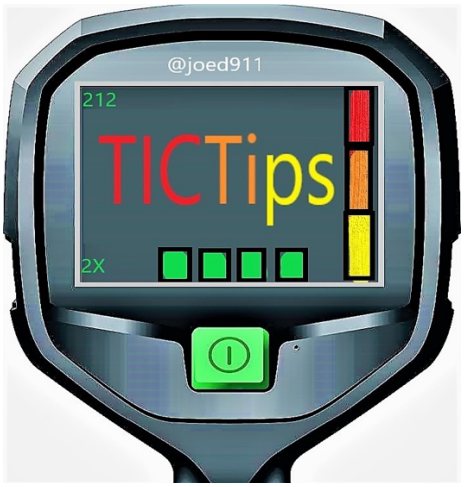


TIC Tips

Fire Training

Training Notes

Fire Behavior & Thermal Imaging: The Basics to Build on!

Joe DeVito

Joe started in the fire service as a volunteer in 1991. He is currently an interim Battalion Chief in SW Florida.

He is a CPSE Accredited Fire Officer and is Level 1 IR Certified. He has had the honor to present in many different conferences and participate in different webcasts and podcasts related to fire behavior and thermal imaging.

Joe has been blessed with great mentors in fire behavior and thermal imaging. His biggest mentor is Andy Starnes, and he will always be grateful for being taken under his wing.

He could not do what he loves without the support of his wife and family.

@joed911 on social media

Fire Behavior Portion of Class

Oxygen – Kill the Air

- 21% room air
- 18.5% fire greatly suppressed.
- Below 16% ceases to burn – to rich.

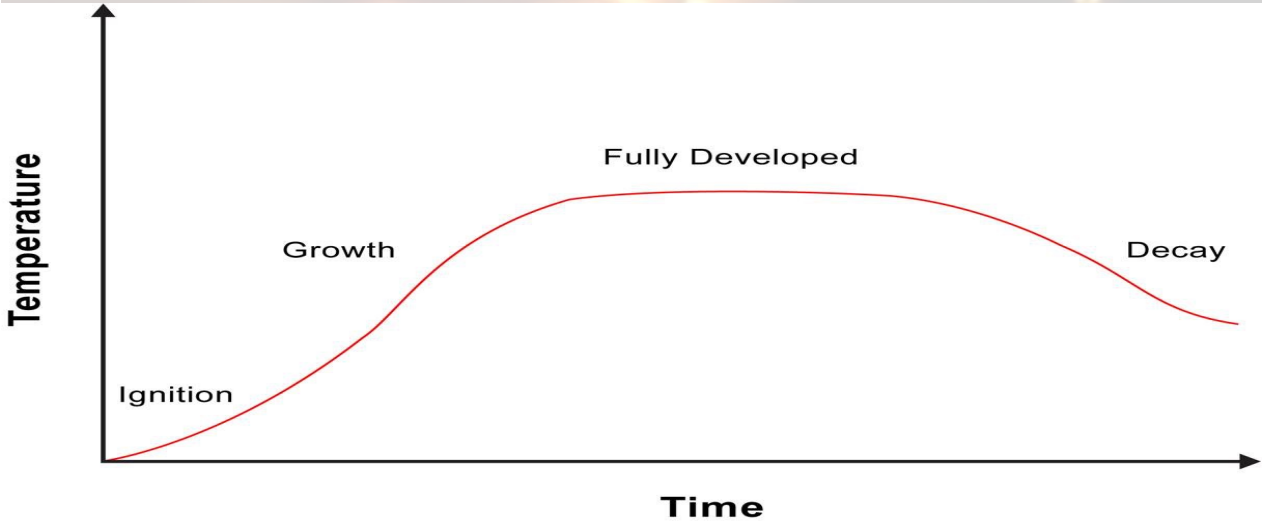
Kill the Heat

- Always transferred from hot to cold
- Conduction – transfer within solids
- Convection – transfer by movement in gases
- Radiation – transfer by electromagnetic waves

