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## Byggnaders termiska egenskaper – Kvalitativ metod för lokalisering av termiska ofullkomligheter i klimatskärmen – Infraröd metod (värmekamera)

*Thermal performance of buildings – Qualitative detection of thermal irregularities in building envelopes – Infrared method*

Europastandarden EN 13187:1998 gäller som svensk standard. Detta dokument innehåller den engelska språkversionen av EN 13187:1998.

I SS-EN 13187 beskrivs en kvalitativ metod för lokalisering av termiska ojämnheter, inklusive lufttäthet, i byggnadens klimatskärm med hjälp av värmekamera. Resultatet som erhålls vid termografering måste tolkas och bedömas av personer som har erforderlig kompetens. Standarden omfattar inte kvantitativ bestämning av konstruktionens värmemotstånd eller lufttäthet.

SS-EN 13187 ersätter SS 02 42 10, Värmeisolering – Termografering av hus (utgåva 2 från 1986).

Motsvarigheten och aktualiteten i svensk standard till de publikationer som omnämns i denna standard framgår av ”Katalog över svensk standard”, som årligen ges ut av SIS. I katalogen redovisas internationella och europeiska standarder som fastställts som svenska standarder och övriga gällande svenska standarder.



EUROPEAN STANDARD

**EN 13187**

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Descriptors: buildings, walls, thermal insulation, quality control, tests, infrared radiation, defects, fault detectors

English version

**Thermal performance of buildings - Qualitative detection of thermal irregularities in building envelopes - Infrared method (ISO 6781:1983 modified)**

Performance thermique des bâtiments - Détection qualitative des irrégularités thermiques sur les enveloppes de bâtiments - Méthode infrarouge (ISO 6781:1983, modifiée)

Wärmetechnische Verhalten von Gebäuden - Qualitativer Nachweis von Wärmebrücken in Gebäudehüllen - Infrarot-Verfahren (ISO 6781:1983, modifiziert)

This European Standard was approved by CEN on 12 November 1998.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.



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EUROPÄISCHES KOMITEE FÜR NORMUNG

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## Foreword

This European Standard has been prepared by Technical Committee CEN/TC 89 "Thermal performance of buildings and building components", the secretariat of which is held by SIS.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 1999, and conflicting national standards shall be withdrawn at the latest by May 1999.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

It is based on International Standard ISO 6781:1983, Thermal insulation – Qualitative detection of thermal irregularities in building envelopes - Infrared method, which was modified to take account of the development of equipment performance and inspection practice. The main modification is the addition of a procedure for "Simplified testing with an IR camera".

This standard is one of series of standards for the design and evaluation of thermal performance of buildings and building components.

## Introduction

Irregularities in the thermal properties of the components constituting the external envelope of a building result in temperature variations over the surfaces of the structure. The surface temperature is also influenced by air flow within and/or through the envelope of the building. The surface temperature distribution can thus be used to detect thermal irregularities due, for example, to insulation defects, moisture content and/or air leakage, in the components constituting the external envelope of the building.

Building thermography is a method of indicating and representing the temperature distribution over a part of the surface of a building envelope. In the context of

this standard, thermography is carried out by means of an infrared radiation sensing system which produces an image based on the apparent radiance temperature of the measured target area. The thermal radiation (infrared radiation density) from the target area is converted by the infrared radiation sensing system to produce a thermal image representing the relative intensity of thermal radiation from different parts of the surface. The intensity of the image is a function of the surface temperature, the characteristics of the surface, the ambient conditions and the sensor itself. The measurement procedure also involves interpretation of the thermal images (thermograms).

## 1 Scope

This standard specifies a qualitative method, by thermographic examination, for detecting thermal irregularities in building envelopes. The method is used initially to identify wide variations in the thermal properties, including air tightness, of the components constituting the external envelopes of buildings.

In this standard two forms of thermography are specified:

*Testing with an IR camera* is primarily intended for the inspection of the overall performance of new buildings or the result after a rebuilding operation.

*Simplified testing with an IR camera* is suitable when carrying out audits, e.g. at the site of a rebuilding project or at production control or other routine inspections.

These two adaptations differ mainly with regard to the reporting and the presentation of results.

The results obtained by means of this method have to be interpreted and assessed by persons who are specially trained for this purpose.

This standard applies to the determination of the location of thermal irregularities and to the location of air leakage paths through the enclosure. This standard does not apply to the determination of the degree of thermal insulation and air tightness of a structure. For such determinations, examinations by other methods are required.

