

भारतीय मानक ब्यूरो

भारतीय मानक मसौदा

वस्त्रादि — अग्निरोधक सोफ़ासाजी के कपडे की अग्नि अवरोधकता — विशिष्ट
(आई एस 15768 का प्रथम पुनरीक्षण)

BUREAU OF INDIAN STANDARDS

Draft Indian Standard

**TEXTILES — RESISTANCE TO IGNITION OF FIRE-RESISTANT
UPHOLSTERY FABRICS — SPECIFICATION**

(First revision of IS 15768)

ICS 13.220.40; 97.140

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FOREWORD

(Formal clause to be added later)

There have been many fire incidents in recent years in residential and public buildings/places, the origin of which could be many, such as, electric short circuiting, ignition. etc. The origin of fire may not be that much dangerous and hazardous as the ease of ignition and spreading of fire due to combustible materials such as, textiles, plastics, upholstery fabric etc. Depending upon the type of materials encountered in burning, its ease of ignition and its fire spread properties, the extent of damage to the life and property could be enormous. In order to prevent or minimize the damage to life and property due to such fire risks, formulation of this standard needs no emphasis.

Specification for resistance to ignition of textile materials and assemblies for use in the public buildings/places exist in various developed countries as a fallout of various legislation, Rules or Acts, etc, or directions of local bodies. The trend is increasing in other countries also and India should be no exception to this. This standard lays emphasis on matching the magnitude of threat posed in various places/buildings with commensurate performance levels of fire resistant textile materials so as to ensure safety of the life and property.

This standard was first published in 2008 and is being revised again to incorporate the following changes:

- a) The scope of the standard has been modified.
- b) The definitions of upholstery fabrics and composites have been incorporated.
- c) Classification of various occupancies into different degrees of hazard has been modified.
- d) The marking clause has been modified.
- e) Amendments have been incorporated.
- f) References have been updated.

This standard is based on BS 7176 : 1995 'Resistance to ignition of upholstered furniture for non –domestic seating by testing composites'. The list of buildings/places under different fire hazard categories have been included taking assistance from SP 7 : 2016 'National Building Code of India 2016'.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1 SCOPE

1.1 This standard covers the requirements for the resistance to ignition of fire-resistant upholstery fabrics in all forms such as roll form or piece form etc.

NOTE — The levels of ignition resistance have been set after careful consideration of the fire risk of the particular end-use environment involved. These levels do not necessarily reflect the behaviour of the upholstered seating in a fully developed fire.

2 REFERENCES

The standards listed in Annex A contain provisions which through reference in this text, constitute provisions of this standard. At the time of publications, the editions indicated were valid. All standards are subject to revision, and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 TERMINOLOGY

For the purposes of this standard the definitions given in SP 45 together with the following shall apply:

3.1 Fire Hazard — Potential for loss of life (or injury) and/or damage to property, by fire.

3.2 Fire Risk — Probability of fire causing loss of life (or injury) and/or damage to property.

3.3 Ignition Risk — The probability that ignition will result if a source of heat is allowed into close proximity or contact with a combustible material.

3.4 Upholstery Fabric — Upholstery fabric is defined as the textile fabric used for covering furniture such as sofas, chairs, ottomans, beds, tables, and other furniture items, including seats and beds used in railways, ships, automobiles, airplanes etc.

3.5 Composite — A composite refers to the combination of different elements of furniture like frame, upholstery fabric (covering fabric), filling materials (foam, feathers, foam crumbs etc.), webbing and other components.

4 PERFORMANCE REQUIREMENTS FOR RESISTANCE TO IGNITION

4.1 Ignitability

The upholstery fabric shall meet the levels of ignition resistance given in Table 1 when tested in accordance with the test methods specified in Table 1 for the various categories of hazardous places/buildings as specified in Annex B.

4.1.1 The testing shall be done as per standards mentioned in Table 1 by making the composite specimens as described in respective Indian Standards specified in Table 1.

4.2 Durability of Flame Retardant Property

The upholstery fabric shall pass the relevant ignition tests as specified in Table 1 before and after 50 *Min* cycles of washing as per the standard or the reduced washing procedure depending upon the type of textile material under test, as specified in Annex D. The upholstery fabric shall be conditioned in the standard atmosphere as per the method specified in IS 6359 before each washing cycle and shall be dried by any method suitable for the fabric type after each washing cycle. The upholstery fabric, which is claimed to be dry cleanable, shall be subjected to 50 dry cleaning cycles as per the method prescribed in Annex C of IS 15612 (Part 2) and shall pass the tests as specified in Table 1 before and after 50 dry cleaning cycles.

