Certification of Thermographers

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Fire Safety | Security | Natural Hazards

The CFPA Europe develops and publishes common guidelines about fire safety, security, and natural hazards with the aim to achieve similar interpretation and to give examples of acceptable solutions, concepts, and models. The aim is to facilitate and support fire protection, security, and protection against natural hazards across Europe, and the whole world.

Today fire safety, security and protection against natural hazards form an integral part of a modern strategy for survival, sustainability, and competitiveness. Therefore, the market imposes new demands for quality.

These Guidelines are intended for all interested parties and the public. Interested parties includes plant owners, insurers, rescue services, consultants, safety companies and the like so that, in the course of their work, they may be able to help manage risk in society.

The Guidelines reflect best practice developed by the national members of CFPA Europe. Where these Guidelines and national requirements conflict, national requirements shall apply.

This Guideline has been compiled by the Guidelines Commission and is adopted by the members of CFPA Europe.

More information: www.cfpa-e.eu

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Key words:

1 Introduction

Defective or overloaded electrical installations can cause overheating or short-circuiting, which can lead to fire. They can also increase the risk of production shutdowns. Early detection of such defects can help save valuable property and possibly even human life. Thermography equipment will aid the discovery and elimination of hot spots in electrical equipment and circuits but for this to happen, it is essential, that the equipment's are operated by qualified personnel, who have the appropriate skills and experience in performing thermography.

A person who has been certified as a qualified thermographer has the documented ability to perform thermography correctly and efficiently on electrical equipment, the main aim being to prevent fire from occurring.

2 Scope

This guideline concerns the practice of thermography, the technique used to measure temperature differences in, for example, electrical installations. In order for thermography to be carried out properly, it is essential that it is be done by people, who have the right skills and experience in this area.

The guideline specifies requirements for thermographer who work on electrical installations to pinpoint possible defects, including fire risks. The necessary skills have been carefully identified; they will ensure that practitioners will carry thermography in a professional and responsible manner.

The guideline also contains important requirements for the third-party certification of people qualified to perform thermography.

It should be noted that the national certification organization might have additional requirements.

3 Requirements for qualification as a thermographer

3.1 Basic education and training

Candidates seeking certification as qualified thermographers must have the education and qualification required according to national legislation to be able to work on electrical installations. The level of qualification required for work in electrical installations must be consistent with the level of certification to be completed.

Candidates seeking certification as qualified thermographers must be able to present documents proving that they have current knowledge of legislation, rules and regulations especially EN 50110-1 (operation of electrical installations). Candidates must also follow and stay updated on changes.

3.2 Training in thermography

Candidates seeking certification as qualified thermographers must have completed training in thermography, covering minimum level 1, described in section 5.

The training must be offered by an established training organization. A training plan must be available which contains the purpose of the training, a training program (content of the training

course), the teachers name and competence, the equipment used, demonstration material and used literature.

3.3 Knowledge of thermography equipment

Candidates seeking certification as qualified thermographers must be familiar with the functioning of thermography equipment (thermal imagers and handguns) and must be able to handle it to produce reliable results. Candidates must also be able to assess the equipment's technical capabilities, diagnose and evaluate any visible variations, and determine whether an equipment's calibration is satisfactory. The candidate shall be competent to validate the equipment as described in section 6.

3.4 Other requirements

Candidates seeking certification as qualified thermographers must carry liability insurance to cover any faults or damage, which they might cause in conducting thermography tasks.

Candidates seeking certification as qualified thermographers must be familiar with and work according to the relevant documents for the type of business or company where the candidate is performing thermography.

4 Requirements for certification field of application

4.1 General requirements

Certification must be conducted by a certifying body, which certifies personnel and should be accredited (if national required) in accordance with EN ISO/IEC 17024 "Conformity assessment -- General requirements for bodies operating certification of persons".

4.2 Examination

Candidates seeking certification as qualified thermographers must complete a written examination to test their knowledge of the subject of section 3.1, 3.2, 3.3 and 3.4.

The thermographers certificate is obtained after passing an exam demonstrating that the candidate has the competence and knowledge of the safety regulations and techniques involved.

The certification procedure specifies the conditions for admission to the examinations (e.g. training, experience).

The examination must be passed no later than 6 months after they have completed their training in thermography. See also section 5.1. The person seeking certification as a qualified thermographer must show a course certificate or similar document to verify appropriate knowledge of safety regulations.

