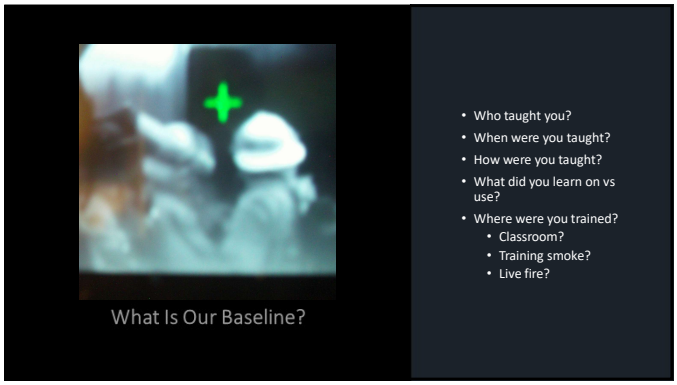
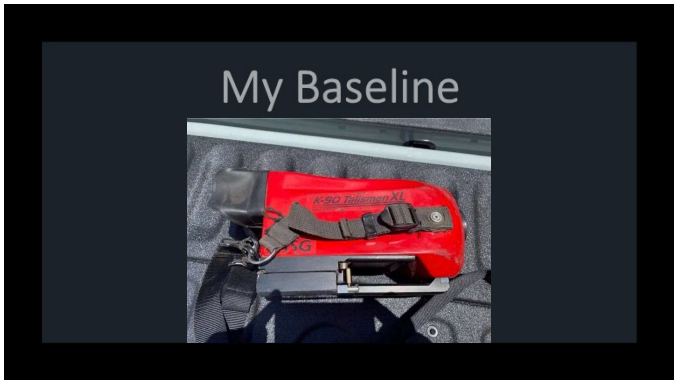

FIREFIGHTER
Thermal Imaging
BEFORE
"The Hand Off"

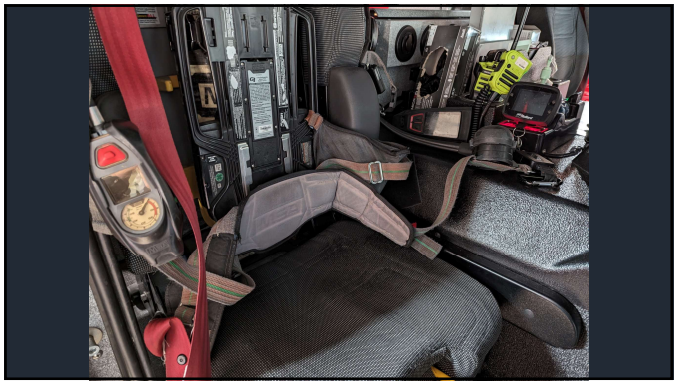
1


What Is Our Baseline?
Who taught you?
When were you taught?
How were you taught?
What did you learn on vs use?
Where were you trained?
Classroom?
Training smoke?
Live fire?

2


My Baseline

3



4

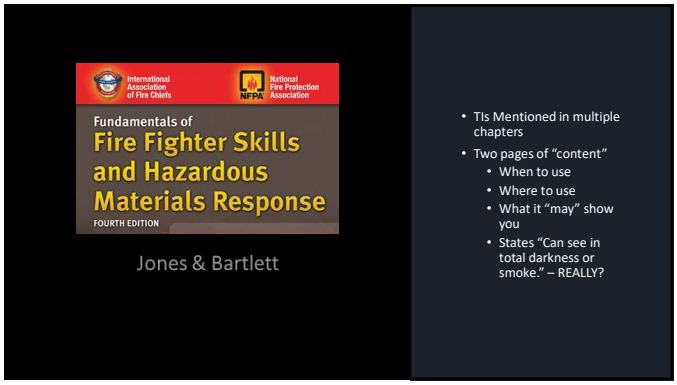
What is yours?

5

"About 58% of respondents received less than an hour of TIC training in the past year."