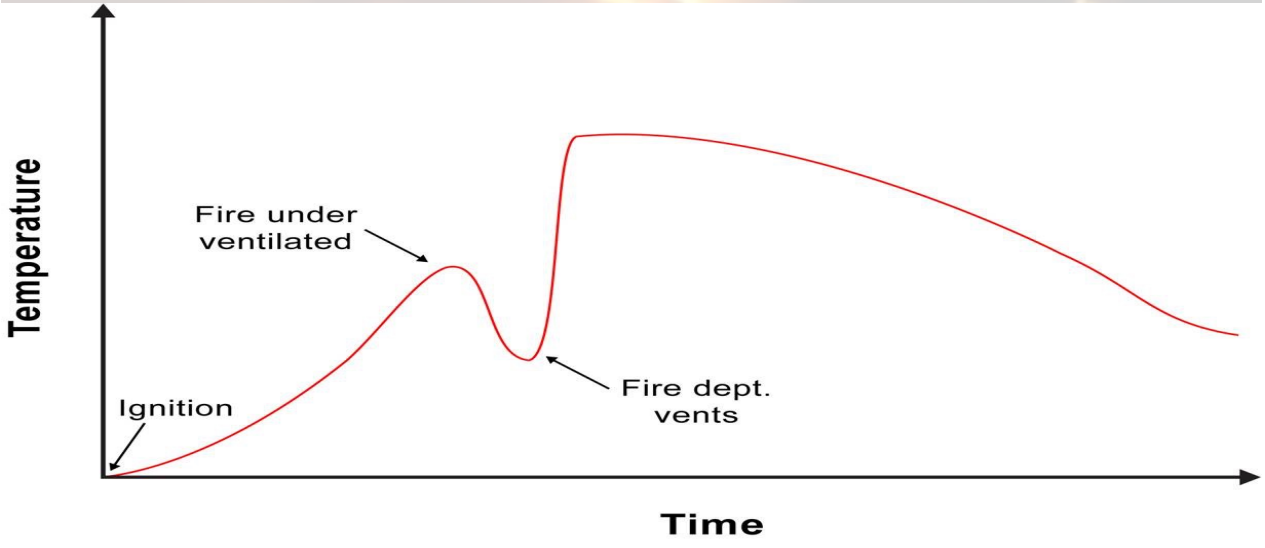
Stages

- Incipient Stage – light smoke (burning off the water)
- Growth – thermal layering begins.
- Fully Developed – flashover occurred.
- Decay Stage – oxygen or fuel is insufficient to sustain combustion.
- Flame Point – lowest temperature to sustain fire.
- Flash Point – Lowest temperature to ignite.
- Pyrolysis – the off gassing of a material due to being heated. The gases are what ignites.

Traditional / Legacy



Fire in a Structure (Modern)



Due to more efficient sealed up structures, the fire is under ventilated and decays until the reintroduction of oxygen.

Smoke

- Byproduct of combustion
- Not the target but the clue
- Smoke is fuel!
- Incomplete combustion
- Always watch smoke then fire. It will tell you more about what is occurring in the structure.
- Volume – Velocity – Density – Color
- Physics
  - Pressure Volume = Molecules Temperature
  - One side goes up, the other side goes up.
  - One side goes down, the other side goes down.
  - Must remained balanced.
- Volume
  - An indicator of the amount of fuel that is off gassing within a space.
  - Hot clean burning fire emits little volume.
    - Incipient Phase
    - Fully developed – free burning

- Velocity
  - Due to:
    - Expansion of gases
    - Restriction of the container
  - If the box is still absorbing the heat the smoke will be laminar
  - Heat driven smoke (closer to fire) will leave the exhaust, rise, and gradually slow down.
  - Pressure driven smoke will leave the exhaust and immediately slow down and balance with the outside air (laminar smoke)

- Density
  - Degree of compactness = quality of burning
  - High density smoke = incomplete combustion
  - Light or thin smoke = good ventilation or incipient burning
  - Density that changes from heavy to light is a sign that flashover occurred or the fire ventilated.

- The denser the smoke, the more fuel there is.
- Dense rapid turbulent smoke sign if impending hostile fire event.

- Color
  - Stage of heating
  - Can determine location.
  - Solids emit white smoke when first heated due to burning off the water in the material.

