INTERNATIONAL STANDARD

ISO 14934-1

First edition
2010-06-15

Fire tests — Calibration and use of heat flux meters —

Part 1: General principles

Essais au feu — Étalonnage et utilisation des appareils de mesure du flux thermique —

Partie 1: Principes généraux

Reference number
ISO 14934-1:2010(E)

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Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 14934-1 was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 1, *Fire initiation and growth*.

This first edition of ISO 14934-1 cancels and replaces ISO/TS 14934-1:2002, which has been technically revised.

ISO 14934 consists of the following parts, under the general title *Fire tests — Calibration and use of heat flux meters*:

— *Part 1: General principles*

— *Part 2: Primary calibration methods*

— *Part 3: Secondary calibration method*

— *Part 4: Guidance on the use of heat flux meters in fire tests* [Technical Specification]

Introduction

In many fire test methods, the radiation level is specified and therefore, it is of great importance that the radiant heat flux be well defined and measured with sufficient accuracy. Radiant heat transfer is also the dominant mode of heat transfer in most real fires.

In practice, radiant heat flux is usually measured with so-called total heat flux meters of the Schmidt-Boelter (thermopile) or Gardon (foil) type. It is important to realize that such meters always register a combined heat flux from radiation and convection. It is also important to realize that the total heat flux meters register the heat flux to a cooled surface which is not the same level of heat flux that a non-cooled surface receives. Finally, the only heat transfer that is well defined is the incident radiant heat of the calibration situation in the black-body radiant sources used for primary calibration.

This part of ISO 14934 gives the terms and definitions intended for use with the other parts, namely ISO 14934-2 (three primary methods for calibration of heat flux meters), ISO 14934-3 (conduct of secondary calibration) and ISO/TS 14934-4 (construction and use of different types of heat flux meters).

Fire tests — Calibration and use of heat flux meters —

Part 1: General principles

1 Scope

This part of ISO 14934 specifies the terms and definitions for the calibration and use of heat flux meters (see ISO 14934-2, ISO 14934-3 and ISO/TS 14934-4). It also describes the relationship between output voltage and total heat flux. It gives uncertainty components that are relevant for the calibration and use of heat flux meters (see Clause 7).

This part of ISO 14934 does not contain the methods for the calibration of heat flux meters, which are covered in ISO 14934-2 and ISO 14934-3.

2 Normative references

The following referenced documents are indispensable for the application of this document and for the other parts of ISO 14934. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 13943:2008, *Fire safety — Vocabulary*

ISO 14934-2, *Fire tests — Calibration and use of heat flux meters — Part 2: Primary calibration methods*

ISO 14934-3, *Fire tests — Calibration and use of heat flux meters — Part 3: Secondary calibration method*

ISO/TS 14934-4, *Fire tests — Calibration of heat flux meters — Part 4: Guidance on the use of heat flux meters in fire tests*

ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

ISO/IEC Guide 99, *International vocabulary of metrology — Basic and general concepts and associated terms (VIM)*

ASTM E511, *Standard Test Method for Measuring Heat Flux Using a Copper-Constantan Circular Foil Heat-Flux Transducer*

ASTM E2683, *Standard Test Method for Measuring Heat Flux Using Flush-Mounted Insert Temperature-Gradient Gages*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13943, ISO/IEC Guide 98-3 and ISO/IEC Guide 99 and the following apply.

NOTE The definitions are listed as primary and secondary definitions. The secondary definitions are developed from the primary definitions. The definitions are listed according to the hierarchy of the concepts.

3.1 Primary definitions

3.1.1
radiation
emission or transfer of energy in the form of electromagnetic waves with the associated photons

NOTE See Reference [1].

3.1.2
heat
energy transferred from one body or system to another due to a difference in temperature

NOTE 1 See Reference [3].

NOTE 2 Heat is expressed in joules.

3.1.3
heat transfer
transfer of energy from one body or system to another as a result of a difference in temperature

EXAMPLE **Radiative heat transfer** (3.2.1), **convective heat transfer** (3.2.2) or conductive heat transfer.

NOTE 1 The bodies can be a gas, liquid, solid body, or some combination.

NOTE 2 Heat transfer is expressed in watts.

NOTE 3 Adapted from definition of 'heat transfer' contained in Reference [3].

3.1.4
convection
transfer of heat by movement of a fluid

[ISO 13943:2008, definition 4.54]

3.1.5
heat flux
amount of thermal energy emitted, transmitted or received per unit area and per unit time

NOTE 1 Heat flux for fire testing purposes is expressed in watts per square metre.

NOTE 2 Outside the fire testing field this definition is given as "heat flux density".

NOTE 3 Adapted from ISO 13943:2008, definition 4.173.

3.1.6
radiosity
total of radiative heat flux emitted and radiative heat flux reflected leaving a surface when no radiative heat flux is transmitted

NOTE 1 See Reference [4].