Firehouse Presents Thermal Imager Results

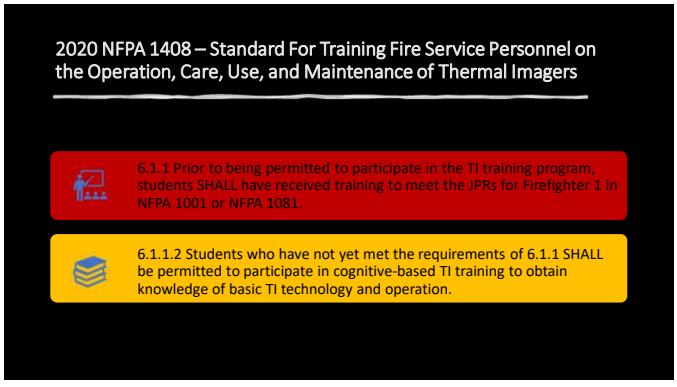
6


International Association of Fire Chiefs
National Fire Protection Association
NFPA
Fundamentals of
Fire Fighter Skills and Hazardous Materials Response
FOURTH EDITION
Jones & Bartlett
• TIs Mentioned in multiple chapters
• Two pages of "content"
• When to use
• Where to use
• What it "may" show you
• States "Can see in total darkness or smoke." – REALLY?

7


NOTHING tells you HOW!

8


2020 NFPA 1408 – Standard For Training Fire Service Personnel on the Operation, Care, Use, and Maintenance of Thermal Imagers
6.1.1 Prior to being permitted to participate in the TI training program, students SHALL have received training to meet the JPRs for Firefighter 1 in NFPA 1001 or NFPA 1081.
6.1.1.2 Students who have not yet met the requirements of 6.1.1 SHALL be permitted to participate in cognitive-based TI training to obtain knowledge of basic TI technology and operation.

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2020 NFPA 1408: 7.1.1

- All participants using TIs ***shall*** understand their use and limitations along with scientific principles describing the operation of the TI.

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- Infrared cameras are non-contact devices that detect thermal energy and then convert it into an electrical signal, which is then processed to produce an image. – Teledyne FLIR

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2021 NFPA 1801 – Standard on Thermal Imagers for the Fire Service

#1 NOT ALL THERMAL IMAGERS ARE NFPA COMPLIANT/CERTIFIED

- NFPA intent is to standardize for durability, safety, and ease of use

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2021 NFPA 1801 – Standard on Thermal Imagers for the Fire Service

- Definitions
  - Blackbody – An object that absorbs all electromagnetic radiation that falls onto it; no radiation passes through the object, and none is reflected.
  - Emissivity – The ratio of the radiation emitted by a surface to the radiation emitted by a blackbody at the same temperature. (TIC = .95) (Lower=reflection)
  - Luminance – A photometric measure of the amount of light that passes through or is emitted from a particular area.
  - Low-Sensitivity – The least thermal sensitive operational mode, used to increase the thermal imager's temperature range.
  - White-Hot Polarity – A display methodology whereby a grayscale image is created based on the fact that the warmest object in the field of view is the whitest object.

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Get To Know Your Imager

- Situational Awareness or Decision Making
- Viewing Area and Layout
- Field of View
- Hertz (Hz)
- Pixels, Resolution, and mK
- Thermal Palette(s)
- Function(s)/Mode(s)
- Advanced Features

15

Situational Awareness vs Decision Making

Seek FirePRO 300 | Seek AttackPRO+

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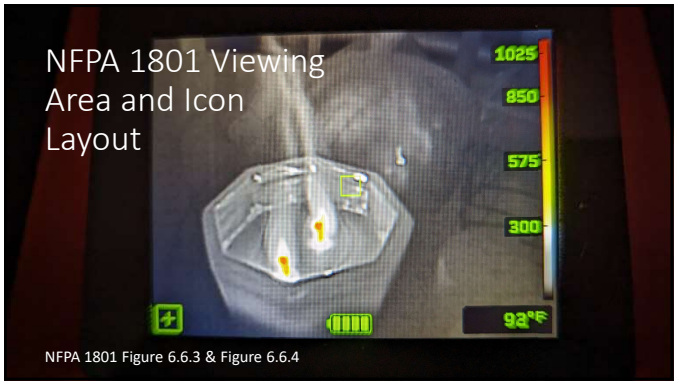
NFPA 1801 Viewing Area and Icon Layout



NFPA 1801 Figure 6.6.3 & Figure 6.6.4

17

NFPA 1801 Figure 6.6.4

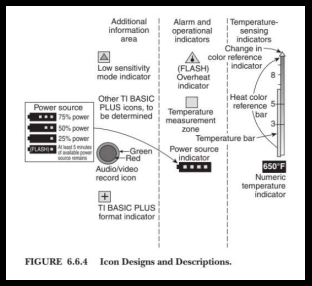


FIGURE 6.6.4 Icon Designs and Descriptions.