4.3 The certificate's period of validity

Certificates are valid for a maximum of 5 years.

If skills´ maintenance in section 4.4. is met, there is no need for a new examination.

If skills´ maintenance in section 4.4. is not met, the person must pass the examination described in section 5.

4.4 Skills' maintenance

For the certificate to remain valid, the certified person must:

- participate in a combined refresher course and experience exchange workshop of at least 8 hours' duration, at least every 36 months. Course content as described in section 5.4.;
- regularly conduct thermography, amounting to at least 50 hours per year;
- the work shall include to analyze the results and write reports;
- training for national electrical safety regulations shall be refreshed every 36 months.

If these maintenance requirements are not met, the certificate must be withdrawn.

5 Training and certification

5.1 Certification levels

Certificates are divided into 3 levels:

- Low voltage,
- High voltage 1 and
- High voltage 2.

Level 1, Low voltage: <1 kV. Applies to, for example, low-voltage switchgear, power stations, distribution centers, apparatus cabinets and compatible similar electrical installations and distributions with a voltage of up to 1 kV.

Level 2, High voltage 1: 1 kV–20 kV. In addition to class 1, also applies to, for example, high-voltage switchgear indoors/outdoors, transformers outside/inside and compatible similar electrical installations and distributions up to 20 kV.

Level 3, High voltage 2: >20 kV. In addition to class 1 and 2, also applies to, for example, indoor/outdoor high-voltage switchgear, transformers, power lines and entire grid stations as well as compatible similar electrical installations and distributions with more than >20 kV.

The applicant must fulfill the knowledge goals described according to 5.3. The minimum requirement for the length of the training is:

- Level 1: 16 hours of training including practical exercises (minimum 4 hours)
- Level 2: 24 hours of training including practical exercises (minimum 6 hours)
- Level 3: 32 hours of training including practical exercises (minimum 8 hours)

5.2 Training plan

The training must be offered by established training organizers.

There must be a training plan that states:

- The purpose of the training,
- the content of the training (training program),
- teacher and his/her skills,
- the equipment and demonstration material used and
- the literature used.

5.3 Training programs

The training program must at least contain the requirements according to level 1, level 2, or level 3.

Completed training must be able to verify with a training certificate or equivalent.

Training program - Level 1
Thermographers must have attended training of at least 16 hours, of which 4 hours of practical exercises as follows:

Basic thermography, 1h
- The different parts and basic function of the thermal imager:
    - Review of the visible parts of the camera and explanation of its operation

Infrared measurement technology, 3h
- Qualitative and quantitative analysis:
    - Qualitative analysis: Measurement range, optical focus, thermal focus, and the importance of the functions.
    - Quantitative analysis: Temperature measurement, object parameters, emissivity, and reflectivity.
- Image interpretation:
    - The structure of the thermal image, what it represents
- Temperature measurement, object parameters
- Measurement accuracy, potential for error measurement
- Instrument performance and limitations:
    - Resolution capability, IFOV
    - Size of the measuring point, MFOV
    - Optics
    - Pixels
- Measuring functions of the instrument

Heat and radiation theory, 3h
- Definitions of temperature and heat
- Heat transfer by heat conduction (conduction)
- Black body theory
- Emissivity and reflectivity:
    - Meaning and connection
- Electromagnetic spectra

Applications for electric thermography, 3h
- Basics of thermography of electrical installations <1 kV
- Common heating patterns and temperatures in electrical installations <1 kV
- Analysis and evaluation of electrical faults <1 kV

Reporting of assignments, 2h
- Elements and content of the report
- Archiving

Practical exercises, 4h
- Basic handling of infrared camera
- Manage menu systems and adjustment of object parameters
- Performing qualitative thermography on two optional objects.

- Performing quantitative thermography on two optional electrical installation objects, one of which should have a simulated fault.
- Emissivity test, an object of choice.

Training program - Level 2
Thermographers must have participated in training of at least 24 hours, of which 6 hours of practical exercises as follows:

Basic thermography, 2h
- The parts and basic functions of the thermal imager:
  - Review of the visible parts of the camera and explanation of its operation
- Accessories for thermal imager, additional equipment:
  - Mounting external optics, telephoto lens, etc.

