

CONFIRMED
DECEMBER 2007

Method for

Calibration of radiometers for use in fire testing

UDC 535.214.4.089.6:536.468.001.4

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The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

Department of the Environment [Building Research Establishment (Fire Research Station)]	Greater London Council
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This British Standard, having been prepared under the direction of the Fire Standards Committee, was published under the authority of the Board of BSI and comes into effect on 27 February 1987

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The following BSI references relate to the work on this standard:
Committee reference FSM/1
Draft for comment 84/40208 DC

ISBN 0 580 15699 0

Amendments issued since publication

Amd. No.	Date of issue	Comments

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Foreword

This British Standard has been prepared under the direction of the Fire Standards Committee and describes a method for the calibration of radiometers used in fire testing. It should be of value to those working in industry and research who are concerned with the measurement of heat transfer by thermal radiation.

A number of fire tests described in British Standards and International Standards published by the International Organization for Standardization (ISO) require test specimens to be exposed to specified levels of irradiance. It is therefore necessary for fire test laboratories to be able to maintain working-standard radiometers to measure irradiance.

This standard describes a method for the calibration of radiometers for use as working standards by comparison with a radiometer of known sensitivity referred to as a secondary standard. The latter will have been calibrated by reference to a defined primary standard of irradiance. Since the standard is intended to apply to radiometers for use in fire tests, the radiator employed is limited to a surface temperature in the range of 800 °C to 1 000 °C.

NOTE A suitable primary standard of irradiance is maintained by the Fire Research Station, Boreham Wood, Herts WD6 2BL.

The calibration of radiometers for use as primary and secondary standards requires considerable expertise and equipment outside that normally available in a fire testing laboratory and is not covered by this standard. For information on the calibration of primary standards and for a detailed account of the principles of the measurement of thermal radiation reference should also be made to J. Sci. Inst., **40**, pp 216 – 220, May 1963, Simms, D.L. & Hinkley, P.L. *An absolute radiometer for the range 0.1 – 2.5 cal cm⁻² sec⁻¹ (0.4 – 10 W cm⁻²)*.

Information on accuracy of calibration, care of radiometers and guidance notes for carrying out the calibration are given in Appendix A, Appendix B and Appendix C. Appendix D gives details of a specific piece of equipment which has been found satisfactory. Appendix E outlines a suitable procedure for the maintenance of a secondary standard of irradiance at a test laboratory.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 14, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This British Standard describes a method for the calibration of radiometers for use in fire testing.

This method may be used to calibrate instruments that are used to measure a rate of heat transfer (heat-flux density) due to a combination of radiation and convection (but see Appendix C which gives guidance notes concerning calibration).

This method applies only to instruments having plane receivers and does not apply to receivers in the form of wires, spheres, etc.

Appendix A gives information on the accuracy of the calibration and reference should be made to the standard describing the test for which the radiometer is intended. Appendix B gives guidance on care of radiometers.

NOTE The title of the publication referred to in this standard is given on the inside back cover.

2 Definitions

For the purposes of this British Standard the following definitions apply.

2.1 radiometer

a transducer that converts radiant flux into an electrical signal

2.2 radiant flux

power (energy per unit time) emitted, transferred or received in the form of radiation

2.3 irradiance (at a point on a surface)

the quotient of the radiant flux incident on an infinitesimal element of surface containing the point, by the area of that element

2.4 absorptance

ratio of the absorbed radiant flux to the incident flux

2.5 receiver

that part of a radiometer which receives and measures thermal radiation

2.6 working-standard radiometer

a radiometer to be calibrated by reference to a secondary standard for subsequent use to monitor irradiance during the course of fire tests

2.7 secondary-standard radiometer

a radiometer with a calibration traceable to a primary standard, used only for calibration of working-standard radiometers

2.8 sensitivity (of a radiometer)

the ratio of the output voltage to the irradiance in the plane of the receiver

NOTE With some radiometers, sensitivity may vary with irradiance.

3 Principle

The calibration of radiometers for use as working standards is carried out by comparing radiometer response at various levels of irradiance with the response of a secondary-standard radiometer at the same levels of irradiance. The measurements are made at different levels of irradiance by varying the distance between the radiant source and the radiometer.

4 Apparatus

NOTE Appendix D gives details of a specific piece of equipment which has been found satisfactory.

4.1 Radiator, with effective radiating area plane, vertical, having no dimension less than 280 mm or more than 470 mm, operating at a constant temperature, uniform over the area, of between 800 °C and 1 000 °C.