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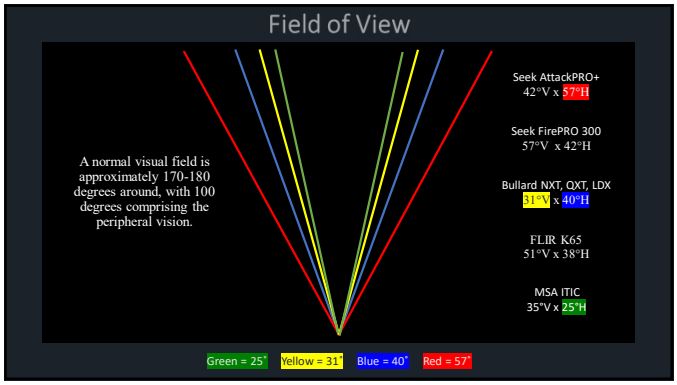
Field of View
A normal visual field is approximately 170-180 degrees around, with 100 degrees comprising the peripheral vision.
Seek AttackPRO+
42°V x 57°H
Seek FirePRO 300
57°V x 42°H
Bullard NXT, QXT, LDX
31°V x 40°H
FLIR K65
51°V x 38°H
MSA ITIC
35°V x 25°H
Green = 25°
Yellow = 31°
Blue = 40°
Red = 57°

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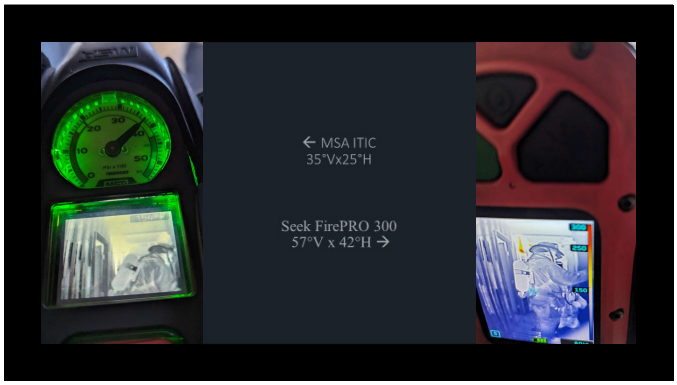
← MSA ITIC
35°Vx25°H
Seek FirePRO 300
57°V x 42°H →

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Hertz (Hz)
Most people see 20-60 Hz
The higher the rate, the less "flicker" or "lag"
60 Hz is roughly 60 frames per second (debated)
Most movies are 24 frames per second (FPS)
If a TIC is 9 Hz, we will likely see flicker and lag
MSA
Flir K2 = 9Hz
MSA ITIC = 9Hz
MSA 5200 = 30Hz

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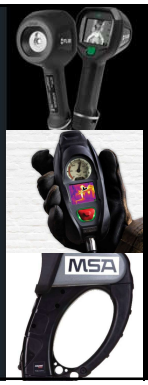
Hertz (Hz) isn't EVERYTHING

- What is the Processor Speed?????



Test them side-by-side

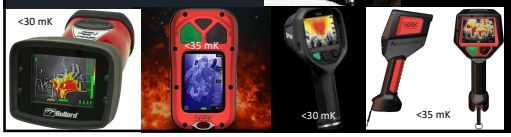
22

Pixels, Resolution, & mK

WHY DO WE CARE?

Flir K2
160x120=19,200

MSA ITIC
220x176=38,720



Bullard NXT
Seek FirePro300
Flir K65
Seek Attack PRO+
320x240=76,800

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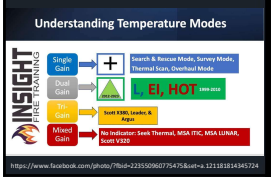
Thermal Palette & Modes

- Palette – How Temp is assigned to pixel color
- Gain – Modes of sensitivity



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NFPA 1408 Image Information & Misinformation

1. Distance and recognition dependent on environment
2. Image Clarity (rain, snow, heat, etc)
3. Image Compromised by Depth Perception
4. Reflectivity – (mirrors, puddles, shiny surfaces)
5. Ability to "see" through windows is dependent on the IR sensor, glass type, and thermal conditions
6. False readings
7. Emissivity and contrasts between objects
8. Water (reflective image)

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- Uniform temps
  - "Everything is grey"
- Distortions
  - Foggy or Dirty Lens
- Reflections
  - Mirrors, water, shiny surfaces

