

Methods of test for

Assessment of the ignitability of upholstered seating by smouldering and flaming ignition sources

Committees responsible for this British Standard

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- Association for Consumer Research (ACRE)
- Association of Consulting Scientists
- Bolton Institute of Higher Education
- Branded Furniture Society
- British Contract Furnishing Association
- British Furniture Manufacturers' Federation
- British Plastics Federation
- British Textile Technology Group
- Chemical Industries Association
- Chief and Assistant Chief Fire Officers' Association
- Confederation of British Wool Textiles Limited
- Consumer Policy Committee of BSI
- Department of the Environment (Building Research Establishment)
- Department of the Environment (Property Services Agency)
- Department of Trade and Industry (Consumer Safety Unit, CA Division)
- EEA (the Electronics and Business Equipment Association)
- Furniture Industry Research Association
- Home Office
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- London Scientific Services
- Man-made Fibres Producers' Committee
- National Bed Federation Limited
- National Fillings Trades Association
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- Textile Research Council (ECRA)
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Foreword

This British Standard has been prepared under the direction of the Consumer and Contract Goods Standards Policy Committee. It is a revision and development of BS 5852-1:1979 and BS 5852-2:1982 and of The Crown Suppliers Fire test specification No. 6 Ignition standard for seating. However, since the Furniture and Furnishings (Fire)(Safety) Regulations 1988 (S.I. 1324) refer to the earlier editions of the standard, neither BS 5852-1:1979 nor BS 5852-2:1982 are to be withdrawn at the present time. This standard extends the range of ignition tests provided by BS EN 1021-1:1993 and BS EN 1021-2:1993.

The combined document also draws on the improvements incorporated in BS 6807 especially with regard to the rationalization of the criteria of ignition, and consists of the following sections.

- *Section 1: General and guidance;*
- *Section 2: Smouldering ignition source;*
- *Section 3: Flaming ignition sources;*
- *Section 4: Methods of test for the ignitability of upholstery composites;*
- *Section 5: Methods of test for the ignitability of complete items of furniture.*

The range of methods specified enables an assessment to be made of the ignitability of upholstered furniture assemblies. These assemblies may be test composites as described in section 4, which may be subjected to any one of a range of flaming ignition sources, or complete items of furniture as described in section 5, which may be subjected to a smouldering cigarette or any one of a range of flaming ignition sources.

NOTE The tests described in section 5 may also be applied to non-upholstered seating.

It cannot be assumed that protection against large flaming sources will automatically give protection against smouldering ignition. Users of the standard should therefore recognize the need to submit test specimens to both smouldering and flaming ignition tests.

WARNING. The results of these laboratory tests relate to the behaviour of the test specimens as supplied under the particular conditions of test and do not take into consideration the effects of ageing, washing, soiling, etc. that may be encountered during the life of the product. It has to be recognized that these tests cannot give a full assessment of fire properties in all situations.

Measures taken to reduce the ignitability of an assembly may adversely affect other fire properties such as smoke and toxic gas evolution and this aspect may require consideration when materials and construction techniques are being evaluated.

Flow diagrams illustrating a systematic method for the detection of ignition throughout a test sequence are given in Figure 8, Figure 9 and Figure 14.

Appendix A gives guidance for designers and specifiers.

Appendix B gives guidance for test operators. It is important that the details given in the appendix are studied before testing is carried out.

Appendix C is a flow chart relating the different test sections and indicates a logical test sequence.

Attention is drawn to BS 7176 which applies the tests described in this standard to upholstered furniture in various hazard areas.

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.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 34, 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.

Section 1. General and guidance

0 Introduction

0.1 Objective

The objective of this standard is to measure the ignitability of upholstered furniture composites and/or complete pieces of furniture.

No method using realistic shapes yet exists for measuring levels of ignition on a continuous scale for these composites and consequently the methods used in this standard provide ignition/non-ignition results at a number of fixed levels. One smouldering source together with a range of flaming sources, whose energy rises by a factor of approximately two at each step, are used. Thus a level representing the boundary of ignition can be associated with a particular construction. Although the levels do not form a continuous series, they do provide more information than an arbitrary single go/no go result and so allow smaller variations in ignitability to be related to actual hazards.

This assessment is intended eventually to form part of a much fuller fire hazard assessment when work now in progress on fire development and smoke and toxic hazards in fire is completed.

