INFRARED THERMOGRAPHY

ELECTRICAL INSPECTIONS

Recent technical manuals published by **National Fire Protection Association** (NFPA) and the **Inter-National Electrical Testing Association** (NETA) prominently recommend the use of infrared inspection in the testing and maintenance of electrical systems

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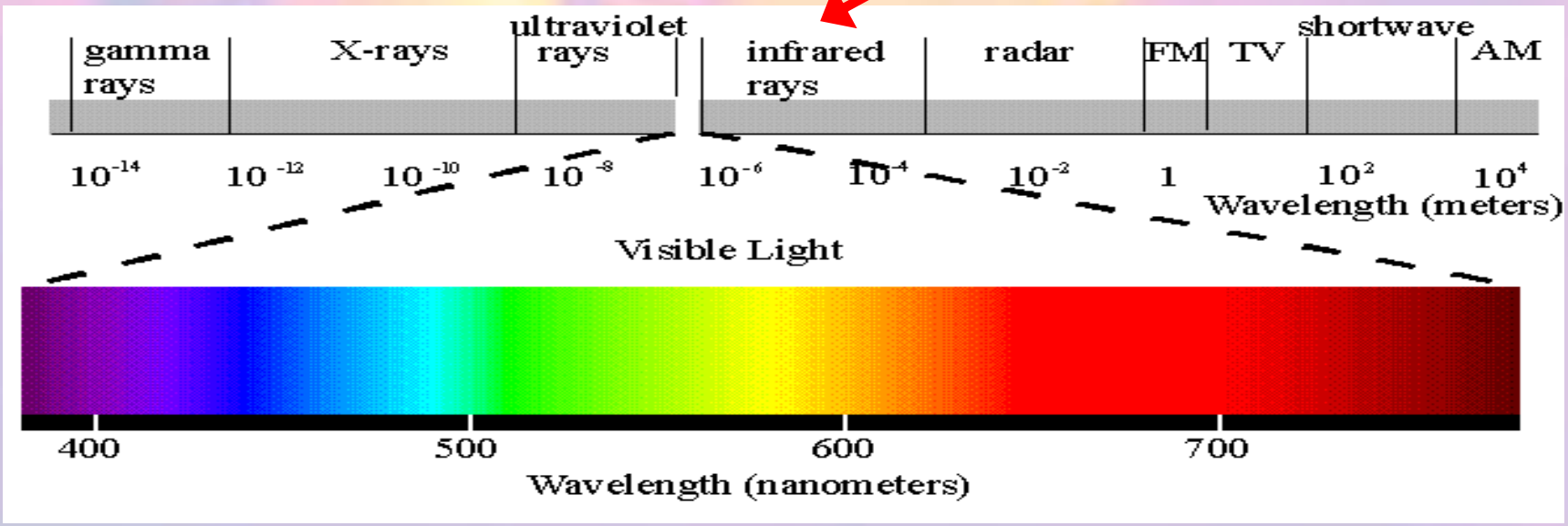
Thermographer Level II

Infrared Radiation

Infrared waves are emitted by low energy electrons jumping in atoms. These waves are given off all objects. Their wavelengths range from one millimeter to 10^{-7} m. Their frequencies range from 10^{11} to 4×10^{14} Hz.

Infrared waves are not visible by the eye

. Wavelength is longer than visible light.



Infrared Thermography

- An Infrared Camera Senses Infrared Radiation
- A Processor In The Camera Assigns Color To The Infrared Radiation-Different Color Equals Different Temperature
- Enabling Us To Visualize The Thermal World