4.3 Toxicity Index

The toxicity Index of gases evolved during burning of 100 g of upholstery fabric shall be 1.0 *Max* when tested by the method prescribed in Annex E.

NOTE — This requirement is to be tested on the upholstery fabric as delivered by the supplier before any washing.

4.4 Visibility Due to Smoke Released on Combustion

The visibility due to smoke released on combustion of upholstery fabric shall conform to either Class A or Class B when tested by the method specified in IS 15782.

NOTE — This requirement is to be tested on the upholstery fabric as delivered by the supplier before any washing.

Table 1 Performance Requirements and Notes on Application of Hazard Categories
(Clause 4.1, 4.1.1 and 4.2)

Sl No.	Hazard Category	Requirements ¹⁾	Typical Examples of Places/Buildings (For guidance only)	Methods of Test
(1)	(2)	(3)	(4)	(5)
i)	Low Hazard Category	To pass the: a) Smouldering cigarette test b) Match flame equivalent test	Annex B	IS 12467 (Part 1) IS 12467 (Part 2)
ii)	Moderate Hazard Category	To pass the: a) Smouldering cigarette test b) Match flame equivalent test c) Crib test, source I	Annex B	IS 12467 (Part I) IS 12467 (Part 2) Annex C
iii)	High Hazard Category	To pass the: a) Smouldering cigarette test b) Match flame equivalent test c) Crib test, source 2	Annex B	IS 12467 (Part I) IS 12467 (Part 2) Annex C

NOTES

1 It is important to realize that the listing of types of premises under different hazard categories in Table 1 is given for guidance only and that the classification of a particular premises into one of the hazard categories is a decision for staff responsible for fire safety.

2 The examples cited in Table 1 for each hazard category cannot be exhaustive and do not cover all types of possible premises in a hazard category. It will be noted that some of the examples appear in more than one hazard category. This reflects the range of hazards possible under different circumstances for particular types of premises. Other examples, whether or not listed in Table 1, could also fall into more than one hazard category. However, when all the relevant factors have been considered, a particular premise can then be assigned to one hazard category.

3 The classification of a particular premises into one of the hazard categories in Table 1 is a decision for staff responsible for fire safety, for example, building control, fire brigade, licensing authorities, or environmental health authorities. Government departments and other organizations often have their own classifications for upholstered furniture where all the hazards have been assessed and a general policy has been adopted. Such classifications may be different from the examples given in Annex B. Attention is drawn to the following factors when classifying a hazard area:

- a) Statutory requirements and other recommendations;
- b) The Building Regulations and Local Authority Bye-Laws;
- c) Consumer Protection Acts and Safety Regulations;
- d) The National Building Code of India, 2016;
- e) Fire precautions in existing places of work that require clearance from fire authorities;
- f) Fire precautions in existing residential care premises;
- g) Fire precautions in existing places of entertainment and like premises;
- h) Fire precautions in premises used as hotels and boarding houses which require a fire certificate;

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- j) Fire safety management in hotels and boarding houses;
 - k) Whether or not people sleep at premises;
 - m) The level of occupancy;
 - n) Whether, in the case of fire, occupants could be expected on their own or whether they would need assistance, for example, Babies, children, old and infirm, the invalid, the sick, and those retained by locked doors;
 - p) The presence or absence of an automatic fire detection and alarm system, or an automatic fire extinguishing system;
 - q) Any special hazards, such as cooking, heating, live flame effects, smoke effects, low lighting levels, strobe lighting, Loud music, drinking, use after dark;
 - r) Whether or not the premises are, during times of use, under the control of staff trained in appropriate evacuation procedures; and
 - s) The location of the hazard area, namely of floors, whether or not high rise and/or below ground and/or windowless.

4 If a particular premise in the low hazard area is also used for sleeping purposes, then that premises shall be assigned the next higher hazard

5 SAMPLING AND CRITERIA FOR CONFORMITY

5.1 Lot

All upholstery fabric pieces/rolls of identical type and composition delivered to a buyer against one dispatch note shall constitute a lot.