NOTE 2 This definition is relevant to method 1 of ISO 14934-2.

NOTE 3 Radiosity is expressed in watts per square metre.

3.1.7
black-body radiation source
ideal thermal radiation source which completely absorbs all incident heat radiation, whatever wavelength and direction

NOTE 1 Adapted from ISO 80000-7:2008.

NOTE 2 A more physical definition of black body radiation source is given in ISO 13943.

3.1.8
irradiance
incident radiative heat flux arriving from all hemispherical directions

NOTE Irradiance is expressed in watts per square metre.

3.1.9
emissivity
ratio of the radiation emitted by a radiant source to the radiation that would be emitted by a **black-body radiation source** (3.1.7) at the same temperature

NOTE Emissivity is dimensionless.

[ISO 13943:2008, definition 4.75]

3.1.10
absorptivity
ratio of the absorbed radiant heat flux to the incident radiative heat flux

NOTE Absorptivity is dimensionless.

3.1.11
radiative intensity
radiative heat flux per unit solid angle leaving a source in a given direction

NOTE 1 Radiative intensity is expressed in watts per steradian.

NOTE 2 See Reference [5].

3.1.12
heat flux meter
instrument responding to incident radiative heat transfer, or convective heat transfer to a cooled surface, or both

3.1.13
radiometer
heat flux meter responding to incident radiative heat flux only

3.1.14
total hemispherical radiometer
radiometer equally sensitive to radiative intensity arriving from all directions above the sensing surface

3.1.15
total heat flux meter
heat flux meter responding to both incident radiative heat transfer and convective heat transfer to a cooled surface

NOTE The expression “heat flux meter” without the denotation “total” is typically used only when it is not specified whether the instrument is a radiometer or a total heat flux meter.

3.1.16
primary standard
standard that is designated or widely acknowledged as having the highest metrological qualities and whose value is accepted without reference to other standards of the same quantity

[ISO/IEC Guide 99]

3.1.17
secondary standard heat flux meter
heat flux meter with a calibration traceable to a primary standard, used only for calibration of working-standard heat flux meters

3.1.18
working-standard heat flux meter
heat flux meter calibrated by reference to a secondary standard for subsequent use during the course of fire tests

3.1.19
sensing surface
surface of the heat flux meter that detects the irradiance

3.1.20
sensitivity
ratio of the output voltage to the measured quantity

3.1.21
Stefan-Boltzmann constant
σ
constant of proportionality in the expression in the Stefan-Boltzmann law for calculating the radiative heat flux from the absolute temperature

NOTE 1 This constant is equal to 5,670 400 $\times$ 10^{-8} watts per square metre and per kelvin to the fourth power.

NOTE 2 See Reference [2].

3.2 Secondary definitions

3.2.1
radiative heat transfer
heat transfer by radiation

NOTE Radiative heat transfer is expressed in watts.

3.2.2
convective heat transfer
transfer of heat to a surface from a surrounding fluid by convection (3.1.4)

NOTE The amount of heat transfer depends on the temperature difference between the fluid and the surface, the fluid properties and the fluid velocity and direction.

3.2.3
total heat transfer
sum of the radiant heat transfer and the convective heat transfer

3.2.4
incident heat radiation
incoming radiative heat

3.2.5
absorbed heat radiation
radiative heat absorbed by a surface

3.2.6
emitted heat radiation
radiant heat emitted from a surface

3.2.7
net heat radiation
difference between the absorbed heat radiation and the emitted heat radiation

3.2.8
radiative heat flux
heat flux by radiative heat transfer

NOTE 1 The adjectives radiative and radiant are interchangeable and both terms are used in ISO 14934 (all parts).

NOTE 2 **Radiosity** (3.1.6) is a similar but not fully synonymous expression.

NOTE 3 Radiant or radiative heat flux is expressed in watts per square metre.

3.2.9
convective heat flux
heat flux by convective heat transfer

NOTE Convective heat flux is expressed in watts per square metre.

3.2.10
total heat flux
sum of net radiant heat flux and convective heat flux

NOTE Total heat flux is expressed in watts per square metre.

4 Symbols

$\dot{q}''_{tot}$	total heat flux to the sensing surface
$\dot{q}''_{rad}$	heat radiation absorbed by the sensing surface
$\dot{q}''_{emi}$	emitted heat radiation from the sensing surface
$\dot{q}''_{con}$	convective heat transfer to the sensing surface
T_{∞}	absolute ambient temperature
ε	absorptivity of the sensing surface; the absorptivity and the emissivity of the sensing surface are assumed equal
I_{rad}	incident heat radiation as defined by the calibration method (see Clause 7); the view angle dependence for the method is included in the value
T_w	absolute temperature of the cooling water, which is assumed to also represent the temperature of the heat flux meter
A_0, A_1, A_2	constants to be determined by the calibration procedure in a best-fit procedure as described in Clause 7