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Interested committees:

Title: Draft BS ISO 5660-5 Reaction-to-fire tests — Heat release, smoke production and mass loss rate. Part 5: Heat release rate (cone calorimeter method) and smoke production rate (dynamic measurement) under reduced oxygen atmospheres.

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



DRAFT International Standard

ISO/DIS 5660-5

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

Part 5: Heat release rate (cone calorimeter method) and smoke production rate (dynamic measurement) under reduced oxygen atmospheres

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

Partie 5: Débit calorifique (méthode au calorimètre à cône) et taux de dégagement de fumée (mesurage dynamique) dans des atmosphères pauvres en oxygène

ICS: 13.220.50

This document is circulated as received from the committee secretariat.

ISO/TC 92/SC 1

Secretariat: **BSI**

Voting begins on:
2025-07-23

Voting terminates on:
2025-10-15

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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.

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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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

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

A list of all parts in the ISO 5660 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.

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

Part 5: Heat release rate (cone calorimeter method) and smoke production rate (dynamic measurement) under reduced oxygen atmospheres

1 Scope

This document specifies the apparatus and procedure for measuring reaction to fire behaviour under reduced oxygen atmospheres. Continuous measurements are made to calculate heat release rates, smoke and specific gas production rates, and mass loss rates. Ignition time measurements are also made and ignition behaviour is obtained. Pyrolysis parameters of specimens exposed to controlled levels of irradiance and controlled levels of oxygen supply can be determined as well.

Different reduced oxygen atmospheres in the test environment are achieved by controlling the oxygen volume concentration of input gas fed into the chamber (vitiation) or by controlling the total volume of atmosphere fed into the chamber (ventilation). Ranges of oxygen volume concentration below 20,95 % of oxygen can be studied. The apparatus is not intended to control enriched oxygen conditions above atmospheric 20,95 % oxygen concentration.

The measurement system prescribed in this document is based on the cone calorimeter apparatus described in ISO 5660-1. Therefore, this document is intended to be used in conjunction with ISO 5660-1.

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 5660-1:2015+A1:2019, *Reaction-to-fire tests — Heat release, smoke production and mass loss rate — Part 1: Heat release rate (cone calorimeter method) and smoke production rate (dynamic measurement)*

ISO 13927:2023, *Plastics — Simple heat release test using a conical radiant heater and a thermopile detector*

ISO 13943, *Fire safety — Vocabulary*

3 Terms and definitions

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

ISO and IEC maintain terminological 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**ambient atmosphere**

atmosphere with an oxygen volume concentration of approximately 20,95 % in a control volume and unrestricted air flow into the same control volume

3.2**reduced oxygen atmosphere**

atmosphere with either one of the following conditions that differ from ambient atmospheres:

- a) vitiated atmosphere: atmosphere with less oxygen molecules than in ambient air in the same volume at same temperature and pressure levels (oxygen concentration below 20,95 %; vitiated conditions), with the remaining molecules balanced by inert gas molecules
- b) under ventilated atmosphere: atmosphere with a limited air supply that leads to fewer oxygen molecules per time supplied to a combustion reaction than needed to allow stoichiometric reactions to take place (under-ventilated conditions)

3.3**vitiation-controlled conditions**

conditions under which the volume concentration of oxygen is intentionally controlled or reduced in the combustion environment

Note 1 to entry: Vitiation-controlled conditions represent an oxygen depleted fire environment.

3.4**ventilation-controlled conditions**

conditions in which the supply rate of (ambient or vitiated) air to the combustion environment is intentionally controlled or limited

Note 1 to entry: Ventilation-controlled conditions represent a fire environment with limited fresh air supply.

4 Symbols

For the purposes of this document, the symbols given in ISO 5660-1 and the following apply.