- Smoke leaves the fuel, and the carbon gets absorbed in the walls and materials.
- The smoke gets filtered and will eventually be white.
- When the smoke is close to the fire or the box can no longer absorb the heat, the smoke will be darker.

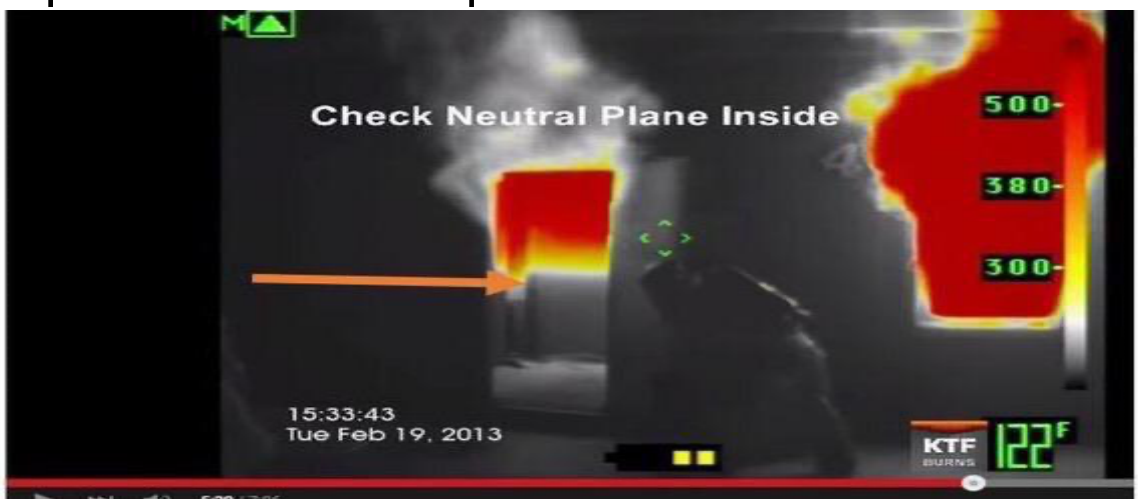
Hostile Fire Events

- Flashover
  - Surfaces in the room reach ignition temperatures simultaneously.
  - Most dangerous stage of fire development
  - It can take minutes to go from zero to five hundred degrees but seconds to go to five hundred to flashover temperatures.

    - Upper portion of the compartment reaches a temperature of approximately 1100 degrees.
    - Large volume of heavy dark turbulent smoke
- Vent Point Ignition (Auto Ignition)
    - Smoke has the temperature needed to ignite, has the fuel (smoke), but is missing the oxygen.
    - It gets the perfect mixture and ignites going back into the room.
- Backdraft
    - Rapid explosion following introduction of oxygen.
    - Fire goes into decay prior flashover and pyrolysis continues.
    - High pressure ignites when oxygen is introduced and exits opening.
- Smoke Explosion
    - Lower temperature smoke then backdraft
    - Smoke collects in void spaces.
    - Needs an ignition to explode.
    - Fire goes out after the smoke explosion.
    - Does not need an opening.
        - Can cause structural damage.
        - Break windows etc.