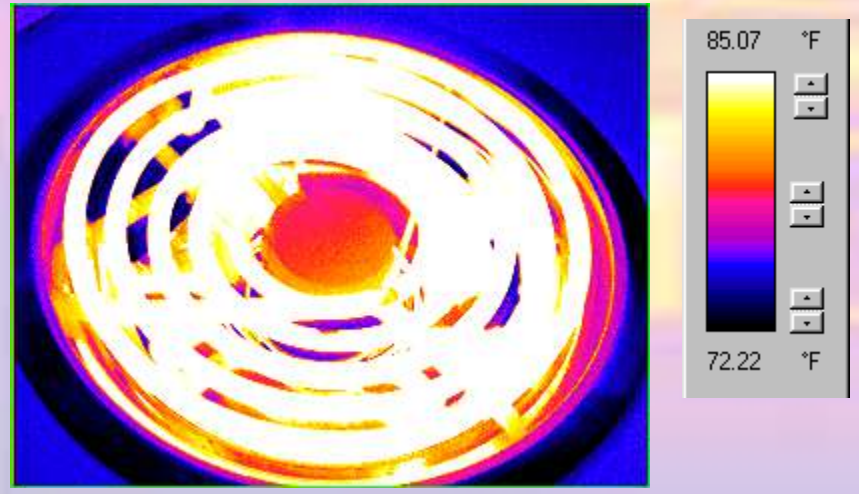
Infrared Image

Color Palette Range Is Chosen For Clarity

Palette 2 Is Better Suited For This Image

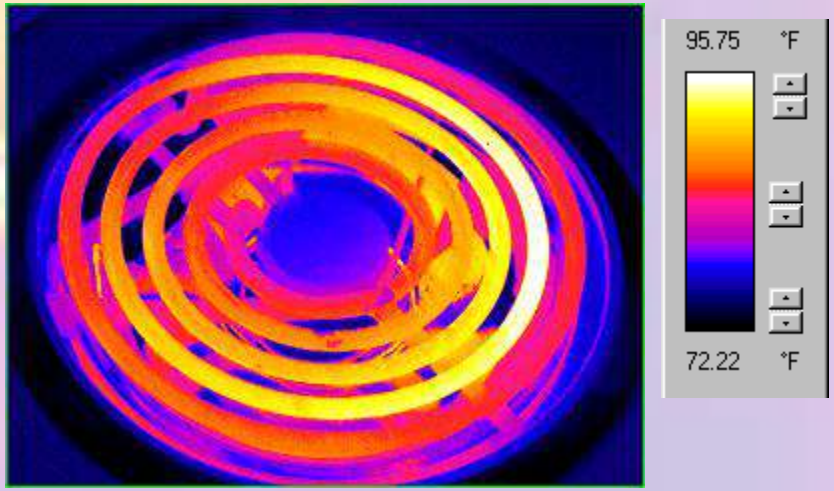
Color Palette 1
White = T>85F
Black = T<72F

1



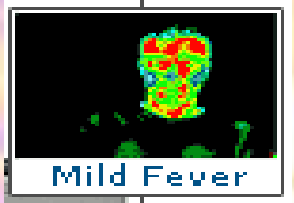
Color Palette 2
White = T>95F
Black = T<72F

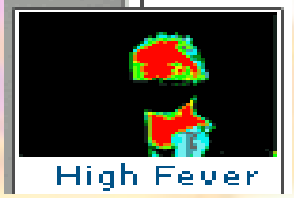
2

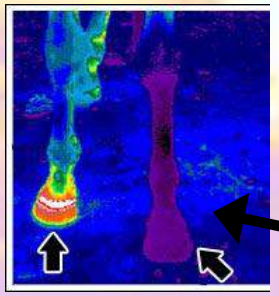


Some Uses Of Infrared Thermography

- Electrical Inspections
  - Hot Connections
  - Failing Components
  - Overloaded Circuits
- Mechanical Inspections
  - Motors, Bearings, Drives, Steam Systems, Boilers
- Fire
  - Hot Spots
  - People Rescue
- Building
  - Thermal Envelope
  - Roof Leaks
- Military







- Medical
  - Severe Acute Respiratory Syndrome (SARS)
- Manufacturing Processes
  - Plastics
  - Carpet
  - Heat/Chilling Processes
- Mill Operations
  - Slag Detection
- Police Work
  - Fugitive Search
  - Drug Enforcement
  - Missing Persons Search
- Animal
  - Equine Hot Joints Ligaments

Benefits of Periodic Electrical Infrared Inspections

- Predictive Maintenance...Allows Scheduling Of Repairs, Forward Buying

- Reduces Downtime… Find It, Repair It, Before It Blows Up and Stops Production

Qualitative
Infrared Electrical Inspection

Qualitative Inspection: The practice of gathering information about an electrical system by observing infrared radiation, recording findings, analyzing findings, and presenting that information.

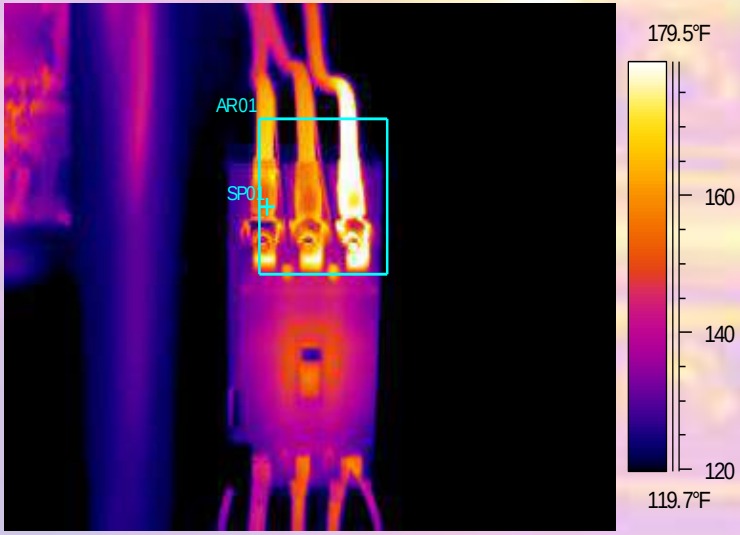
Exceptions: are abnormally warm components that may be a potential problem. Exceptions are usually identified by comparing the thermal patterns of like components.

