

## Infrared (IR) Inspections of Electric Distribution Facilities

### SUMMARY

This utility procedure establishes requirements for performing infrared (IR) inspections (i.e., thermography) on overhead (OH) and underground (UG) electric distribution facilities, excluding substations. This procedure also explains the permitted use of non-utility-graded IR cameras by restoration employees and other employees who are infrequent users. Finally, this procedure defines roles and responsibilities for employees who perform IR inspections, as well as the roles and responsibilities for implementing this procedure.

Level of Use: Informational Use

### TARGET AUDIENCE

The target audience includes the following PG&E employees:

- Electric distribution planning and operations
- Compliance
- Asset strategy reliability
- Electric distribution asset strategy and development
- Electric maintenance and construction (M&C)
- Power quality
- Restoration and control
- Service planning and design
- Project delivery

### SAFETY

Wear personal protective equipment (PPE) at all times when performing IR inspections. This includes, but is not limited to, flame-resistant (FR) clothing, hard hats, safety glasses, and suitable footwear.

### BEFORE YOU START

WEAR appropriate PPE.

USE the appropriate IR camera.

## Infrared (IR) Inspections of Electric Distribution Facilities

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### PROCEDURE STEPS

#### 1 General Information

- 1.1 Compliance inspectors and outside contractors perform IR inspections on electric distribution facilities; however, restoration employees, contractors, and other infrequent users can be responsible for performing some of the actions described in this procedure, depending on the job.
- 1.2 Background
  1. USE IR imaging and temperature-measuring systems as diagnostic tools in both electric transmission and distribution (T&D) system inspections and in preventive maintenance programs. IR imaging can accurately identify and initiate the repair or replacement of faulty devices, equipment, and components.
  2. Based on industry specifications, connectors require lower operating temperatures than their respective conductors. When the connector's temperature is greater than the temperature of its respective conductor, a higher-resistance connection exists and a failure is likely, but not precisely predicted. Connector degradation occurs faster with an increase in load or temperature.
  3. Conductor manufacturers recommend that the usual maximum operating temperature for tensioned, bare conductor be limited to 75° Centigrade (C) (i.e., 167° Fahrenheit [F]).
  4. Conductor manufacturers recommend that the usual maximum operating temperature for insulated conductor be limited to the following temperatures:
    - 75°C (167°F) for high molecular weight polyethylene (HMWPE) material
    - 90°C (194°F) for cross-linked polyethylene (XLPE) material
    - 105°C (221°F) for ethylene propylene rubber (EPR) material

## Infrared (IR) Inspections of Electric Distribution Facilities

### 1.3 Equipment

1. USE IR imaging systems to detect and record all heat radiating in an imaging system's field of view.
  - a. The IR camera uses an image-scanning technique to specifically identify heat radiating from a target and the target's background. These units capture and store heat images pictorially for immediate or future evaluation.
  - b. Using these units, the operator can PINPOINT the hottest spot on the observed target.
2. USE only a utility-grade IR camera when performing IR inspections.
3. USE either utility-grade or non-utility-grade IR cameras as an aid for troubleshooting facilities or equipment known to have power-quality issues.
4. USE non-utility-grade IR cameras to identify hot spot connections or equipment when troubleshooting or performing work verification.

#### NOTE

DO NOT USE non-utility-grade IR cameras to perform regulatory-mandated IR inspections (managed by the compliance department) or IR inspections performed under the PG&E IR program (managed by the asset strategy department).

## 2 Requirements and Recommendations

### 2.1 Implementation

1. This IR procedure was developed as a key element of a preventive maintenance program. The recommended maintenance priorities provided in [Table 1](#), "Corrective Maintenance Priorities for Overhead Distribution Facilities," on Page 6, and [Table 2](#), "Corrective Maintenance Priorities for Underground Distribution Facilities," on Page 8, reduce the risk of component failures, prevent further facility damage, and facilitate a proactive approach to repairing or replacing components identified as abnormal.
2. When performing IR inspections, ENSURE that line equipment (e.g., capacitor banks, line regulators, line reclosers) are in service and are carrying load.

#### NOTE

BE AWARE that thermography scanning requires the conductor to be energized and carrying load current.

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### 2.2 Scheduling Recommendations

When operational needs allow, COMPLETE the following tasks:

1. SCHEDULE IR inspections starting in July and finishing no later than October.
2. If IR inspections are scheduled during circuit off-peak hours, PERFORM load transfers to increase the circuit's normal loading to approximately 40% rated load of the electrical equipment being inspected.