Flow Path

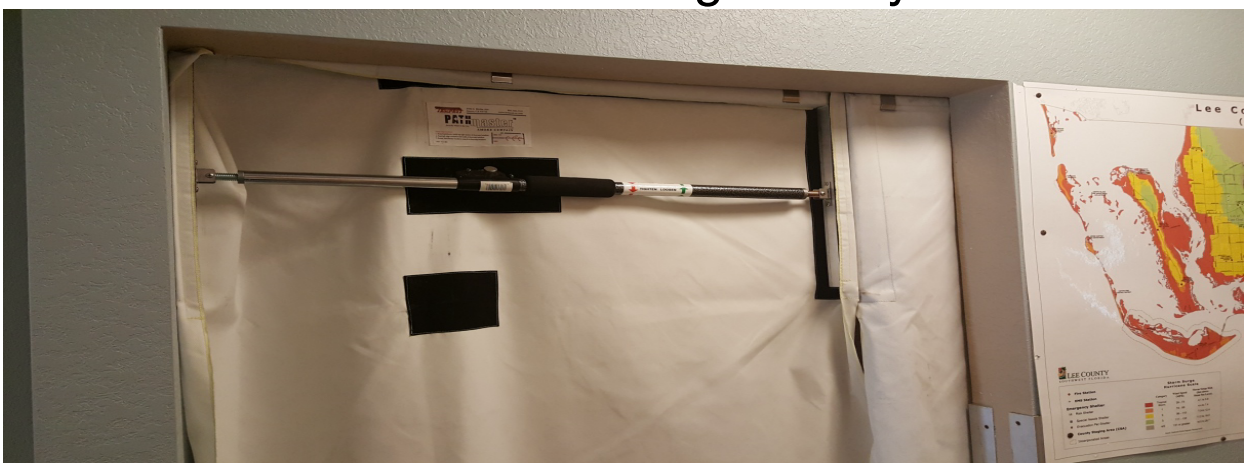
- Volume between inlet and exhaust
- Neutral Plane – separation between high pressure and low pressure



- Lift – neutral plane rises due to cooling or ventilation.
- Unidirectional Flow Path
  - The exhaust is filled with smoke or fire.
  - The air coming from another area is pushing it out the exhaust.

- Bidirectional Flow Path
  - Ventilation opening has clean air coming in the bottom of it and smoke or fire coming out of the top of it.

- Controlling the Flow Path
  - 10 to 20 MPH winds can cause rapid fire progression and alter flow path.
  - Door Control – tough to maintain.
  - Smoke Curtain – hang in entry.



The End of Fire Behavior Portion

Thermal Imaging Portion of Class

What is a thermal imager?

- Reads infra-red (IR) heat and makes it visible on our thermal imaging camera (TIC)
- It cannot see through:
  - Water
  - Windows
  - Walls – can see studs in wall.
  - Floors
  - Furniture
- Limitation of the TIC
  - Not actual temperature
  - Reflectors
  - Water vs Hole in floor
- Limitation of user
  - Poor or no training
  - No experience with it
  - Over relying on it

