



Standard Guide for Examining Electrical and Mechanical Equipment with Infrared Thermography¹

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1. Scope

1.1 This guide lists the responsibilities of the end user and the infrared thermographer when examining electrical and mechanical systems.

1.2 This guide outlines the specific content required to document qualitative and quantitative infrared examinations of electrical and mechanical equipment²

1.3 *This guide may involve use of equipment and materials in the presence of heated, moving or all of these or electrically energized equipment.*

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

- 2.1 *ASTM Standards:*
E 1316 Terminology for Nondestructive Examinations³

3. Terminology

3.1 Definitions:

3.1.1 *end user*—the person responsible for using the information provided by an infrared examination.

3.1.2 *exception*—an abnormally warm or cool connector, conductor or component.

3.1.3 *infrared examination*—the use of an infrared imaging system to provide thermal data about a structure, system, object or process.

3.1.4 *inventory list*—a list of the equipment by the infrared thermographer.

3.1.5 *qualified assistant*—a person provided and authorized by the end user to perform the tasks required by the infrared thermographer. He/she shall be knowledgeable of the operation and history of the equipment to be examined and of all safety practices and rules of the end user.

3.1.6 *qualitative infrared inspection*—an infrared examination that provides images of exceptions but not temperature data.

3.1.7 *quantitative infrared inspection*—an infrared examination that provides both images of exceptions and temperature data.

3.2 See also Terminology E 1316.

4. Significance and Use

4.1 This guide can be used by an end user to specify infrared examinations of electrical and mechanical equipment and an infrared thermographer to perform them.

4.2 This guide lists the joint responsibilities of the end user and the infrared thermographer when using infrared thermography.

4.3 The purpose of an infrared examination is to identify and document exceptions in the end user's electrical or mechanical systems, or both.

4.3.1 In electrical equipment, warm exceptions are usually created by an increase in resistance caused by loose or deteriorated connections, short circuits, overloads, load imbalances or faulty, mismatched or improperly installed components. Cool exceptions are usually caused by failed components.

4.3.2 In mechanical equipment, warm exceptions are usually created by friction caused by improper lubrication, misalignment, worn components or mechanical loading anomalies. Cool exceptions are usually caused by failed components.

4.3.3 Exceptions in insulation systems are usually caused by missing or deteriorated materials, improper installation or insufficient amounts of material.

4.4 Providing opinions about the causes of exceptions, the integrity of the equipment or recommendations for corrective actions require knowledge and skills beyond those of infrared thermography.

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² This guide is adapted from the *Guideline for Infrared Inspection and Mechanical Systems* developed by Infraspection Institute, 1971 Shelburne Road, Shelburne, VT 05482, 1993.

³ *Annual Book of ASTM Standards*, Vol 03.03.

4.5 Infrared examinations provide data about equipment at the time of examination only.

4.6 Infrared examinations are not remedial.

4.7 An infrared examination of electrical and mechanical equipment does not assure its proper operation. Other tests and proper maintenance are necessary to ensure their reliable performance.

5. Personnel Responsibilities

5.1 The infrared thermographer shall:

5.1.1 Have sufficient knowledge of the components, construction and theory of electrical or mechanical equipment, or both, to understand the observed patterns of radiation,

5.1.2 Be knowledgeable of, and comply with, the safety practices and rules of the end user, and

5.1.3 Use an infrared imaging system with imaging or radiometric capabilities, or both, sufficient to meet the examination requirements.

5.2 Unless he/she is a licensed electrician, professional engineer or has other equivalent qualifications, the infrared thermographer:

5.2.1 Shall not perform any tasks that are normally done by these personnel. Unless so qualified and authorized by the end user, the infrared thermographer,

5.2.2 Shall not remove or replace covers or open or close cabinets containing electrical or mechanical equipment,

5.2.3 Shall not measure electric loads of equipment, and

5.2.4 Shall not touch any equipment and shall maintain a safe distance from it.

5.3 The qualified assistant shall fulfill the responsibilities listed in 3.1.5, 6.1, 6.2, 6.4 through 6.4.3, 6.7.1, and 6.8.

5.4 The end user shall assume full responsibility for consequences resulting from actions taken, or not taken, as a result of data provided by an infrared examination.

6. Procedure

6.1 The end user shall provide, to accompany the infrared thermographer, a qualified assistant who is knowledgeable of the operation and history of the equipment to be examined.

6.2 With the assistance of the qualified assistant, the infrared thermographer shall develop an inventory list of the equipment to be examined in a logical, efficient and safe route through the facility.

6.3 The infrared thermographer shall perform a calibration test(s), before each quantitative infrared examination, to ensure that all temperature-measuring equipment is within the manufacturers' standard specifications for accuracy.