Electrical Inspection Items

- Transformer
  - Pad Mount
  - Dry
  - Overhead
- Service Entrance
- Main Switchgear
- Motor Control Centers
- Disconnects
- Bus Duct
- Distribution Panels
- Control Panels
- Rectifiers
- Drives
- Capacitor Banks
- Any Electrical Connection

Exception Analysis

Below is an exception. One of the conductor terminals is hot.
Hot Terminal Temperature…..203F
Left Terminal Temperature….156F
Temperature difference is …… 47F



When should you repair this exception?

Exception
Repair Priority Criteria

Priority 0

Temperature Difference **10F or Less**
No Corrective Measures Required
At This Time.

Priority 1

Temperature Difference **10F to 20F**
Corrective Measures Required
At Next Maintenance Period

Priority 2

Temperature Difference **20F to 30F**
Corrective Measures Required
As Scheduling Permits

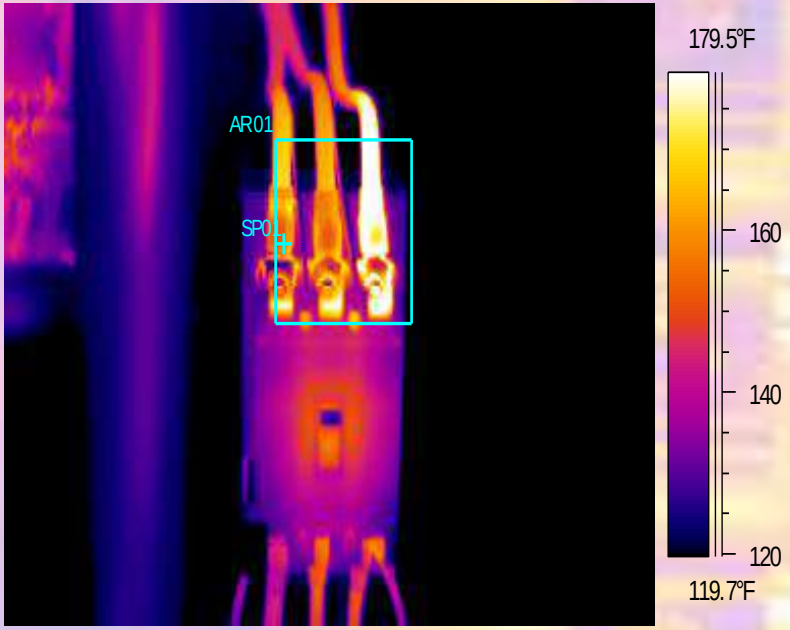
Priority 3

Temperature Difference **30F to 100F**
Corrective Measures Required
As Soon As Possible

Priority 4

Temperature Difference **Over 100F**
Corrective Measures Required Immediately

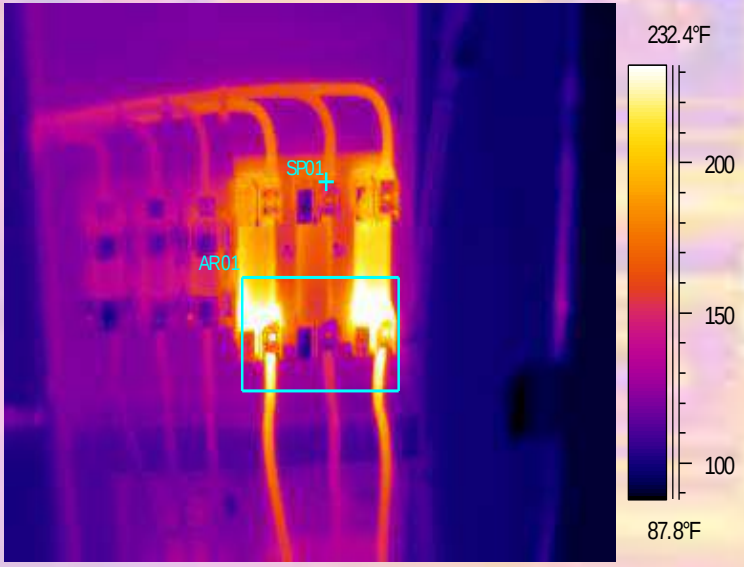
Exception Example #1
Breaker Connections