### 2.3 Equipment Specifications

PERFORM the following actions:

1. ENSURE that video-imaging equipment using IR technology to inspect UG electric distribution facilities meets the following specifications:
  - a. The system must be sealed.
  - b. The equipment must be portable.
2. ENSURE that video-imaging equipment used for OH IR inspections includes the following features:
  - a. Ability to store images for future analysis.
  - b. Adjustable, ambient temperature and emittance settings.
  - c. Ability to interchange lenses.
3. ENSURE that approved, utility-grade and non-utility-grade IR cameras meet all specifications listed in [Attachment 4, "Minimum Specifications for Approved Infrared Cameras."](#)

### 2.4 Records and Documentation

1. When conducting IR inspections under a specific maintenance activity type, PERFORM the following actions:
  - a. USE [Form TD-2022P-01-F01, "Infrared Inspection Log"](#) (SEE [Attachment 1](#)), to record required information. The ["Infrared Inspection Log"](#) is available either in hard copy or electronically on PG&E mobile devices.
    - (1) DETERMINE the appropriate maintenance priority based on the temperature values found in [Table 1](#) on Page 6 and [Table 2](#) on Page 8.
    - (2) IF there is obvious physical damage,  
  
THEN TAKE corrective action immediately.

## Infrared (IR) Inspections of Electric Distribution Facilities

### 2.4 (continued)

- b. USE [Form TD-2022P-01-F02, "Infrared Data Sheet"](#) (SEE [Attachment 2](#)), to report identified, abnormal, compelling conditions. The ["Infrared Data Sheet"](#) is available either in hard copy or electronically on PG&E mobile devices.
  - (1) DETERMINE the appropriate maintenance priority based on the temperature values found in [Table 1](#) on Page 6 and [Table 2](#) on Page 8.
  - (2) IF there is obvious physical damage,  
  
THEN TAKE corrective action immediately.
- c. REPORT defective/damaged components on [Form 62-0113, "Material Problem Report"](#) (SEE [Attachment 3](#)), AND RETAIN the report for additional analysis as described in [Utility Standard SCM-2106S, "Material Problem Report Standard."](#)
- d. UPLOAD the completed [Form TD-2022P-01-F02](#) to SAP's Electric Compliance (EC) Notification.

### 2.5 Determining Corrective Maintenance Priorities

When determining corrective maintenance priorities, READ the ["Notes in reference to Table 1,"](#) under [Table 1](#) on Page 7, and under ["Notes in reference to Table 2,"](#) on Page 9, AND PERFORM the following actions:

- 1. REFER to [Table 1](#) on Page 6 and [Table 2](#) on Page 8 to assess and prioritize the relative severity of the conditions found during an inspection.
- 2. USE the measured temperatures and temperature differentials provided in the tables to make these determinations described in [Step 2.5.1](#) above.
  - a. [Table 1](#) on Page 6 and [Table 2](#) on Page 8 describe the methods used when performing IR Inspections. Those methods are:
    - (1) **Differential Temperature analysis** – Refers to relative temperature values of a hotspot with respect to other parts of the equipment with similar conditions.
    - (2) **Absolute Temperature analysis** – Refers to actual temperature values measured from the hotspot.
- 3. Between methods (1) and (2) above, the most reliable is the differential temperature analysis because, unlike the absolute temperature analysis, it is minimally affected by environmental factors such as ambient temperature, humidity, and emissivity.

## Infrared (IR) Inspections of Electric Distribution Facilities

2.5 (continued)