## 2 Normative references

This standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN ISO 7345	Thermal Insulation – Physical quantities and definitions (ISO 7345:1987)
EN ISO 9288:1996	Thermal insulation – Heat transfer by radiation – Physical quantities and definitions (ISO 9288:1989)

## 3 Definitions

For the purposes of this standard, the definitions in EN ISO 7345 and EN ISO 9288 the following definitions apply:

**3.1 thermography:** Determination and representation of surface temperature distribution by measuring the infrared radiant density from a surface, including interpretation of casual mechanisms producing the irregularities in the thermal images.

**3.2 thermal image:** Image which is produced by an infrared radiation sensing system and which represents the apparent radiance temperature distribution over a surface.

**3.3 thermogram:** A thermal image, documented by a photograph of the camera display, by a recording on a video tape or a digital data diskette or as a file on a computer or hard disk drive.

**3.4 total radiance:** Radiant heat flow rate divided by the solid angle around the direction  $\bar{\Delta}$  and the projected area normal to this direction. [EN ISO 9288:1996]

NOTE: Radiance includes emitted radiation from a surface as well as reflected and transmitted radiation.

**3.5 apparent radiance temperature:** Temperature determined from the measured total radiance.

NOTE: This temperature is the equivalent black body temperature which would produce the same total radiance.

**3.6 isotherm image:** Thermal image with isotherms.

**3.7 isotherm:** A region on the display consisting of points, lines or areas having the same infrared radiation density.

**3.8 IR camera:** An infrared radiation sensing system which produces a thermal image based on the apparent radiance temperature

## 4 Principle

Thermographic examination of parts of buildings comprises:

- a) determination of the surface temperature distribution over a part of a building envelope, from the apparent radiance temperature distribution obtained by means of an infrared radiation sensing system;
- b) ascertaining whether this surface temperature distribution is 'abnormal', i.e. if it is due, for example, to insulation defects, moisture content and/or air leakage;
- c) if so, assessment of the type and the extent of defects.

In order to determine whether the observed variations in the thermal insulation properties are abnormal, the thermograms obtained are compared with the anticipated temperature distribution over the surface, determined by the design characteristics of the building envelope and by the environment at the time of examination. The anticipated temperature distributions can be determined by means of 'reference thermograms' (see 5.3 and annexes A, B and C), calculations or other investigations. This determination is based on drawings and other documents relating to the external envelope and to the heating and ventilation system of the building under investigation.

The general procedure for the interpretation of thermal images is represented schematically in figure 1.

## 5 Infrared radiation sensing system

The infrared radiation sensing system shall comprise

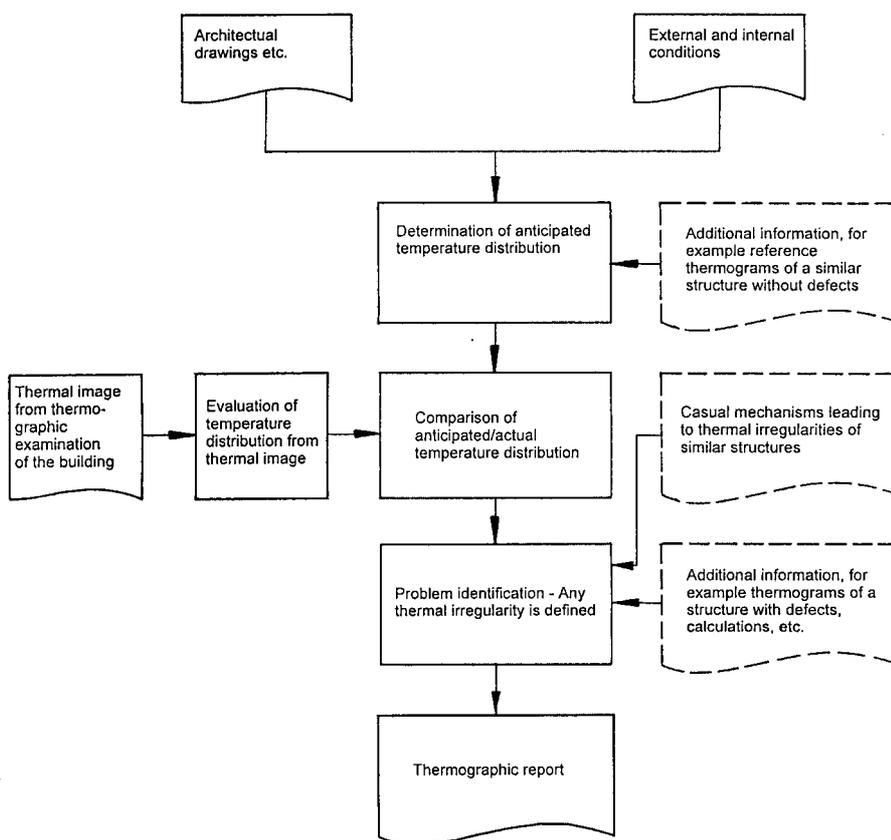
- a) an infrared radiation sensor, operating at a wavelength between 2 and 12  $\mu\text{m}$ , which can sense apparent radiance temperatures of interest with sufficient resolution<sup>1)</sup>;