Hot Spot Temperature……203F
Reference Temperature….156F
Temperature Difference….47F

Repair Priority 3
Corrective Measures Required
As Soon As Possible

Exception Example #2
Fuse Block



Hot Spot Temperature……303F

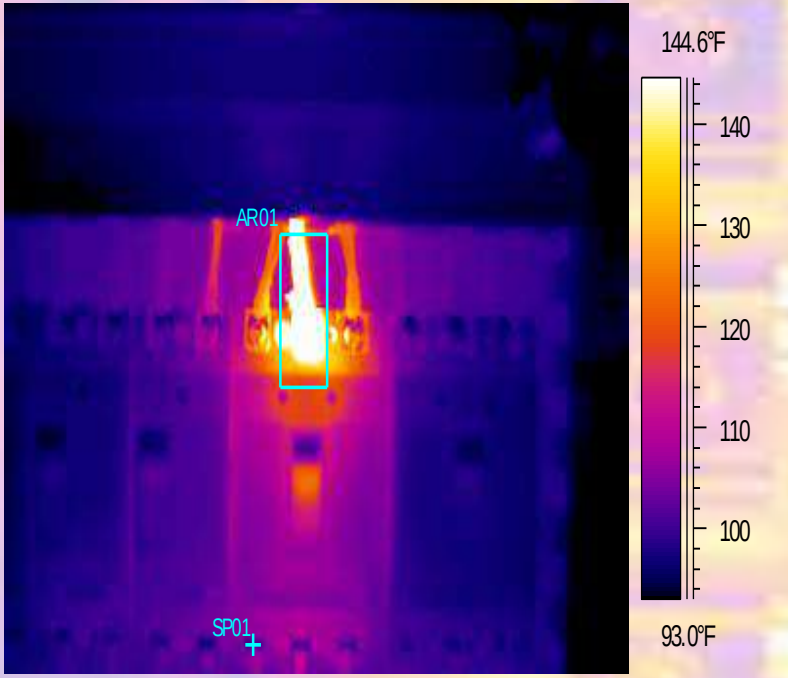
Reference Temperature….170F

Temperature Difference….133F

Repair Priority 4

Corrective Measures Required Immediately

Exception Example #3
Breaker Connections

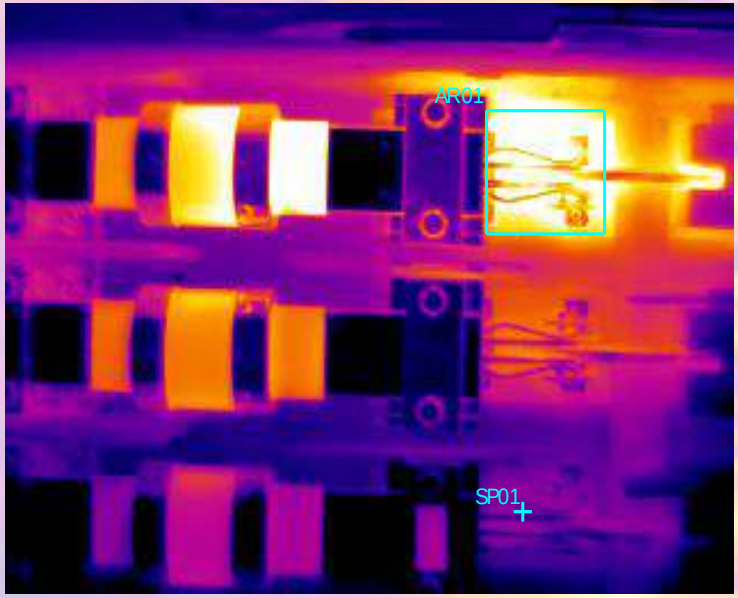


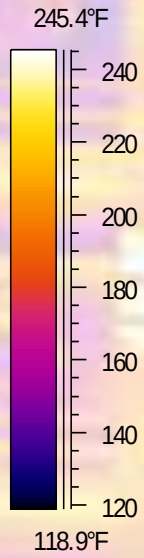
Hot Spot Temperature…...459F
Reference Temperature…..101F
Temperature Difference….358F