**Table 1. Corrective Maintenance Priorities for Overhead Distribution Facilities**

Differential Temperature ( $\Delta T$ ) Analysis			
Distribution Facilities	Condition	Temperature Differential ( $\Delta T$ )	Priority/Due Date
Arrester cutouts and pot-head termination	Normal	$\Delta T \leq 10^{\circ}\text{C}$ $\Delta T \leq 18^{\circ}\text{F}$	No maintenance required.
	Minor	$10^{\circ}\text{C} < \Delta T \leq 25^{\circ}\text{C}$ $18^{\circ}\text{F} < \Delta T \leq 45^{\circ}\text{F}$	Write EC tag with Priority E. Complete within <b>180</b> days.
	Medium	$25^{\circ}\text{C} < \Delta T \leq 45^{\circ}\text{C}$ $45^{\circ}\text{F} < \Delta T \leq 81^{\circ}\text{F}$	Write EC tag with Priority B. Complete within <b>90</b> days.
	Severe	$\Delta T > 45^{\circ}\text{C}$ $\Delta T > 81^{\circ}\text{F}$	Write EC tag with Priority B. Complete within <b>30</b> days.
Connector and switch	Normal	$\Delta T \leq 25^{\circ}\text{C}$ $\Delta T \leq 45^{\circ}\text{F}$	No maintenance required.
	Minor	$25^{\circ}\text{C} < \Delta T \leq 45^{\circ}\text{C}$ $45^{\circ}\text{F} < \Delta T \leq 81^{\circ}\text{F}$	Write EC tag with Priority E. Complete within <b>180</b> days.
	Medium	$45^{\circ}\text{C} < \Delta T \leq 60^{\circ}\text{C}$ $81^{\circ}\text{F} < \Delta T \leq 108^{\circ}\text{F}$	Write EC tag with Priority B. Complete within <b>90</b> days.
	Severe	$\Delta T > 60^{\circ}\text{C}$ $\Delta T > 108^{\circ}\text{F}$	Write EC tag with Priority B. Complete within <b>30</b> days.



## Infrared (IR) Inspections of Electric Distribution Facilities

### 2.5 (continued)

**Table 1. Corrective Maintenance Priorities for Overhead Distribution Facilities (continued)**

Absolute Temperature (T) Analysis			
Distribution Facilities	Condition	Temperature Limits	Priority/Due Date
Arrester cut-outs and pot-head termination	Normal	$T_{\text{hot spot}} \leq 70^{\circ}\text{C}$ $T_{\text{hot spot}} \leq 158^{\circ}\text{F}$	No maintenance required.
	Minor	$71^{\circ}\text{C} < T_{\text{hot spot}} \leq 80^{\circ}\text{C}$ $160^{\circ}\text{F} < T_{\text{hot spot}} \leq 176^{\circ}\text{F}$	Write EC tag with Priority E. Complete within <b>180</b> days.
	Medium	$80^{\circ}\text{C} < T_{\text{hot spot}} \leq 85^{\circ}\text{C}$ $176^{\circ}\text{F} < T_{\text{hot spot}} \leq 185^{\circ}\text{F}$	Write EC tag with Priority B. Complete within <b>90</b> days.
	Severe	$T_{\text{hot spot}} \geq 85^{\circ}\text{C}$ $T_{\text{hot spot}} \geq 185^{\circ}\text{F}$	Write EC tag with Priority B. Complete within <b>30</b> days.
Connector and switch	Normal	$T_{\text{hot spot}} \leq 85^{\circ}\text{C}$ $T_{\text{hot spot}} \leq 185^{\circ}\text{F}$	No maintenance required.
	Minor	$85^{\circ}\text{C} < T_{\text{hot spot}} \leq 105^{\circ}\text{C}$ $185^{\circ}\text{F} < T_{\text{hot spot}} \leq 221^{\circ}\text{F}$	Write EC tag with Priority E. Complete within <b>180</b> days.
	Medium	$105^{\circ}\text{C} < T_{\text{hot spot}} \leq 120^{\circ}\text{C}$ $221^{\circ}\text{F} < T_{\text{hot spot}} \leq 248^{\circ}\text{F}$	Write EC tag with Priority B. Complete within <b>90</b> days.
	Severe	$T_{\text{hot spot}} > 120^{\circ}\text{C}$ $T_{\text{hot spot}} > 248^{\circ}\text{F}$	Write EC tag with Priority B. Complete within <b>30</b> days.

**Notes in Reference to [Table 1](#) (Page 6 and Page 7):**

1. If the IR component has already failed, significant damage, or its condition results in significant exposure to the general public, write an EC tag with Priority A, and take corrective action immediately. Refer to the [Electric Distribution Preventive Maintenance Manual \(EDPM Manual\)](#) for more information.
2. Create the EC tag, and complete the required action(s) within the due date as shown in the [Table 1](#) "Priority/Due Date" column.
3. For live-front terminations on pad-mounted transformers or equipment, use the OH temperature-differential values to determine priorities as shown in [Table 1](#) in the "Temperature Limits" column.
4. [Table 1](#) does not apply to transformer tanks. When working with transformer tanks, refer to [Numbered Document 068178, "Distribution Transformer Temperature,"](#) Table 1, "Transformer Temperatures–Mineral Oil Filled," on Page 2, and Table 2, "Transformer Temperatures–Natural Ester Filled," on Page 3.
5. Temperature conversion factor:  $^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times (5/9)$
6. Temperature differential:  $^{\circ}\text{C}_{\text{diff}} = (^{\circ}\text{F}_{\text{diff}}) / 1.8$