0.2 Background

0.2.1 An assessment of the results of various research projects, carried out to investigate the fire properties of furniture, clearly indicates that tests carried out on component materials in isolation could not give a true indication of their behaviour when combined with other component materials in a piece of furniture. Therefore, to evaluate the ignitability of any item of seating, having due regard to the effects of interactions between materials and of design, it is necessary to test the complete finished item of furniture. Such testing procedures are contained in section 5. However, there is a very wide range of designs and materials employed, so tests have been developed to assess upholstery materials combined together to give information regarding the ignitability properties of assemblies that might be used in a number of different circumstances. Model tests (see section 4) of this kind can eliminate the least useful combinations from further consideration in the design process.

0.2.2 The form of the test rig was decided after observation of many ignition experiments had shown that the position at which accidentally dropped cigarettes are most likely to cause ignition is in any angle between adjacent surfaces, whereas accidentally dropped flaming materials have worse effects where vertical and horizontal surfaces are involved. These situations have been modelled even though in practice the assembly might be used only on a single surface. The results, therefore, provide a measure of the ignitability of a combination of cover and filling which is equally valid for the different designs of furniture in which the combination might be used and for the different applications in that furniture.

The design of the furniture is an important additional consideration which can enhance or detract from the flammability performance of the item. For example, there may be pleats or folds in the primary cover; loops or crevices created by braids, piping, zips, inches or other trimmings; traps and chimneys created by cushions; the presence of wing arms or other overhangs; or an exposed area beneath the seat which is vulnerable to ignition from floor level. In such cases stylized representation is not easily possible nor practical. For these reasons tests on actual items are included in this standard.

Ideally these tests should be the final stage of the sifting process for ignitability, when the most useful candidate constructions are checked to ensure that the extra complexities of shape and added materials do not render the predictions from rig tests misleading.

0.2.3 The following ignition sources are specified.

- a) *Smouldering*. This consists of a single cigarette since it is unrealistic to use multiple cigarettes at a single position and the "fail-safe" magnitude is a full cigarette rather than smaller parts.

b) *Flaming*. This range consists of butane flames and burning wooden cribs which form a sequence of increasing thermal output from that approximating to the burning of a small flame to that approximating to the burning of four double sheets of a full-size newspaper. It has to be emphasized that the cribs are not intended to reproduce burning newspapers in all respects and the thermal output comparisons are given for guidance only. The cribs have been designed to give an additional weight loading (greater than that obtained with newspaper) on the upholstery composite. This is important in order to include situations that may occur in practice and to ensure that the test method errs on the side of safety with combinations prone to failure under load. Examples of these situations might be high localized cover tension induced by deep-buttoned upholstery, or the presence of heavy books close to the ignition source.

These sources are also static and apply their energy over a restricted area. Some real life sources spread flames gradually over a larger area of the composite. The latter type of behaviour is different from, and is not modelled by, the larger ignition sources of equivalent thermal energy defined in this standard.

0.2.4 The scenarios modelled by these tests do not include deliberate arson and/or vandalism, though the tests include the application of reasonably large sources to undamaged furniture. The larger sources are intended to cover situations where a higher degree of carelessness is more probable or for locations where a higher level of resistance to secondary ignition is paramount. If arson is an important part of the in-use situation then other test methods attempting to reproduce the ingenuity of the fire-raiser should be carried out.

0.3 Method of use

The test methods in section 4 measure the ignitability of the overall composite of materials, i.e. cover(s), infill materials, etc. as constructed on the test specimen. The results can not be stated as being applicable to the general behaviour of any individual component but only to the total composite tested.

The ignitability of an assembly may be determined by applying the sources in the order of source 2 to source 7, but for many specification purposes a test(s) involving one, or a limited number of selected sources, may be required.

The ignitability of an assembly may be determined by applying sources 0 to 1 which are defined in BS EN 1021-1:1993 and BS EN 1021-2:1993 respectively.

The ignitability of a complete item of furniture may be determined by applying the sources in the order of source 0 to source 7, but for many specification purposes a test(s) involving one, or a limited number of selected sources, may be required.

In the case of the tests described in section 5 the results will be applicable only to the finished item of furniture tested.

1 Scope

This British Standard when used in conjunction with BS EN 1021-1:1993 and BS EN 1021-2:1993, describes methods for assessing the ignitability of material combinations, e.g. covers and fillings used in upholstered seating, or complete items of seating, when subjected to either a smouldering cigarette or to flaming ignition sources of thermal output ranging from that of a burning match to that approximating to the burning of four double sheets of full-size newspaper, as might be applied accidentally to any item of furniture.

