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Performance of buildings — Detection of heat, air and moisture irregularities in buildings by infrared methods —

Part 1: General procedures

Performance des bâtiments — Détection d'irrégularités de chaleur, air et humidité dans les bâtiments par des méthodes infrarouges —

Partie 1: Modes opératoires généraux

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Contents

Page

Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 163, *Thermal performance and energy use in the built environment*, Subcommittee SC1, *Test and measurement methods,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 89, *Thermal performance of buildings and building components,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition cancels and replaces ISO 6781:1983, which has been technically revised.

The main changes are as follows:

— now comprises the first part of the ISO 6781 series, which addresses the general user of thermography and provides general requirements pertinent to thermography;

NOTE Further parts of the ISO 6781 series provide specific thermographic requirements pertinent to thermographic practitioners, and the technical requirement for thermography of specific types of buildings.

— covers general requirements concerning detection of air leakage and moisture anomalies, using thermographic methods, in addition to thermal anomalies;

— thoroughly updates the thermographic requirements resulting from the vast technological upgrades in thermography since ISO 6781:1983 was published;

— provides general information and specific constraints concerning qualitative thermography and quantitative thermography;

— provides general information and requirements regarding the qualification of thermographic operators and report writers.

A list of all parts in the ISO 6781 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Infrared building thermography provides a tool to qualitatively identify the presence of energy-wasting defects and anomalies within building structures. These defects and anomalies can include, for example, thermal insulation defects, moisture content, and / or unwanted air movement or leakage within the building enclosure.

Building thermography is carried out by means of an infrared thermography camera, which produces an image based on the apparent radiance temperature of the target surface area. The thermal radiation (infrared radiation density) from the target area is converted by the infrared thermography camera to produce a thermal image (thermogram). This image (thermogram) represents the relative intensity of thermal radiation from different parts of the surface. The radiation intensity indicated by the image is related directly to

a) the surface temperature distribution,

b) the characteristics of the surface,

c) the ambient conditions, and

d) the sensor itself.

As a result, surface temperature distribution can be a key parameter for monitoring the performance of building components, building enclosure and the diagnostics of problems. In use, via analysis of surface temperature distributions, irregularities in the heat and moisture properties of building enclosures and components, and air movement within the building enclosure, can be indicated. These irregularities can be due to, for example, thermal insulation defects, moisture content, air leakage within components or through assemblies, or incorrect installation of components which comprise the construction of the building.

To realize its full utility as an initial qualitative screening technique, or an in-depth diagnostic technique, thermography must often be supported and/or validated by other methods. These methods include, but are not limited to, infrared photosensitive tracer gas methods, fan pressurization of the building enclosure, heat-flow metres, smoke diffusion, anemometry, moisture metres and relative humidity (RH) sensors.

Infrared building thermography inspection methodologies can be used for either new-construction quality control applications or in existing buildings as ongoing condition monitoring for periodic or specific building-condition reporting. The latter applications may be accompanied with visual fault symptoms, while the former may not necessarily present symptoms via visual faults.

Performance of buildings — Detection of heat, air and moisture irregularities in buildings by infrared methods —

Part 1: General procedures

1 Scope

This document specifies requirements and methodologies for infrared thermographic services for detection of heat, air and moisture irregularities in buildings that help users to specify and understand

a) the extent of thermographic services required,

b) the type and condition of equipment available for use,

c) the qualifications of equipment operators, image analysts, and report authors and those making recommendations, and

d) the reporting of results.

It provides guidance to understanding and utilizing the final results stemming from provision of the thermographic services.

This document is applicable to the general procedures for infrared thermographic methods as can be applied to residential, commercial, and institutional and special use buildings.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6781-3, *Performance of buildings — Detection of heat, air and moisture irregularities in buildings by infrared methods — Part 3: Qualifications of equipment operators, data analysts and report writers*

ISO 7345, *Thermal performance of buildings and building components — Physical quantities and definitions*

ISO 9288, *Thermal insulation — Heat transfer by radiation — Vocabulary*

ISO 9869-1, *Thermal insulation — Building elements — In-situ measurement of thermal resistance and thermal transmittance — Part 1: Heat flow meter method*

ISO 9972, *Thermal performance of buildings — Determination of air permeability of buildings — Fan pressurization method*

ISO 10878, *Non-destructive testing — Infrared thermography — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7345, ISO 9288, ISO 10878 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1 General terms

3.1.1
system
regularly interacting or interdependent group of associated entities (e.g. components, factors, members, parts) forming an integrated whole and delineated by its spatial and temporal boundaries

Note 1 to entry: One or more of the associated entities define the boundary of the system.

3.1.2
analysis
careful scrutiny of constituent parts of a *system* (3.1.1) in order to thoroughly understand the whole

3.1.3
function
functional purpose of the building, building component or building *system* (3.1.1)

Note 1 to entry: The function is the activity assigned to, required of, or expected of the system.

3.1.4
residential building
building meeting the parameters defined in local building codes as small/residential building and as agreed with the customer receiving thermographic services

3.1.5
parameter
numerical or other measurable factor forming one of a set that sets the conditions for measurement, or defines the system and its operation

3.1.6
performance
behaviour, characteristics and efficiency of a building, building component or building *system* (3.1.1)

3.1.7
sign
characteristic parameter of a signal, which shows information about a state

3.1.8
symptom
perception, made by means of human observations and measurements (descriptors), which may indicate the presence of one or more *faults* (3.1.12) with a certain probability

3.1.9
syndrome
group of *signs* (3.1.7) or *symptoms* (3.1.8) that collectively indicate or characterize an abnormal condition

3.1.10
anomaly
something that deviates from what is standard, normal or expected, and an *irregularity* (3.1.12) or *abnormality* (3.1.11) in a *system* (3.1.1)

3.1.11
abnormality
deviation from a standard condition

3.1.12
irregularity
condition which significantly departs from the operational norm

3.1.13
fault
condition that occurs when a building or one of its components or assemblies degrades or exhibits abnormal behaviour, which may lead to the *failure* (3.1.14) to perform in accordance with its design intent

Note 1 to entry: A fault can be the result of a failure, but can exist without a failure.

