



# Evaluating Conditions from Infrared (IR) Inspection in Transmission Line

TD-1001M-JA19

Effective: 04/30/2021, Rev: 1

## PPE:

Standard T-Line PPE, including the following:

- Hard hat
- Safety glasses
- Gloves
- FR clothing

## Tools:

- Video-imaging equipment
- IR Camera

## Guidance Document References:

- [TD-1001M, "Electric Transmission Preventive Maintenance Manual"](#)

## Level of Use:

- ☐ Information
- ☒ Reference
- ☐ Continuous

## Purpose

IR inspection procedures are a key element of the preventive maintenance program.

The recommended maintenance priorities reduce the potential for component failures and facility damage and facilitate a proactive approach to repairing or replacing identified abnormal components.

## Condition Codes

Inspect the structure using the form to record issues.

Determine the condition of each item. Consider all conditions to determine the appropriate Priority Code for any Notification, if required.

- **5** = Heavy Damage with Safety Concerns
- **4** = Heavy Damage
- **3** = Moderate Damage
- **2** = Light Damage
- **1** = No Visible Damage



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## IR Inspections

- Electric transmission system inspections and preventive maintenance programs use IR imaging and temperature-measuring systems to identify faulty components and initiate repairs or replacement proactively.
- Based on industry specifications, connectors should experience lower operating temperatures than their respective conductors. This means that any time the temperature of a connector is greater than the temperature of its respective conductor, a higher-resistance connection exists and a failure can be expected, but not precisely predicted. It is probable that degradation occurs faster with an increase in load or temperature.
- Conductor manufacturers recommend a usual maximum operating temperature of 185°F for tensioned, bare conductor.
- Conductor manufacturers recommend the following maximum operating temperatures for insulated conductors:
  - 167°F for high-molecular-weight polyethylene (HMWPE).
  - 194°F for cross-linked polyethylene (XLPE).
  - 194°F for ethylene-propylene rubber (EPR).
- With insulated conductor systems, the temperature measured at the surface of an insulated conductor or component could be between 20% and 50% of the actual temperature of the targeted conductor or component (e.g., if the actual temperature of the component is 212°F, the measured temperature could be between 68°F and 122°F, respectively).
- IR imaging systems detect and record all the heat being radiated in their fields of view. IR cameras use an image-scanning technique to identify heat radiated from a target and its background. IR imaging systems capture and store the heat images pictorially for immediate or future evaluation. Using IR imaging systems, the operator can pinpoint the precise location of the hottest spot on the target being observed.
- The recommended maintenance is based on the measured operating temperature of both the target and its respective connectors or conductors, the temperature differentials between the target and its respective, adjacent components, or thermal image showing component hot, as well as the operational risk associated with each.



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## Determining Maintenance Priorities

Transmission Facilities	Temperature Differential ( $\Delta T$ )	Priority/Remarks
<b>Overhead &amp; Underground Direct heat (See Notes)</b>	$\geq 100^{\circ}\text{F}$	Priority A <sup>1</sup> : Notify supervisor and repair, replace, or make component safe immediately.
	$25^{\circ}\text{F}$ to $99^{\circ}\text{F}$	Priority B <sup>2</sup> : Repair or replace component within 3 months.
	$\leq 24^{\circ}\text{F}$	Priority B <sup>3</sup> : Repair or replace component within 3 months.
<b>Underground Indirect heat <sup>4,5</sup> (See Notes)</b>	$20^{\circ}\text{F}$ and over	Notify supervisor. Contact Underground Engineering to determine mitigation.

### Notes:

- <sup>1</sup> If excessively high operating temperatures ( $\geq 100^{\circ}\text{F}$ ) are found or an obvious physical damage is observed, take immediate action (Priority A).
- <sup>2</sup> Priority B tags have a high priority. Correct B tags as soon as possible, preferably within 60 days, but not to exceed a period of 3 months.
- <sup>3</sup> All IR findings with a differential delta of less than  $24^{\circ}\text{F}$  may be prioritized as a "B" tag at the discretion of the inspector/CIRT reviewer, when additional evidence supports the rating (e.g., limited load, additional wind speed, photos of addition mechanical damage).
- <sup>4</sup> Underground – Upon completion of repair or replacement, perform another IR inspection to verify that the abnormal condition was corrected and component is operating under normal condition.
- <sup>5</sup> Temperature taken at underground cable terminals is illustrated in Figure 1 below: Location 1 is an indirect reading; Location 2 is a direct reading.