Infrared measurement technology, 4h
- Qualitative and quantitative analysis:
  - Qualitative analysis: Measurement range, optical focus, thermal focus and the importance of the functions.
  - Quantitative analysis: Temperature measurement, object parameters, emissivity, reflectivity, and transmissivity
- Image interpretation:
  - The structure of the thermal image, what it represents
- Temperature measurement, object parameters
- Temperature measurement, corrections for environmental factors
- Measurement accuracy: potential for error measurement
- Instrument performance and limitations:
  - Dissolution ability, IFOV, demonstration
- Measurement point size, MFOV, demonstration:
  - Optics
  - Pixels
- Measuring functions of the instrument

Heat and radiation theory, 5h
- Definitions of temperature, heat, and thermal energy.
- Heat transfer by heat conduction (conduction), convection and radiation.
- Blackbody theory and radiation laws
- The laws of thermodynamics
- Emissivity, reflectivity, transmissivity:
  - Meaning and connection
- Electromagnetic spectra

Applications for electric thermography, 5h
- Basics of thermography of electrical installations <1 kV
- Common heating patterns and temperatures in electrical installations <1 kV
- Analysis and evaluation of electrical faults <1 kV
- High voltage installations, switchgear, cable termination, transformer, etc.<20 kV:
  - Analysis and evaluation of electrical faults.

Reporting of assignments, 2h

- Elements and content of the report
- Archiving
- Example and demonstration.

Practical exercises, 6h

- Basic handling infrared camera
- Manage menu systems and adjustment of object parameters
- Execution qualitative thermography on two objects
- Performing quantitative thermography four electrical installation objects, of which at least one >1 kV
- Conducting practical test of wind cooling on an electrical installation object.
- Emissivity test, two copper and aluminum electrical plant objects.

Training program - Level 3

Thermographers must have attended training of at least 32 hours of which 8 hours of practical exercises as follows:

Basic thermography, 3h

- The parts and basic functions of the thermal imager:
  - Review of the visible parts of the camera and explanation of its operation
- Accessories for thermal imager, additional equipment:
  - Mounting external optics, telephoto lens, demonstration, etc.

Infrared measurement technology, 6h

- Qualitative and quantitative analysis:
  - Qualitative analysis: Measurement range, optical focus, thermal focus and the importance of the functions.
  - Quantitative analysis: Temperature measurement, object parameters, emissivity, reflectivity, and transmissivity.
- Image interpretation:
  - The structure of the thermal image, what it represents
- Temperature measurement, object parameters
- Temperature measurement, corrections for environmental factors
- Measurement accuracy: potential for error measurement
- Instrument performance and limitations:
  - Dissolution ability, IFOV, demonstration and practice
  - Measurement point size, MFOV, demonstration and practice
  - Optics
  - Detector and pixels
- Measuring functions of the instrument
- Measurement at a distance:
  - Influence of environmental factors, measuring point, compensation
- Angular influence

Heat and radiation theory, 6h

- Definitions of temperature, heat, and thermal energy.
- Heat transfer by heat conduction (conduction), convection and radiation.
- Black body theory and radiation laws
- The laws of thermodynamics
- Emissivity, reflectivity, transmissivity:

    - Meaning and connection
    - All factors affecting emissivity, demonstration, and practice.
- Electromagnetic spectra

Applications for thermography of electrical installations, 6h
- Basics of thermography of electrical installations <1 kV
- Common heating patterns and temperatures in electrical installations <1 kV
- Analysis and evaluation of electrical faults <1 kV
- High voltage installations, switchgear, cable termination, transformer, etc. <20 kV:
    - Analysis and evaluation of electrical faults
- High voltage installations, Power lines, Separators, Transformers, etc. >20 kV:
    - Analysis and evaluation of electrical faults

Reporting of assignments, 3h
- Elements and content of the report
- Archiving
- Example and demonstration
- Analysis program

Practical exercises, 8h
- Basic handling of infrared camera
- Manage menu systems and adjustment of object parameters
- Manage menu systems and adjustment of ambient parameters
- Execution qualitative thermography on four objects
- Performing quantitative thermography four electrical installation objects, of which at least two >1 kV
- Conducting practical test of wind cooling on at least 1st electrical installation object.
- Carrying out practical test of the size of the measuring point, MFOV, on at least two connections on electrical installation objects.
- Emissivity test, two cups, aluminum electrical plant objects plus at least two optional materials.
- Emissivity test varying corrosion and surface texture

5.4 Refresher course and experience exchange workshop

The goals are to maintain the knowledge, which achieved during the training and further to develop and update the certified person's knowledge.