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1) Experience in field tests has shown that a minimum resolvable temperature difference of 0,3 °C at a surface temperature of 20 °C and at a spatial frequency of 0,052 cycle/mm would be sufficient for the purposes of this standard.

- b) a device which renders visible and displays, in the form of a thermal image, the apparent radiance temperature over the surface being examined;
- c) a device which makes it possible to record the thermal image and, if relevant, measured digital data;
- d) a means of establishing temperature levels on the surface under examination.

During the test period, no significant drift in the infrared radiation sensing system shall occur.



Dotted boxes indicate suggested use of additional information.

Figure 1: General procedure for the interpretation of thermal images in thermographic examinations

## 6 Thermographic examination

### 6.1 General test requirements

In order to define the actual test requirements, and in particular the side of the building envelope (outdoors or indoors) from which the thermographic examination is to be performed, the following factors need to be considered:

- a) the specifications and capabilities of the thermographic equipment;
- b) the characteristics of the building envelope, i.e. the respective types and locations of heating systems, structural elements and insulating layers;
- c) the radiative properties of the surface, e.g. the cladding materials;
- d) climatic factors;
- e) accessibility for easy inspection;
- f) influences of the environment;
- g) other factors of importance.

The temperature difference across the envelope shall be sufficiently large to permit the detection of thermal irregularities. For ease of interpretation, the thermographic examination should preferably be carried out with constant temperature and pressure differences across the envelope. (The interpretation of thermograms taken under non-steady state conditions requires a higher degree of expertise and knowledge of building physics.) This implies, among other things, that the test shall not be carried out when the outside or inside air temperature is liable to vary considerably, or when the structure is exposed to direct solar radiation, or when the wind varies markedly.

These general requirements shall be considered when a thermographic examination is carried out. The actual requirements may be varied according to the thermal properties of the building envelope under examination and the characteristics of the infrared radiation sensing system used. They may also be varied to take account of the local climate. The conditions shall be taken into account when carrying out the examination and when evaluating the thermograms, and shall be carefully recorded in the thermographic report (see clause 7).

NOTE: An example of an actual set of test requirements, applicable to Scandinavian conditions, is given in annex D. Special national conditions may justify other sets of test requirements to ensure approximate steady state conditions.

## 6.2 Procedure

When available, drawings and other documents relating to the building envelope to be examined shall be consulted. The emissivity of the surface materials shall be estimated from appropriate tables.

Information concerning outside air temperature, cloudiness, precipitation and any moisture on the outside of the building, together with wind conditions, shall be recorded. The orientation of the building with respect to the points of the compass shall also be recorded.

If air leakages are relevant to the examination, a pressure difference shall be produced across the building envelope, or the examination shall be carried out at an appropriate time such that a pressure difference exists. If the main purpose of the thermographic examination is to locate air leakages, the pressure difference shall be at least 5 Pa at the location of the inspection. The thermographic examination shall be carried out from the low pressure side.

The effects produced by ventilated air layers, for example in walls or by heat sources (if any) installed in the building (embedded pipes, smoke ducts, etc.), on the temperature of the envelope under examination shall be estimated. If possible, heat sources that might interfere with the examination shall be shut off before the start of the examination. Furniture, pictures, etc., that might influence the result, shall be removed so that the test areas are unobstructed. The changes required shall be made in a way that avoids transient effects.

Immediately before the start of the examination, the inside and outside air temperatures shall be determined to an accuracy of  $\pm 1$  °C. When the pressure difference across the envelope is to be determined, it is recommended that this be measured to an accuracy of  $\pm 2$  Pa over the leeward and windward side for each storey. The observed values shall be recorded. It is especially important to identify the direction of the pressure difference across the section of the building envelope and the position of the neutral plane, if any.

Anticipated temperature distributions for the envelope under investigation shall be selected, taking into consideration the conditions for the examination.

The infrared radiation sensing system shall be set and adjusted in accordance with the directions for its use. The sensitivity, the range and the aperture, as appropriate, shall be set to cover the temperature range of the surface being studied.