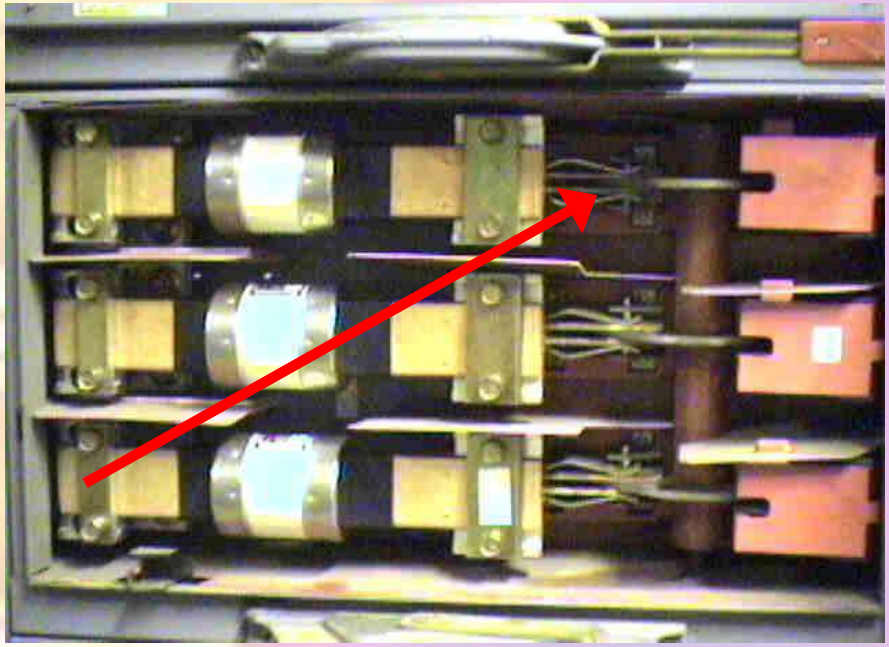
Repair Priority 4
Corrective Measures Required Immediately

Exception Example #4

Main Switchboard Fused Switch



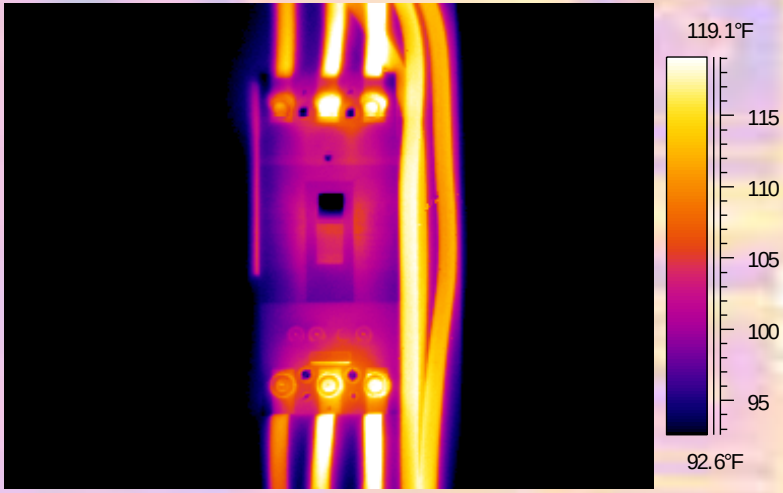




Hot Spot Temperature...311F
Reference Temperature..151F
Temperature Difference...160F

