HOME INSPECTOR

THERMOGRAPHY

RULE

THERMAL IMAGING

A Thermal imaging camera or device should never be used alone in diagnosing a problem or situation. If this is the only means of gathering data, use wording or similar wording such as “possible”.

The more evidence and data acquired always makes your findings more definitive.

Viewing anything through the device will only display the thermal or radiant heat given off.

MODULE 1

INTRO TO

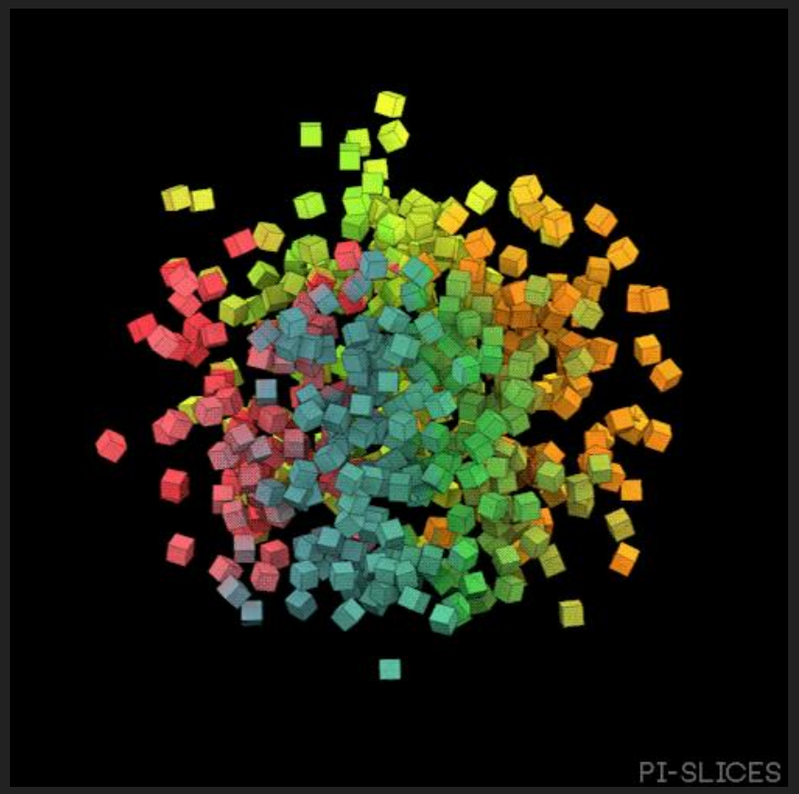
THERMODYNAMICS

WHY IS UNDERSTANDING THERMODYNAMICS IMPORTANT?

- Understanding what heat is and the ways heat is transferred will give you a better understanding of how systems are designed to work. You will also be able to use it as a tool to help diagnose problems within a home or structure and see things that might have been over looked.

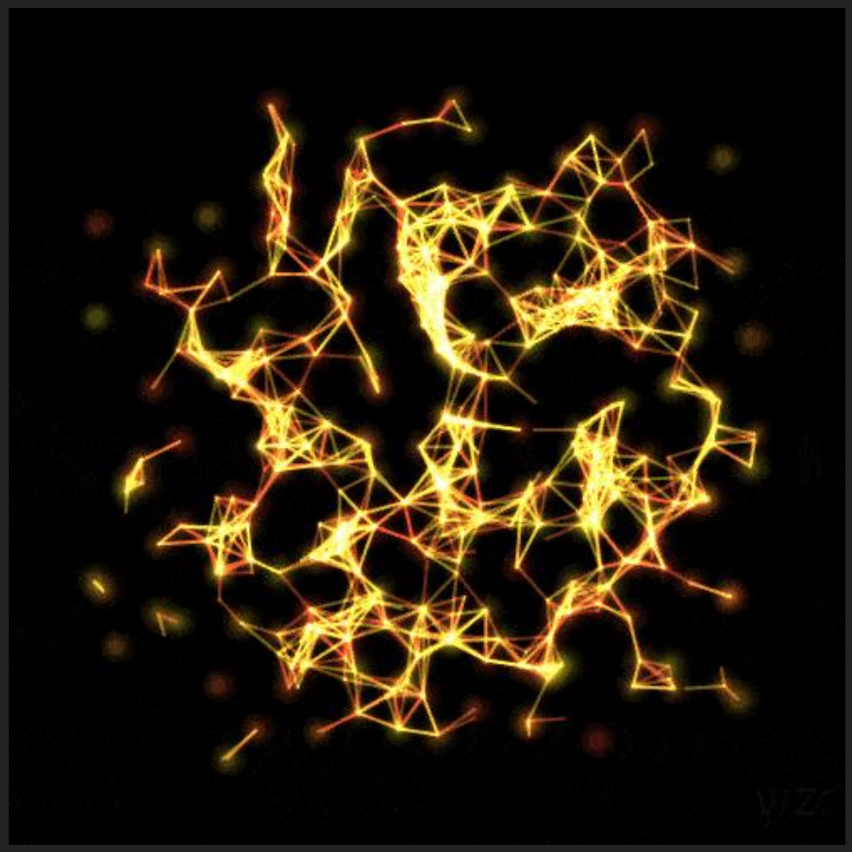
ENTROPY

- The amount of disorder within a substance
- On the molecular level, it is the total movement (energy) of particles in a given space



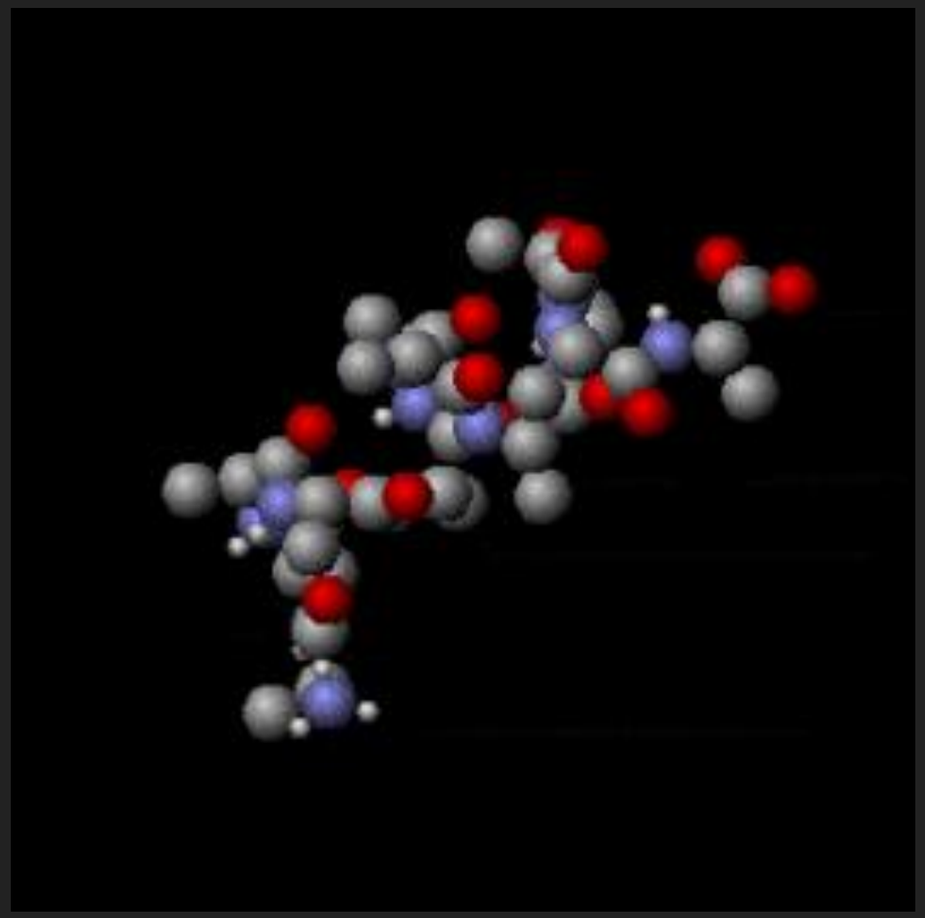
HEAT

- It is the total amount of energy or entropy that is transferred from one substance to another
- Energy can only pass from a “warmer” object to a “cooler” object, never the opposite
- An object cannot technically cool down, it loses its heat to its surroundings through heat transfer



TEMPERATURE

- It is the measure of entropy or heat within a given system
- Measurements such as Fahrenheit, Celsius, and Kelvin
- Absolute zero, or zero entropy is 0 Kelvin or -273.15 Celsius

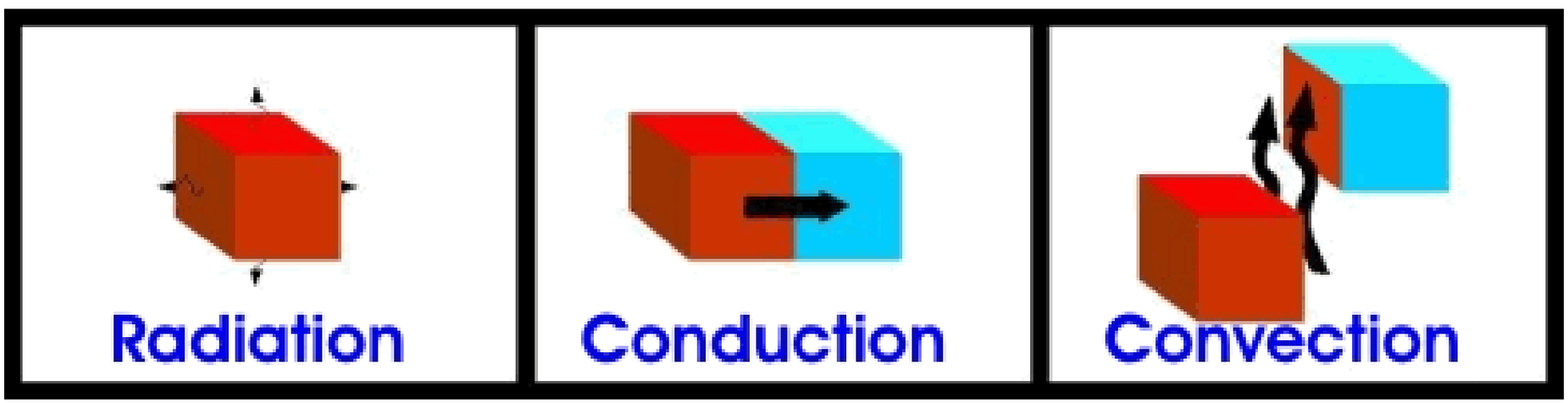


LAWS OF THERMODYNAMICS

- Zeroth law of thermodynamics: If two systems are in thermal equilibrium with a third system, they are in thermal equilibrium with each other. This law helps define the concept of temperature.
- First law of thermodynamics: When energy passes, as work, as heat, or with matter, into or out from a system, the system's internal energy changes in accord with the law of conservation of energy. Equivalently, perpetual motion machines of the first kind(machines that produce work with no energy input) are impossible.
- Second law of thermodynamics: In a natural thermodynamic process, the sum of the entropies of the interacting thermodynamic systems increases. Equivalently, perpetual motion machines of the second kind (machines that spontaneously convert thermal energy into mechanical work) are impossible.
- Third law of thermodynamics: The entropy of a system approaches a constant value as the temperature approaches absolute zero. With the exception of non-crystalline solids (glasses) the entropy of a system at absolute zero is typically close to zero, and is equal to the natural logarithm of the product of the quantum ground states.

