

CONFIRMED
DECEMBER 2007

Fire tests on building materials and structures —

Part 32: Guide to full scale fire tests within buildings

UDC 614.841.332:620.1:69.01

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

Autoclaved Aerated Concrete Products Association	Queen Mary College Industrial Research
London Scientific Services	Thermal Insulation Manufacturers and Suppliers Association (TIMSA)
National GRP Construction Federation	University College London
Phenolic Foam Manufacturers' Association	

This British Standard, having been prepared under the direction of the Fire Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 30 November 1989

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The following BSI references relate to the work on this standard:
Committee reference FSM/1
Draft for comment 87/41174 DC

ISBN 0 580 17617 7

Amendments issued since publication

Amd. No.	Date of issue	Comments

Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
1 Scope	1
2 General	1
3 Definitions	1
4 Design and configuration	1
5 Specimens	3
6 Ignition sources	4
7 Monitoring	5
8 Safety precautions	10
9 Data recording	10
10 Test report	11
Appendix A Fire test facilities	13
Figure 1 — Fire test facilities	13
Publications referred to	Inside back cover

Foreword

This Part of BS 476 has been prepared under the direction of the Fire Standards Policy Committee.

The guide does not conflict with the concept or recommendations of the ISO/TC 92, Fire tests on building materials and structures, proposal DP 9705 “Room fire test in full scale for surface products” which specifies one configuration of test rig and one degree of ventilation. This proposal is being developed to standardize a test method for the fire performance of surface products under closely specified conditions.

This guide is designed to enable a quantitative assessment to be made of the fire behaviour of a given specimen or a total interacting system, based on sound experimental practice and scientific principles. It will help to eliminate the risk of providing an incorrect assessment of a product such as may inadvertently occur if data from tests based on a limited range of experimental variables are extrapolated to other situations which are not directly comparable.

The complete programme for any test series of full scale enclosed fire experiments usually involves many different considerations and possible simulations. This guide reflects the current state of knowledge and suggests a choice of geometry, ignition sources, ventilation and similar aspects of the experiment, not all of which will be appropriate to every test situation.

Because of the developments in measuring techniques, this Part of BS 476 has been couched in terms of advisory rather than mandatory statements in order to allow the use of up-to-date techniques as they become available.

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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 Part of BS 476 provides comprehensive recommendations on the conduct of full scale experiments simulating fires in buildings. Such tests, of varying scale and configuration, can be used to evaluate the behaviour of building components, assemblies or constructions and/or contents under actual fire conditions. The advice on experimental design and instrumentation and the analysis and reporting of results provides a basis for a consumer/contractor agreement for the execution of *ad hoc* work.

The guide may be used to establish, as far as is reasonably possible, laboratory conditions that represent a specific set of fire conditions, with an emphasis on examination of the pre-flashover behaviour and contribution to fire growth of the product(s) under consideration.

The choice of ignition source and test construction is based on the objective of the fire experiment which may be:

- a) a comparison of the fire performance of different materials;
- b) a comparison of theory and experiment;
- c) a simulation experiment;
- d) a measurement of the fire behaviour of composites, assemblies and finished products;
- e) an investigation of the interaction of components within the system;
- f) an authentication of fire properties measured in small scale tests.

2 Definitions

For the purposes of this Part of BS 476, the definitions given in BS 4422 apply, together with the following.

2.1

closed test arrangement

a form of compartment, capable of imposing a restriction on ventilation at some stage during a fire

2.2

open test arrangement

a form of compartment which enables unrestricted ventilation to the fire throughout the duration of the test

2.3

associated construction

a form of construction that may be required for the testing of some elements of construction and to which the test specimen is connected, e.g. the wall into which a glazed element would be fitted

2.4

test construction

a complete assembly of a specimen and any associated construction

2.5

pilot ignition

ignition by a small flame or spark of the flammable mixture of air and decomposition volatiles evolved from a heated combustible material that may accumulate above its surface

2.6

spontaneous ignition

ignition of the flammable mixture of air and decomposition volatiles evolved from the heated material that may accumulate above its surface without provision of additional energy from spark or flame once the flammable mixture attains its spontaneous ignition temperature

2.7

critical exposure

the minimum irradiance at which ignition (pilot or spontaneous as specified) can be effected, regardless of duration

3 General

If only one test is envisaged, it is preferable to carry out tests in the most severe conditions likely to be encountered including position, orientation and size of ignition source. For example, for wall lining materials the interrelationship between walls, ceilings and ignition source needs careful consideration. Positioning an ignition source in the corner of a test arrangement is recommended if it is the most severe condition. In such a case, additional side wall tests, with the ignition source placed against a plain wall arrangement would not be required, but if it is suspected that such an arrangement would significantly affect behaviour, then such tests would be necessary.