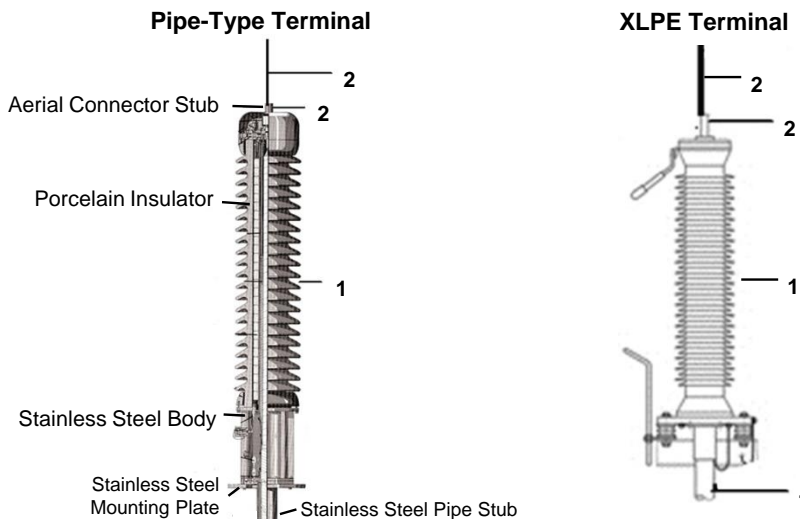


Figure 1. Pipe-Type and XLPE Terminals



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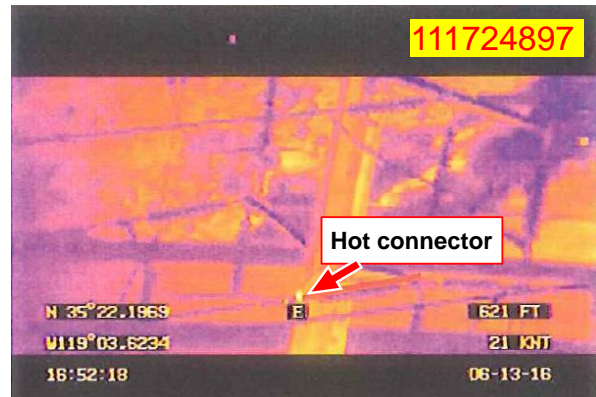
## Condition Levels and Impact

Condition 5

**Excessively high operating temperatures (Temperature Differential  $\geq 100^{\circ}\text{F}$ ), or obvious physical damage observed.**

**Action:**

1. Priority Code A.
2. Take pictures of damage.



Problem Area Temperature	187°F
Ambient Area Temperature	74°F
Total Temperature Rise	113°F



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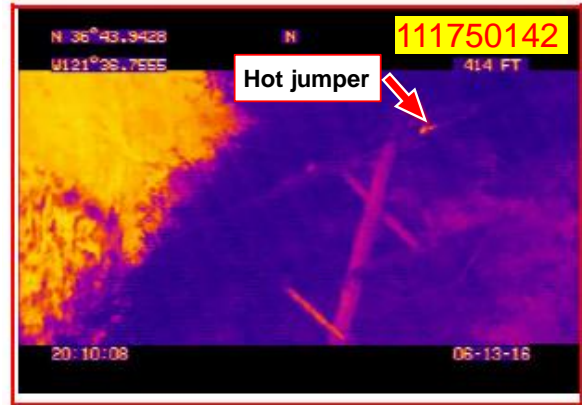
## Condition Levels and Impact