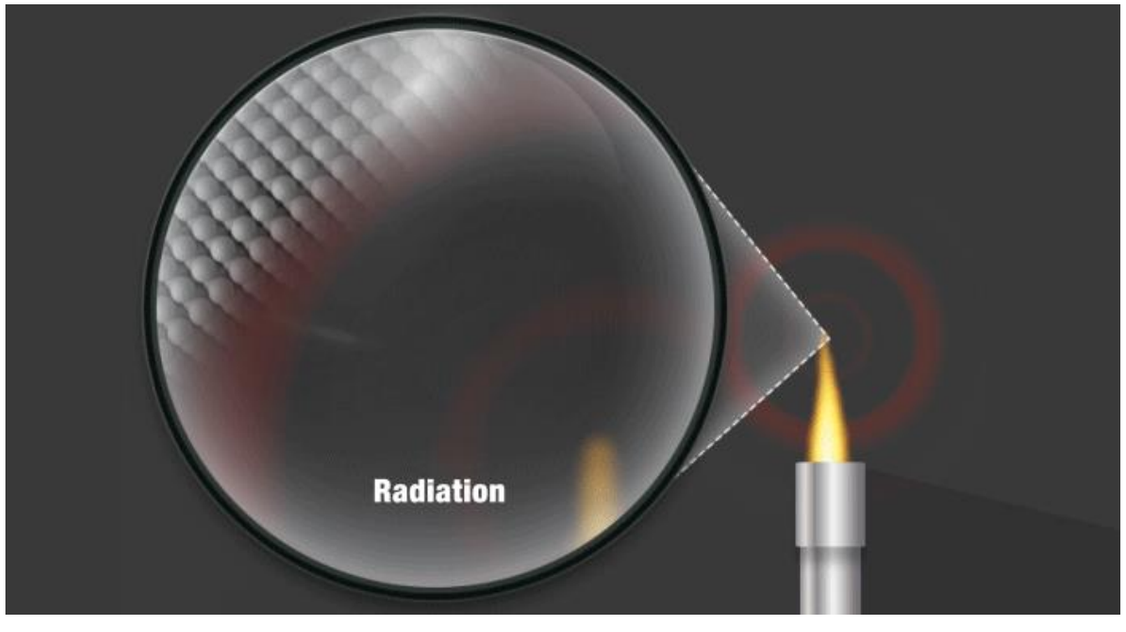
TYPES OF HEAT TRANSFER

- Radiation
- Conduction
- Convection



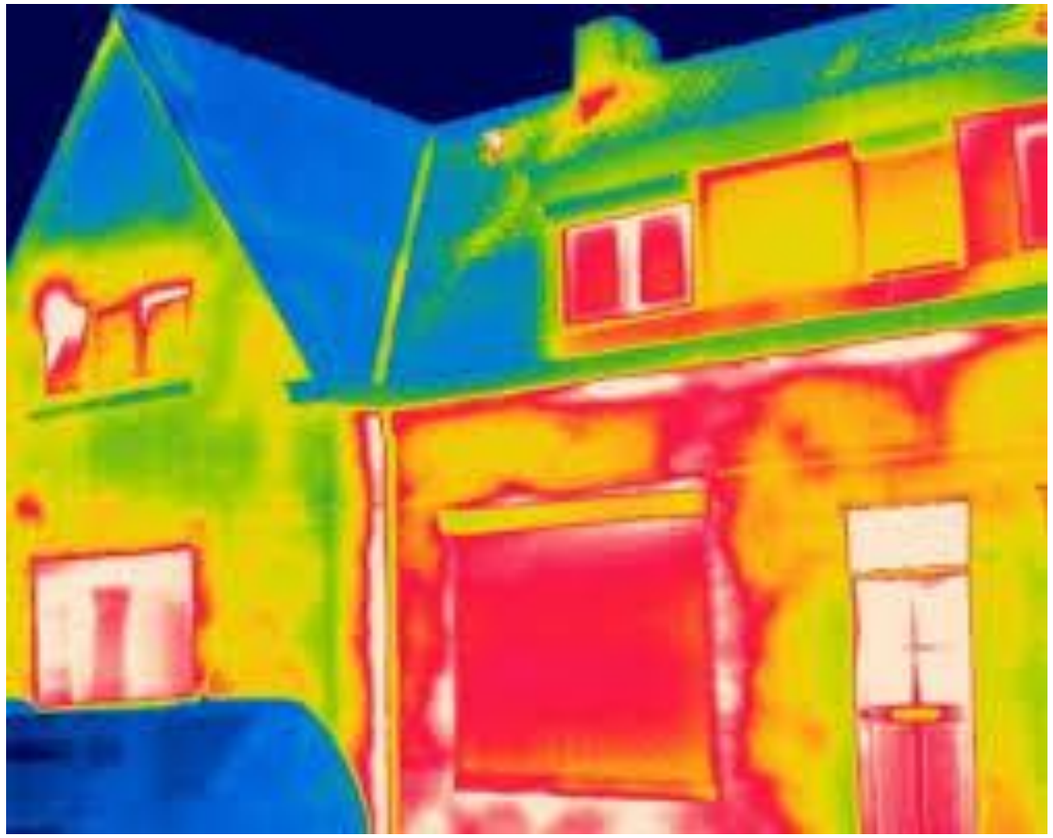
RADIATION

- It is electromagnetic radiation generated by the thermal motion of charged particles in matter.
- All matter with a temperature greater than absolute zero emits thermal radiation.
- When the temperature of a body is greater than absolute zero, inter-atomic collisions cause the kinetic energy of the atoms or molecules to change.



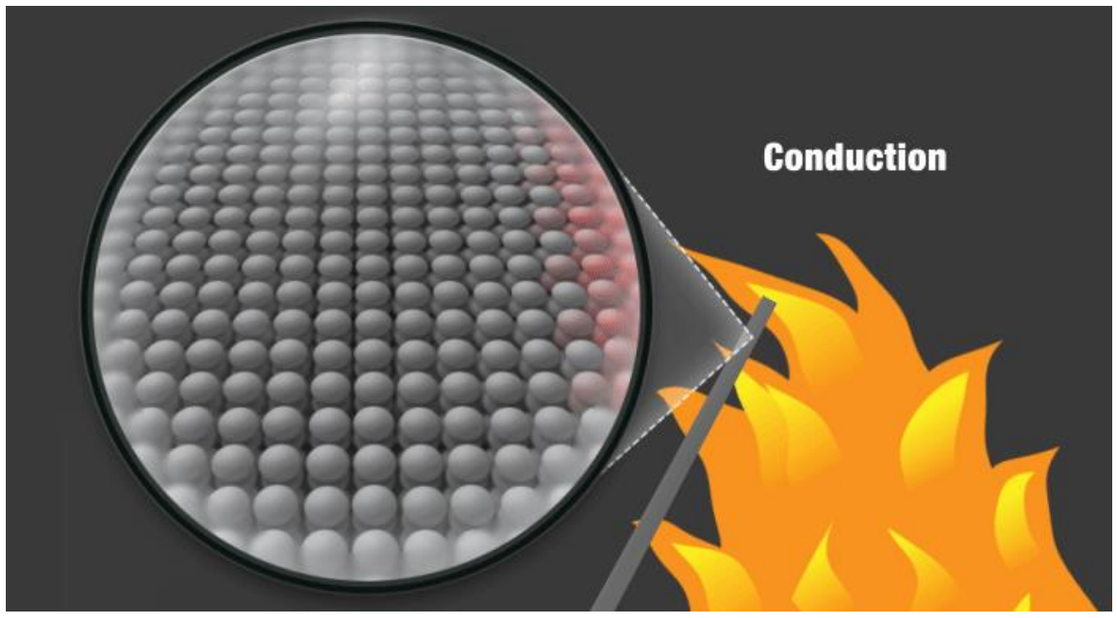
RADIANT HEAT IN A HOME

- It is the main source accounting for more than 95% of heat transference into a home



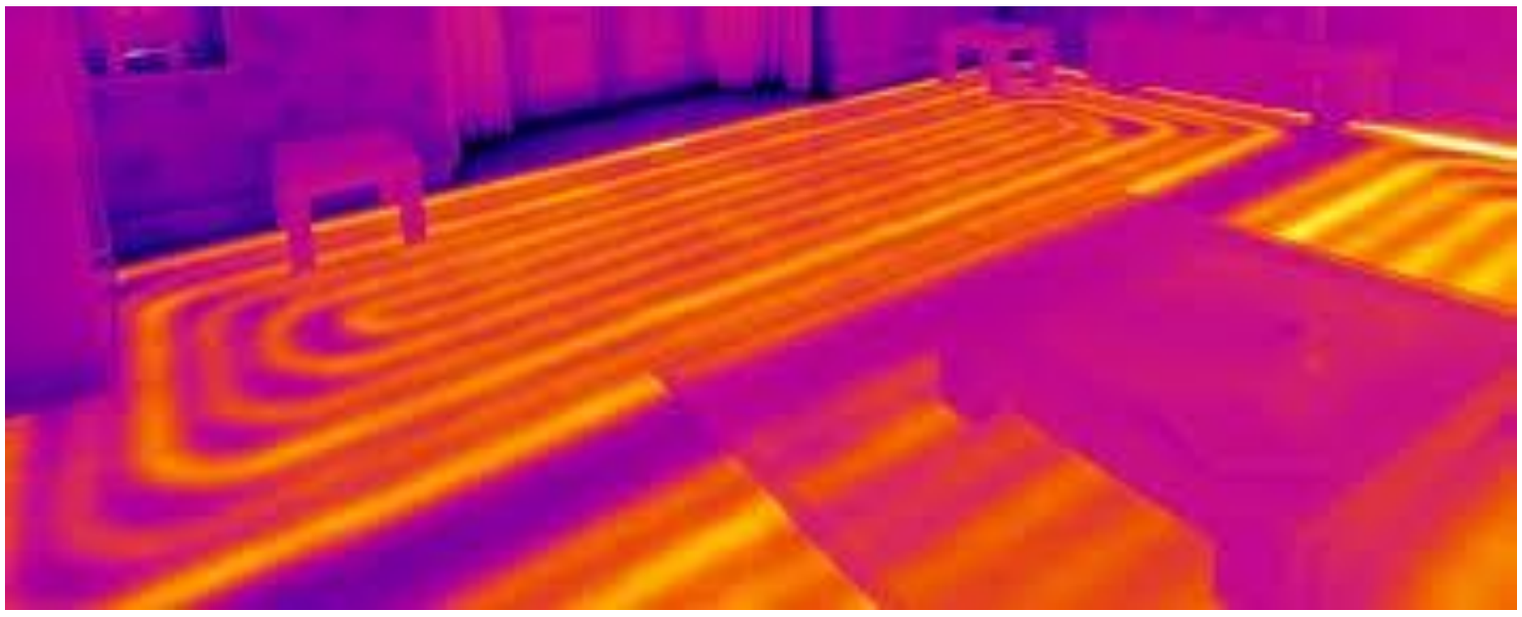
CONDUCTION

- It occurs when adjacent particles vibrate against one another.
- It is the most significant means with solid or between solid objects in thermal contact.



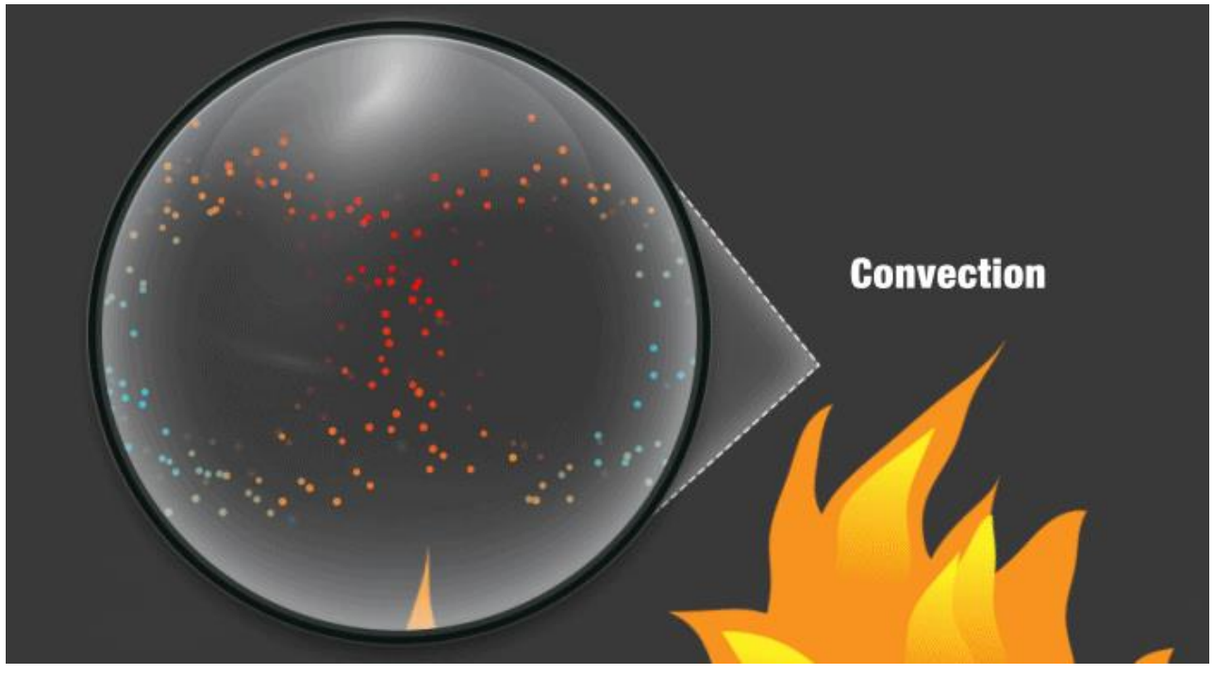
CONDUCTION

- The floor heating system in the image below shows the heat conducting through the solid surfaces of the floor and radiating that heat to our imager showing the image on our screen.