4.2 Mounting apparatus, designed to bring the receiver of each radiometer (working standard and secondary standard) quickly in turn into a preset, locked position opposite the centre of the radiator and capable of being moved towards or away from the radiator in order to vary the irradiance. The movement shall be over a range which will provide an appropriate range of irradiance, and shall avoid placing the radiometer in any plume of combustion gases from the radiator. The means for locking the radiometer in position shall be rigid and such that the plane of the receiver of the radiometer is parallel to the plane of the radiator and the centre of the receiver lies on the normal from the centre of the radiator.

The radiometer mounting apparatus shall be designed so that radiometers are not mounted directly over a substantial mass of metal or other material that will get hot when the radiant panel is running.

NOTE 1 Any undue interference with the natural airflow towards and up to the radiant panel should be avoided.

The mounting apparatus shall incorporate means to support two (or more) radiometers which may differ in size and mounting arrangements and shall be designed so that the radiometers can be positioned with their receivers in the same vertical plane parallel to the face of the panel. No part of the mounting apparatus shall project in front of the radiometers being tested.

All exposed surfaces of the radiometer mounting apparatus shall be coated with a heat-resisting, matt black finish.

NOTE 2 Where the secondary-standard and working-standard radiometers are not identical in shape, then a special positioning device may be needed.

4.3 Instrumentation

4.3.1 Secondary-standard radiometers, three or more secondary-standard radiometers are required for periodic intercomparisons to maintain a reliable standard of irradiance. A suitable scheme for these intercomparisons is outlined in Appendix E.

4.3.2 Recording instrumentation, capable of assimilating the incoming data and producing a record, both permanent and immediately available to the operator, of the reading of each radiometer at intervals of not greater than 5 s, having range settings appropriate to the outputs of the radiometers.

4.4 Additional equipment

4.4.1 Locating spacer, of any convenient thickness for positioning radiometers in relation to any special positioning device.

4.4.2 Protective clothing, such as heat-resisting gloves, and eye protection if necessary.

4.4.3 Low-pressure air supply and/or water supply, for radiometers requiring these cooling media (see C.5).

5 Test environment

5.1 The test apparatus shall be contained in a room with a ceiling height at least 1.5 m above the top of the radiator. Any wall, floor, ceiling or other surface within 2 m of the radiator shall not have a shiny finish, particularly a shiny metallic finish. Any side walls shall be at least 1.5 m from the radiometer under test.

5.2 Adequate provision shall be made for the removal of any combustion gases from the area of the apparatus.

5.3 The test apparatus shall be contained in an essentially draught-free environment, particular care being taken to avoid draughts across the instruments under test. If necessary, screens shall be provided but these shall be at least 1.5 m from the radiometer under test.

6 Setting up procedure

6.1 General

Check that the apparatus is assembled correctly. Ensure that the mounting apparatus moves smoothly in relation to the face of the radiator, lubricating any sliding parts, if necessary, with a heat-resisting grease or graphite.

6.2 Mounting and alignment of radiometers

6.2.1 With the radiator off, mount the secondary-standard radiometer and the working-standard radiometer or radiometers which are to be calibrated in the mounting apparatus. Take care to ensure that all leads and tubes to radiometers are protected against radiation (wrapping with thin shiny aluminium foil has been found suitable; see C.6), and that they do not become entangled in any mechanism when it is moved. If a water-cooled or forced air-cooled radiometer is to be tested, then connect the appropriate supply and ensure that the flow rate is in accordance with the manufacturer's recommendations.

6.2.2 Adjust the radiometers in turn horizontally, vertically and in angular orientation so that when brought into the test position their receivers lie in the same plane parallel to the plane of the radiant panel, with the centres of the receivers on the normal from the centre of the panel.

Ensure that the receivers of the radiometers are clean and not obstructed in a sight line to the radiator when in the test position. Place small screens in front of the radiometers to shield them from the radiator.

NOTE As far as possible, the radiometers should be screened from radiation except during actual readings.

6.2.3 Connect the secondary-standard and working-standard radiometers independently to the recording instrumentation using appropriate leads. Turn on the radiator and adjust its control to give an operating temperature in the range 800 °C to 1 000 °C. Allow the radiator to reach a steady state before commencing measurements.

NOTE Laboratories supplying instruments for calibration should be aware that with a new working-standard radiometer or one which has not been previously used, it is advisable to age the receiver artificially before a calibration is carried out to avoid, or reduce, initial drift in sensitivity. It is recommended that this be done by exposing the receiver to radiation for 20 h to 25 h in a series of exposures of several hours duration, at an irradiance approximating to the maximum at which it is likely to be used. With some types of radiometer it may be advisable to monitor sensitivity and continue ageing until it has stabilized.

7 Calibration

7.1 Switch on the recording instrumentation, allowing any necessary time for warming up.