## Infrared (IR) Inspections of Electric Distribution Facilities

2.5 (continued)

**Table 2. Corrective Maintenance Priorities for Underground Distribution Facilities**

Differential Temperature Rise Analysis			
Distribution Facilities	Condition	Temperature Differential ( $\Delta T$ )	Priority/Due Date
Elbow and termination	Normal	$\Delta T \leq 6^{\circ}\text{C}$ $\Delta T \leq 11^{\circ}\text{F}$	No maintenance required.
	Medium	$6^{\circ}\text{C} < \Delta T \leq 20^{\circ}\text{C}$ $11^{\circ}\text{F} < \Delta T \leq 36^{\circ}\text{F}$	Write EC tag with Priority B. Complete within 60 days.
	Severe	$\Delta T > 20^{\circ}\text{C}$ $\Delta T > 36^{\circ}\text{F}$	Write EC tag with Priority B. Complete within 30 days.
Joint/splice and switch	Normal	$\Delta T \leq 6^{\circ}\text{C}$ $\Delta T \leq 11^{\circ}\text{F}$	No maintenance required.
	Medium	$6^{\circ}\text{C} < \Delta T \leq 12^{\circ}\text{C}$ $11^{\circ}\text{F} < \Delta T \leq 22^{\circ}\text{F}$	Write EC tag with Priority B. Complete within 60 days.
	Severe	$\Delta T > 12^{\circ}\text{C}$ $\Delta T > 22^{\circ}\text{F}$	Write EC tag with Priority B. Complete within 30 days.
Absolute Temperature (T) Analysis			
Distribution Facilities	Condition	Temperature Limits	Priority/Due Date
Elbow and termination	Normal	$T_{\text{hot spot}} \leq 80^{\circ}\text{C}$ $T_{\text{hot spot}} \leq 176^{\circ}\text{F}$	No maintenance required.
	Medium	$80^{\circ}\text{C} < T_{\text{hot spot}} \leq 88^{\circ}\text{C}$ $176^{\circ}\text{F} < T_{\text{hot spot}} \leq 190^{\circ}\text{F}$	Write EC tag with Priority B. Complete within 60 days.
	Severe	$T_{\text{hot spot}} > 88^{\circ}\text{C}$ $T_{\text{hot spot}} > 190^{\circ}\text{F}$	Write EC tag with Priority B. Complete within 30 days.
Joint/splice and switch	Normal	$T_{\text{hot spot}} \leq 85^{\circ}\text{C}$ $T_{\text{hot spot}} \leq 185^{\circ}\text{F}$	No maintenance required.
	Medium	$85^{\circ}\text{C} < T_{\text{hot spot}} \leq 120^{\circ}\text{C}$ $185^{\circ}\text{F} < T_{\text{hot spot}} \leq 248^{\circ}\text{F}$	Write EC tag with Priority B. Complete within 60 days.
	Severe	$T_{\text{hot spot}} \geq 120^{\circ}\text{C}$ $T_{\text{hot spot}} \geq 248^{\circ}\text{F}$	Write EC tag with Priority B. Complete within 30 days.



## Infrared (IR) Inspections of Electric Distribution Facilities

### 2.5 (continued)

#### Notes in Reference to [Table 2](#) (Page 8):

1. If the IR component has already failed, has significant damage, or its condition results in significant exposure to the general public, write an EC tag with Priority A, and take corrective action immediately. Refer to the [EDPM Manual](#) for more information.
2. Create the electric corrective (EC) tag, and complete the required action(s) within the due date as shown in the [Table 2](#) "Priority/Due Date" column.
3. For live-front terminations on pad-mounted transformers or equipment, use the OH temperature-differential values to determine priorities as shown in [Table 2](#) on Page 8.
4. [Table 1](#) does not apply to transformer tanks. When working with transformer tanks, refer to [Numbered Document 068178](#), Table 1 on Page 2, and Table 2 on Page 3.
5. For underground switches, the delta temperature values shown in [Table 2](#) are between switch components and the bushing-elbow interface.
6. Temperature conversion factor:  $^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times (5/9)$
7. Temperature differential:  $^{\circ}\text{C}_{\text{diff}} = (^{\circ}\text{F}_{\text{diff}}) / 1.8$