The course is arranged by the certifying body, a course provider, a professional association or similar organization – must have a duration of at least 8 hours and must revise the theoretical and practical topics within these areas:
- Thermodynamics and radiation,
- infrared measurement techniques,
- job reporting,
- new laws, rules, regulations, and standards.

The course ends with an examination. The examination is by multiple-choice questions.

6 Requirements for thermographic equipment

Persons certified as qualified thermographers shall be able to validate that the equipment has the following described capacity:

- Provide direct temperature in at least one selectable point at a time on the display,
- permit the measurement of the temperature in the entire image field,
- enable digital storage of image data,
- facilitate temperature analysis on digitally stored images (on the equipment or on a computer),
- measure temperature with an accuracy of ± 2 degrees Celsius (°C) in the temperature range 0 - 100 °C ± 4 °C in the range 100 – 200 °C,
- facilitate correction for distance, emissivity and reflected background radiation,
- permit geometric resolution during the measurement: during practical use in the field, the degree of accuracy specified above must be complied with for objects with a size down to 1/50 of the display field width (objects 6 mm wide or less),
- record thermal resolution: at least 0.1 °C at 30 °C.

An equipment's technical capabilities must be specified by the manufacturer/supplier. The manufacturer/supplier of the equipment must document its accuracy with a calibration certificate. The equipment's accuracy must be checked against that of a reference equipment of known accuracy at least once per year.

7 Inspection report

7.1 General content

The report must consist of main section and error reporting. All temperature figures can be rounded to the nearest whole number. Values of emission factors are given with two valid figures.

Main section and Error reporting section must both always begin with the following information:

- Name of responsible contractor and thermographer,
- name of responsible person at client,
- time and place for the thermography.

The main section must always contain, but should not be limited to, the following:

- If possible, detailed information about surroundings and load conditions as well as weather when measuring outdoors,
- description of equipment used and date of last calibration,
- description of criteria used for misclassification,
- detailed list and unequivocal data on object type and so on for all investigated electrical installations,
- summary description of all discovered deviations and errors,
- summary of the results from the measurements.

The error reporting section must always include, but not be limited to, the following:

- Digital thermograms on all deviations, fault points,
- detail photographs, optical images,
- unambiguous description of fault location/faulty component,
- detailed data on load conditions if it does not affect electrical safety (for all phases),
- temperature measurement at the deviation (fault location),
- temperature measurement on reference, an equivalent to a point considered normal,

- accounting for the temperature increase on the deviation compared to the normal,
- indicated emission factor,
- the thermographer's assessment and analysis of errors, cause of errors and proposed measures,
- other relevant information, remarks, and observations.

7.2 Conclusions

All deviations assessed as faults in electrical installations included in the report must be categorized as:
Cat 1 = Serious deviation, should be addressed immediately.
(Risk of fire is imminent, should be addressed urgently)

Cat 2 = Serious deviation, should be addressed as soon as possible.
(Risk of fire, action should be planned as soon as possible)

Cat 3 = A minor deviation, a new check is agreed, or the fault is fixed as preventive maintenance.
(There may be a risk of fire, a new check can be arranged, or the error can be fixed as preventive maintenance)

Cat 4 = No need for action.
(For example, in case of follow-up inspection, condition picture or other views on the electrical installation)

Guideline to categorization Note! should only be considered as indicative for low voltage:
The guidance refers to connection points and electrical components in switchgear, switchboards, and apparatus cabinets, as well as similar equipment that is under a fully acceptable load <1 kV.

Guidance Cat 1 = When the temperature increase compared to normal is more than 35 °C, the absolute temperature of the deviation is more than 75 °C and there is visible damage.

Guidance Cat 2 = When the temperature increase compared to normal is between 10 and 35 °C, the absolute temperature of the deviation is less than 75 °C and there is no visible damage.

Guidance Cat 3 = When the temperature increase compared to normal is less than 10 °C and the absolute temperature is well below 70 °C. It cannot be ruled out that the slight increase in temperature may be due to normal causes.

Guideline Cat 4 = Used for follow-up inspection, condition picture or for other opinions on the electrical installation, for example if there is no contact protection.

It is always the thermographer's assessment that applies at the time of measurement, you can always categorize up or down a step depending on the overall assessment.

Guidance for high voltage is more subjective and a small increase in temperature can be very serious depending on the circumstances. The choice of categorization for faults on high-voltage installations must always be made through a total assessment based on the type of deviation, the location of the deviation, the heat pattern, amperage, temperature increase and absolute temperature, as well as the influence from the environment and the consequences of the breakdown. Generally, high voltage faults are categorized as more serious than low voltage faults.