Table 1 — Symbols and their designations and units

Symbol	Designations	Unit
A_S	initially exposed surface area of the specimen	m^2
C	orifice flow meter calibration constant	$m^{1/2} g^{1/2} K^{1/2}$
γ	thermal expansion factor	(dimensionless)
$\tilde{\gamma}$	thermal changeable dilution factor	(dimensionless)
Δh_c	net heat of combustion	$kJ g^{-1}$
$\dot{m}_e$	mass flow rate in the exhaust duct during the test	$kg s^{-1}$
$\dot{m}_e^0$	initial mass flow rate in the exhaust duct	$kg s^{-1}$
$\dot{m}_f$	mass flow rate of fuel, burning rate of the specimen	$kg s^{-1}$
$\dot{m}_g^E$	mass flow rate of the incoming gas mixture to the enclosure	$kg s^{-1}$
Δp	orifice meter pressure differential	Pa
$\dot{q}(t)$	heat release rate	kW
$\dot{q}_A(t)$	heat release rate per unit area	$kW m^{-2}$
ϕ	oxygen depletion factor	(dimensionless)
T_e	absolute temperature of gas at the orifice meter	K

Table 1 (continued)

Symbol	Designations	Unit
$\dot{V}_A$	volume flow rate of Air	L/min
$\dot{V}_g^E$	volume flow rate of Gas to the enclosure	L/min
$\dot{V}_N$	volume flow rate of Nitrogen gas	L/min
$X_{O_2, Air}$	oxygen concentration in air (bottled, pressurized)	(dimensionless)
$X_{O_2}^1$	value of combustion gas oxygen analyser reading, before delay time correction	(dimensionless)
$X_{O_2}^A$	actual value of combustion gas oxygen analyser reading	(dimensionless)
$X_{O_2}^{A^0}$	initial baseline value of combustion gas oxygen analyser reading (with enclosure environment established)	(dimensionless)
$X_{O_2}^{A^S}$	surrounding baseline value of oxygen analyser reading (before enclosure environment established – enclosure door open)	(dimensionless)
X_{CO}^A	actual value of combustion gas carbon monoxide analyser reading	(dimensionless)
$X_{CO_2}^A$	actual value of combustion gas carbon dioxide analyser reading	(dimensionless)
$X_{O_2}^E$	oxygen concentration in the enclosure	(dimensionless)
$X_{CO_2}^{A^S}$	surrounding baseline value of combustion gas carbon dioxide analyser reading (before enclosure environment established – enclosure door open)	(dimensionless)
$X_{H_2O}^S$	Surrounding value of water vapor	(dimensionless)
H	relative air humidity of the surrounding before the test	%
P	ambient pressure, in Pa, of the surrounding before the test	Pa
T_a	is the ambient temperature, in K, of the surrounding before the test	K

5 Principle

The principle of this test method is based on the observation that, generally, both thermal and chemical products of a combustion reaction vary in quantity and quality depending on the atmospheric environmental conditions in which the reactions occurs. This test method provides a controlled environment to assess the contribution that a product under test can make to the rate of heat release, the production rate of gaseous products, and the smoke production rate, in different reduced oxygen atmospheres and/or differently ventilated atmospheres during the product's involvement in fire. The properties are determined on small representative specimens. Specimens in the test are burned in ambient atmospheres or predetermined reduced oxygen atmospheres, while being subjected to a predetermined external irradiance within the range of 0 kW m⁻² to 50 kW m⁻². Measurements are made of oxygen and other gas concentrations in the exhaust, light transmission, exhaust gas flow rates, and specimen mass.

Heat release rate measurement is based on the observation that the net heat of combustion is proportional to the amount of oxygen required for combustion. The relationship is that approximately 13,1 × 10³ kJ of heat are released per kilogram of oxygen consumed. This is accurate within ±5 % for complete combustion and differs by ±20 % considerably for incomplete combustion. Measurements of oxygen concentrations and total exhaust gas flow rates are conventionally made. Enhanced measurements of carbon dioxide concentrations, carbon monoxide concentrations, other species concentrations, soot, water vapor, and unburnt fuel allow application of appropriate corrections depending on stoichiometries of the combustion reactions. These measurements are used to calculate the mass of oxygen consumed. Results are reported as heat release rate and total heat release, both normalized to exposed specimen surface area. The heat release rate of a burning specimen is calculated as the product of the oxygen mass consumed by the fire and the averaged proportionality 13,1 × 10³ kJ kg⁻¹ with corrections for incomplete combustion. The enhanced measurements for carbon dioxide, carbon monoxide, and water vapor are applied for general corrections in this document. Where available, specific values for the proportionality can be used as quotient of the heat of combustion