Condition 4

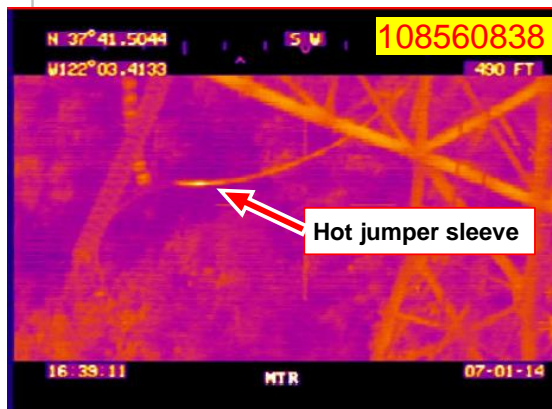
**High operating temperatures  
(Temperature Differential = 25–99°F).**

**Action:**

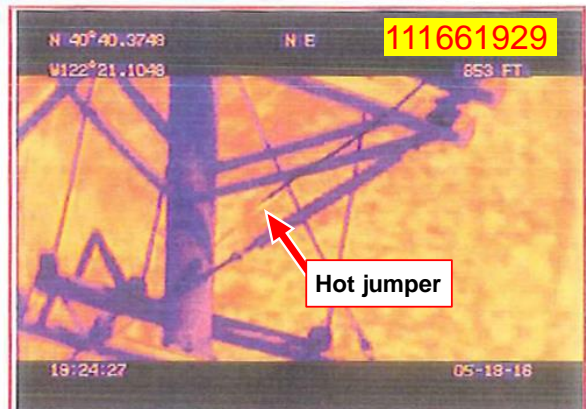
1. Priority Code B
2. Take pictures of damage



Problem Area Temperature	86°F
Ambient Area Temperature	56°F
Total Temperature Rise	30°F



Problem Area Temperature	132°F
Ambient Area Temperature	64°F
Total Temperature Rise	68°F



Problem Area Temperature	136°F
Ambient Area Temperature	85°F
Total Temperature Rise	51°F



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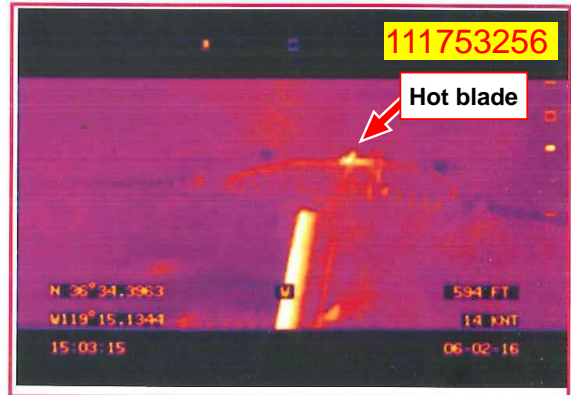
## Condition Levels and Impact

Condition 4

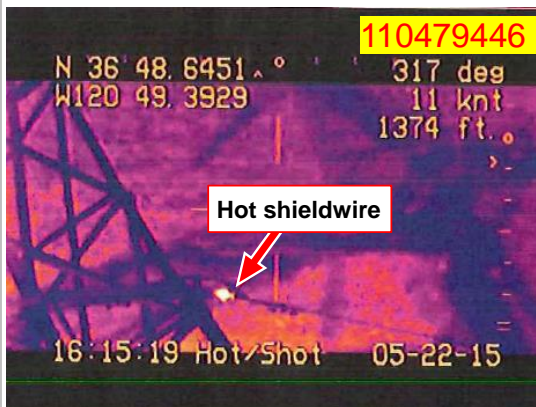
**High operating temperatures  
(Temperature Differential = 25–99°F).**

**Action:**

1. Priority Code B
2. Take pictures of damage



Problem Area Temperature	148°F
Ambient Area Temperature	74°F
Total Temperature Rise	74°F



Problem Area Temperature	98°F
Ambient Area Temperature	58°F
Total Temperature Rise	40°F



Problem Area Temperature	123°F
Ambient Area Temperature	56°F
Total Temperature Rise	67°F