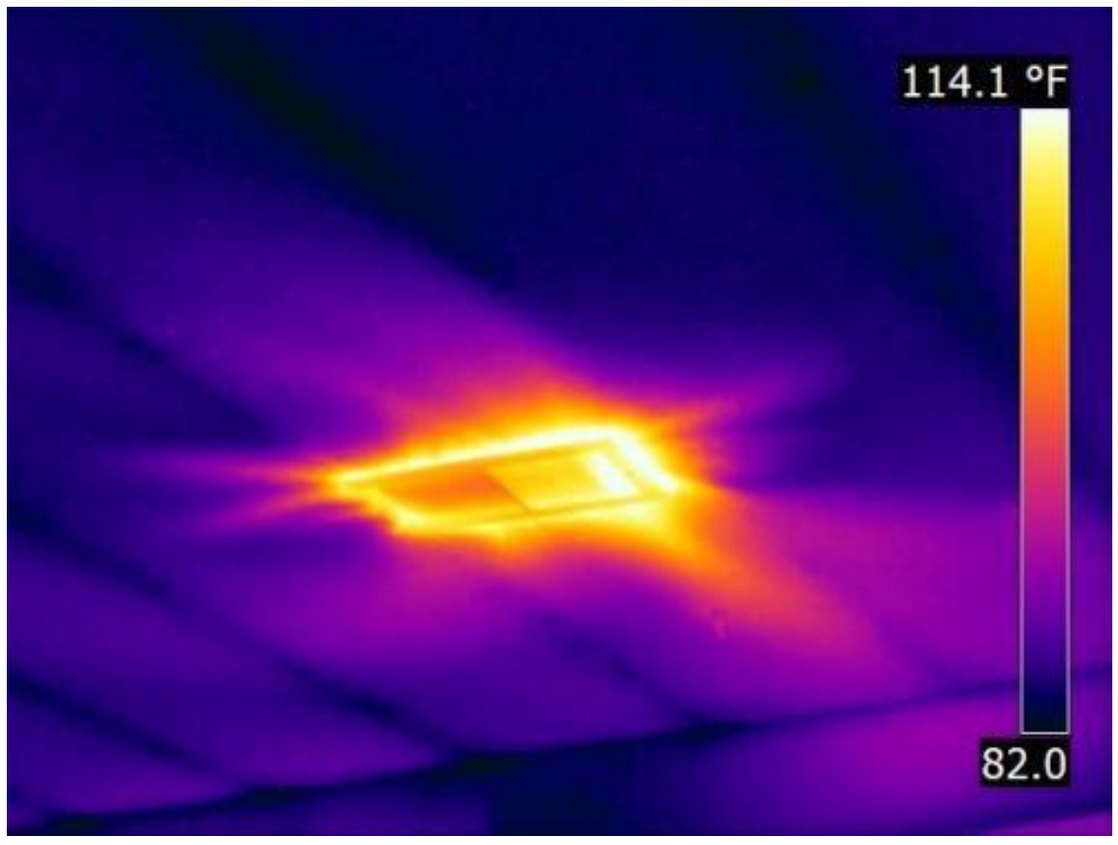
CONVECTION

- It is the transfer of heat from one place to another by the movement of fluids, a process that is essentially the transfer of heat via mass transfer
- It is usually the dominant form of heat transfer in liquids and gases



CONVECTION

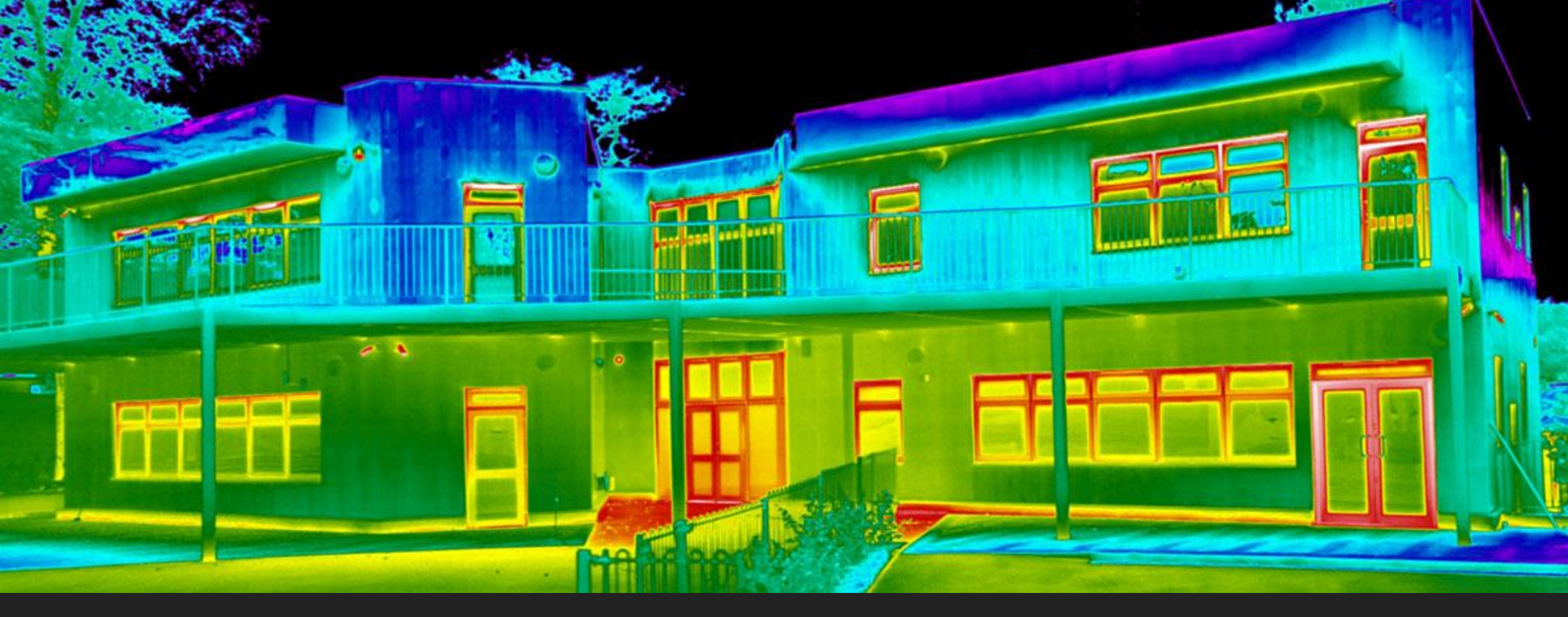
- Below is photo of convected, conditioned air heating adjacent solid surfaces, the heat is conducted through the solid surfaces and radiates outward toward our imager giving the image we see.



THERMAL INSULATION

Definition of thermal insulation

- 1 : the process of insulating against transmission of heat
- 2 : material of relatively low heat conductivity used to shield a volume against loss or entrance of heat by radiation, convection, or conduction

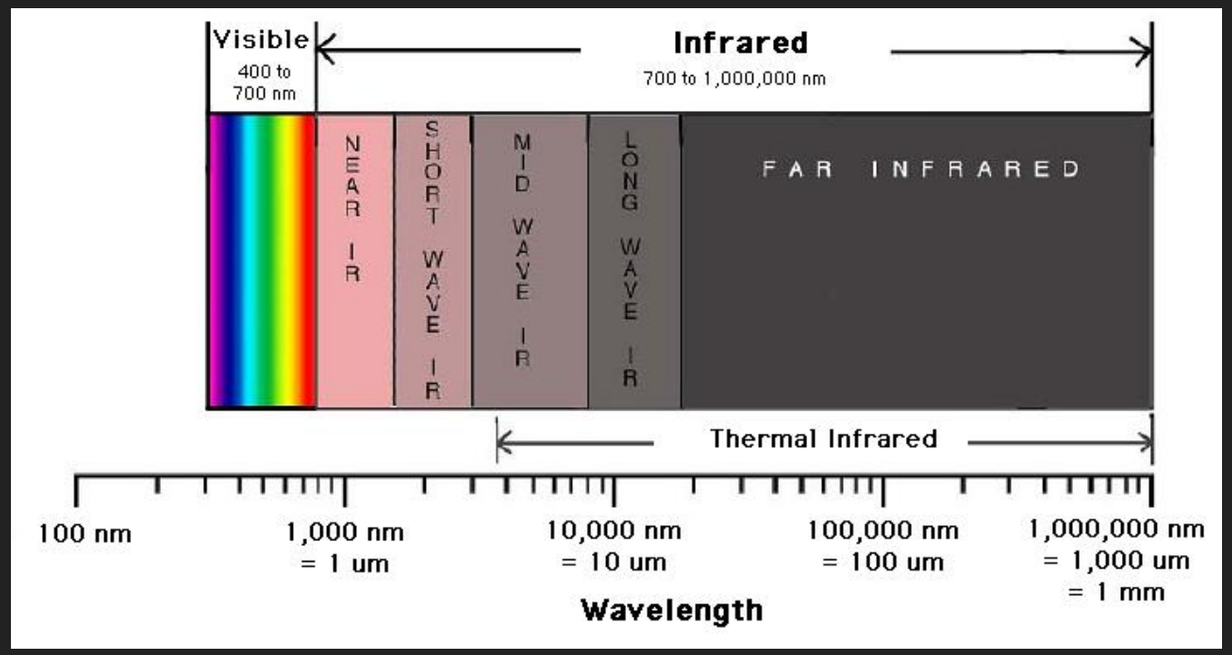


MODULE 2

THERMAL IMAGING

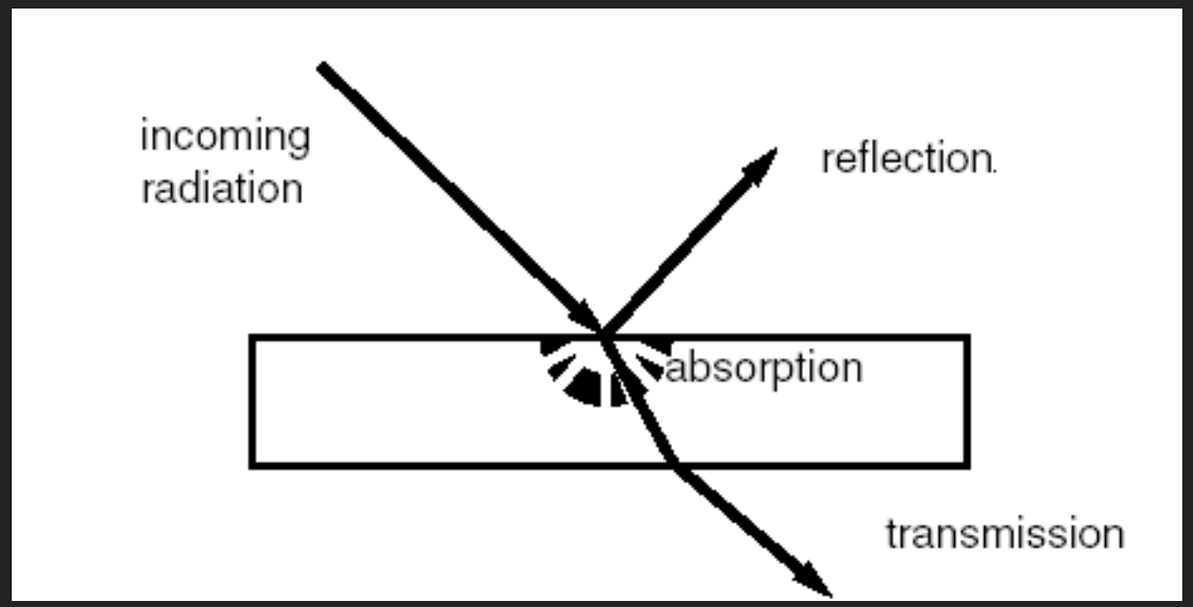
WHAT IS THERMAL IMAGING?

- It is the detection of radiation in the long-infrared range of the electromagnetic spectrum (roughly 9,000-14,000 nanometers) using a camera which will give a visual display of the variances of that radiation.