## 3 Procedures

### 3.1 Setting Up the IR Camera

1. To obtain accurate measurements, it is critical to ESTABLISH the IR imaging-system setup parameters for **emissivity and background temperature**.
  - a. USE other imaging-system setup parameters primarily to record initial or future evaluations of heat radiating from a target and its background.
2. SET the emissivity value at 0.95. This eliminates the need to set the background temperature. In this case, the target is considered a black body, totally reflective, and nontransmissive.
  - a. With highly emissive targets, the actual reflected energy is so small with respect to the emitted energy that the temperature measurement is well within reason for predictive maintenance applications.
  - b. As the emissivity value of the target decreases, the influence of background radiation increases and, consequently, so does the potential for errors based on background temperature settings.
  - c. If the emissivity value is set at less than 0.95 and the background temperature setting is adjusted inaccurately, the chances are greater that the target's resulting temperature measurement will contain errors than if the emissivity value were set at 0.95.

## Infrared (IR) Inspections of Electric Distribution Facilities

### 3.1 (continued)

#### **EXAMPLE**

When the emissivity setting is less than 0.95 and the background temperature setting is **higher** than the actual background temperature, the target temperature measurement is lower than it should be. However, if the background temperature setting is **lower** than the actual background temperature, then the target temperature measurement is higher than it should be. The measurement deviation is compounded as the emissivity setting decreases from 0.95.

- d. Setting the emissivity value at 0.95:
  - (1) Eliminates the need to determine exact emissivity and background temperature values.
  - (2) Simplifies the system operation.
  - (3) Results in reasonably accurate measurements.

#### **EXAMPLE**

When taking IR measurements on OH systems where the ceiling (sky) is unlimited, determining an accurate background temperature is nearly impossible. Most targets have dark surfaces with emittance values very close to 0.95.

### 3.2 IR Inspection Measurement Points

[Figures 1](#) through [Figure 8](#), "Infrared Inspection Measurement Points," on Page 12, display the temperature measurement points on various conductor assemblies.

### 3.3 IR Scanning Techniques

1. If the thermal image's color pallet shows an elevated differential temperature between the targeted component and conductor/cable, FOLLOW the steps below:
  - a. CENTER the targeted component in the viewer or sight of the IR scanning device, AND OBSERVE the measured temperatures. SEE the measurement points in [Figure 1](#) through [Figure 8](#) on Page 12.
  - b. SCAN approximately 1 to 2 feet of the conductor/cable entering and/or leaving the targeted image, AND OBSERVE the measured temperatures. SEE the measurement points in [Figure 1](#) through [Figure 8](#) on Page 12.
  - c. TAKE load readings **if a compelling abnormal condition is identified**.

## Infrared (IR) Inspections of Electric Distribution Facilities

### 3.3 (continued)

- d. For radial, live-front terminations without adjacent component(s) on the same phase, COMPARE the phase connector to other phase connectors, AND TAKE load readings **if a compelling abnormal condition is identified**.
- e. For looped, live-front terminations, COMPARE the connector temperatures on the same phase to each other, AND TAKE a load reading on each cable **if an abnormal condition is found**. This helps to ensure the temperature differential is not load related.