Repair Priority 4
Corrective Measures Required Immediately

Exception Example #5
Breaker Load

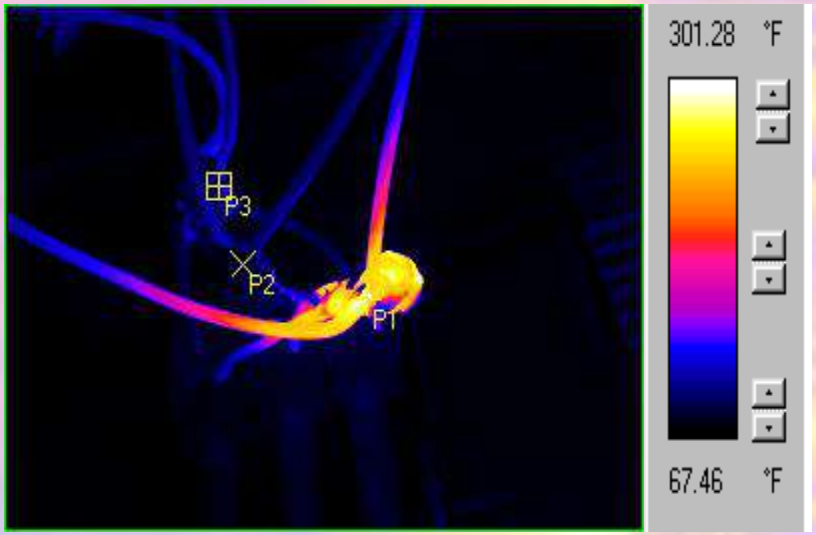


Hot Spot Temperature….71F
Reference Temperature…55F
Temperature Difference..16F

Breaker Load A-105 amps
B-150 amps
C-167 amps

Repair Priority 0
No Corrective Measures Required
At This Time

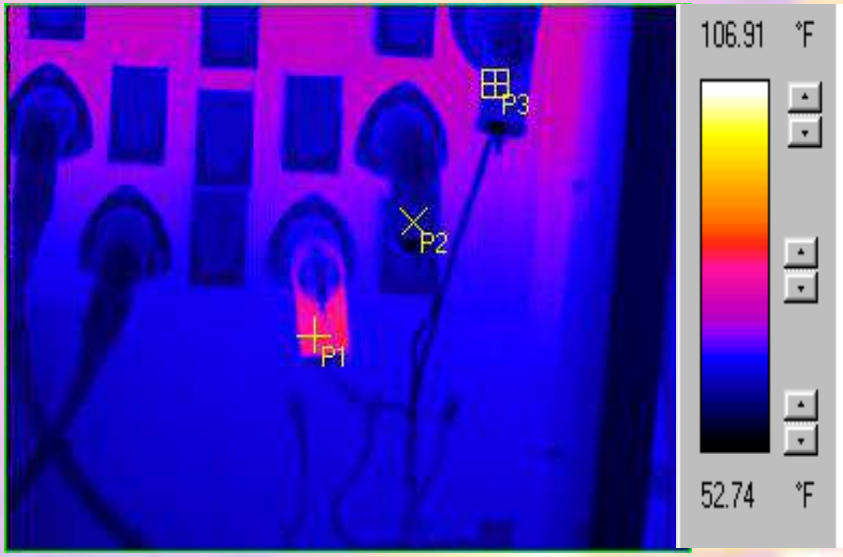
Exception Example #6
Building Service Drop

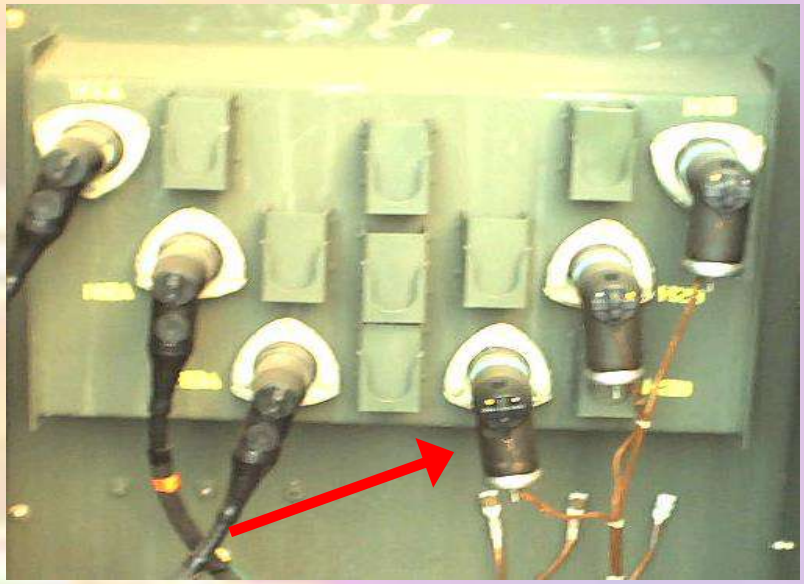


Hot Spot Temperature...301F
Reference Temperature…77F
Temperature Difference..224F
Ambient Temp……45 F

Repair Priority 4
Corrective Measures Required Immediately

Exception Example #7
Arrestor Pad Mount Transformer

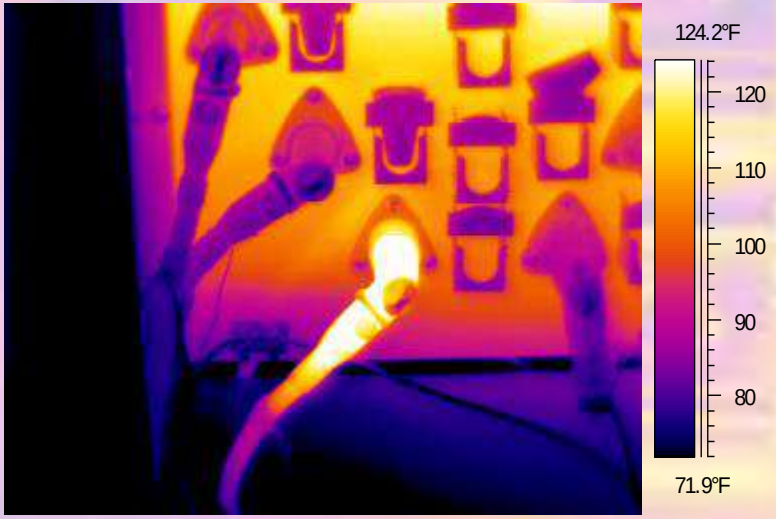




Hot Spot Temperature….92F
Reference Temperature...58F
Temperature Difference..32F
Ambient Temperature….45F