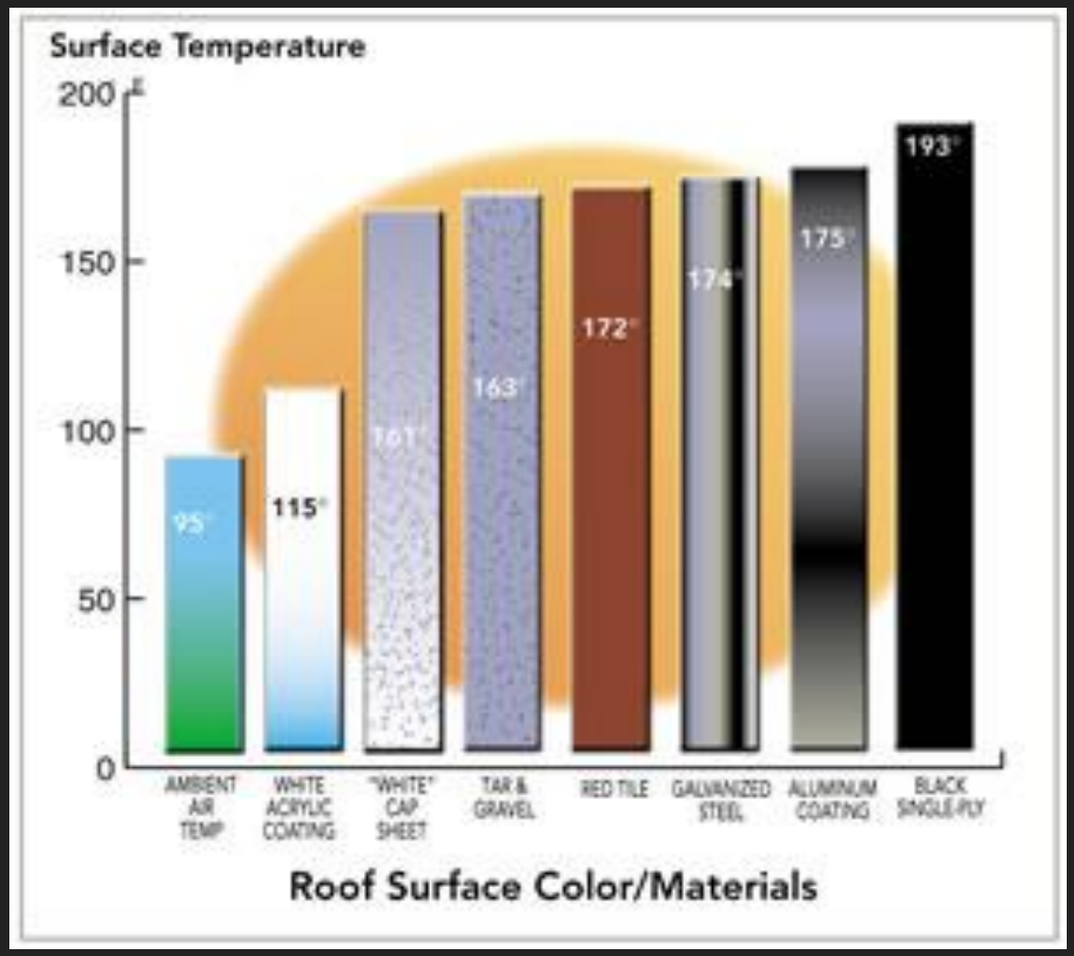
MATERIALS

- Differing materials have differing properties
- Some might reflect nearly all radiant heat
- Some absorb more than others
- Color influences absorption amounts



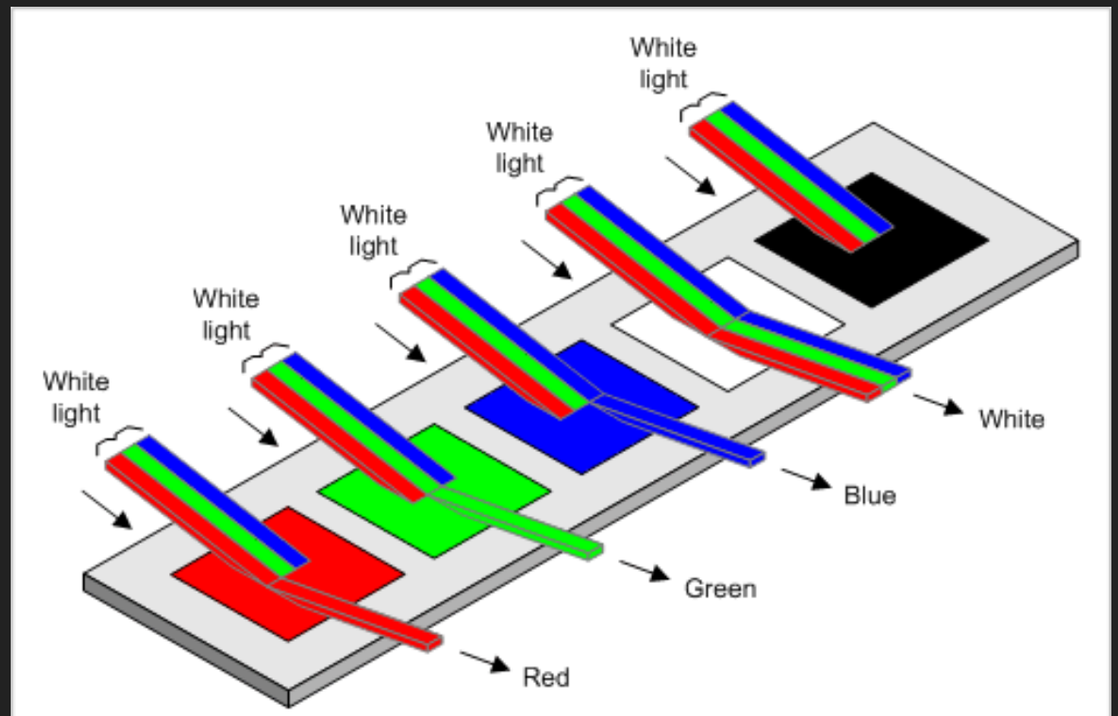
THERMAL RESISTANCE

- Thermal resistance can be measured in materials
- This measurement is the materials Lambda
- Typically the denser the material, the lower the lambda or more conductive the material is to heat



DOES COLOR MATTER?

- When color is seen, that is the color reflected from the material. So if a leaf is green, the leaf is absorbing the red and blue spectrums of light.
- White light is a reflection of blue, red, and green light spectrums together.
- Black is an absorption all visible wavelengths of light.



Shining white light on different colored paints

DOES COLOR MATTER?

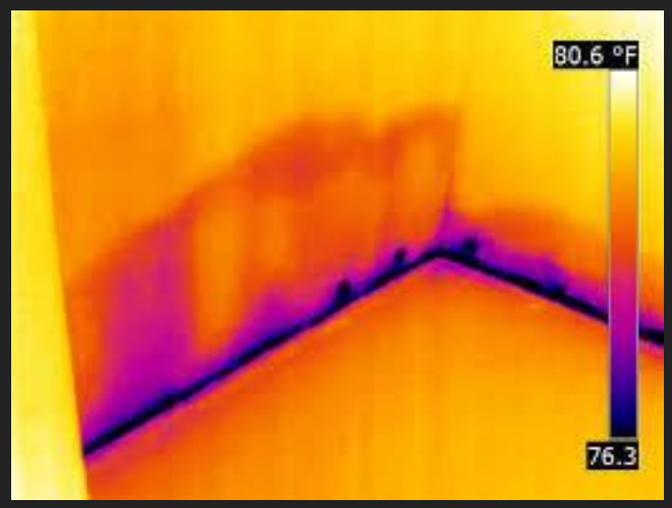
- Because black absorbs all colors of light, the material will convert the light into thermal heat and will radiate a portion of that heat back in our infrared spectrum.
- Because of this effect, darker color roofs will heat up more decreasing total lifespan of the product. This is just one way color can influence the home as there are many more.

WHAT SHOULD THERMAL IMAGING BE USED FOR?

- Detecting water or moisture in different substrates
- Problems in electrical
- Leaking AC air ducts
- Gaps in insulation
- Leaking windows or doors
- Thermal bridges

WHAT SHOULD IT NOT BE USED FOR?

- It should not be the sole tool to diagnose a problem within a home.
- It is only able to visualize radiant heat, usually the by product another type of heat transfer i.e. the evaporative effect of wet drywall.

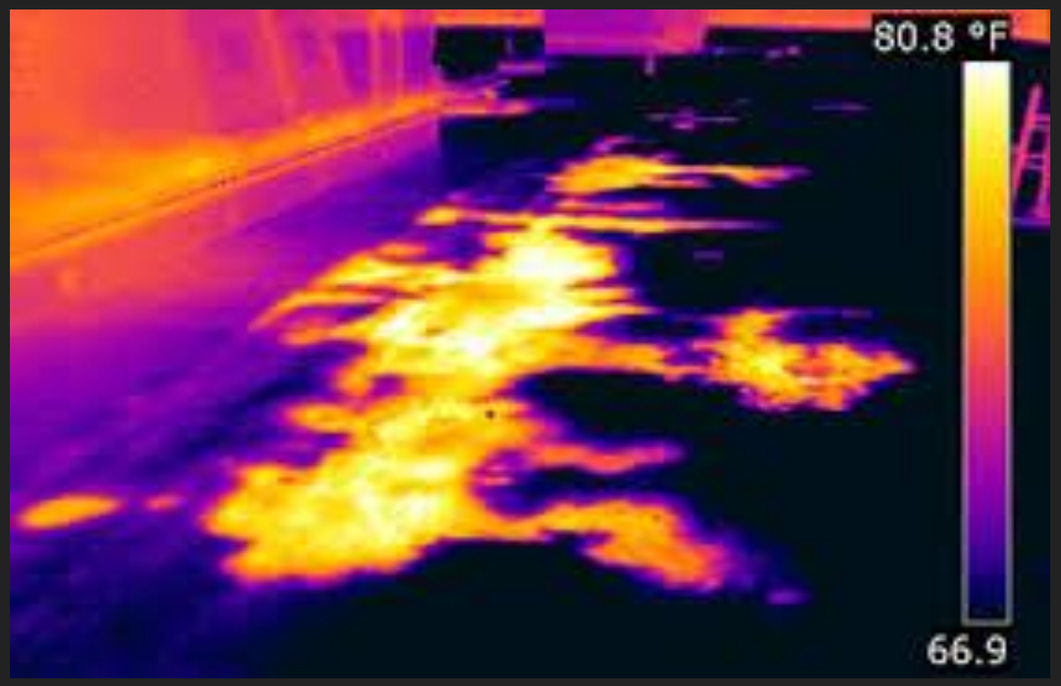


HOW TO USE A THERMAL IMAGING CAMERA

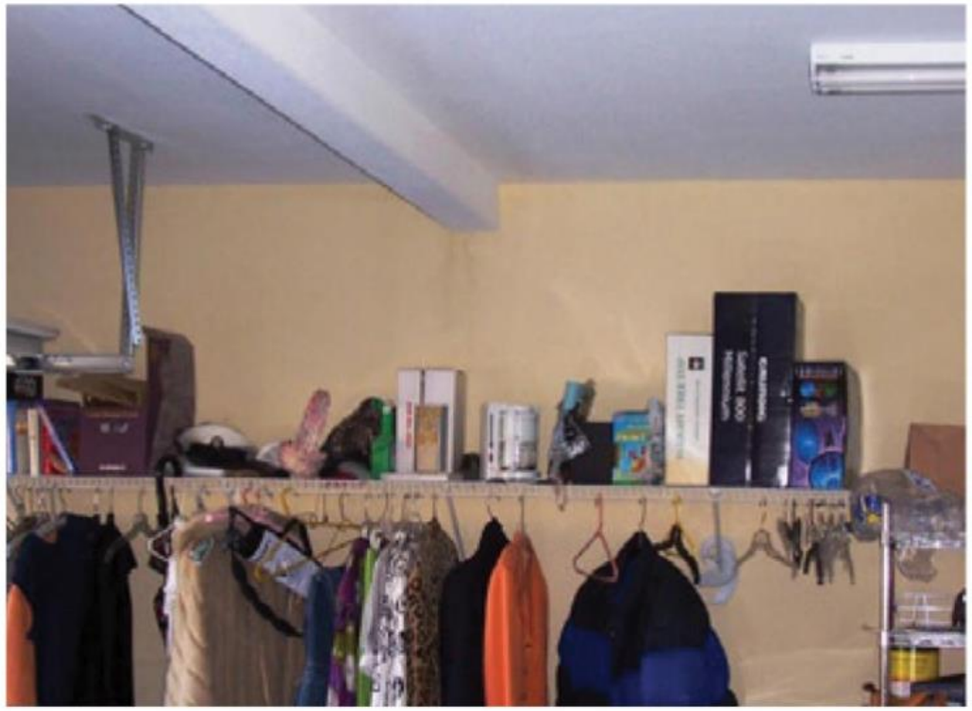
- When viewing the camera and variances in color are noted, a question must be asked to why there is a difference in color.
- Color or temperature change can be due to:
  - evaporative effect of a liquid
  - reflection of radiant heat
  - cooling or heating of an object from convected air
  - heating of a conductive material

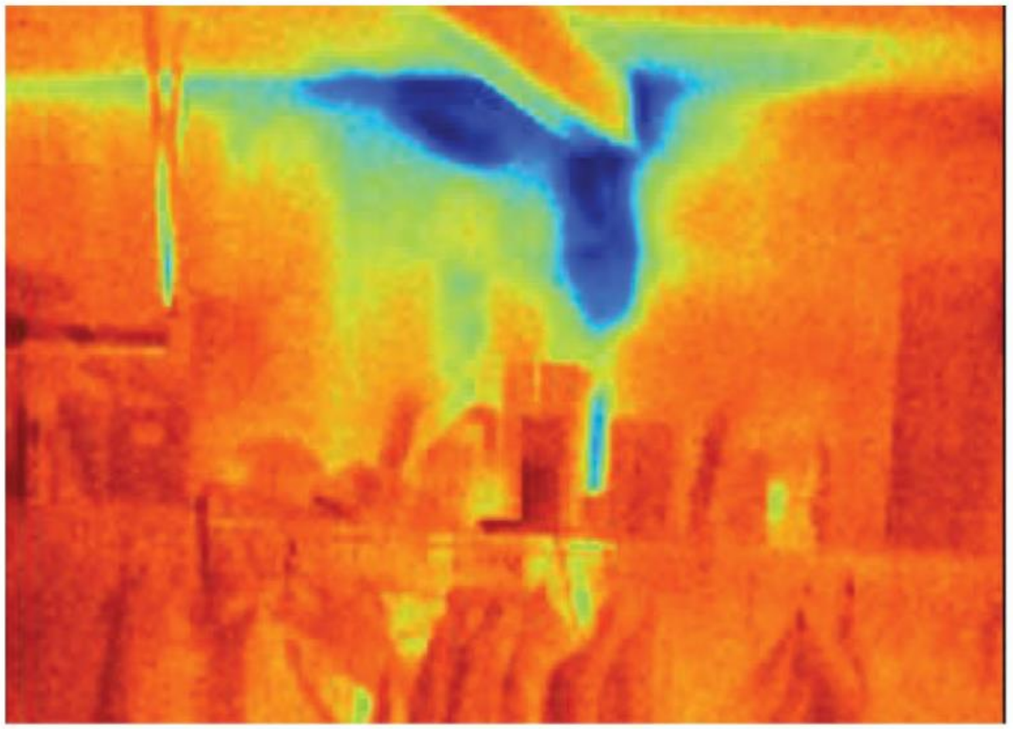
EVAPORATIVE EFFECT

- What is this picture of a flat commercial roof telling us?