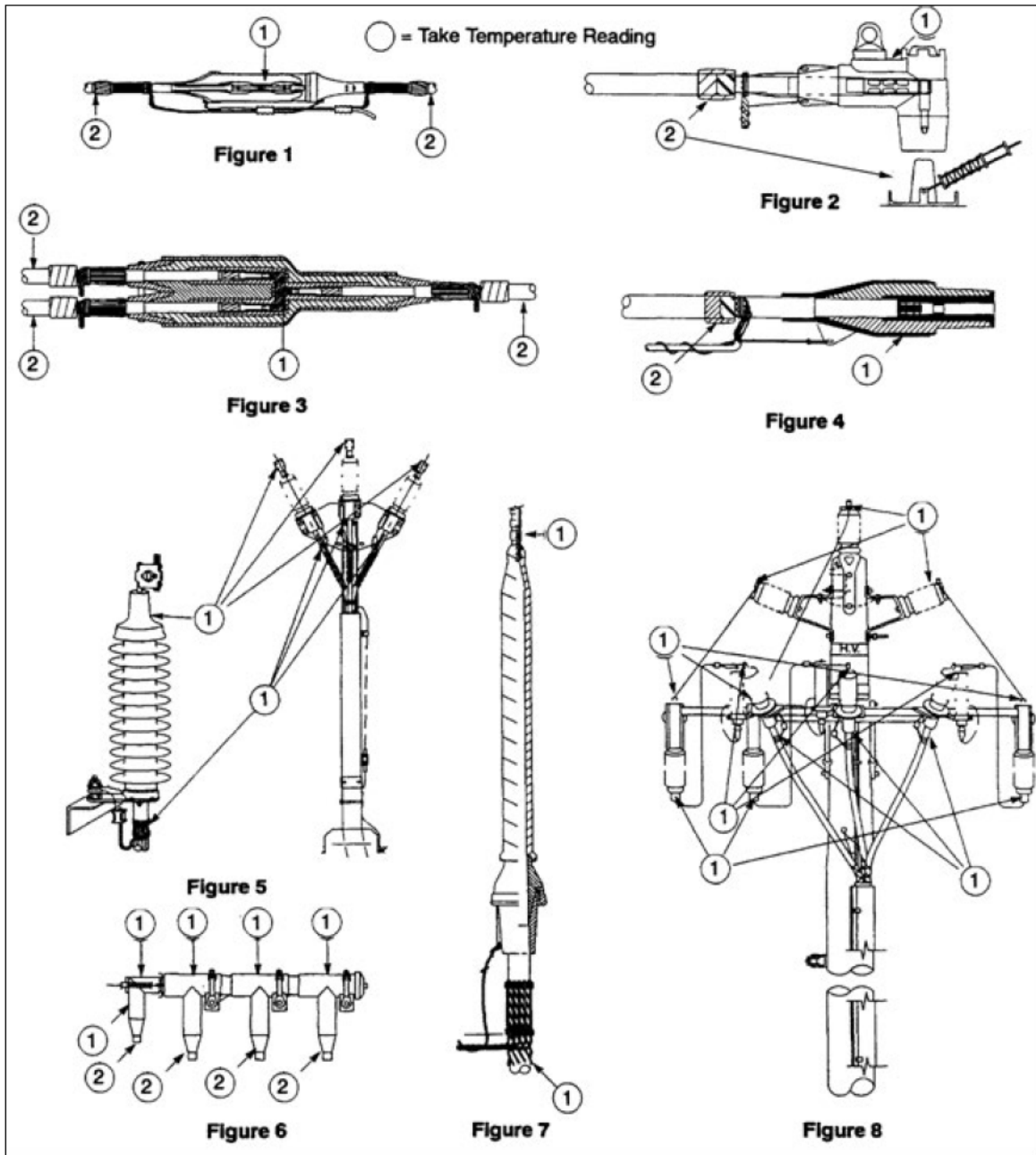
#### NOTE

Due to load imbalances, a temperature difference between different phases of cables on the same circuit is an expected condition and does not, in itself, indicate any anomalies.

- 2. If the temperature differential is within the normal value shown in [Table 1](#) on Page 6 and [Table 2](#) on Page 8, but the temperature-absolute value exceeds the normal value shown in [Table 1](#) and [Table 2](#), PERFORM the following actions:
  - a. CREATE a temporary load transfer (recommended) to increase the load viewed by the targeted component.
  - b. REPEAT the IR inspection on the same component.
  - c. RECORD the findings.

## Infrared (IR) Inspections of Electric Distribution Facilities

### 3.3 (continued)



**Figures 1–Figure 8  
Infrared Inspection Measurement Points**

**Notes:**

1. Numbers ① and ② are the measurement points referred to in [Subsection 3.3, "IR Scanning Technique,"](#) Step 1 through Step 2, starting on Page 10.
2. Observe excessive temperature readings for figures that only designate measurement points. ①

## Infrared (IR) Inspections of Electric Distribution Facilities

### 3.4 Using an IR Camera to Identify Hot Transformers and UG Switches

The IR camera provides thermal images that can identify transformer tanks with high temperatures caused by high loading. Thermal images also identify switch tanks with high temperatures caused by internal switch problems. When imaging transformer and switch tanks, PERFORM the following actions:

1. When identifying a transformer tank with a high temperature, TAKE the actions described in [Numbered Document 068178](#), Table 1 on Page 2, and Table 2 on Page 3.
2. When identifying an oil switch tank with a temperature higher than its cable terminations, CREATE an EC tag with Priority A to replace the switch immediately.

## 4 Implementation Roles

### 4.1 The senior director in charge of electric asset strategy has the following responsibilities:

1. DEVELOP AND OVERSEE a prioritized plan that meets the requirements of this procedure. The plan must include performance measures and schedules for reporting progress on the systemwide annual plan.
2. COMPILE a systemwide annual plan based on area-specific submittals. ENSURE that the plan and periodic status reports are available on a schedule determined by the distribution asset management electric operation engineering senior director.
3. IMPLEMENT a quality assurance program to assess compliance with this procedure and to support continuous improvement.
4. DEVELOP AND OVERSEE the funding and forecasting necessary to comply with this procedure.
5. MONITOR progress, AND VERIFY compliance with this procedure.