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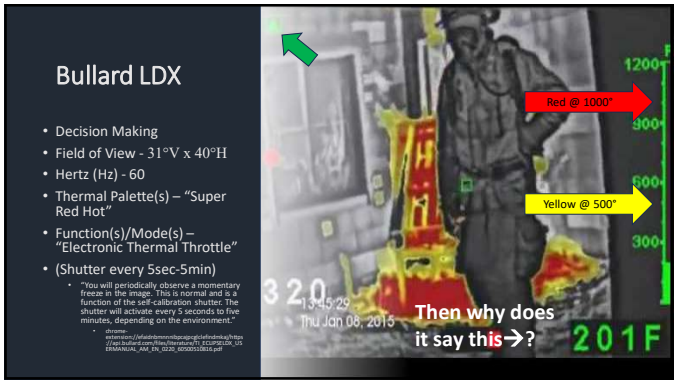
35’ Sensitivity Test
300
250
150
74°F
1025
850
575
300
72°

28


35’ Sensitivity Test
75F

29


Bullard LDX
• Decision Making
• Field of View - 31°V x 40°H
• Hertz (Hz) - 60
• Thermal Palette(s) – “Super Red Hot”
• Function(s)/Mode(s) – “Electronic Thermal Throttle”
• (Shutter every 5sec-5min)
“You will periodically observe a momentary freeze in the image. This is normal and is a function of the self-calibration shutter. The shutter will activate every 5 seconds to five minutes, depending on the environment.”
Red @ 1000°
Yellow @ 500°
1200
900
600
300
320
13:45:29
Thu Jan 08, 2015
Then why does it say this→?
201F

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Bullard LDX
• Bullard LDX Ultra High-Definition Thermal Imager New UHD TIC – Live Fire
https://www.youtube.com/watch?v=Y1nhm7IrUZ0
• Bullard Thermal Throttle
https://www.youtube.com/watch?v=5jCeXCs0Ifg
• Electronic Thermal Throttle
https://www.youtube.com/watch?v=juX1s-_52Cc
• Bullard Eclipse Thermal Imager DVR Operations
https://www.youtube.com/watch?v=7IPC3fD7Vs
• Bullard LDX Digital Video Recording (DVR) Video Downloading
https://www.youtube.com/watch?v=mncSs0d6DY4

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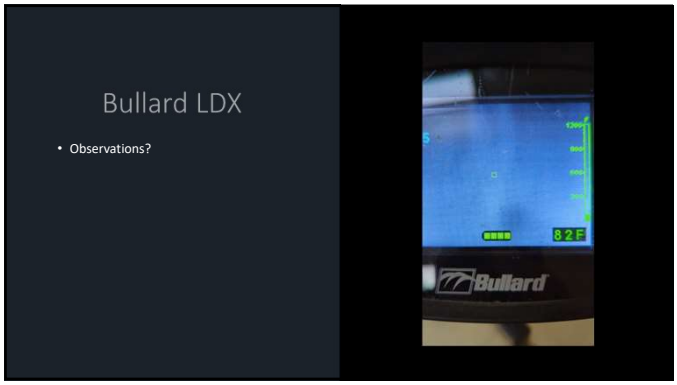
Bullard LDX
• Observations?
82 F
Bullard

32


Bullard NXT
• Decision Making
• Field of View - 31°V x 40°H
• Hertz (Hz) - 60
• Thermal Palette(s) – "Super Red Hot"
• Function(s)/Mode(s) – "Electronic Thermal Throttle"
• (Shutter every 5sec-5min)
• "You will periodically observe a momentary freeze in the image. This is normal and is a function of the self-calibration shutter. The shutter will activate every 5 seconds to five minutes, depending on the environment."
• chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://api.bullard.com/files/literature/TI_ECLIPSELDX_USERMANUAL_AM_EN_0220_60500510816.pdf
833 F
Bullard

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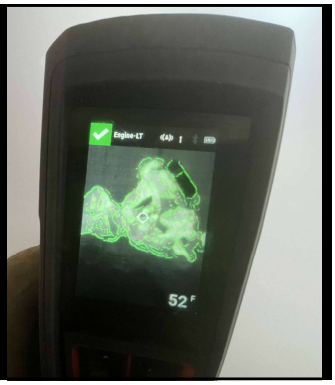
MSA LUNAR

- Awareness Imager
- Field of View - ??? Not Published
- Hertz (Hz) – 16Hz
- Thermal Palate(s) – 10 Selectable
- Functions & Modes



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MSA LUNAR

- Observations?