MOISTURE IN CEILING

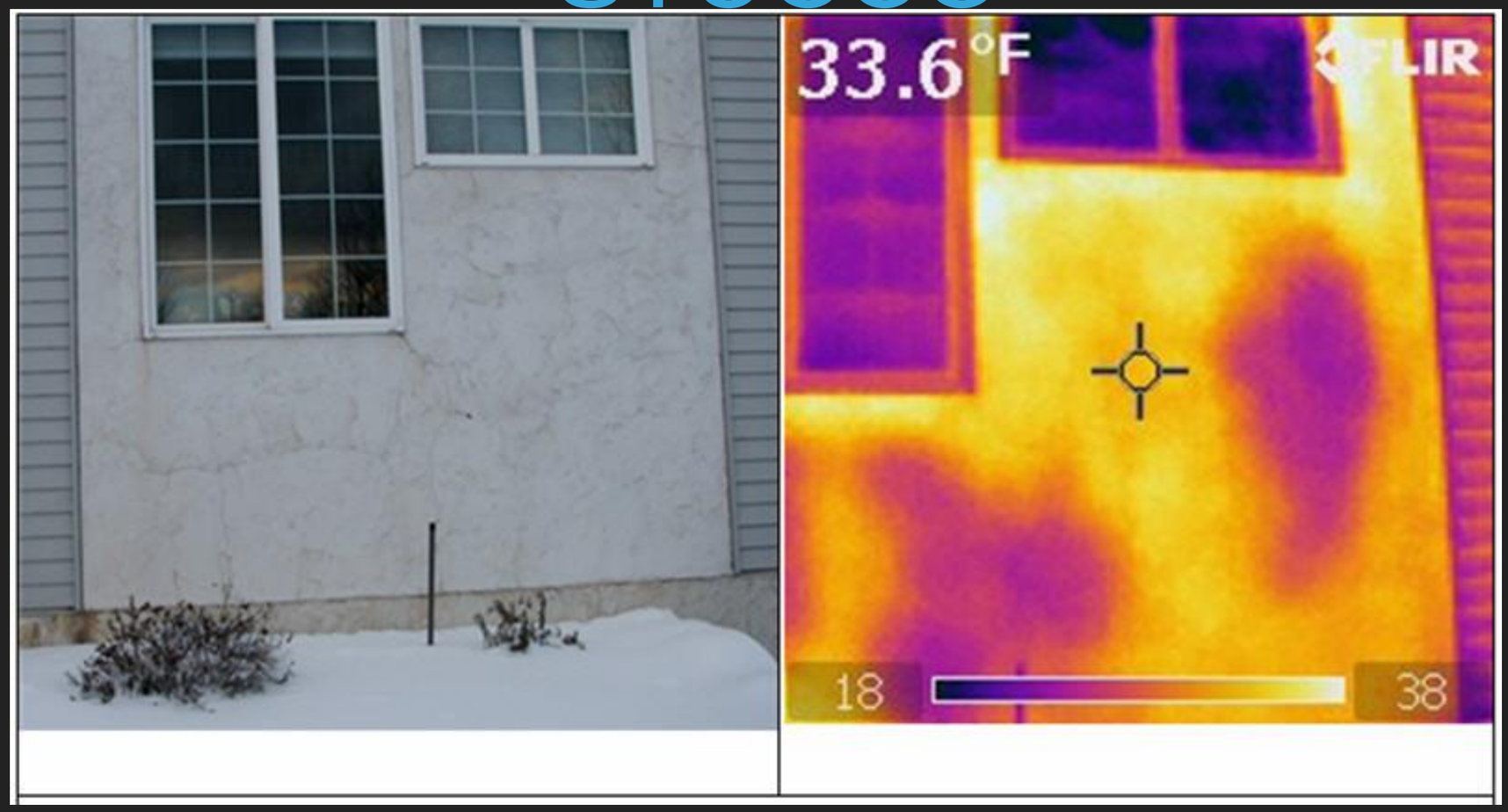




- Would you have found this without the thermal imager?

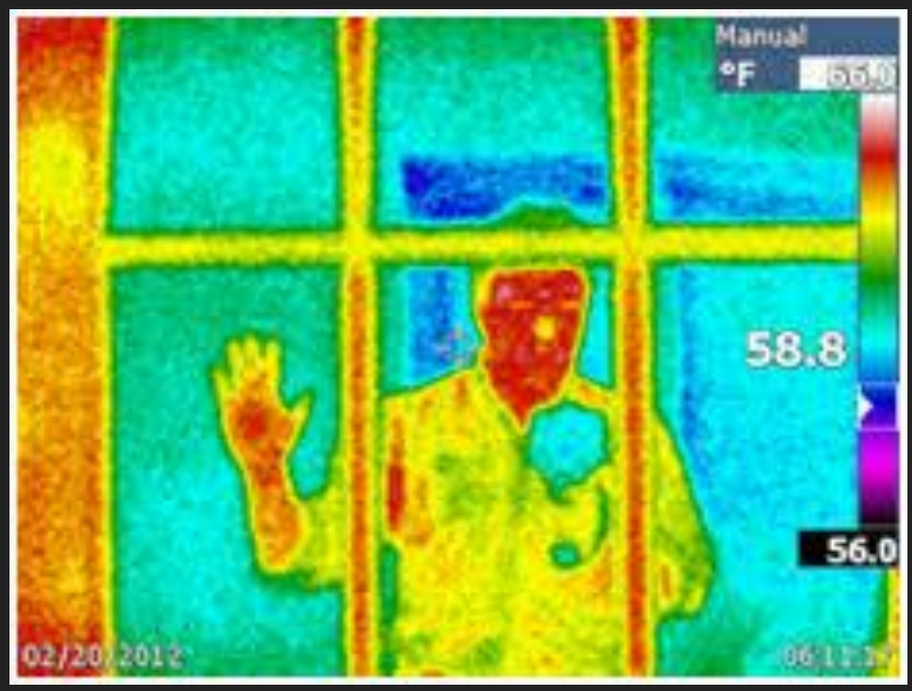
MOISTURE IN CEILING

MOISTURE UNDERNEATH STUCCO



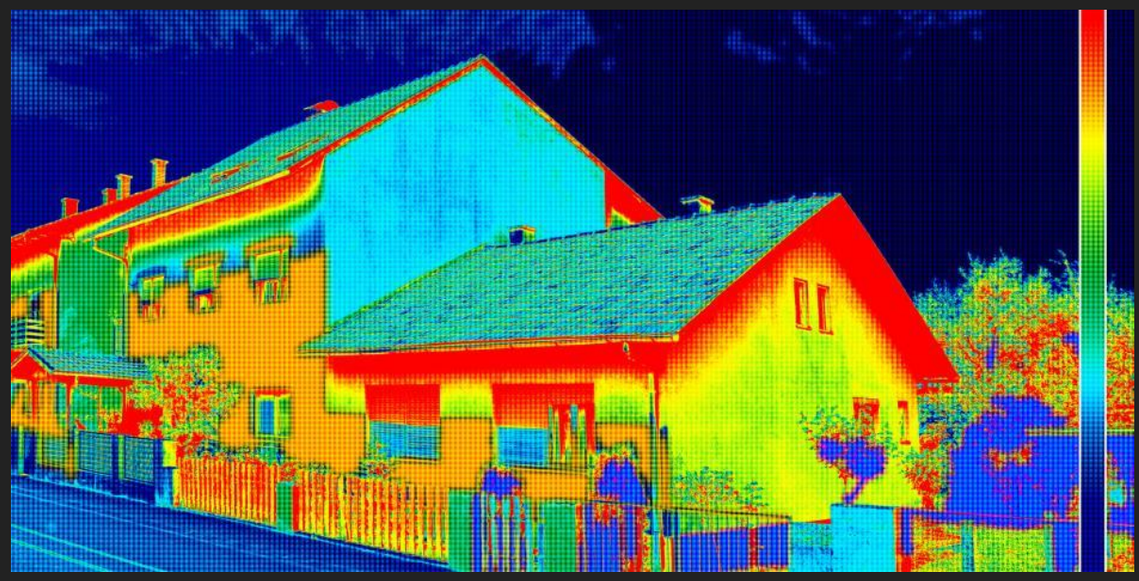
REFLECTING RADIANT HEAT

- Be careful at what you look at. Always when looking through the TIC (thermal imaging camera) that you look with your own eyes to see what you are really looking at.



EXTERIOR

- What is this picture telling you?
- What can you learn from it?
- Ask yourself, why are certain areas cooler than others?



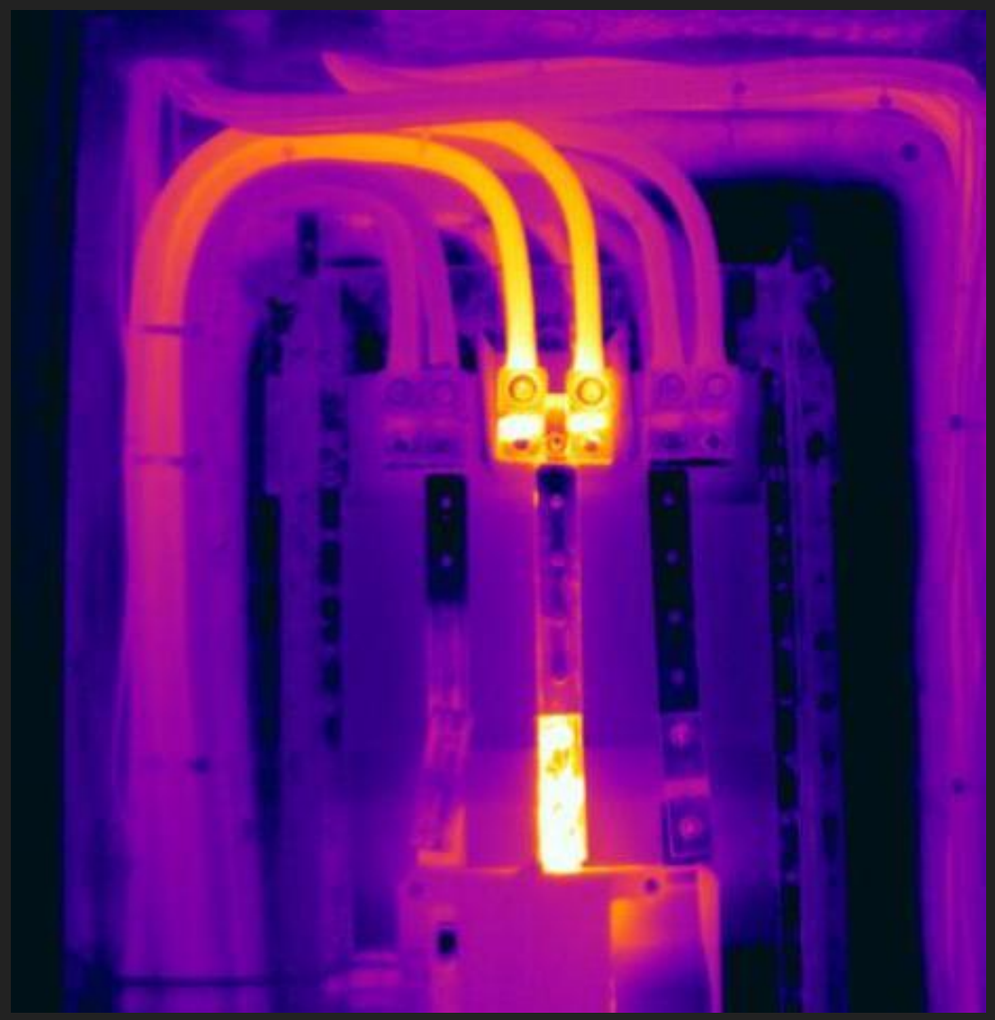
ELECTRICAL

- UL489 Paragraph 7.1.4.1.6 says the maximum temperature on handles, knobs, and other surfaces subject to user contact during normal operation shall not exceed 60°C (140°F) on metallic and 85°C (185°F) on nonmetallic surfaces.
- For this reason, a general temperature of 60°C (140°F) should be used as a maximum allowable temperature for all electrical components.