NOTE 1 It does not necessarily cover ignition caused by deliberate acts of vandalism with arson.

A specimen tested as described in section 4 comprises a single fabric, interlining (if used) and infill. If the proposed item of furniture comprises different combinations of materials in the seat, back and arms, all such combinations are tested separately on the rig.

Possible ways in which the standard can be used either to indicate the potential ignitability of components in conjunction with other specified materials or where more specific information is required about design features are given in Appendix A.

Section 5 describes methods for assessing the ignitability of complete items of furniture.

NOTE 2 The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

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

2.1

ignition source

source of energy which is used to ignite combustible materials or products

2.2

smouldering

the combustion of a material with or without the emission of light and generally evidenced by smoke and an increase in temperature but without a flame

2.3**progressive smouldering**

smouldering that is self-propagating,
i.e. independent of the ignition source

2.4**flaming**

undergoing combustion in the gaseous phase with
the emission of light and heat

2.5**flammability**

the ability of a material or product to burn with a
flame under specified test conditions

2.6**ignitability**

a measure of the ease with which a material,
product or component can be ignited so as to flame
or progressively smoulder

2.7**test zones**

those components and/or design features of the test
specimen which are nominated for localized testing

3 General principle

A test specimen is subjected to a series of ignition
sources. The series is designed to represent a range
of actual intensities that might be accidentally
encountered in various end-use environments.

In section 4 the test rig stylizes the critical geometry
of vertical/horizontal junctions typically found in
furniture, but tests a single cover/filling
combination. In section 5 the test specimen consists
of a complete item of furniture.

4 Health and safety of operators

NOTE There is considerable risk with these tests and it is
essential that suitable precautions be taken, which may include
the provision of breathing apparatus and protective clothing.

4.1 Enclosure

For safety, the tests shall be conducted in a suitable
fume cupboard or purpose-built room so that
individuals are not exposed to any fumes
(see 9.4 and 18.3).

4.2 Extinguishers

Readily accessible means of extinguishing the test
specimens shall be provided.

NOTE 1 For preference, water should be provided for
smouldering fires and a fire extinguisher for flaming fires.
Carbon dioxide extinguishers are not suitable for extinguishing
test specimens.

NOTE 2 Extinction of test specimens may be difficult and care
should be taken that they are disposed of only when completely
inert. It may be necessary to immerse smouldering specimens in
water, or place them in a sealed non-combustible enclosure. To
ensure complete safety other suitable steps may have to be taken.

5 Atmosphere for conditioning and testing**5.1 Conditioning**

All test specimen materials shall be conditioned
immediately before the test for 72 h in indoor
ambient conditions and then for at least 16 h
at $20 \pm 5^\circ\text{C}$ and $50 \pm 20\%$ r.h.

5.2 Testing

For testing, a substantially draught-free
environment having a temperature of $23 \pm 7^\circ\text{C}$ and
a relative humidity of $45 \pm 25\%$ shall be used.

NOTE Certain performance specifications and upholstered
furniture safety regulations may require additional
pre-treatment, e.g. a water soak before conditioning. These
requirements and any pre-treatment shall be noted in the test
report (see clauses 14 and 24 and Appendix D).

Section 2. Smouldering ignition source

6 Smouldering cigarette

6.1 General

In normal use the smouldering ignition source most likely to be encountered by furniture is a smouldering cigarette. An untipped standard-sized cigarette has been selected as representative of the most severe of the range of cigarettes on sale. This source is designated ignition source 0.

6.2 Smouldering cigarette, source 0

Source 0 shall be an untipped cigarette¹⁾ complying with the following:

length (a):	70 ± 4 mm;
diameter (b):	8 ± 0.5 mm;
mass (c):	1 ± 0.1 g;
smouldering rate (d):	12 ± 3.0 min over 50 mm distance.

The smouldering rate shall be verified as follows on one sample from each batch of 10 cigarettes used.

Mark the cigarette, conditioned as described in 6.3, at 5 mm and 55 mm from the end to be lit. Light it as described in 6.4 and impale it horizontally in draught-free air on a horizontal wire spike inserted not more than 13 mm into the unlit end. Record the time taken to smoulder from the 5 mm mark to the 55 mm mark.