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Flir K1

- Awareness
- Field of View - 57°V x 44°H
- Resolution – 160x120 w/MSX
- Hertz (Hz) – 8.7
- Thermal Palette(s) –
  - TI Basic, WH, Iron
- Sensitivity
  - <100 mK
- Photo Capability

https://www.flir.com/products/k1/?vertical=public+safety&segment=solutions

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Flir K2

- Awareness
- Field of View - 47°V x 35°H
- Resolution – 160x120 w/MSX
- Hertz (Hz) – 9
- Thermal Palette(s) –
  - TI Basic
- Sensitivity
  - <100 mK
- Photo Capability

https://www.flir.com/products/k2/?vertical=public+safety&segment=solutions

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MSA 5200

- Decision Making
- Field of View - 41°V x 55°H
- Resolution – 160x120
- Hertz (Hz) – 30
- Thermal Palette(s) –
  - WH
- Sensitivity
  - High – <65 mK
  - Low – <240 mK
  - Switches @32% image in high sense mode

chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://media.msanet.com/NA/USA/TIC/EvolutionTIC/Evolution5200TIC/3400-53-5200TIC-Specs.pdf

38

MSA 5800

- Decision Making
- Field of View - 27°V x 36°H
- Resolution - 320x240
- Hertz (Hz) – 60???
- Thermal Palette(s) –
  - WH, BH, F&I, Fusion, Rainbow
- Sensitivity
  - High – <65 mK
  - Low – <240 mK
  - Switches @32% image in high sense mode

chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://s7d9.scene7.com/is/content/minesafetyappliances/EVOLUTION%205800%20Bulletin%20-%20EN

39

MSA 6000 (+)

- Decision Making
- Field of View - 27°V x 36°H
- Resolution - 320x240
- Hertz (Hz) – 60???
- Thermal Palette(s) –
  - WH, BH, Rain, Iron Bow, S&R, F&I (up to 8)
- Sensitivity
  - High – <40-<78 mK
  - Low – <234 mK
  - Switches @32% image in high sense mode
  - Low Sensitive color ~1000°F

40

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What Can a TIC Do For Us?

1. Search
2. Fire Attack
3. Investigations
4. Overhaul
5. Motor Vehicle Accidents
6. Size-up
7. Haz-Mat
8. Electrical Emergencies
9. USAR Operations
10. Rapid Intervention Crew (RIC) Ops
11. Accountability
12. Rehab
13. Participant Safety
14. Ventilation
15. Apparatus Placement
16. Stream Placement
17. Exposure Protection
18. Water Rescues
19. Assisting other agencies (LE)
20. Wildland
21. Building Construction
22. Training
23. Other by AHJ

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Our Focus
• Size-Up
• Fire Attack
• Search & Rescue
• RIC

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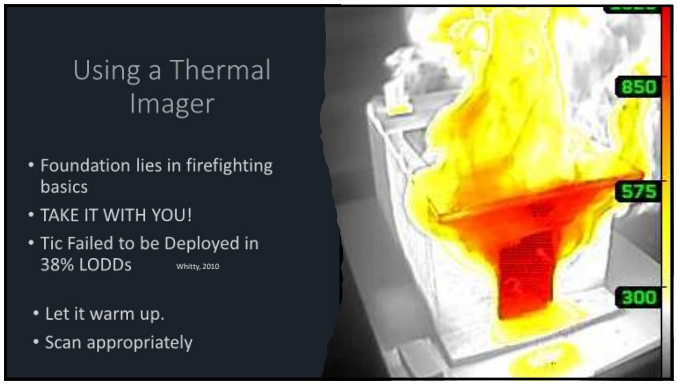

Using a Thermal Imager
• Foundation lies in firefighting basics
• TAKE IT WITH YOU!
• Tic Failed to be Deployed in 38% LODDs Whitty, 2010
• Let it warm up.
• Scan appropriately
850
575
300

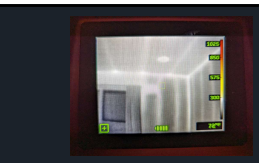
44

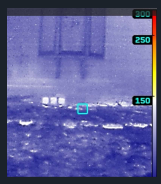

Size-Up
• Low to High
• Use Appropriate Speed
• For the imager
• For your eyes
• For your recognition
• Complete the Scans
• Don't stop at first color
• Choose the angle
• Imagers see in straight lines
• Change your "line of sight"
1025
850
575
300
300
250
150
53°F

45

Size-Up

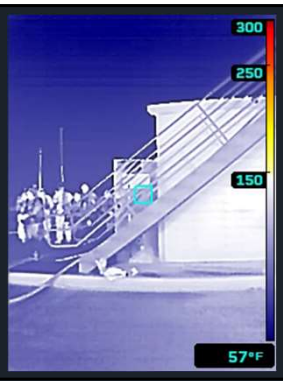
- Conduction
  - "Thermal Bridging" = effects
  - Glass
    - Low "E" vs Single Pane
    - Uncoated glass ≈ .84
    - Low E ≈ < .14
- Convection
- Radiation
- Which "Mode" Should I Use?????