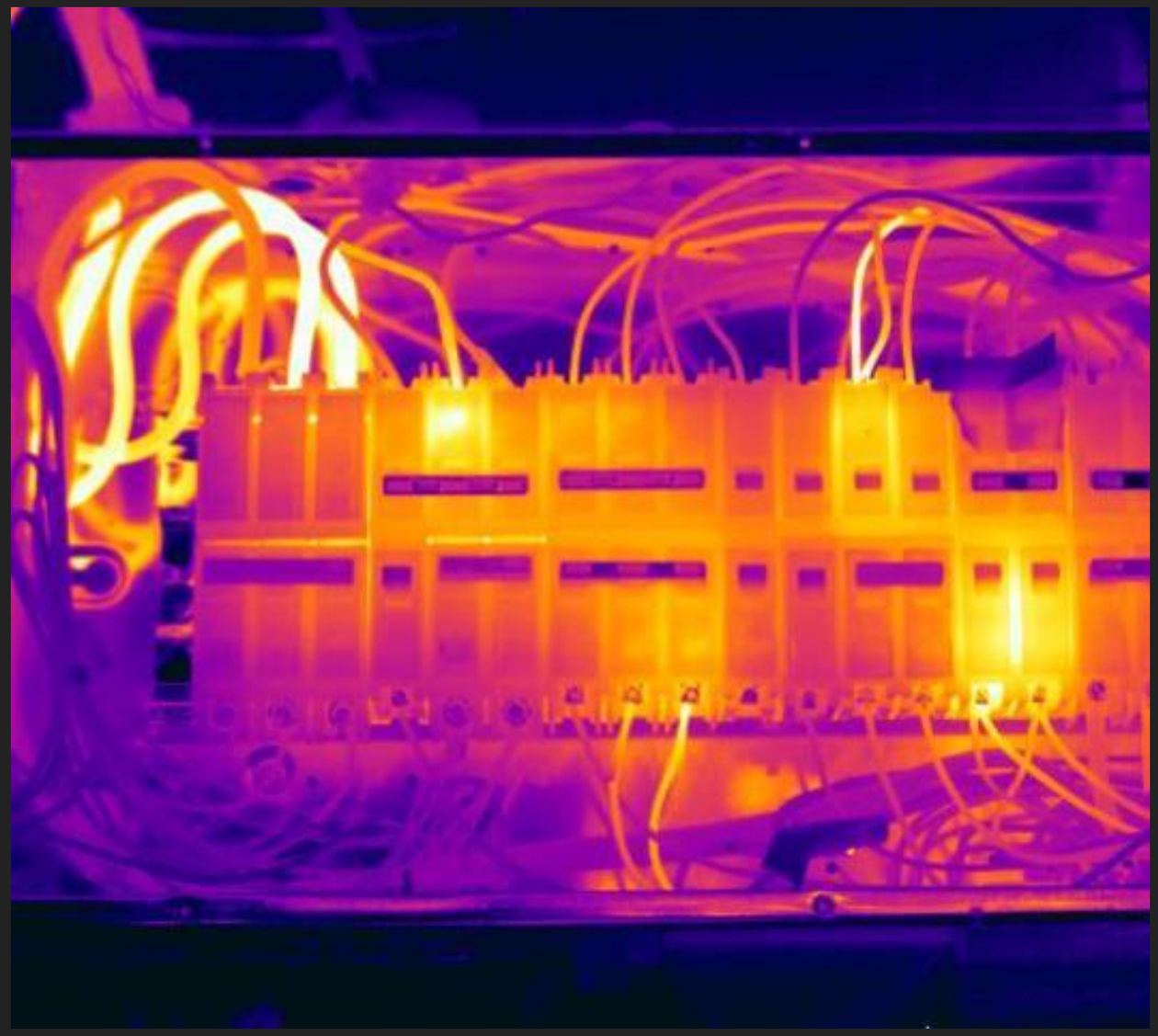
HOT FUSE AND CONDUCTORS

HOT FUSE AND CONDUCTOR

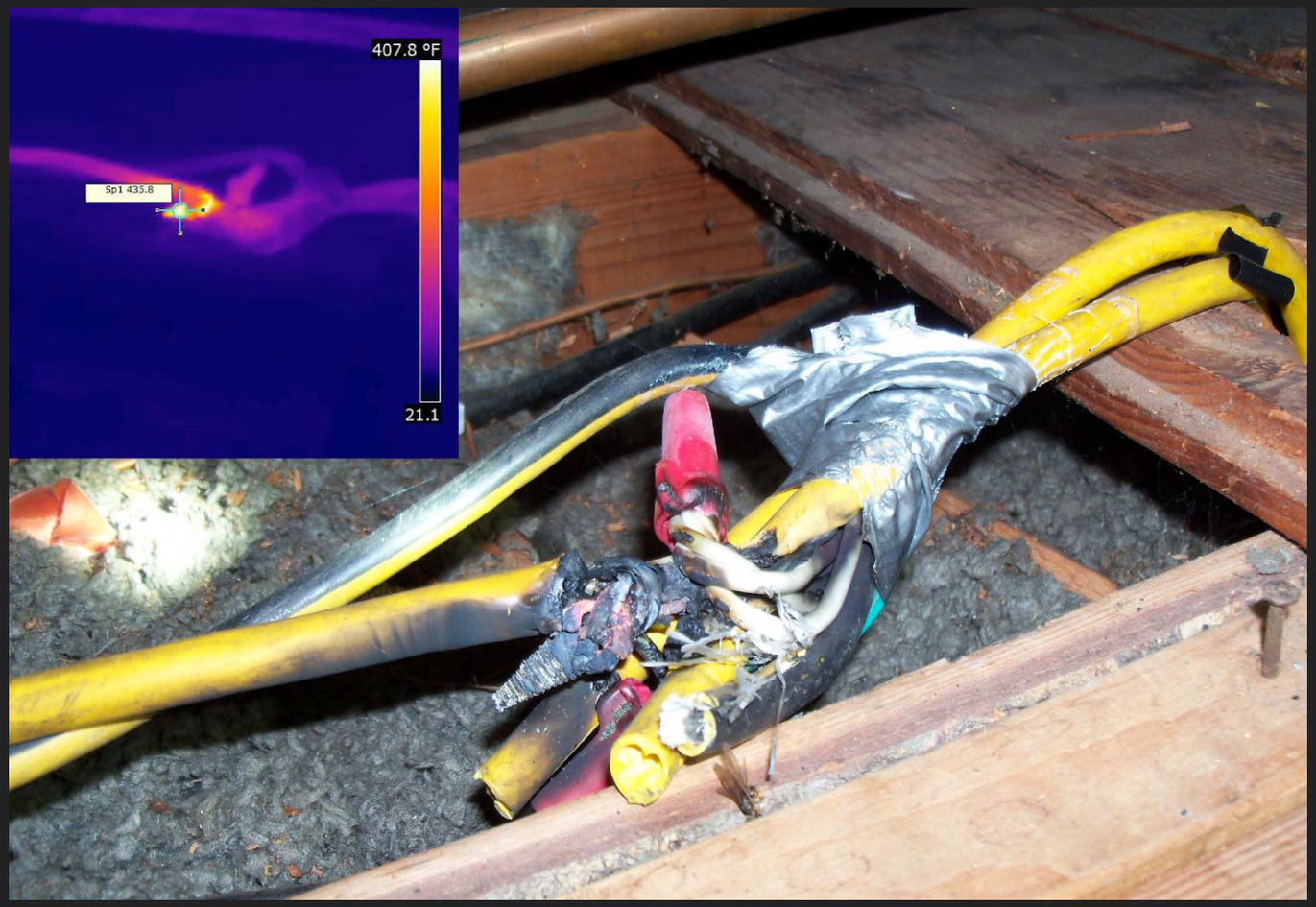
HOT SHUNT AND CONDUCTORS



MULTIPLE HOT MCB’S AND CONDUCTORS



MULTIPLE HOT MCB’S AND CONDUCTORS



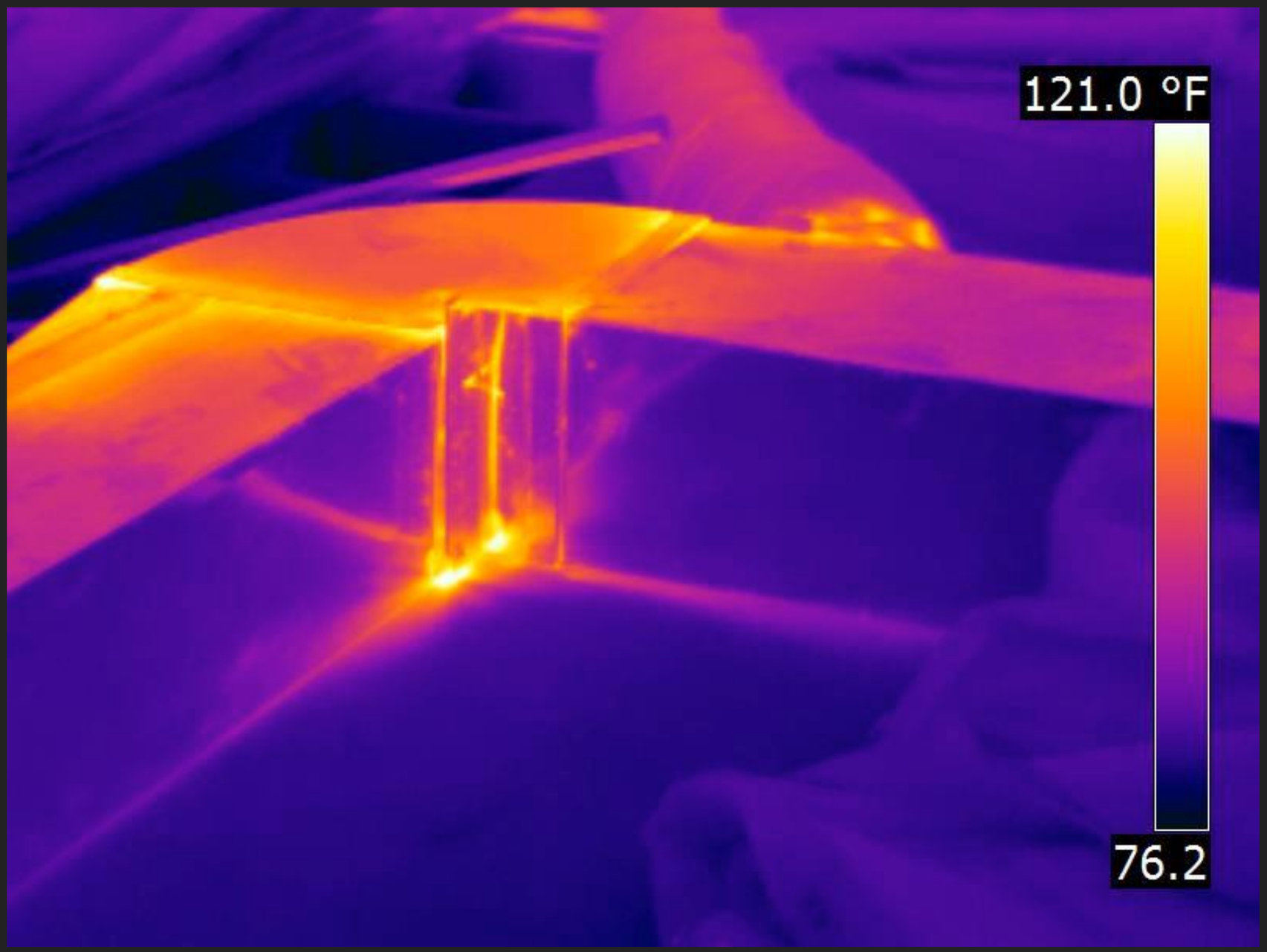
INSULATION


Insulation Faults
Air Leakage
Uninsulated Wall
Insulation Gaps

LACK OF INSULATION

GAPS OF INSULATION