5.2 The number of upholstery fabric rolls to be selected at random shall be according to col 2 and 3 of Table 2.

5.3 The number of upholstery fabric pieces to be selected at random shall be according to col 2 and 3 of Table 3.

5.4 Number of Tests and Criteria for Conformity

5.4.1 The samples of upholstery fabric rolls selected shall be in accordance with col 3 of Table 2. The lot shall be declared conforming to the requirements of this standard if all the samples meet the requirements as specified in this standard.

5.4.2 The samples of upholstery fabric pieces selected shall be in accordance with col 3 of Table 3. The lot shall be declared conforming to the requirements of this standard if all the samples meet the requirements as specified in this standard.

Table 2 Sample Size
(Clauses 5.2 and 5.4.1)

Sl No.	Lot Size	Sample Size
(1)	(2)	(3)
i)	Up to 50	2
ii)	51-150	3
iii)	151-300	3
iv)	301-500	5

v)	501-1 000	7
vi)	1001 and above	7

Table 3 Sample Size
(Clauses 5.3 and 5.4.2)

Sl No.	Lot Size	Sample Size
(1)	(2)	(3)
iii)	Upto 300	3
iv)	301-500	5
v)	501-1 000	5
vi)	1 001 and above	8

6 MARKING

6.1 Each piece of upholstery fabric material shall carry a permanently stitched and clearly readable label with the following information:

- Nature and composition of the upholstery material, for example, polyester/cotton blended (50 : 50 percent);
- Length and width, in mm and mass, in g/m²;
- Name and address of the manufacturer or his trade-mark(s);
- The words 'FIRE RESISTANT'; and
- Any other information as required by the law in force.

6.2 The minimum size of the graphic part of the label shall be 50 mm × 50 mm. The colour of the label shall be white with a green border and the words 'FIRE RESISTANT' shall be of a distinct colour and of minimum height 5 mm.

Note — In case the fabric is in piece form, the label shall be present on each piece of upholstery fabric.

6.3 The following wording shall also appear on the label:

- Complies with this standard; direct test/ predictive test for low hazard (not recommended for use in higher hazard areas); or
- Complies with this standard for medium hazard (not recommended for use in higher hazard areas)' or
- Complies with this standard for high hazard.

6.3.1 The letters of the wording shall be easily legible and of minimum height 2 mm.

6.4 BIS Certification Marking

The upholstery fabric may also be marked with the Standard Mark.

6.4.1 The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act, 2016* and the Rules and Regulations made thereunder. The details of conditions under which the license for the use of Standard Mark may be granted to manufacturers or producers may be obtained from Bureau of India Standards.

7 PACKING

The upholstery fabric shall be packed as per the relevant Indian Standard or as agreed to between the buyer and the seller.

ANNEX A

(Clause 2)

(LIST OF REFERRED STANDARDS)

<i>IS No.</i>	<i>Title</i>
6359 : 2023	Method for conditioning of textiles
12467 (Part 1) : 2006	Textiles – Assessment of the ignitability of upholstered furniture Part 1 Ignition source: smouldering cigarette (<i>first revision</i>)
12467 (Part 2) : 2006	Textiles – Assessment of the ignitability of upholstered furniture Part 2 Ignition source: match flame equivalent (<i>first revision</i>)
15612 (Part 2): 2006	Textiles – Burning behaviour of curtains and drapes Part 2 Measurement of flame spread of vertically oriented specimens with large ignition source
IS 15782 : 2008	Textiles – Method for determining deterioration of visibility due to smoke released on combustion of materials
SP 45 : 1988	Handbook on glossary of textile terms

ANNEX B

(Clause 4.1 and Table 1)

BROAD CLASSIFICATION OF VARIOUS OCCUPANCIES INTO DIFFERENT DEGREES OF HAZARD

B-1 Low Hazard Occupancies

- a) Analytical, Inspection and/or Q.C. Laboratories;

- b) Assembly buildings (small) – Institutional / Office Seminar or Meeting halls;
- c) Clubs;
- d) Day Centres;
- e) Dwellings, lodges, dormitories, etc;
- f) Educational and Research Institutions;
- g) Office premises;
- h) Places of worship; and
- i) Residential buildings (except hotels);
- j) Museums, archives and record rooms

B-2 Moderate Hazard Occupancies

- a) Airport and other transportation terminal buildings;
- b) Assembly buildings (large): Places of Public Entertainment or Gatherings
- c) Casinos;
- d) Computer Installations (like data centres, server rooms, etc);
- e) Hospitals including ‘X’ ray and other diagnostic clinics;
- f) Mercantile occupancies (departmental stores, shopping complex, shopping malls, etc);
- g) Museums, archives, record rooms;
- h) Places of public entertainment (exhibitions, marriage pandals, theatres, cinema halls, etc.);
- i) Public Halls;
- j) Public houses and bars; and
- k) Residential apartments, hotels, cafes, restaurants

B-3 High Hazard Occupancies

- a) Hazardous occupancy buildings;
- b) Offshore installations;
- c) Prison cells;
- d) Sleeping accommodation in certain hospital wards; and
- e) Underground shopping complexes and underground shopping malls.