46

360° Size-Up



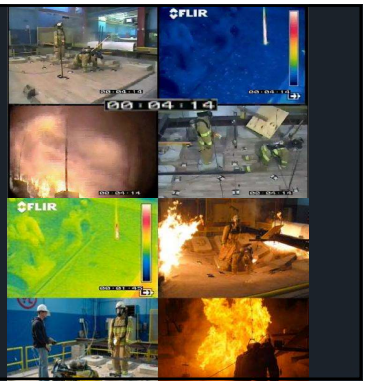
47

360° Size-Up

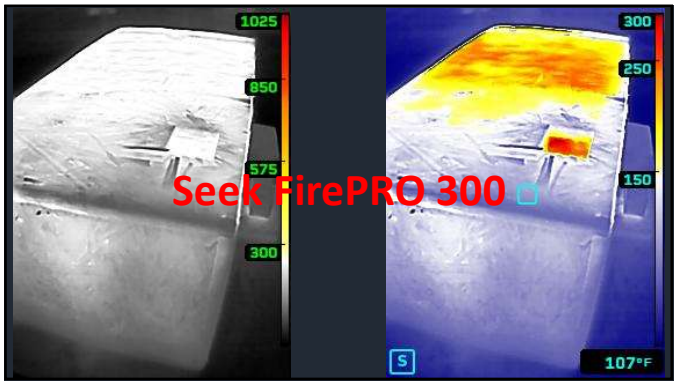
48

Size-Up

- UL Structural Stability of Engineered Lumber in Fire Conditions
- September 30, 2008
- https://fsri.org/research/structural-stability-engineered-lumber-fire-conditions
- chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://fsri.org/sites/default/files/2021-07/NC9140-20090512-Report-Independent.pdf

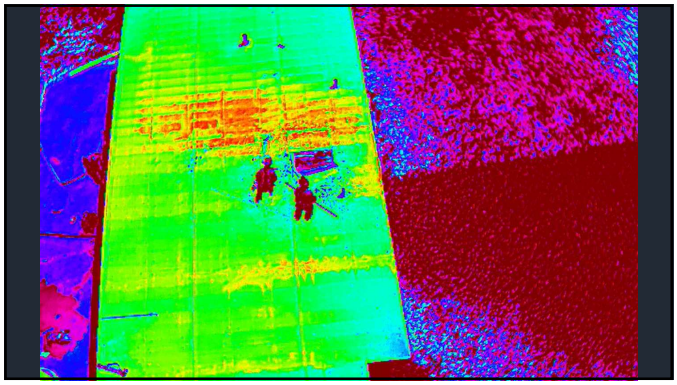


49



50

51



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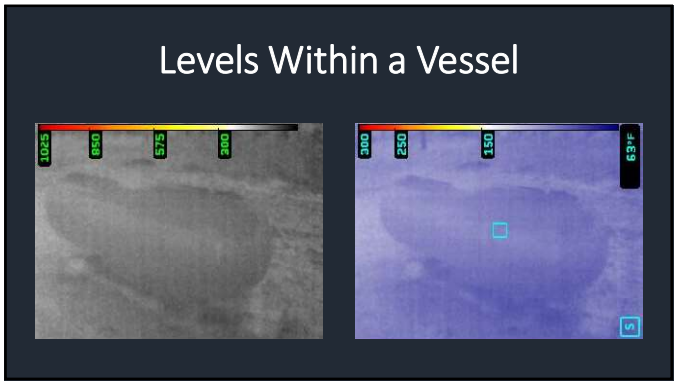
Levels Within a Vessel



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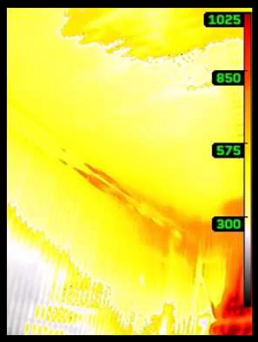
Spray and Pray?