Repair Priority 3
Corrective Measures Required
As Soon As Possible

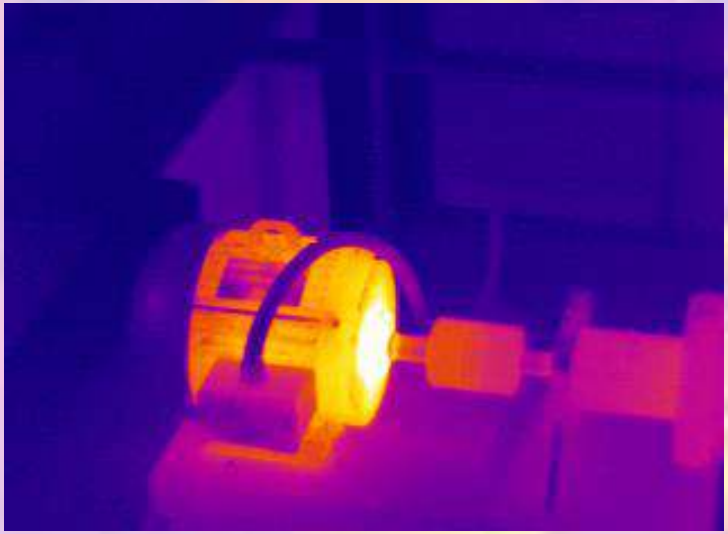
Exception Example #9
Pad Mount Transformer High Side

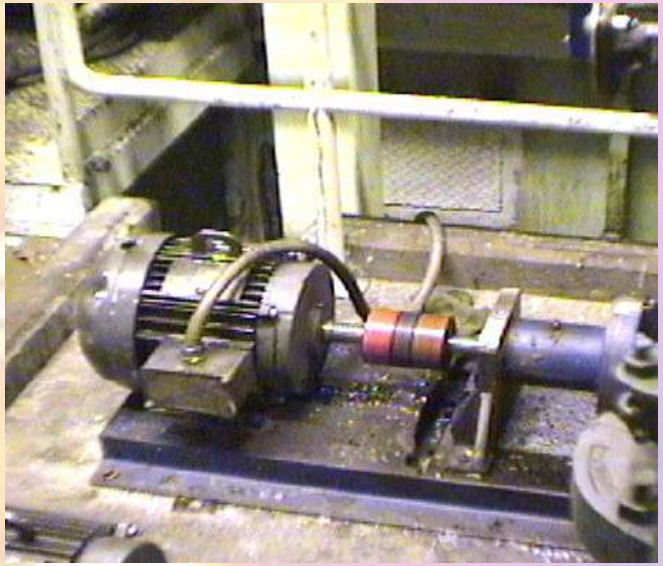


Hot Spot Temperature….159F
Reference Temperature…98F
Temperature Difference..61F
Ambient Temperature….71F

Repair Priority 3
Corrective Measures Required
As Soon As Possible

Exception Example #10
Motor Drive End Bearing Hot

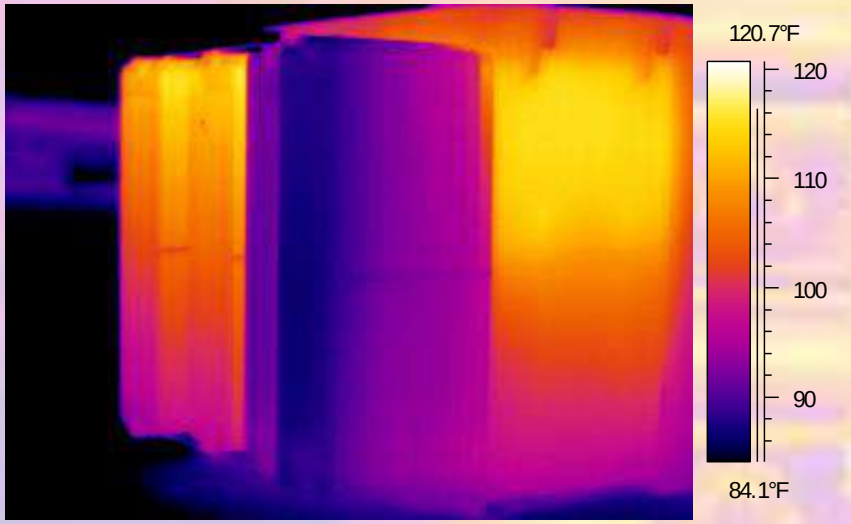




Hot Spot Temperature….127F
Reference Temperature…99F
Temperature Difference..28F
Ambient Temperature….74F