6.3 Conditioning of cigarettes

The cigarettes shall be conditioned immediately before the test for 72 h in indoor ambient conditions and then for at least 16 h at 20 ± 5 °C and 50 ± 20 % r.h.

6.4 Igniting the cigarette

Light a cigarette and draw air through it until the tip glows brightly. Not less than 5 mm and not more than 8 mm of the cigarette shall be consumed in this operation.

¹⁾ For information on the availability of a suitable cigarette apply to Enquiry Section, BSI, Linford Wood, Milton Keynes MK14 6LE enclosing a stamped addressed envelope for reply.

Section 3. Flaming ignition sources

7 Butane gas flames and flaming wooden cribs

7.1 General

A range of seven flaming ignition sources are provided, numbered in ascending order of severity from ignition source 1 to ignition source 7, approximating to the burning of four double sheets of a full-size newspaper.

7.2 Butane gas flame, ignition sources 1, 2 and 3

7.2.1 Burner and controls

A burner tube consisting of a length of stainless steel tube, 8.0 ± 0.1 mm outside diameter, 6.5 ± 0.1 mm internal diameter and 200 ± 5 mm in length, is connected by flexible tubing via a flowmeter, fine control valve, on-off valve (optional) and cylinder regulator complying with BS 3016 and providing a nominal outlet pressure of 28 mbar²⁾ to a cylinder containing butane (see BS 4250-1).

NOTE 1 Such steel tubing may be marketed as 5/16 in outside diameter, 0.028 in wall thickness. Where tubing of these dimensions is not readily available, stainless steel tubing of approximately similar dimensions may be used providing that the 50 mm length at the "flame" end of the tube is machined to the given size.

NOTE 2 Possible variations in performance may occur when the gas cylinder is nearly empty.

The flowmeter is calibrated to supply butane gas flow rates as specified in Table 1. The flexible tubing connecting the output of the flowmeter to the burner tube is 2.5 m to 3.0 m in length with an internal diameter of 7.0 ± 1.0 mm.

7.2.2 Gas flow control

It is essential that the rate of supply of the butane to the burner tube complies with the flow rates specified.

NOTE Some difficulties have been reported with the supply and measurement of the butane, particularly where the butane cylinder has, of necessity, to be stored in an environment cooler than the defined test conditions and/or some distance from the test rig. In these cases, and in other situations where difficulties occur, it is important that there is sufficient length of tubing inside the controlled environment (23 ± 7 °C) to ensure that the butane equilibrates to the required temperature before flow measurement. One way to assist this is to pass the butane, before flow measurement, through a metal tube immersed in water maintained at a temperature such that flow corrections for temperature variations are avoided (see Table 1).

Great care needs to be exercised with the measurement and setting of the flow rate of the butane. Direct reading flowmeters, even those obtained with a direct butane calibration, need to be checked when initially installed and also at intervals by a method capable of measuring accurately the absolute butane flow at the burner tube. One way of doing this is to connect the burner tube with a short length of tubing, of approximate internal diameter 7 mm, to a soap bubble flowmeter, such that the upward passage of a soap film meniscus in a glass tube of calibrated volume (e.g. a burette) over a known period of time gives an absolute measurement of the flow. Fine control valves which can each be preset to one of the desired butane flow rates, with simple switching means from one to the other, have also proved helpful.

7.3 Crib ignition sources 4, 5, 6 and 7

7.3.1 Materials and construction

The following are required for the construction of the cribs:

- dry planks of the softwood *Pinus silvestris* (Scots pine), which have been stored in warm dry conditions for a minimum of 1 week;
- BPC grade absorbent surgical lint, approximately 200 g/m², which is cut into nominal squares 40 mm × 40 mm (each square having a mass of approximately 0.3 g);
- polyvinyl acetate (PVA) or other suitable wood adhesive for gluing together the sticks and lint.

7.3.2 Assembly of the cribs

The crib parameters are given in Table 2 and Table 3. The cribs are illustrated in Figure 1 to Figure 4. Suggested methods of construction are given in 7.3.3.

The required number and sizes of sticks, conditioned in accordance with 7.4, are selected to provide the required total mass and are assembled into cribs with the square of lint incorporated, fluffy side uppermost when the crib is standing on its base. The sticks in each layer are parallel to one another and at right angles to the sticks in the adjacent layer. The sticks in each layer are placed as far away from each other as possible (except for the two main crib sticks forming the base of crib 6), but without undue overhang at their ends, to form a square-sectioned crib. The sticks are glued together and the lint secured with small amounts of the adhesive.

