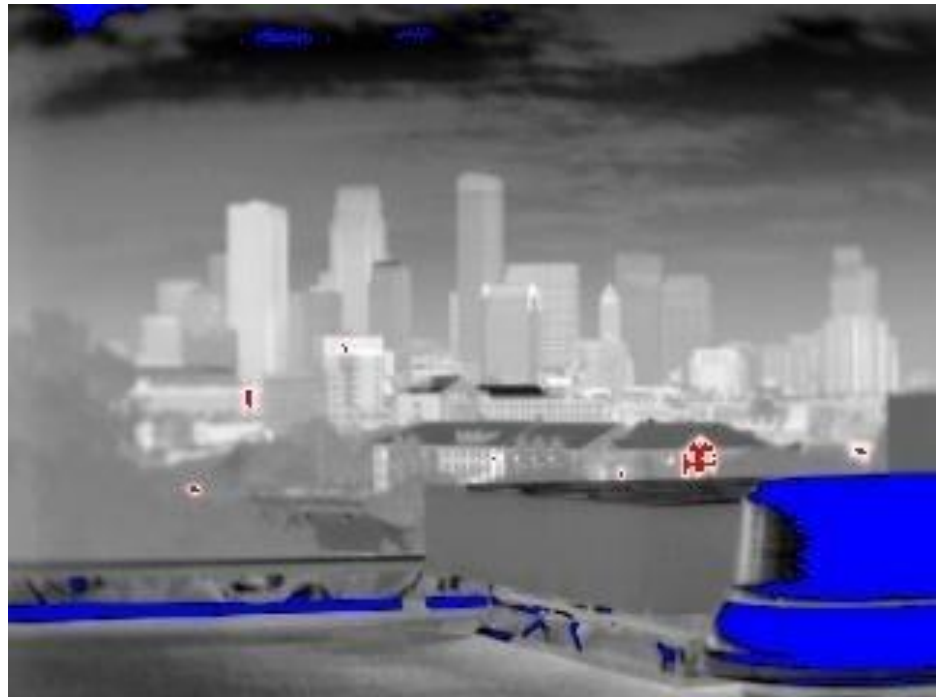
Thermal resolution is the detector size

- Thermal resolution – what are you imaging?
- Depends on your Application
- Cameras vary in detector sizes such as:
 - 120 x 120
 - 160 x 120
 - 320 x 240
- Distance to target vs. target size
 - Spatial resolution (smallest area seen by a detector, or spot size)
 - Temperature measurement accuracy, or IFOV measurement (smallest area that can be measured)
 - Can be improved by getting closer to the target
- Budget



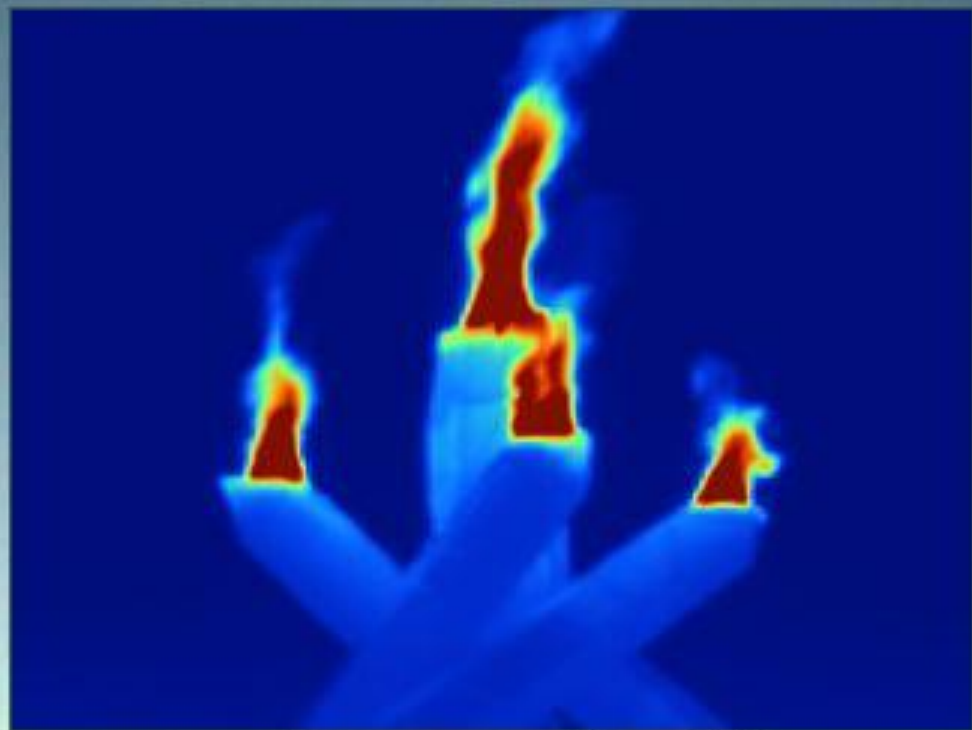
Choosing an imager

- Visual camera option – on board or separate digital camera?
 - Keeping track of images on two cameras (date/time stamp)
- Ease of use! Buttons, feel, menu system, etc.
- Voice annotation
- Laser pointers
- Display
- Compass
- Compare side by side!



Choosing an imager

-and let's not forget the **software!**
 - Free or is there a license charge? Upgrading?
 - Does it do the job for you?
 - **Remember your report represents you and your company!**
- Know your budget
- Plan for training
 - The cameras may be very powerful and very easy to operate but the need to understand thermography has **not** changed!
- Talk to reputable people in your industry
 - Like TruTech Tools!



The Reality

A thermal imager can be your answer!

1. Thermal Imagers are easy to use, point/focus/capture
2. They will make you more effective and efficient
3. “Time is money” find and report thermal anomalies more quickly
4. Consider training and inspection route development

You **WILL find thermal problems**

1. ...discover and report problems faster
2. ...validate repairs
3. ...verify new installations - commissioning
4. ...save money!

Using an infrared camera effectively, you WILL see a positive ROI!

Questions?

Review!



***Thank you
for your time and attention!***

COMING SOON....

***For a copy of the **slides** or link to a **recorded session**
go to: www.TruTechTools.com/webinars***

See more videos from TruTech:

www.youtube.com/user/jimbergmann3

Contact us:

John W. Pratten III, Level III Thermographer – ASNT Compliant

Proactive Maintenance Consultants, LLC

Cell: 612-554-2664 jwp.pmc@gmail.com

Bill Spohn, Co-Owner: Bill@TruTechTools.com

Jim Bergmann, Co-Owner: Jim2@TruTechTools.com

Eric Preston, Sales Manager: Eric@TruTechTools.com

www.TruTechTools.com

888-224-3437



Making measurement science work!

Coming soon from TruTechTools!

- Camera training - Brand specific
 - Fluke
 - Testo
 - FLIR

The Fluke logo consists of the word "FLUKE" in a bold, black, sans-serif font, followed by a registered trademark symbol (®). It is set against a solid yellow rectangular background.

FLUKE®

The Testo logo features the word "testo" in a white, lowercase, sans-serif font. It is centered within a large, orange, three-dimensional sphere that has a subtle gradient and a shadow at its base.

testo