It is thus essential to carry out tests on walls and ceilings in the most stringent arrangement foreseeable. Because of difficulty which might arise from variable weather conditions, it is recommended that full scale tests be carried out within an adequately dimensioned, roofed enclosure.

4 Design and configuration

4.1 General

Configuration of specimens and ignition sources is of importance in a large scale fire test; compartment geometry and ventilation have major effects on test results.

In general the test should be carried out full scale. If this is impracticable the scale should be as large as possible and particular care is needed with interpretation of results. Physical and mechanical fixings and jointing elements which are likely to be used in practice should be incorporated in the specimen in full scale in order to establish the effect of such products under fire conditions.

The minimum height of the test rig should be normal storey height (2.3 m) but it may be necessary to exceed this dimension. The ratio between the height and lateral dimensions of the test rig should be realistic. Normally there should be no scaling of thickness although if this is necessary the minimum thickness of the test rig should be such that there is no change in the thermal effects on fixings nor significant differences in heat loss to the surroundings during the early stages of a test. There should be no scaling of surface irregularities. With regard to ignition sources there should be no scaling in terms of impingement area, thermal severity, or application time, although with experience, it may be possible to introduce time limits.

It is important to avoid limiting ventilation too severely. Vents should be either to the full height of the test rig, or to door height, whichever is preferred. The latter arrangement will cause a concentration of hot gases in the upper part of the test room. The size of vent may prevent or delay flashover. In situations where it is necessary to use a closed test arrangement, vent area should be representative of full scale so that results can be indicative of performance in practice. Such tests require additional safety measures due to explosibility problems, such as careful monitoring of temperatures and remote venting and exhaust extraction after the fire is considered to be extinguished (see 4.4.2).

The choice of configuration of the test facility depends on the above considerations and on the required fire scenario. The alternative configurations given in Appendix A provide a sufficiently wide range to take account of these points.

4.2 Size and shape of compartment

The compartment size, shape and openings should be chosen to simulate the nature or type of compartment in which the subject material, product, or system is expected to be used in actual service. If there is a range of sizes, then account should be taken of the fact that for a given ignition exposure, the smaller compartment sizes will usually provide the most severe fire development conditions. Preferably the compartment should be designed to be symmetrical and as simple as possible for ease of analysis. The test construction could be a wall system or a lining applied to an appropriate realistic support but it has to be noted that the results of the test will only apply to that particular combination and care would be needed with the application of those results to systems with variants of that tested. The floor of the test rig should have thermal properties approximately equal to those which will be encountered in use. The roof/ceiling of the test rig should be flat, unless a sloping roof/ceiling is being investigated. If the actual roof/ceiling is not being subjected to test, the roof/ceiling used in the test should have thermal properties approximately equal to those which will be encountered in use.

In a test for linings with unrestricted ventilation the horizontal dimensions of the specimen may be scaled down and are of less importance than the vertical dimensions, although the horizontal dimensions should be sufficient to contain the ignition source and obtain information on fire spread, including spread across junctions. A full height rig with a 1 : 1 ratio of height to horizontal length on both sides of the corner would usually be the minimum required.

The arbitrary decisions made when designing an enclosed test will influence the behaviour in the test and therefore the ranking order of the material performance. It is desirable that flexibility of test configuration is maintained but ISO is developing a test with precise requirements for dimensions and if such a closed test is required on a standard basis then use should be made of the ISO test (ISO/DP 9705).

4.3 Thermal and radiative properties of associated construction

The thermal conductivity, density and heat capacity of the wall lining will affect the rate of fire growth within the test structure. The test structure therefore should be representative of those materials with which the structure will be used in practice and should not influence the fire behaviour of the material under test in an unrealistic way.