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Condition 4

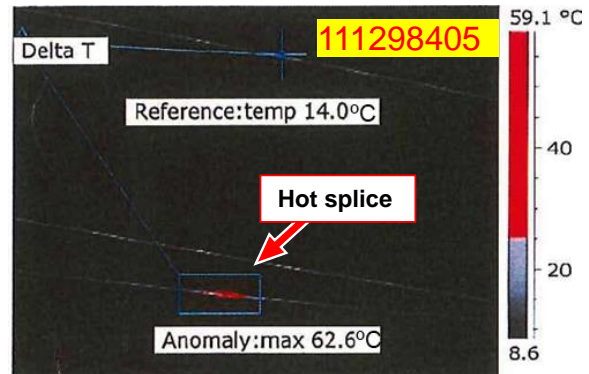
**High operating temperatures  
(Temperature Differential = 25–99°F).**

**Action:**

1. Priority Code B
2. Take pictures of damage



Problem Area Temperature	139°F
Ambient Area Temperature	52°F
Total Temperature Rise	87°F



Problem Area Temperature	145°F
Ambient Area Temperature	57°F
Total Temperature Rise	88°F





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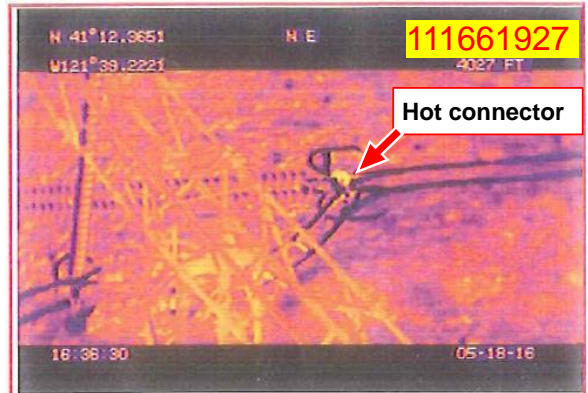
## Condition Levels and Impact

Condition 4

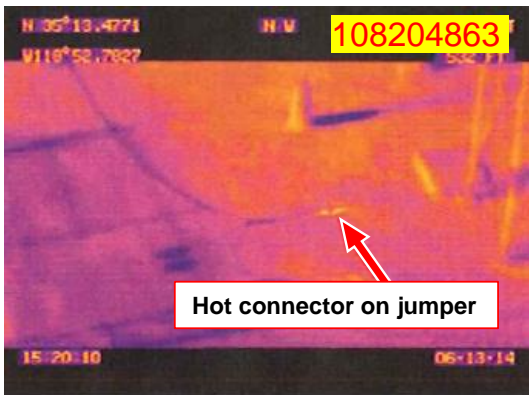
All IR findings with a differential delta of less than 24°F may be prioritized as a “B” tag at the discretion of the inspector/CIRT reviewer, when additional evidence supports the rating (e.g., limited load, additional wind speed, photos of addition mechanical damage).

### Action:

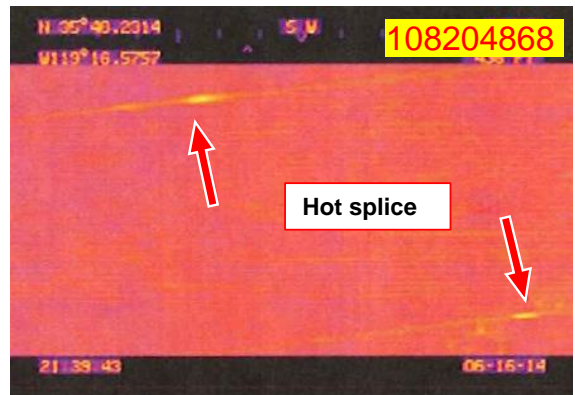
1. Priority Code B
2. Take pictures of damage



Problem Area Temperature	85°F
Ambient Area Temperature	63°F
Total Temperature Rise	22°F



Problem Area Temperature	87°F
Ambient Area Temperature	66°F
Total Temperature Rise	21°F



Problem Area Temperature	105°F
Ambient Area Temperature	84°F
Total Temperature Rise	19°F