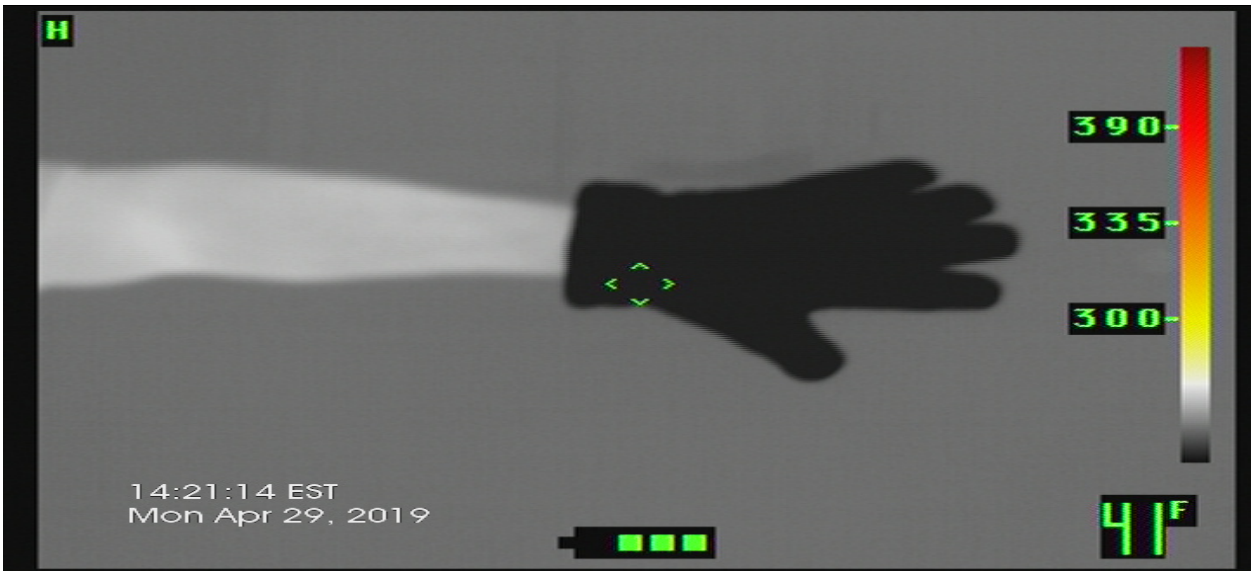
Emissivity

  - Object's ability to emit heat.
  - Emissivity of zero (shiny mirror) to emissivity of 1.0
  - Organic Painted Oxidized objects 0.95
  - The higher emissivity the more accurate the temperature reading

Types of Emitters

- Active Emitter – gives off heat at a low to medium rate.

- Active Emitter with Insulator

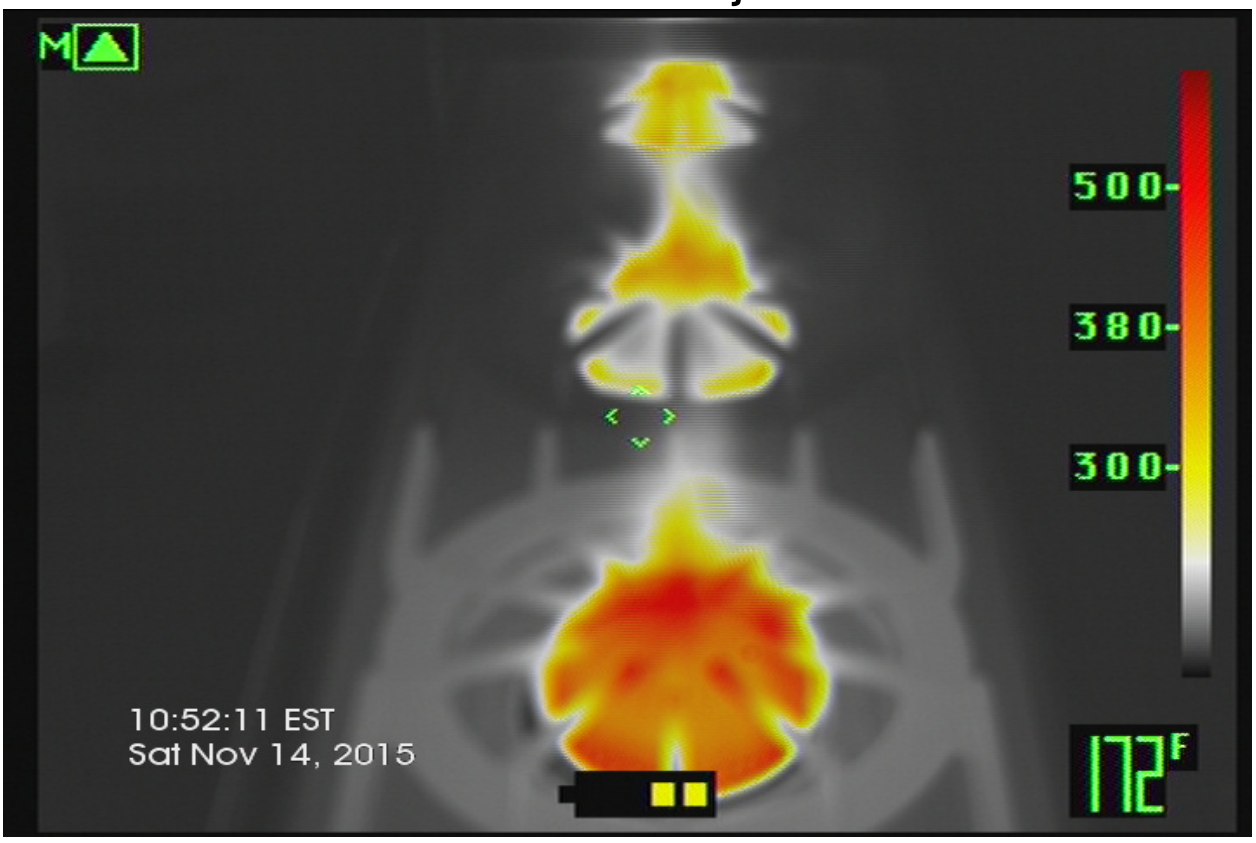


This can be a problem in search. If you do not recognize what you are looking at, you must investigate it. An anomaly!