### 4.2 The director in charge of restoration compliance operations has the following responsibilities:

1. DEVELOP annual plans to identify and request the resources necessary to achieve all of the area-specific requirements described in this procedure. These annual plans identify area-specific objectives for inspecting and maintaining electric distribution equipment. In addition, the plans provide for the training needed to achieve the area-specific requirements described in this procedure.
2. SUBMIT annual plans AND periodic status reports on a schedule determined by the electric distribution maintenance manager.

### 4.3 Compliance managers ENSURE that area employees are aware of and comply with the area-specific requirements described in this procedure.



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- 4.4 Directors, managers, and supervisors who direct the inspection and maintenance of electric distribution facilities have the following responsibilities:
1. ENSURE the work necessary to comply with this procedure is performed safely, efficiently, and in a timely manner.
  2. Accurately TRACK AND REPORT work progress.
- 4.5 Supervisors have the following responsibilities:
1. ENSURE that employees who perform facility assessments and subsequent maintenance are qualified to perform their assigned tasks.
  2. Periodically CHECK employees' work to verify its accuracy and completeness, as well as the timely and succinct recordkeeping of the work.
- 4.6 Employees assigned facility inspection and maintenance tasks have the following responsibilities:
1. PERFORM assignments efficiently and safely. ENSURE not only personal safety, but also public safety. Employees must only perform work for which they are qualified.
  2. When necessary, NOTIFY supervisors of any additional training, equipment, or resources required to efficiently and safely perform work.
- 4.7 IF IR inspections are performed by outside contractors,

THEN SEE [Attachment 5, "Guideline for Validating Overhead \(OH\) Infrared \(IR\) Inspection Contract Work."](#) for additional instructions.

### END of Instructions

### DEFINITIONS

**Abnormal conditions:** A condition that impacts or has the potential to adversely impact safety, service reliability, or asset life. Typically, these are conditions where the facility may fail to perform the function for which it was installed.

**Ambient temperature:** The prevailing temperature in the immediate vicinity of an object or target; the temperature of the target's environment.

**Background temperature:** The temperature(s) of the surrounding scene reflected off the target.

**Component temperature:** The temperature of the targeted surface being evaluated.

**Distribution facilities:** Any conductors or associated equipment operating at voltages up to 50,000 volts (V), namely 50 kilovolts (kV).



## Infrared (IR) Inspections of Electric Distribution Facilities

### DEFINITIONS (continued)

**Emissivity:** The relative ability of a surface to emit heat by radiation. Emissivity is the ratio of the heat emitted by a surface compared to that emitted by a black body.

**Emittance value:** The ratio of the intensity of thermal radiation at a given wavelength or spectral waveband from a target to the thermal radiation emitted by a black body with the same temperature as the target.

**Field of view:** The size of the scene surrounding the target, as observed by the infrared (IR) scanner and expressed as the ratio between the size of the scene surrounding the target and the distance between the target and the scanner.

**Infrared notification:** A form or electronic record used as a checklist to identify and record a specific, abnormal maintenance condition(s) that impacts safety, service reliability, or asset life.

**Infrequent users:** Employees including troublemen, crew foremen, and supervisors who use IR cameras to perform qualitative analysis to help assess the condition of energized electric distribution facilities. Infrequent users are not engaged in everyday IR inspections.

**Input form:** A form or electronic record used in the field as a checklist to record a specific, abnormal maintenance condition(s) that impacts safety, service reliability, or asset life. The recorded information is used to create an Electric Preventive Corrective Maintenance (EPCM) Notification.

**Inspection:** In this procedure, “inspection” refers to IR inspections using thermal imaging equipment to observe differential patterns of IR radiation. These patterns provide specific information about a structure system, object, or target. An inspection can also refer to a special type of diagnostic test using IR thermography.

**Inspection cycle:** Established schedules ensuring that facilities are inspected at durations based on calendar years. Inspections must be performed and completed within the calendar year for which they are scheduled.

**Inspection log:** A form or electronic record used to document inspections and identify abnormalities that require correction or a follow-up inspection.

**Priority:** The urgency to perform repairs identified in a notification.

**Reference temperature:** The temperature of a like piece of equipment at the same location as that registering the component (“fault”) temperature.

**Reflective:** The ability of a target to reflect or send back rays. A mirror has a reflective surface with respect to visible light.