ANNEX C

(Table 1)

CRIB TEST

C-1 PRINCIPLE

Materials forming a composite are assembled together on the test rig appropriate to the ignition source being used.

C-2 APPARATUS

C-2.1 Test Rig, as specified in Fig. 1 and 2 of IS 12467 (Part 1), consisting of two rectangular frames hinged together and capable of being locked at right angles to each other. The frames shall securely hold the expanded steel platforms and a standard edging section may be used around the expanded steel to give protection and greater rigidity. The hinge rod shall be

continuous across the back of the rig. The frame shall be lockable at right angles to each of the pairs of the members forming the back legs.

C-2.2 Test Enclosure, either a room with a volume greater than 20 m³ (which contains adequate oxygen for testing). or a smaller enclosure with a thorough flow of air (between 0.02 m/s to 0.2 m/s) equipped with inlet and extraction systems.

C-2.2.1 The atmosphere within the enclosure during the test shall have a temperature of 25 ± 5°C and a relative humidity of 50 ± 20 percent. A means of extracting smoke and toxic gases shall be provided for all such enclosures.

C-2.3 Propane-2-ol

C-2.4 Graduated Glass Syringe, or other suitable measuring instrument, capable of measuring 1.4 ± 0.1 ml of propane-2-ol.

C-2.5 Stop Clock, accurate to 1 s and capable of measuring at least 1h.

C-2.6 Crib Ignition Sources

C-2.6.1 *Materials and Construction*

The cribs shall be constructed from the following:

- a) Dry planks of the softwood *Pinus Kesiya* (Khasi Pine) which have been stored in warm dry conditions for a minimum of one week;
- b) 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); and
- c) Polyvinyl acetate or other suitable wood adhesive for gluing together the sticks and lint.

C-2.6.2 *Assembly of the Cribs*

C-2.6.2.1 The crib assembly shall have the parameters as specified in Tables 4 and 5. The arrangements of cribs are illustrated in Fig. 1 and 2. The suggested methods of construction are given in C-2.7.

C-2.6.2.2 Select the required number and sizes of sticks conditioned in accordance with C-3 to provide the required total mass and assemble into cribs with the square of lint incorporated, fluffy side uppermost when the crib is standing on its base. The sticks in each layer shall be parallel to one another and at right angles to the sticks in the adjacent layer. The sticks in each

layer shall be placed as far away from each other as possible, but without undue overhang at their ends glued together and the lint secured with small amounts of the adhesive.

Table 4 Parameters of Crib 1 (Ignition Source 1)
(Clause C-2.6.2.1)

SI No. (1)	Parameter (2)	Requirement (3)
i)	Stick length, mm	40 ± 2
ii)	Stick square section, mm	6.5 ± 0.5
iii)	Number of sticks	20
iv)	Total mass of sticks, g	17 ± 1
v)	Number of layers each of two sticks	10
vi)	Approximate lint dimensions, mm	40×40

Table 5 Parameters of Crib 2 (Ignition Source 2)
(Clause C-2.6.2.1)

SI No. (1)	Parameter (2)	Requirement (3)
i)	Main crib stick length, mm	80 ± 2
ii)	Main crib stick square section, mm	12.5 ± 0.5
iii)	Number of sticks, main crib	18
iv)	Number of layers each of two sticks in main crib	9
v)	Ignition crib base stick length, mm	80 ± 2
vi)	Ignition crib stick length, mm	40 ± 2
vii)	Square section of all sticks in the ignition crib, mm	6.5 ± 0.5
viii)	Number of ignition crib base sticks	4
ix)	Number of ignition crib sticks	6
x)	Number of layers each of two sticks in ignition crib	5
xi)	Total mass of main and ignition crib sticks, g	126 ± 4
xii)	Approximate lint dimensions, mm	40×40

C-2.7 Suggested Methods of Construction

C-2.7.1 Crib 1

Glue together 18 sticks to form the main crib body. Stick one square of lint across 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* Fig. 1).