- Passive Emitters cannot make their own heat but can absorb heat and can release it.
    - Found in inanimate objects.

- Density and mass are keys to absorption.
    - Example of lightweight vs heavy timber construction
- Direct Emitter
    - Gives off constant high strength IR energy on its own like the sun.
    - Never point the TIC at the sun as you will burn out the microbolometer.

- Reflectivity is ambient IR reflected from a body unrelated to the body's own heat.
    - An example is a mirror.
- Follow angle in = angle out
    - If we change our angle the reflection will move but the actual object will not



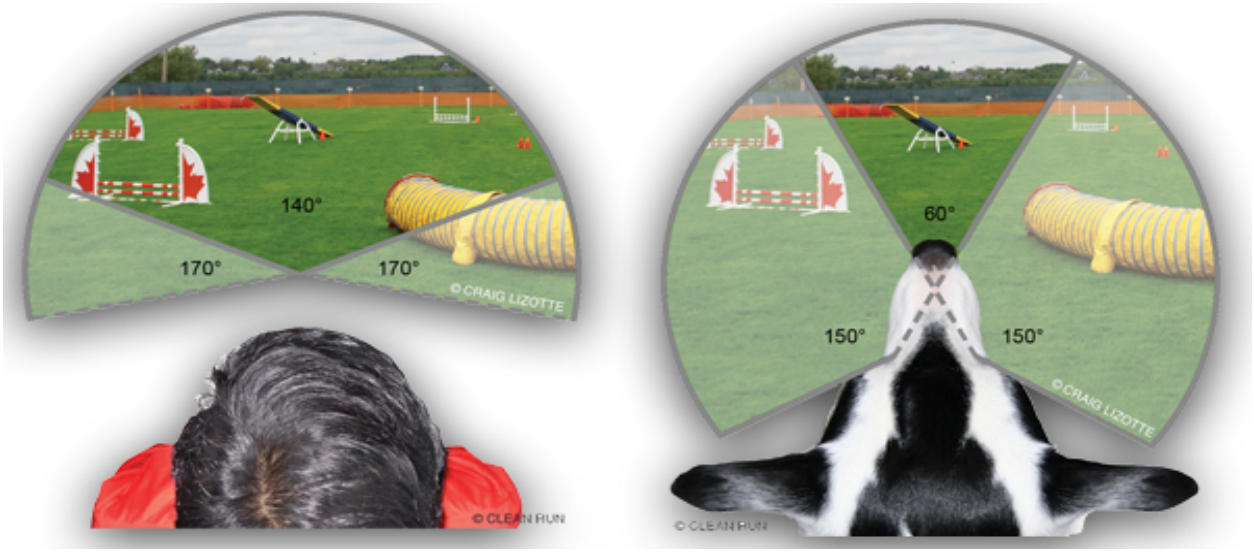
Pictured 2 burners with 2 reflections in the backsplash.

- Transmissivity
    - Object's ability to let heat move through it.
    - Glass and water are bad.
    - Gas is good.

This picture shows a reflection on left and only half of the person due to the shower curtain lower emissivity. All showers and bathtubs should be treated and closets and checked during search.

Parts of a Thermal Imaging Camera

- Optics system
- Field of view
    - The area visible by the TIC. Field of view (FOV) is measured in degrees and can be horizontal, vertical, or diagonal measurements.



- TIC FOV is less than a dog's FOV.
- The larger number is always horizonal FOV.
- When you rotate your TIC, the display does not auto rotate like your phone.
- When you need to see more up and down, rotate the camera sideways and your larger FOV is now vertical.