8 Archiving

All inspection reports must be kept by the inspections company for each inspected electrical equipment involved and by the user company for a minimal duration of two inspection periods.

European guidelines

Fire (https://cfpa-e.eu/category-guidelines/fire-prevention-and-protection/)
Guideline No 1 F - Internal fire protection control
Guideline No 2 F - Panic & emergency exit devices
Guideline No 3 F - Certification of thermographers
Guideline No 4 F - Introduction to qualitative fire risk assessment
Guideline No 5 F - Guidance signs, emergency lighting and general lighting
Guideline No 6 F - Fire safety in care homes
Guideline No 7 F - Safety distance between waste containers and buildings
Guideline No 8 F - withdrawn
Guideline No 9 F - Fire safety in restaurants
Guideline No 10 F - Smoke alarms in the home
Guideline No 11 F - Recommended numbers of fire protection trained staff
Guideline No 12 F - Fire safety basics for hot work operatives
Guideline No 13 F - Fire protection documentation
Guideline No 14 F - Fire protection in information technology facilities
Guideline No 15 F - Fire safety in guest harbours and marinas
Guideline No 16 F - Fire protection in offices
Guideline No 17 F - Fire safety in farm buildings
Guideline No 18 F - Fire protection on chemical manufacturing sites
Guideline No 19 F - Fire safety engineering concerning evacuation from buildings
Guideline No 20 F - Fire safety in camping sites
Guideline No 21 F - Fire prevention on construction sites
Guideline No 22 F - Wind turbines – Fire protection guideline
Guideline No 23 F - Securing the operational readiness of fire control system
Guideline No 24 F - Fire safe homes
Guideline No 25 F - Emergency plan
Guideline No 26 F - withdrawn
Guideline No 27 F - Fire safety in apartment buildings
Guideline No 28 F - Fire safety in laboratories
Guideline No 29 F - Protection of paintings: transports, exhibition and storage
Guideline No 30 F - Managing fire safety in historic buildings
Guideline No 31 F - Protection against self-ignition end explosions in handling and storage of silage and fodder in farms
Guideline No 32 F - Treatment and storage of waste and combustible secondary raw materials
Guideline No 33 F - Evacuation of people with disabilities
Guideline No 34 F - Fire safety measures with emergency power supply
Guideline No 35 F - Fire safety in warehouses
Guideline No 36 F - Fire prevention in large tents
Guideline No 37 F - Photovoltaic systems: recommendations on loss prevention
Guideline No 38 F - Fire safety recommendations for short-term rental accommodations
Guideline No 37 F - Fire protection in schools
Guideline No 38 F - Fire safety recommendations for short-term rental accommodations
Guideline No 39 F - Fire protection in schools
Guideline No 40 F - Procedure to certify CFPA-E Fire Safety Specialists in Building Design
Guideline No 41 F - Safety instructions for the use and charging of small and medium size lithium ion powered devices

Natural hazards *(https://cfpa-e.eu/category-guidelines/natural-hazards/)*
Guideline No 1 N - Protection against flood
Guideline No 2 N - Business resilience – An introduction to protecting your business
Guideline No 3 N - Protection of buildings against wind damage
Guideline No 4 N - Lighting protection
Guideline No 5 N - Managing heavy snow loads on roofs
Guideline No 6 N - Forest fires
Guideline No 7 N - Demountable / Mobile flood protection systems
Guideline No 8 N - Ensuring supplies of firefighting water in extreme weather conditions
Guideline No 9 N - Protection against hail damage

Security *(https://cfpa-e.eu/category-guidelines/security/)*
Guideline No 1 S - Arson document
Guideline No 2 S - Protection of empty buildings
Guideline No 3 S - Security systems for empty buildings
Guideline No 4 S - Guidance on keyholder selections and duties
Guideline No 5 S - Security guidelines for museums and showrooms
Guideline No 6 S - Security guidelines emergency exit doors in non-residential premises
Guideline No 7 S - Developing evacuation and salvage plans for works of art and heritage buildings
Guideline No 8 S - Security in schools
Guideline No 9 S - Recommendation for the control of metal theft
Guideline No 10 S - Protection of business intelligence
Guideline No 11 S - Cyber security for small and medium-sized enterprises
Guideline No 12 S - Security Guidelines for Businesses

Comments and corrective actions:

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