C-2.7.2 Crib 2

Glue together 16 of the main crib sticks to form the main crib body to make construction A (*see* Fig. 2B). 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* Fig. 2A). When the adhesive is set, invert construction B and glue it to construction A (*see* Fig. 2B).

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 crib 1 and inner side of crib 2. A hardwood block nominally 55 mm × 55 mm × 155 mm is suitable for crib 2. The sticks are glued around the block and block removed before the glue sets. For example, crib 1 is made by gluing 18 sticks together, removing the block, fixing lint in place on top and then gluing on the remaining two sticks.

C-3 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 $25 \pm 5^{\circ}\text{C}$ and 50 ± 20 percent relative humidity.

C-4 TEST SPECIMENS

C-4.1 General

The test specimen shall comprise a structure with vertical and horizontal parts of the composite of upholstery materials under test. These materials shall be representative of the cover, filling and other components to be used in the composites.

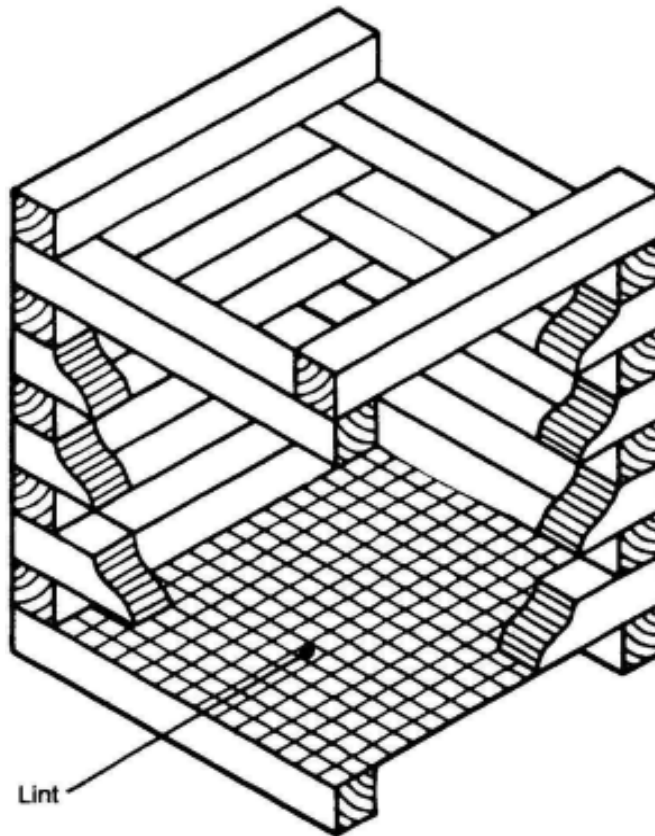


FIG. 1 CRIB 1

C-4.2 Cover Material and Fabric Inter-Liner

C-4.2.1 *Test specimens used shall be as shown in Fig. 3.*

C-4.2.2 The long dimension shall be cut parallel to the machine direction. The cover may be constructed from smaller pieces of test materials provided that the resulting seams do not occur within 100m, of the area likely to be affected by the test or they are located behind the pivot bar. If lack of test materials requires the use of additional alternative material, for example, side extension, their use shall be stated in the test report.

C-4.2.3 The cut-outs shall be positioned such that when assembled on the test rig, the lie of the pile is down the vertical assembly and from the hinge to the front of the horizontal assembly. Where a fabric inter-liner is used, it is cut to the same dimensions. and in the same orientation as the cover, for fitting to the rest rig under the cover.

C-4.3 Upholstery Filling

C-4.3.1 It shall consist of two pieces of filling, one $(450 \text{ mm} \pm 5 \text{ mm}) \times (450 \text{ mm} \pm 5 \text{ mm}) \times (75 \text{ mm} \pm 2 \text{ mm})$ thick and the other $(450 \text{ mm} \pm 5 \text{ mm}) \times (300 \text{ mm} \pm 5 \text{ mm}) \times (75 \text{ mm} \pm 2 \text{ mm})$ thick for each test. Some cushioning assemblies may consist of several layers that may be typically felt, wadding or various foams. Where the total thickness exceeds 75 mm, the upper

75 mm of the cushioning assembly is reproduced, except that the upper layer(s) are not continued over and round the edges of the assembly.