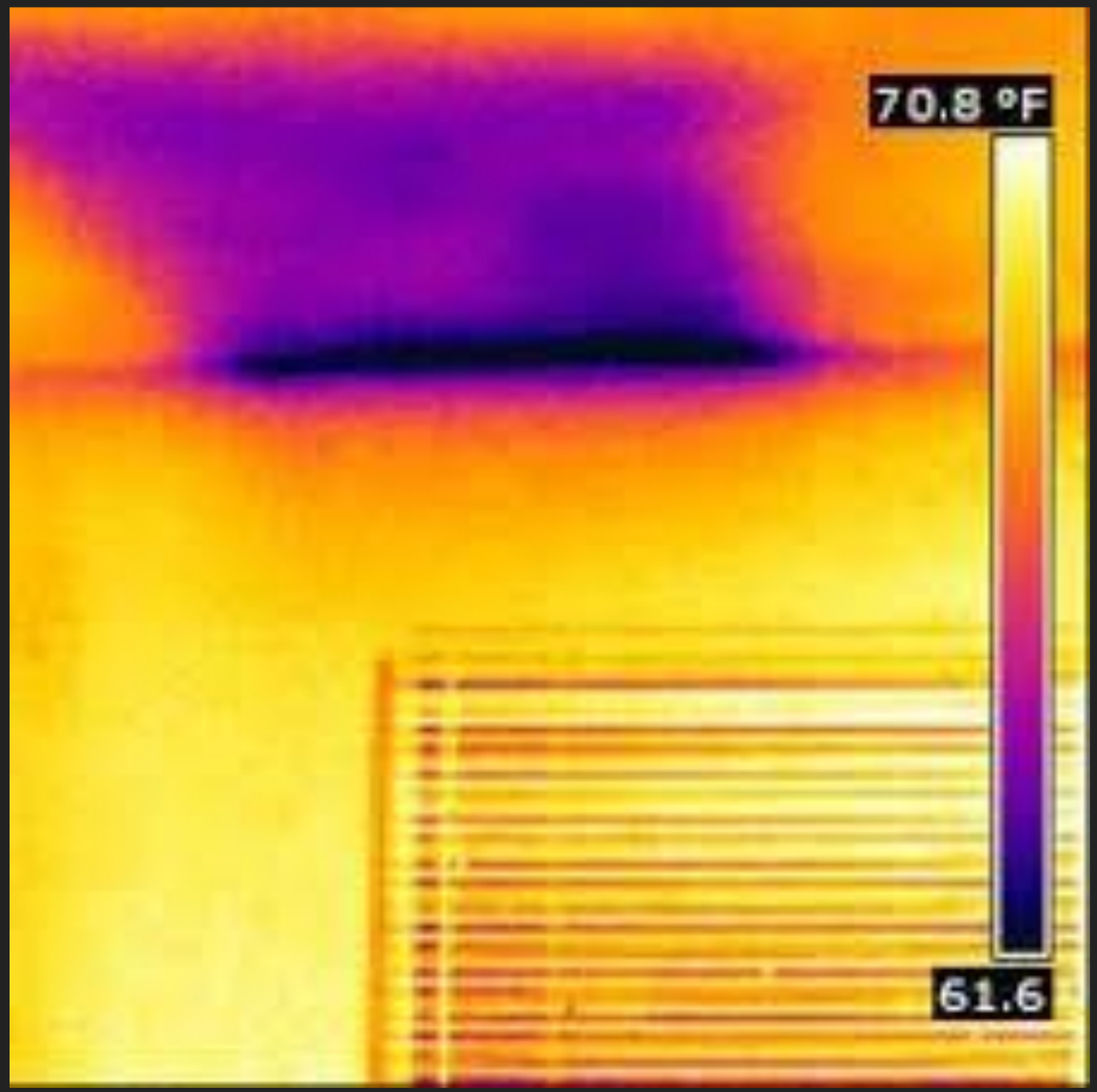
LEAKING DUCTWORK



LEAKING DUCTWORK

POORLY SEALED VENT

WHAT DO WE SEE?



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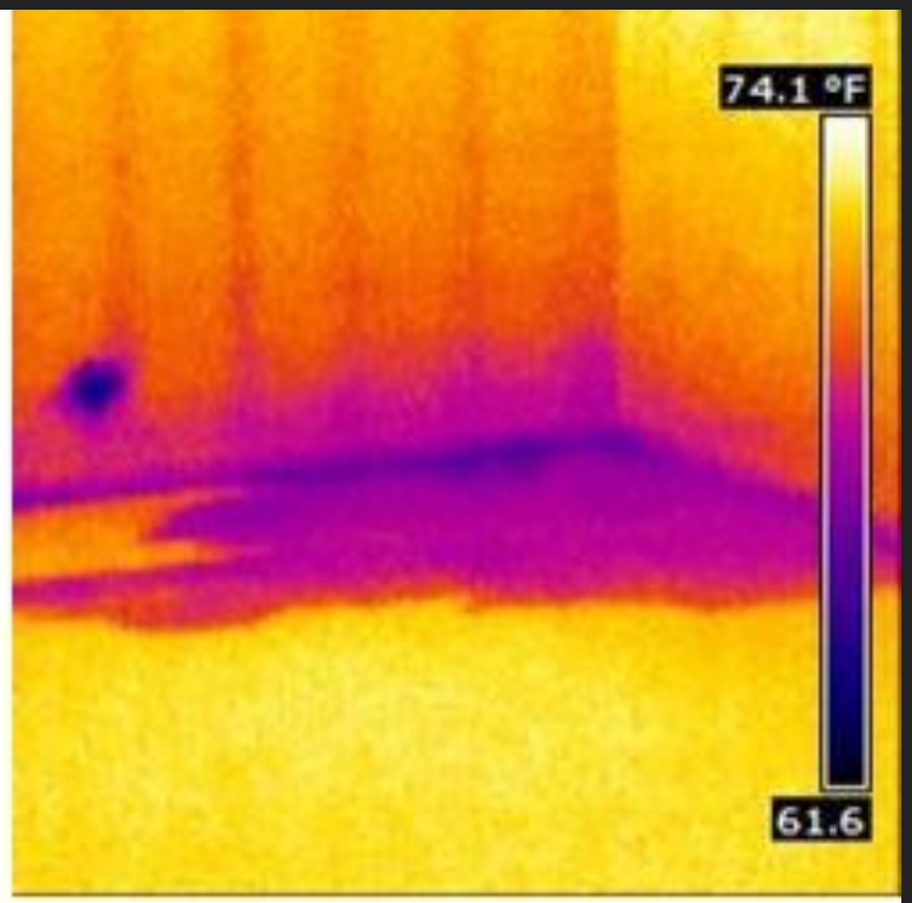

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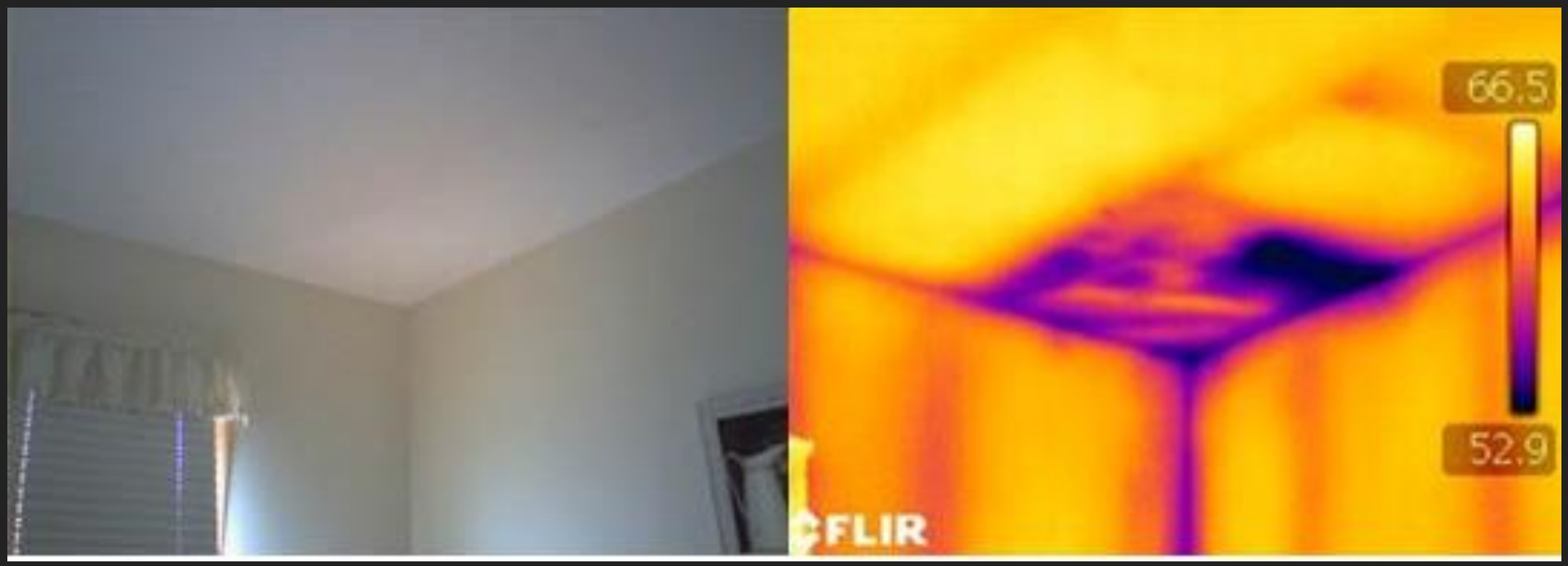

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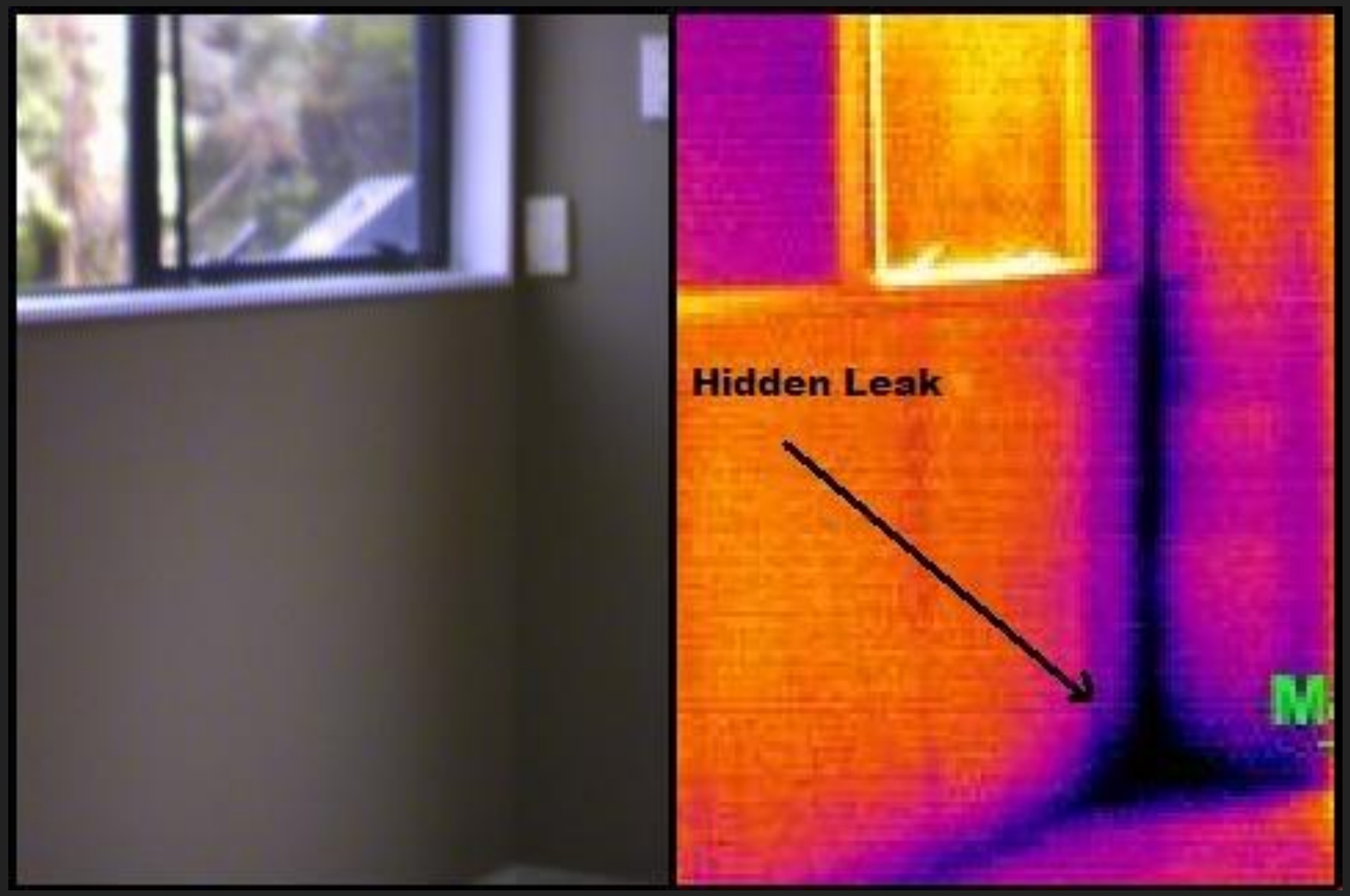