OR

55

Erase It?



56

Erase It?

57

Should we "feel" the heat?

- Sensing Heat
- 20kW/m2 Heat Release Rate

	Thickness	Time to Hole
• NFPA 1981 – 2007 Edition SCBA mask	= 2.2mm	=1:50
• NFPA 1981 – 2007 Edition SCBA mask with new geometry	= 2.6mm	=1:54
• NFPA 1981 – 2013 Edition SCBA Mask	= 4.1mm	=6:59

  - @ 446°F Polycarbonate melts
  - (NOTE: Thermal insult was seen at lower HRR. See the study for more information.)

Madrzykowski, D. & Kesler, R. 2023

OR

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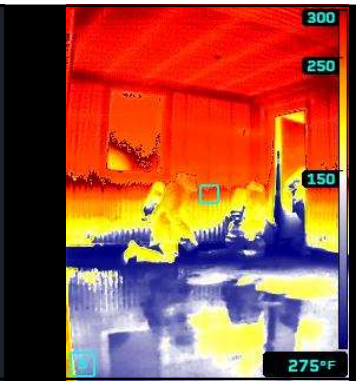
Should we SEE it?

WHY?



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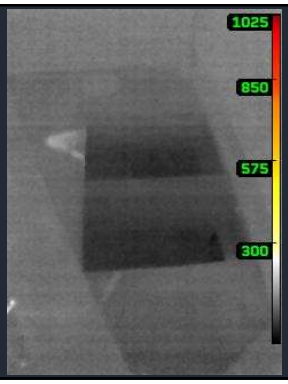
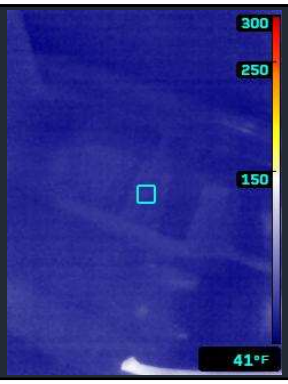
Can a TIC see a hole in floor?



60

Can a TIC see a hole in floor?



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Search & Rescue

- What is arguably the single most important factor in search and rescue?

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Search & Rescue

Should THEY "feel" the heat?

- "There is clear evidence that the perception of pain in adult human skin occurs just above 43 °C. When the basal layer of the epidermis reaches 44 °C, burn injury occurs." – Science Direct
  - 43°C = 109.4°F = Skin feels pain from a burn
  - 44°C = 111.2°F = Burn Injury
- 60°C =140°F for 5 seconds = Third Degree burn involving nerves

NIST Data - https://www.nist.gov/el/fire-research-division-73300/firegov-fire-service/fire-dynamics

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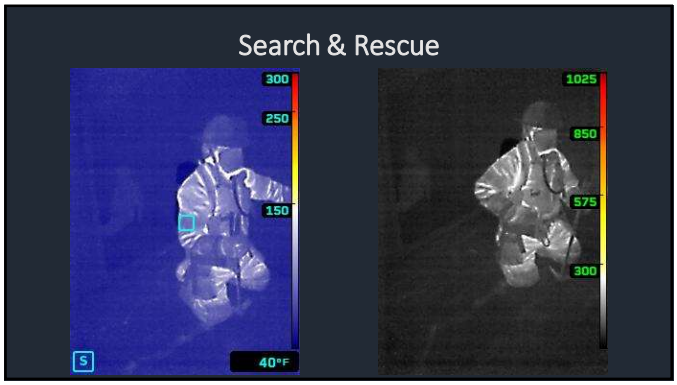
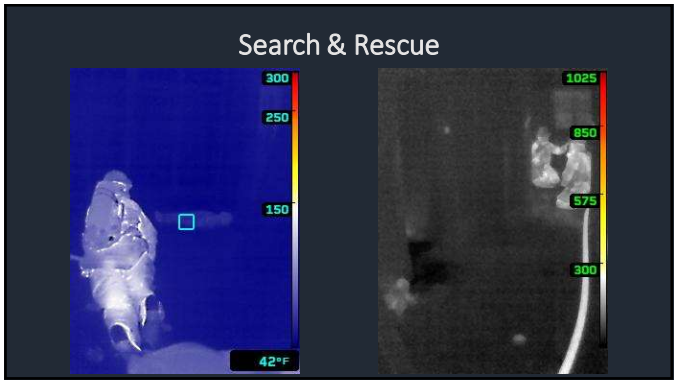
Search & Rescue Training
300
250
150
47°F
Are you training in limited to no-vis?
Are you able to see to assess them?
300
250
150
35°F