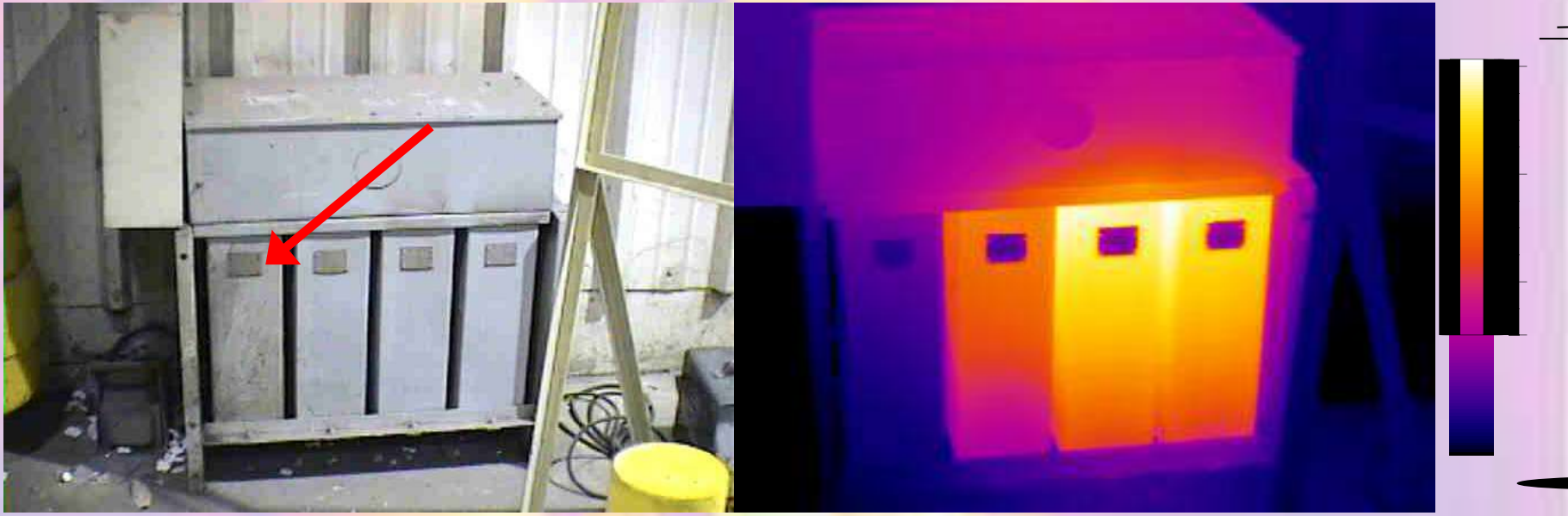
Repair Priority ?
Mechanical System

Thermal Picture
Pad-Mount Cooling Fins



In this case the exception is cold

Thermal Picture
480 Volt Capacitor Bank



Again the exception is cool

Infrared Tips

Use a Certified Thermographer

–Proper Training is vital to understand thermography

–Cost Effective - Quality Camera is $20,000 to $50,000

Scan should cost from $800 to $1500 per day

Inspect When System Load Is High

–Useless To Scan Under Light or No Load

–Keep in mind that an infrared electrical inspection is only a report of the electrical system at the time of the inspection. Equipment that was off or unloaded because of cycling or scheduling may have problems that were not evident at the time of the inspection.

Do Inspections On A Periodic Basis

--Annually Good - Semi-Annually Better (at least first couple of times)

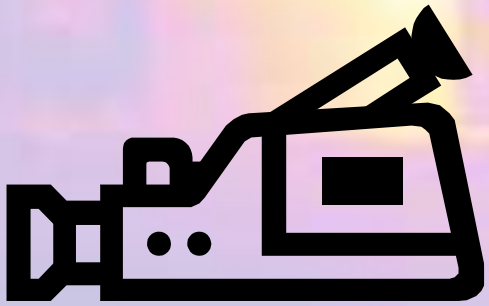
Insures that over period of time all equipment is inspected

Benefit of Electrical Infrared Inspections

- "...From a return on investment perspective, infrared inspection programs have proven that on average for every $1 spent on infrared electrical inspections, there is a $4 return on investment for materials and labor from fixing the problems before it fails..."

  "Cost/Benefits Analysis of Infrared Programs." *Maintenance Technology Magazine* June 2001

$1.00 ***$4.00***



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