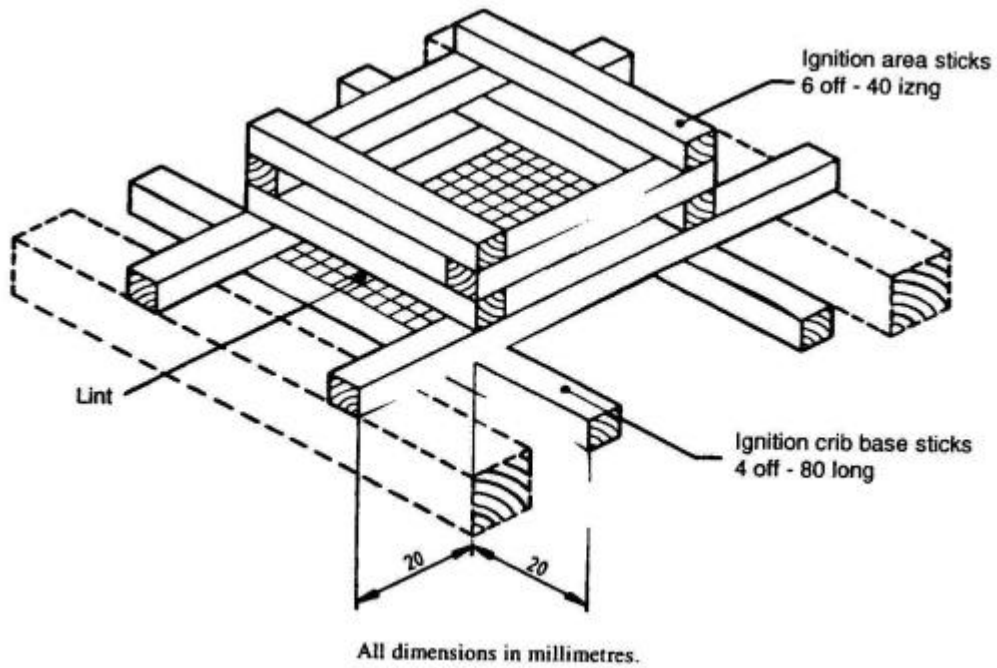
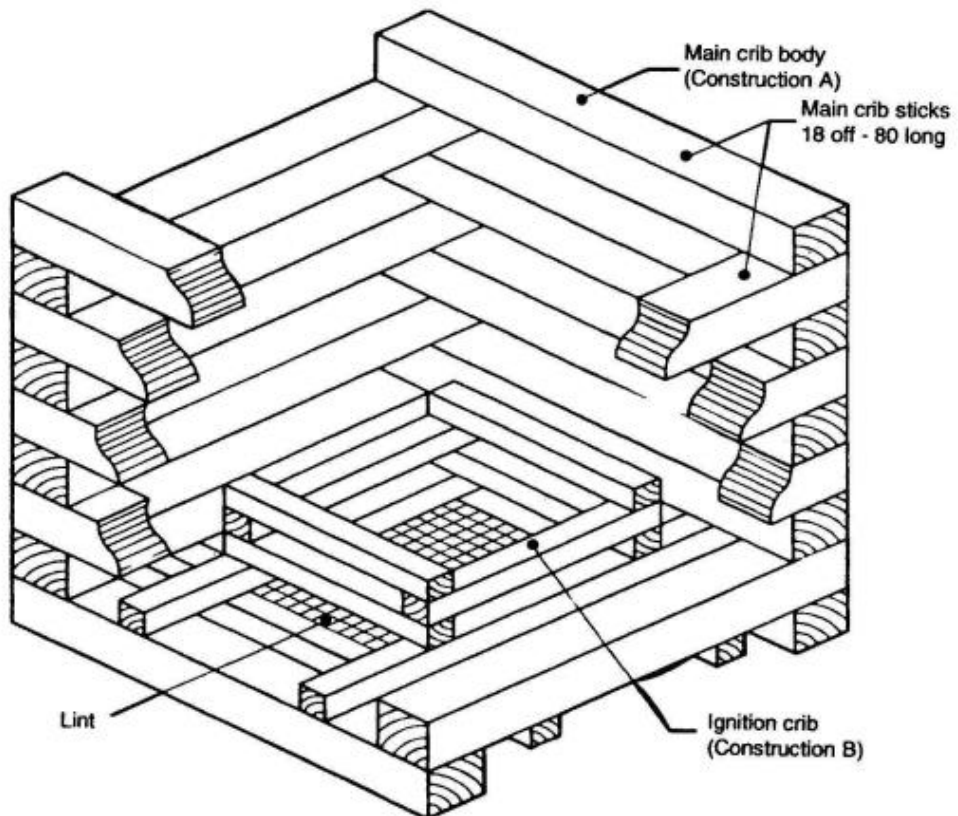
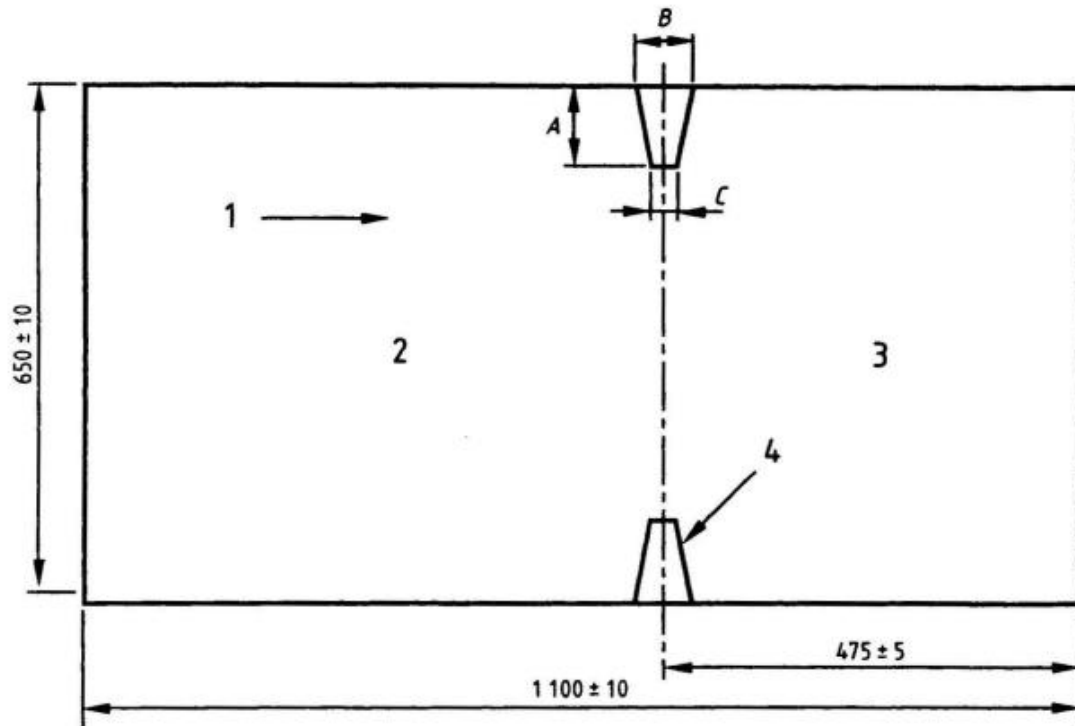


