
Reaction-to-fire tests — Heat release, smoke production and mass loss rate —

Part 2: Smoke production rate (dynamic measurement)

*Essais de réaction au feu — Débit calorifique, taux de dégagement de
fumée et taux de perte de masse —*

Partie 2: Taux de dégagement de fumée (mesure dynamique)

Reference number
ISO 5660-2:2002(E)

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Printed in Switzerland

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 part of ISO 5660 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 5660-2 was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 1, *Fire initiation and growth*.

ISO 5660 consists of the following parts, under the general title *Reaction-to-fire tests — Heat release, smoke production and mass loss rate*:

- *Part 1: Heat release rate (cone calorimeter method)*
- *Part 2: Smoke production rate (dynamic measurement)*
- *Part 3: Guidance on heat and smoke release rate*

Annexes A, B and C of this part of ISO 5660 are for information only.

Reaction-to-fire tests — Heat release, smoke production and mass loss rate —

Part 2:

Smoke production rate (dynamic measurement)

1 Scope

This part of ISO 5660 specifies a small-scale method for assessing the dynamic smoke production rate of essentially flat specimens exposed to controlled levels of radiant heating under well-ventilated conditions with or without an external igniter. The rate of smoke production is calculated from measurement of the attenuation of a laser light beam by the combustion product stream. Smoke obscuration is recorded for the entire test, regardless of whether the specimen is flaming or not.

The measurement system prescribed by this part of ISO 5660 is an extension of the apparatus described in ISO 5660-1. Therefore, this part of ISO 5660 is used in conjunction with ISO 5660-1.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 5660. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 5660 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 5660-1:2002, *Reaction-to-fire tests — Heat release, smoke production and mass loss rate — Part 1: Heat release rate (cone calorimeter method)*

ISO 13943:2000, *Fire safety — Vocabulary*

3 Terms and definitions

For the purposes of this part of ISO 5660, the terms and definitions given in ISO 5660-1 and ISO 13943 and the following apply.

3.1

smoke obscuration

reduction, usually expressed as a percentage, in the intensity of light due to its passage through smoke

3.2

extinction coefficient

natural logarithm of the ratio of incident light intensity to transmitted light intensity, per unit light path length

3.3

smoke production

integral of the smoke production rate over the time interval being considered

3.4

smoke production rate

product of the volumetric flow rate of smoke and the extinction coefficient of the smoke at the point of measurement

4 Symbols

See Table 1.

Table 1 — Symbols and their designation

Symbol	Designation	Units
A	Exposed surface area of specimen	m^2
D'	Optical density	1
$\dot{m}_e$	Mass flow rate in exhaust duct	$\text{kg} \cdot \text{s}^{-1}$
F	Calibration factor	m^{-1}
I_0/I	Ratio of incident light to transmitted light	1
k	Linear Napierian absorption coefficient (commonly called extinction coefficient)	m^{-1}
k_1	Measured calibration extinction coefficient	m^{-1}
k_2	Calculated calibration extinction coefficient	m^{-1}
k_m	Measured extinction coefficient	m^{-1}
L	Light path length through smoke	M
m_{ig}	Specimen mass at ignition (sustained flaming)	kg
m_t	Specimen mass at the end of the test	kg
$\dot{m}$	Mass loss rate of specimen	$\text{kg} \cdot \text{s}^{-1}$
Δm	Specimen mass loss	kg
M	Molecular mass of the gases flowing through the exhaust duct	$\text{kg} \cdot \text{mol}^{-1}$
S	Total smoke production	m^2
S_A	Total smoke production per unit area	$\text{m}^2 \cdot \text{m}^{-2}$
$S_{A,1}$	Total smoke production per unit area before ignition	$\text{m}^2 \cdot \text{m}^{-2}$
$S_{A,2}$	Total smoke production per unit area after ignition	$\text{m}^2 \cdot \text{m}^{-2}$
P_s	Smoke production rate	$\text{m}^2 \cdot \text{s}^{-1}$
$P_{s,A}$	Smoke production rate normalized to the specimen area	$\text{s}^{-1} \left[= (\text{m}^2 \cdot \text{s}^{-1}) / \text{m}^2 \right]$
Δt	Sampling time interval	s
T_s	Temperature of the smoke at the point of measurement	K
$\dot{V}_s$	Volume flow rate of smoke at the point of measurement	$\text{m}^3 \cdot \text{s}^{-1}$
ρ	Density	$\text{kg} \cdot \text{m}^{-3}$
σ	Specific extinction area	$\text{m}^2 \cdot \text{kg}^{-1}$

NOTE Detailed discussion of some of these parameters and their units is given in reference [12].

5 Principle

This test method is based on the observation that, generally, the intensity of light that is transmitted through a volume of combustion products is an exponentially decreasing function of distance. This is commonly referred to as Bouguer's law. Specimens in the test are burned in ambient air conditions, while being subjected to a predetermined external irradiance within the range $0 \text{ kW} \cdot \text{m}^{-2}$ to $100 \text{ kW} \cdot \text{m}^{-2}$ and measurements are made of smoke obscuration, exhaust gas flow rate, and mass loss rate of the specimen. Smoke obscuration is measured as the fraction of laser light intensity that is transmitted through the smoke in the exhaust duct. This fraction is used to calculate the extinction coefficient according to Bouguer's law. The test results are reported in terms of smoke production and smoke production rate—both normalized to the exposed specimen surface area. Smoke production rate is calculated as the product of the extinction coefficient and the volume flow rate of the smoke in the exhaust duct. Smoke