- Distance to spot ratio D:S

    - Think of a flashlight on the wall
    - If you stand 10 feet away, you have a 1-foot circle of light on the wall.
    - The further away you are the less accurate and bright the light will be.
    - Same for temperatures on your TIC
    - Know your camera to find your D:S
- The Detector
    - Detects and converts image to temperature map.
    - Focal Plane Array
    - Refresh rate – frames per second.
    - Our eyes see 30 Hz.
    - Go to fast camera gets dizzy and shutters.
    - Shutter – image freeze on camera.
    - If shutter, return to scan where the shutter occurred.
- Resolution
    - 160 x 120 child's hand 7 feet away
    - 320 x 240 child's hand 15 feet away
    - 364 x 288 child's hand 20 feet away

- Display

    - Objects warmer than the environment
        - White
        - Yellow
        - Orange
        - Red
    - Objects warmer than the environment
        - Grey
        - Black
- Thermal Contrast – how well objects stand out.
    - If no contrast, make it by spraying water.
- Thermal Inversion – Objects change shade due to temperature of environment not the object.
- Numeric Temperature Measurement (NTM)
    - The number in the crosshairs
    - Should not be used in fires.
        - Reads surface temps not air temps.
        - Convection waves move through the room faster than the surfaces can absorb heat.
    - The NTM is approximate temperature of surface at the crosshairs.
    - Used in machinery and electrical.

- TI Basic High Gain
  - Automatically starts here when turned on.
  - Field of view under 300 degrees
  - Greyscale
  - Focuses on objects, not heat.
  - Should be used when searching.
- TI Basic Low Gain
  - % of field of view over 300 degrees
  - Green triangle top left corner
  - Colorization
  - Focuses on heat not objects.
- Diagnostic vs Awareness
  - Diagnostic
    - High Resolution at least 320x240
    - Refresh Rate per NFPA min 25 Hz.
    - Larger display screen
  - Awareness
    - May be 320x240 or less.
    - Refresh rate less than 25 Hz.
    - Small screen
    - Used for flow path and egress.
- Get the Picture
  - When scanning start low

        - High gain mode
        - Under the heat
        - If changes to low gain, point camera to ground.
    - Scan lower half of room side to side.
        - Assure the cameras field of view matches your field of view.
    - Scan upper half of room side to side.
        - Assure the cameras field of view matches your field of view.
    - If in a higher room, utilize Z pattern to fill FOV.
    - Think of 7 sides including temperatures of material inside the box
- Practical Applications
    - Size Up
        - Heat area location of the structure.
        - Extent
        - Ventilation profile
        - Access
    - Search
        - TIC lead
            - Larger areas
            - Scan area.

        - Inform FFs of plan.
        - Advance
    - TIC directed.
        - Bedrooms
        - Either scan and show FF where to go, or
        - Scan and label walls clockwise.
            - Left wall #1 door wall #4.
            - Tell FF bed on 2 closets on 1 go!
    - Point to Point.
        - Quickest way is direct line.
        - Like a mix of TIC lead and TIC directed – separate to cover more ground while staying in voice contact.
    - VEIS
        - Mix of size up and search
- RIT
    - Remember thermal inversion.
    - Look for dark SCBA bottles.
    - Look for dark hose lines.
- Water Application
    - Do not pencil, erase the heat.

        - Hold camera off to side of nozzle.
            - Nozzle person erases the heat at the base of the fire.
            - Erase all the heat in the thermal picture.
        - Another method, Clock method
            - Stand behind nozzle person and give them directions via clock numbers.
    - Ventilation
        - Superheated gases
        - Trusses
        - Structural Integrity
    - Overhaul
        - Heat in walls.
        - Investigative mode if TIC has one.
    - Electrical
        - Powerlines
        - Fuse Boxes
        - Wires Arcing
    - Water Rescue
        - Cannot see through water.
        - Last known area
        - Boats

        - Floating
    - Outdoor searches
    - Motor Vehicle Crashes
        - Patient to seat ratio
- Haz Mat
    - How much left in container
    - Release point.
        - Endothermic
        - Exothermic
    - Specific gravity less than one will float in water.
- Brush Fires
    - Drones
    - Fences
    - Livestock
    - Other vehicles
    - Hot areas
- Medical
    - DVT
    - Amputations
    - Circulation Occlusions

The uses are endless based on the imagination of the end user!