FIG. 2A CRIB 2 - CONSTRUCTION B



2B COMPLETE CRIB 2

FIG. 2 CONSTRUCTION OF THE CRIBS



Approximate cut-out dimensions

Key

- 1 Lie of pile
- 2 Vertical
- 3 Horizontal
- 4 Cut-outs

- A : 110
- B : 50
- C : 20

FIG. 3 DETAILS OF TEST SPECIMENS FOR FABRIC COVERS AND INTER-LINERS

C-4.3.2 Where this filling is less than 75 mm thick the test piece shall be built up to the required thickness by adding to the underside a further layer of the bottom material.

C-4.3.3 If lack of test materials requires the use of additional alternative materials such as side extensions, the additional materials shall not be positioned within 100 mm of the ignition source, or above the top of the ignition source if used in the vertical part of the test specimen. The use of additional materials shall be noted in the test report.

C-4.3.4 In case of the loose filling material, for example, foam crumb or feathers, the filling shall be built up beneath the covering materials to reproduce the 75 mm thickness of the assembly at a realistic filling density. Where necessary, a finer grid material or air porous fabric may be laid over the expanded metal of the test rig to retain the filling.

C-4.3.5 If, in use, the loose infill is enclosed in an interlining (or ticking), two bags of the interlining suitably filled and to the overall dimensions given above for use as the upholstery filling beneath the cover(s) shall be used.