²⁾ 1 mbar = 100 N/m² = 0.1 kpa.

Table 1 — Parameters of ignition sources 1, 2 and 3

Parameter	Source 1	Source 2	Source 3
Gas flow rate	45 ± 2 ml/min at 25 °C ^a 44 ± 2 ml/min at 20 °C	160 ± 5 ml/min at 25 °C ^a 157 ± 5 ml/min at 20 °C	350 ± 10 ml/min at 25 °C ^a 344 ± 10 ml/min at 20 °C
Gas burn time	20 ± 1 s	40 ± 1 s	70 ± 1 s

^a Under these conditions the flame height for source 1 is approximately 35 mm, for source 2 approximately 145 mm and for source 3 approximately 240 mm, measured from the top of the burner tube when held vertically upwards and when the flames are burning freely in air.

Table 2 — Parameters of crib ignition sources 4 and 5

Parameter	Source	
	4	5
Stick length	40 ± 2 mm	40 ± 2 mm
Stick square section	6.5 ± 0.5 mm	6.5 ± 0.5 mm
Number of sticks	10	20
Total mass of sticks	8.5 ± 0.5 g	17 ± 1 g
Number of layers each of two sticks	5	10
Approximate lint dimensions	40 mm × 40 mm	40 mm × 40 mm
NOTE See B.1.		

Table 3 — Parameters of crib ignition sources 6 and 7

Parameter	Source	
	6	7
Main crib stick length	80 ± 2 mm	80 ± 2 mm
Main crib stick square section	12.5 ± 0.5 mm	12.5 ± 0.5 mm
Number of sticks main crib	8	18
Number of layers each of two sticks in main crib	4	9
Ignition crib base stick length	80 ± 2 mm	80 ± 2 mm
Ignition crib stick length	40 ± 2 mm	40 ± 2 mm
Square section of all sticks in the ignition crib	6.5 ± 0.5 mm	6.5 ± 0.5 mm
Number of ignition crib base sticks	2	4
Number of ignition crib sticks	8	6
Number of layers each of two sticks in ignition crib	5	5
Total mass of main and ignition crib sticks	60 ± 2 g	126 ± 4 g
Approximate lint dimensions	40 mm × 40 mm	40 mm × 40 mm
NOTE See B.1.		

7.3.3 Suggested methods of construction

NOTE A simple way to ensure that the core of the crib is correct is to build the crib around a former. A smooth hardwood block nominally 27 mm × 27 mm × 100 mm is suitable for cribs 4 and 5 and the inner cribs of sources 6 and 7. A hardwood block nominally 55 mm × 55 mm × 150 mm is suitable for cribs 6 and 7. The sticks are glued around the block and the block removed before the glue sets. For example, crib 5 is made by gluing 18 sticks together, removing the block, fixing lint in place on top and then gluing on the remaining two sticks.

7.3.3.1 Crib 4

Glue together eight sticks to form the main crib body. Stick one square of lint across the crib square section and then glue on the remaining two sticks to form the base (see Figure 1).

7.3.3.2 Crib 5

Glue together 18 sticks to form the main crib body. Stick one square of lint across the crib square section and then glue on the remaining two sticks to form the base (see Figure 2).

7.3.3.3 Crib 6

Glue together six of the main crib sticks to form the main crib body to make construction A. Glue together the eight ignition crib sticks and the two ignition crib base sticks; stick one square of lint across the ignition crib square section and then glue the remaining two main crib sticks to make construction B [see Figure 3 (a)]. When the adhesive is set invert construction B and glue it to construction A [see Figure 3 (b)].

7.3.3.4 Crib 7

Glue together 16 of the main crib sticks to form the main crib body to make construction A. Glue together the six ignition crib sticks plus two of the ignition crib base sticks to form the ignition crib body; stick one square of lint across the ignition crib square section and then glue on the remaining two ignition crib base sticks to form the ignition crib; glue on the remaining two main crib sticks to make construction B [see Figure 4 (a)]. When the adhesive is set, invert construction B and glue it to construction A [see Figure 4 (b)].

7.4 Conditioning

The sticks and the cribs shall be conditioned immediately before the test for 72 h in indoor ambient conditions and then for at least 16 h at 20 ± 5 °C and 50 ± 20 % r.h.