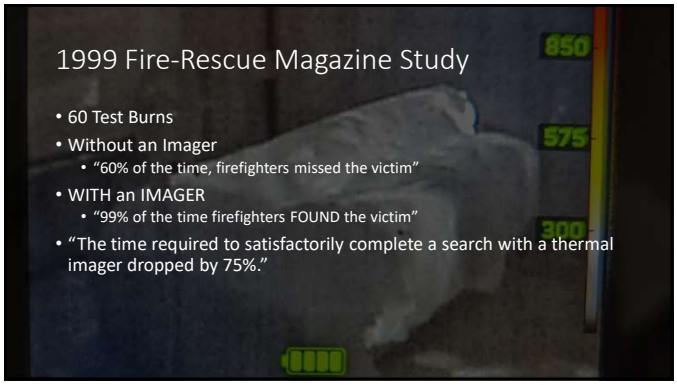
64


Search & Rescue
300
250
150
S
40°F
1025
850
575
300

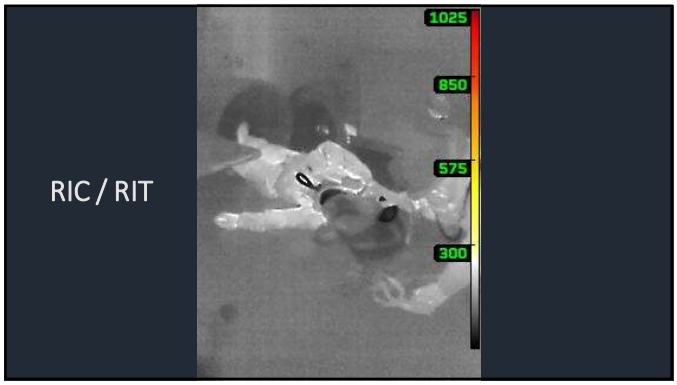
65


Search & Rescue
300
250
150
42°F
1025
850
575
300

66


1999 Fire-Rescue Magazine Study
• 60 Test Burns
• Without an Imager
• "60% of the time, firefighters missed the victim"
• WITH an IMAGER
• "99% of the time firefighters FOUND the victim"
• "The time required to satisfactorily complete a search with a thermal imager dropped by 75%."
850
575
300

67

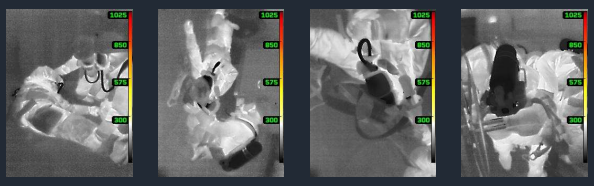

RIC / RIT
1025
850
575
300

68


RIC/RIT
• Situational Awareness
• Search
• Assessment
• Packaging
• Escape/Egress
1025
850
575
300

69

What can we identify?



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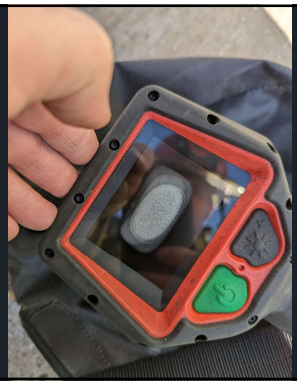
What Do You Do When Your Tic "Fails?"

- Go "Back to Basics"
- Proceed to location of last orientation
- Consider notifying command of TIC failure



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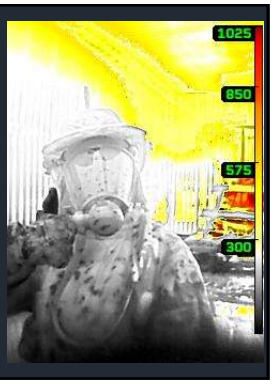
Care and Maintenance

- Follow manufacturers recommendations
- Keep it
  - Clean
  - Charged
  - Secure
- Clean with Mild Soap and water
- Ensure screws are snug
- Verify the battery run-time



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Demonstrations / Drills

- Station "Tour"
- Depth Perception
- Size-Up
- TIC in cold smoke (theater)
- Search and Rescue
- TIC Failure
- TIC with Fire Box
- TIC with 1403-Burn

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Time to

TRAIN
DEVELOP
&
COACH

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QUESTIONS?

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Thank you!

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