## Infrared (IR) Inspections of Electric Distribution Facilities

### DEFINITIONS (continued)

**Temperature differential (also known as “temperature rise”):** The difference in temperature between the component (fault) temperature and the reference temperature.

**Thermography:** Any photographic, videotape, computer-generated, or graphic record of information derived from an IR inspection.

**Transmissive:** The ability of a medium to allow electromagnetic radiation to pass through it without being reflected or absorbed (i.e., sending or transmitting rays from one point to another). Glass is highly transmissive to visible light.

**Utility-grade IR cameras:** IR cameras that meet the minimum specification listed in [Attachment 4, “Minimum Specifications for Approved Infrared Cameras.”](#)

**Non-utility-grade IR cameras:** IR cameras available to infrequent users who are not performing overhead or underground inspections. See [Attachment 4](#) for more details.

### IMPLEMENTATION RESPONSIBILITIES

The senior director in charge of asset management is responsible for approving, revising, and distributing this procedure.

Supervisors must ensure that the tailboard for this procedure is delivered by 07/15/2018 (procedure’s effective date).

### GOVERNING DOCUMENT

NA

### COMPLIANCE REQUIREMENT / REGULATORY COMMITMENT

NA

### REFERENCE DOCUMENTS

#### Developmental References:

- [Aluminum Electrical Conductor Handbook](#)
- [Infraspection Institute Manuals:](#)
  - *Infrared Inspection Manual*
  - *Infrared Methodology and Technology Manual*
  - *Infraspection Instruction Manual, Level II*

## Infrared (IR) Inspections of Electric Distribution Facilities

### REFERENCE DOCUMENTS (continued)

#### Developmental References (continued):

- [Institute of Electrical and Electronic Engineers \(IEEE\) documents:](#)
  - [Automatic Diagnosis System of Electrical Equipment Using Infrared Thermography](#)
  - [Robotized inspection of power lines with infrared vision](#)
- [Utility Standard TD-2301S, "Patrols and Detailed/Intrusive Inspections of Electric Overhead and Underground Distribution Facilities"](#)

#### Supplemental References:

- [Electric Distribution Preventive Maintenance \(EDPM\) Manual](#)
- [Numbered Document 068178, "Distribution Transformer Temperature"](#)
- [Utility Standard SCM-2106S, "Material Problem Report Standard"](#)

### APPENDICES

NA

### ATTACHMENTS

[Attachment 1, Form TD-2022P-01-F01, "Infrared Inspection Log"](#)

[Attachment 2, Form TD-2022P-01-F02, "Infrared Data Sheet"](#)

[Attachment 3, Form 62-0113, "Material Problem Report"](#)

[Attachment 4, Minimum Specifications for Approved Infrared Cameras](#)

[Attachment 5, Guideline for Validating Overhead \(OH\) Infrared \(IR\) Inspection Contract Work](#)

### DOCUMENT REVISION

This utility procedure cancels and supersedes Utility Procedure TD-2022P-01, "Infrared Inspection of Electric Distribution Facilities," Rev. 0, dated 12/20/2013.

This utility procedure also moves the following two bulletins to **For Reference Only (FRO)**:

- Utility Bulletin TD-2022B-001, "Revised Corrective Maintenance Priorities Tables when Performing Infrared Inspections," Rev. 0, dated 04/17/2015.
- Utility Bulletin TD-2022B-002, "Infrared Cameral Approved for Restoration and Infrequent Users," Rev. 0, dated 02/15/2017.

## Infrared (IR) Inspections of Electric Distribution Facilities

### DOCUMENT APPROVER

██████████ Senior Manager  
Distribution Standards Engineering

### DOCUMENT OWNER

██████████ Senior Manager  
Distribution Standards Engineering

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### REVISION NOTES

Where?	What Changed?
Summary	<ul style="list-style-type: none"><li>Added a sentence to explain the permitted use of non-utility graded IR cameras by restoration and infrequent uses.</li></ul>
Section 2.5, "Determining Corrective Maintenance Priorities"	<ul style="list-style-type: none"><li>Incorporated the information communicated in Utility Bulletin TD-2022B-001:<ul style="list-style-type: none"><li>Split former Table 1 into <a href="#">Table 1</a> and <a href="#">Table 2</a>.</li><li>Revised temperature values and required time to complete the corrective action.</li></ul></li></ul>
Attachment 4 and Attachment 5	<ul style="list-style-type: none"><li>Added these two new attachments.</li></ul>