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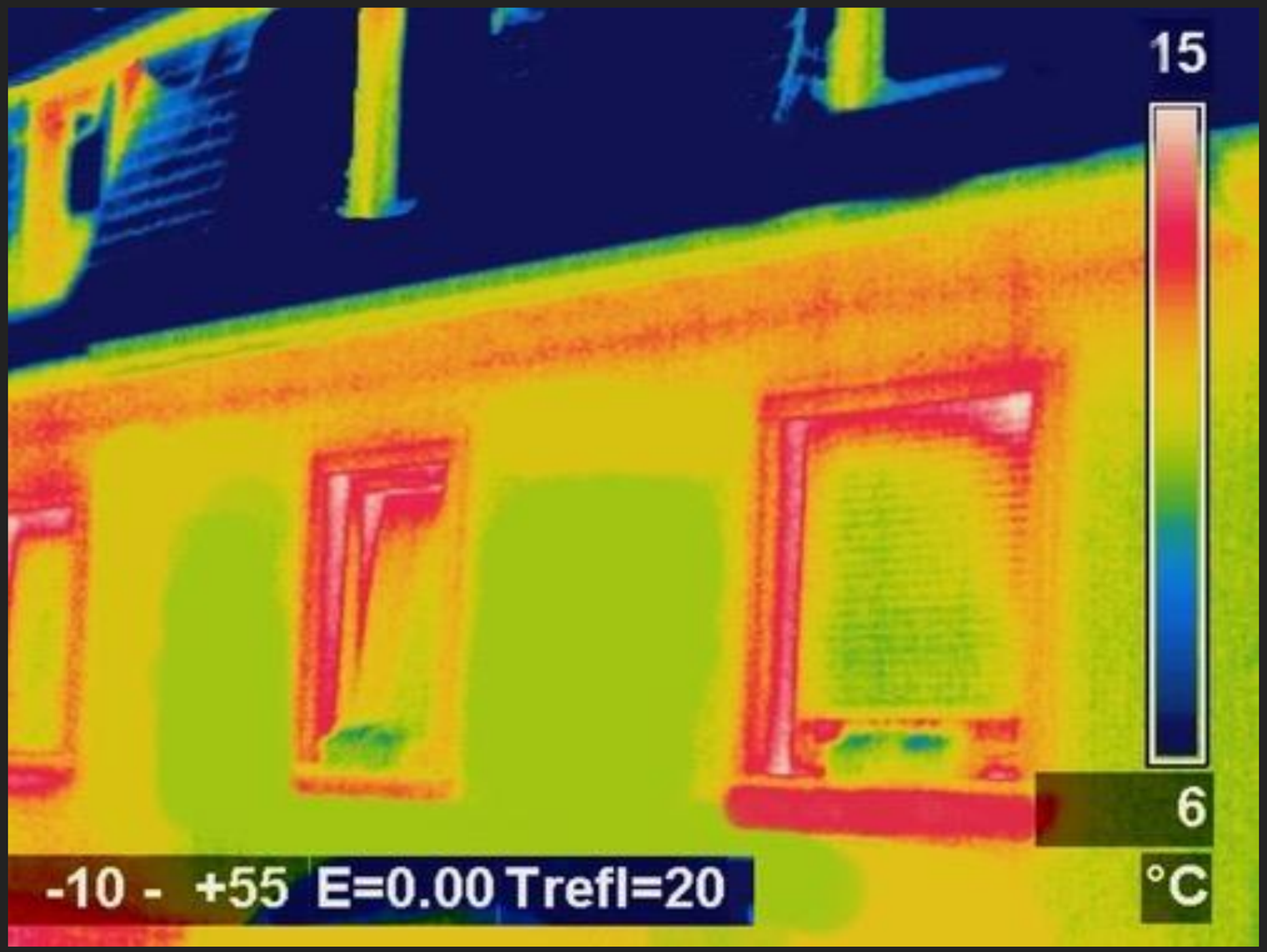

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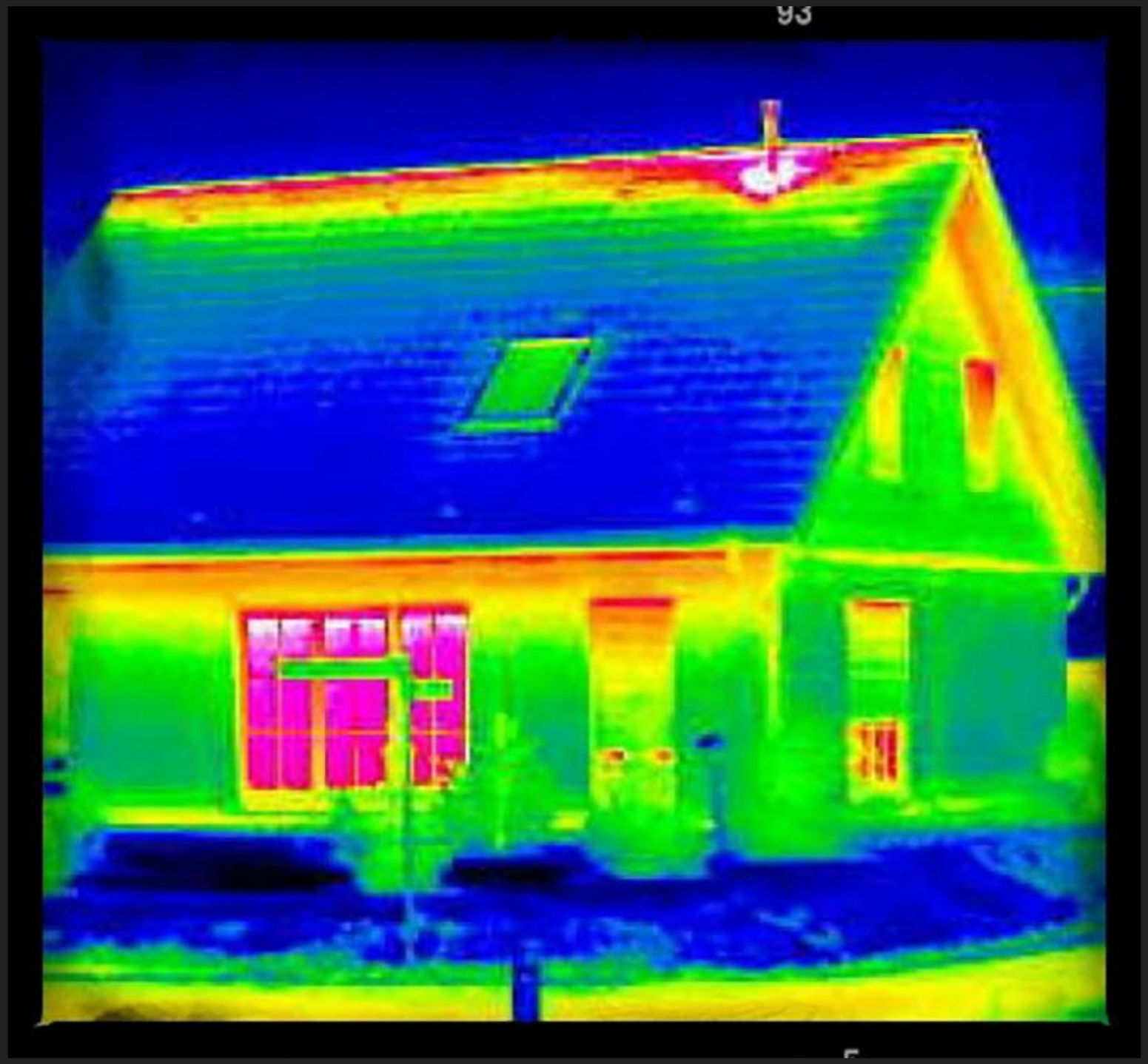

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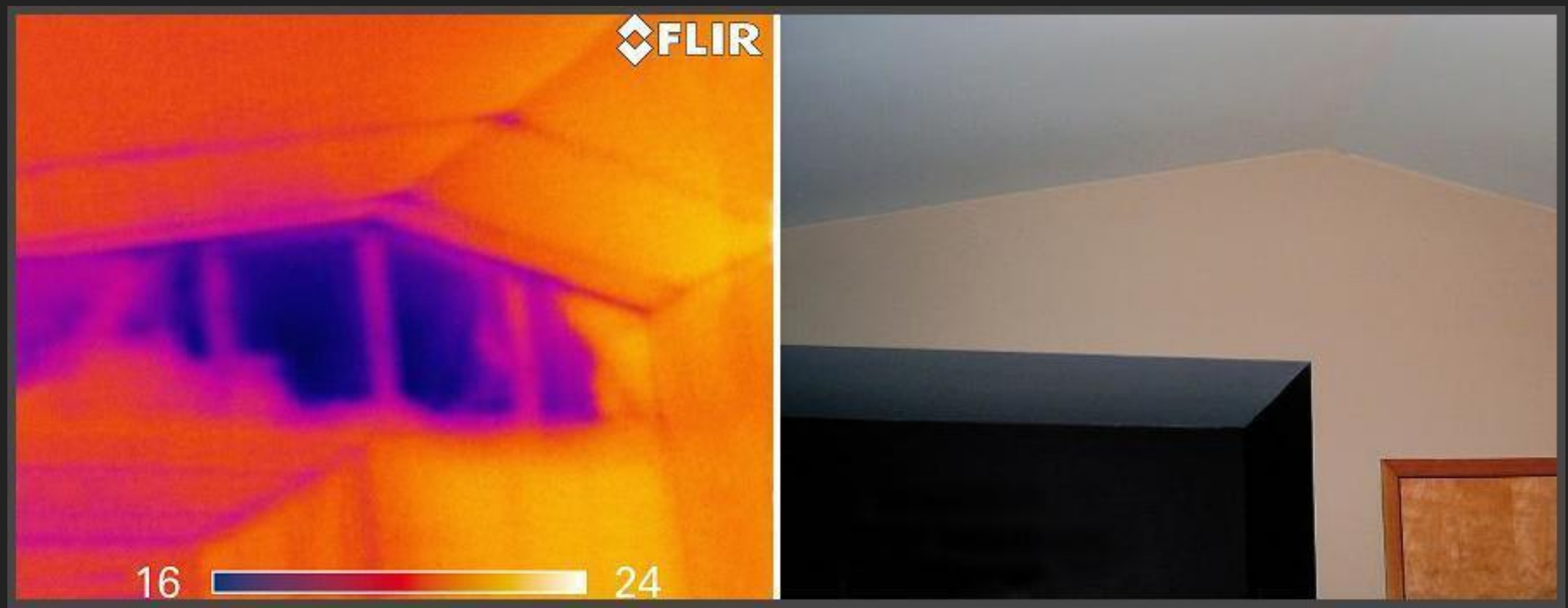

MODULE 3

CHOOSING THE RIGHT HANDHELD THERMAL IMAGING CAMERA

FACTORS TO INFLUENCE OUR DECISION

- Cost
- Marketability
- Report integration
- Durability
- Resolution
- Thermal sensitivity
- Frequency or refresh rate
- Battery life

COST

- Cost of thermal imagers can vary quite a bit and as technology improves, the price inherently decreases
- Cheap units can be only a few hundred dollars while more expensive ones can be several thousand at least

MARKETABILITY

- While thermal imagers are an excellent tool to have on home inspections, the use of a thermal does not usually increase the fee for the inspections. This tool when properly utilized and the data interpreted correctly, will ultimately provide better service to client and decrease your total liability.

- This is a vital tool for leak detection, roof inspections, and mold assessing which are excellent auxiliary services to offer and can be marketed separately from home inspections.

REPORT INTEGRATION

- While virtually all thermal imagers allow the user to capture photos and sometimes video, integrating those findings into your report needs to be easy.

- Many thermal imagers have have memory chips or cards that can be taken out to transfer the photos. Newer ones allow you to transfer them wirelessly. If you are using a smart phone or table for reporting, then by far the easiest is with a thermal that connects directly to your phone.

DURABILITY

- Thermal imagers are used on a wide range of professions to include electricians, firefighters, and now most recently, home inspectors. Many of the thermal imagers on the market are there for geared toward that profession.

- While as home inspectors, you will not a need a thermal imager to be rated to 500 F, you will want to choose one that will last through many years of use. This technology is progressing rapidly and while you want to choose one that lasts, upgrading in the near future should be taken into consideration.

RESOLUTION

- The resolution of the unit will determine the clarity and will allow you to determine what you are looking at. The higher the resolution, the better the image. The minimum acceptable for home inspectors should be 160 x 120.
- Anything less than this, such as 80 x 60, the photo is usually unusable.
- Some units will have image enhancement which will outline any objects so identification is easier.

THERMAL SENSITIVITY

- Thermal sensitivity is important to consider but not as important as resolution. The higher the sensitivity the more distinguishable smaller cold or warmer areas are. This becomes more and more important when you are further and further away from the objects observed.

- Higher sensitivity imagers are recommended for uses such as when we apply them on drones and other applications when we are unable to get closer to the objects being observed.

FREQUENCY

- Frequency is the refresh rate of the imagers display. So if an imager has a frequency of 9 hz, it will refresh the image 9 times per second. The higher the frequency rate, typically the higher the cost of the unit as well. One should be chosen that does not impede or slow down your inspection too much while offering a competitive price for what it is being used for.

BATTERY LIFE

- How long does the battery last?
- How much is a replacement?
- How long does it take to recharge?

THE END