Note 2 to entry: Planned actions or lack of external resources are not a fault.

3.1.14
fault propogation
characterization of the change in severity of a *fault* (3.1.12) over time

3.1.15
failure
termination of the ability of an item to perform a required *function* (3.1.4)

Note 1 to entry: Failure is an event as distinguished from *fault* (3.1.12), which is a state.

3.1.16
failure mode
effect by which a *failure* (3.1.14) is observed

3.1.17
diagnostics
examination of *symptoms* (3.1.8) and *syndromes* (3.1.9) to determine the nature of *faults* (3.1.12) or *failures* (3.1.14) (i.e. kind, situation, extent)

3.1.18
root cause
either a set of conditions or actions, or both, that occur at the beginning of a sequence of events and result in the initiation of a *failure mode* (3.1.15)

3.1.19
root cause failure analysis
RCFA
after a failure, the logical systematic examination of an item, its construction, application and documentation in order to identify the *failure mode* (3.1.15) and determine the failure mechanism and its basic cause

Note 1 to entry: Root cause failure analysis is often used to provide a solution to chronic problems.

3.1.20
prognostics
analysis of the symptoms of *faults* (3.1.12) to predict a future condition and remaining useful life

3.1.21
prognosis
result of the prognostics process

3.1.22
qualitative
relating to measuring, or measured by the quality of something, rather than its quantity

3.1.23
quantitative
relating to measuring, or measured by the quantity of something, rather than its general qualities

3.2 Thermography terms

3.2.1
infrared
IR
portion of the electromagnetic spectrum extending from the red visible wavelength, 0,75 µm to 1 mm

Note 1 to entry: Because of instrument design and infrared transmission characteristics of the atmosphere, most infrared measurements are made between 0,75 µm and 15 µm wavelengths.

3.2.2
thermography
representation of the temperature distribution of a surface, in a thermal image

3.2.3
thermographic analysis
interpretation and determination of the casual mechanisms producing variations and irregularities in the thermal image

3.2.4
quantitative thermographic examination
examination of whole buildings, structures or components using thermographic methods with the objective of providing *quantitative* (3.1.22) output

Note 1 to entry: Reporting requirements for both qualitative and quantitative examinations are specified in Clause 19.

3.2.5
infrared thermography camera
IRT camera
instrument that collects the infrared radiant energy from a target surface and produces a monochrome (black and white) or colour image, where the grey shades (monochrome) or colour hues are related to the target surface apparent temperature

3.2.6
thermal image
image which is produced by an infrared thermography camera and which represents the apparent radiance temperature distribution over the target surfaces

Note 1 to entry: Such images are sometimes called "infrared thermograms".

3.2.7
temperature isotherm
enhancement feature applied to an image, which marks an interval of equal apparent temperature

3.2.8
radiation density isotherm
region on an infrared (IR) (3.2.1) display consisting of points, lines or areas having the same infrared radiation density

3.2.9
isotherm image
output from an infrared thermography camera showing *temperature isotherms* (3.2.7) and *radiation density isotherms* (3.2.8)

3.2.10
ironbow palette image
image comprising a colour palette running from black through blue, magenta, orange, yellow to white that creates best contrast, in particular regarding edges and shapes

3.2.11
image interpretation
processing and comparing apparent surface temperatures and thermal patterns against those representative of the ideal design, construction, installation and maintenance criteria

Note 1 to entry: In the case of a thermal image or thermogram this can include temperature scaling, spot temperature measurements, thermal profiles, image manipulation, subtraction and storage.

3.2.12
apparent temperature
uncompensated reading from an infrared thermography camera containing all radiation incidents on the detector, regardless of its source

3.2.13
attenuating media
windows, filters, atmospheres, external optics, materials or other media that attenuate the infrared radiation emitted from a source

3.2.14
black body
ideal perfect emitter and absorber of thermal radiation at all wavelengths

Note 1 to entry: The *emissivity* (3.2.15) of a black body is 1... ε = 1.

Note 2 to entry: This is described by Planck's law.

3.2.15
emissivity
ε
ratio of a target surface's radiance to that of a *black body* (3.2.14) at the same temperature and over the same spectral interval

3.2.16
total radiance
radiant heat flow rate divided by the solid angle around the direction Δ and the projected area normal to this direction

Note 1 to entry: Radiance includes emitted radiation from a surface as well as reflected and transmitted radiation.

3.2.17
apparent radiance temperature
temperature determined from the measured total radiance

Note 1 to entry: This temperature is the equivalent *black body* (3.2.14) temperature which would produce the same total radiance.

3.2.18
reflectivity
ρ
ratio of the total reflected energy from a surface to total incident energy on that surface

Note 1 to entry: $\rho = 1 - \varepsilon - \tau$; for a mirror, reflectivity approaches 1,0; for a black body, $\rho = 0$.

Note 2 to entry: Technically, reflectivity is the ratio of the intensity of the reflected radiation to the total radiation; reflectance is the ratio of the reflected flux to the incident flux. In infrared thermography (IRT), the two terms are often used interchangeably.

3.2.19
reflected apparent temperature
T_{refl}
apparent temperature of other objects that are reflected by the target into the thermography camera