6.4 The qualified assistant shall prepare the equipment for examination by:

6.4.1 Obtaining authorization necessary to gain access to the equipment to be examined and notifying operations personnel of the examination activities,

6.4.2 Opening or removing, or both, all necessary cabinet and enclosure covers immediately before examination to provide the infrared thermographer with direct views of the equipment.

6.4.3 Ensuring that the equipment to be examined is under adequate load, creating satisfactory loads when necessary, and allowing sufficient time for recently energized equipment to produce stable thermal patterns.

6.5 When examining the equipment, the thermographer will comply with all safety rules, regulations and practices of the end user.

6.6 The infrared thermographer shall perform examinations when the environmental and physical conditions, such as solar gain, wind, surface and atmospheric moisture and heat transfer are favorable to gathering accurate data.

6.7 The infrared thermographer shall document any exceptions found by recording the data required in 7.2 through 7.2.9 or 7.3 through 7.3.6, or all of these.

NOTE 1—Special care must be exercised when examining surfaces having low emissivities (<0.5). In these circumstances exceptions may be more difficult to detect. Also, such surfaces produce reflections that can be misleading. The infrared thermographer should be aware of these potential error sources and use techniques to minimize them, such as moving the position of the imager and blocking the surfaces from reflected sources.

6.7.1 When requested by the infrared thermographer, the qualified assistant shall measure the loads of electrical equipment.

6.8 The qualified assistant shall close or replace, or both, the cabinet and enclosure covers that had been opened or removed in 6.4.2 immediately after examination and documentation by the infrared thermographer.

6.9 The infrared thermographer shall prepare a report for the end user containing the appropriate content listed in Section 7.

6.10 The infrared thermographer shall, when requested by the end user, re-examine each exception after repair to assure that its operating temperature is normal and the potential problem corrected.

7. Report

7.1 The infrared thermographer shall provide documentation for all infrared examinations. The following information shall be included in a report to the end user:

7.1.1 The name, affiliation, address, and telephone number of the infrared thermographer, and his/her certification level and number, if applicable.

7.1.2 The name and address of the end user,

7.1.3 The name(s) of the assistant(s) accompanying the infrared thermographer during the examination,

7.1.4 The manufacturer, model and serial number of the infrared imaging system used,

7.1.5 The inventory list (see 6.2) with notations of the items of equipment that were examined and explanations for the items not examined. Also, the items with low-emissivity surfaces (see Note 1) should be identified.

7.1.6 The date(s) of the inspection and when the report was prepared.

7.2 When performing a qualitative infrared examination, the infrared thermographer shall provide the following information for each exception identified:

7.2.1 Its exact location,

7.2.2 A description, such as its significant nameplate data, phase or circuit number, rated voltage, current rating and/or rotation speed,

7.2.3 The ambient air temperature and, when relevant, the wind speed and direction and the sky conditions at the time of the examination,

7.2.4 The time the exception was documented,

7.2.5 Hardcopies of the thermal image (thermogram) and of a corresponding visible-light image,

7.2.6 The field of view or magnification multiplier of the infrared imager lens, and any imager settings that could affect the accuracy, reliability, or repeatability of the inspection data.

7.2.7 Notation of any attenuating media, such as windows, filters, atmospheres or external optics,

7.2.8 If desired, a subjective repair priority rating provided by the qualified assistant or end user representative, or both, based on the importance of the exception to the safe and profitable operation of the facility, and

7.2.9 Any other information or special conditions which may affect the results, repeatability or interpretation of the exception.

7.3 When performing a quantitative infrared examination, the infrared thermographer shall provide the following additional information for each exception:

NOTE 2—The purpose of a quantitative infrared inspection is to produce temperature data. If temperature data are not desired or required, then the infrared thermographer performs a qualitative infrared inspection and does not measure or provide temperatures.

7.3.1 The distance from the infrared camera to the exception,

7.3.2 Whenever possible, the maximum rated load of an electrical system exception and its measured load at the time of the examination, and

7.3.2.1 The percentage load on the electrical exception, calculated by dividing its measured load by its rated load and multiplying by 100,

7.3.3 The reflected temperature, emissivity and transmission values used to calculate the temperature(s) of the exception,

7.3.4 The temperature of the exception,

NOTE 3—Actual temperatures of surfaces having low emissivities may differ from corrected radiometric measurements.

7.3.5 If requested, the difference between the temperature of the exception and the temperature of a defined reference such as a similar component under similar load, ambient temperature or a standard (see Note 3), and

7.3.6 If requested, a comparison of the measured temperatures with reference standards, and complete identification of these standards, including their sources.

8. Keywords

8.1 imaging; infrared; infrared examination; infrared inspection; infrared testing; infrared thermography; nondestructive testing; radiometry; temperature criteria; temperature measurement

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