Note — The tests described in this section are unsuitable when used with composites where the loose filling materials flows out of the assembly during the test and either extinguishes, moves or adversely affects the burning of the ignition sources. A more positive result may be obtained with such materials are tested as a complete item of furniture.

C-5 CRITERIA OF IGNITION

C-5.1 General

The ignition criteria shall include both the progressive smouldering and flaming ignition and shall be assessed separately.

C-5.2 Progressive Smouldering Ignition

The following types of behaviour shall be considered as progressive smouldering ignition:

- a) any test specimen that displays escalating smouldering combustion behaviour so that it is unsafe to continue the test and forcible extinction is required;
- b) any test specimen that smoulders until it is essentially consumed or that smoulders to the extremities of the specimen, that is to either side or to the full thickness of the specimen, within the duration of the test;
- c) any test specimen that produces externally detectable amounts of smoke, heat or glowing 60 min after ignition of the crib; and
- d) any test specimen that, on final examination shows evidence of charring within the filling (other than discoloration) more than 100 mm in any direction apart from upwards from the nearest part of the original position of the source.

Note — In practice it has been found that there is usually a clear distinction between materials that char under the influence of the ignition source but that do not propagate further (non-progressive) and those where smouldering develops in extent and spreads (progressive)

C-5.3 Flaming Ignition

The following types of specimens shall be considered as flaming ignition.

- a) any test specimen that displays escalating flaming combustion behaviour so that it is unsafe to continue the test and forcible extinction is required;
- b) any test specimen that burns until it is essentially concerned within the test duration;

c) any test specimen on which any flame front reaches the extremities of the specimen other than the top of the vertical part of the test specimen or passes through the full thickness of the specimen within the duration of the test;

d) for flaming ignition source 1 any test specimen that continues to flame for more than 10 min after ignition of the crib;

e) for flaming ignition source 2 any test specimen that continues to flame for more than 13 min after ignition of the crib; and

f) for all sources; any test specimen from which debris causes an isolated floor fire not meeting the requirements of items (d) or (e).

NOTE — It is recommended that composites which fail criterion (c), for example because the full thickness is penetrated by molten material rather than by flames, are tested as a complete item of furniture.

C-6 PROCEDURE

Note — For safety, all tests should be carried out in a suitably constructed enclosure.

C-6.1 Preparation

C-6.1.1 Ensure that the means of fire extinguishing are close to hand.

C-6.1.2 Open out the test rig and thread the covering fabric and, if used, the fabric inter-liner, behind the hinge bar so that the cut outs are aligned with the hinge bar.

C-6.1.3 Place the filling pieces under the covering fabric(s) and locate the filling pieces in the frame recesses.

C-6.1.4 Lock the frames at right angles by the bolts or pins ensuring that the filling components are not displaced. Fasten the fabric(s) over the top, bottom and sides of the frame using clips and secure the fabric(s) under even tension by allowing approximately 20 mm of fabric to wrap around the frame so that the edge of the fabric just contacts the expanded metal.

C-6.2 Wood Crib Tests (Ignition Sources 1 and 2)

C-6.2.1 Use a new specimen for each test. After the assembly of a crib (*see C-2.6.2*) and after conditioning (*see C-3*) it add slowly 1.4 ± 0.1 ml of propane-2-ol to the centre of the lint. Place the crib on the horizontal part in contact with the vertical part of the test specimen, centrally between the sides of the rig. The base sticks of the crib shall be parallel to the vertical surface of the test specimen.

C-6.2.2 Within 2 min of adding the propane-2-ol to the lint, ignite the alcohol from the front and above the lint, using a match, small gas flame or hot wire ignition, and simultaneously start the clock.

C-6.2.3 If the crib collapses causing embers to be scattered over a distance greater than 100 mm measured from the edge of the crib, repeat the test with a new crib placed in position on a new test specimen.

C-6.2.4 Observe for evidence of ignition (*see C-5*) in the interior and/or cover.

C-6.2.5 If flaming or progressive smouldering of the composites is observed (*see C-5*) extinguish the test specimen and record ignition for the ignition source used.

C-6.2.6 If flaming or progressive smouldering of the composites is observed (*see C-5*) repeat the test. If flaming or progressive smouldering is not observed in this retest, record non-ignition for the ignition source used, unless the test specimen fails the final examination specified in **C-6.2.3**. In this case, extinguish the test specimen and record ignition.

C-7 FINAL EXAMINATION

As cases of progressive smouldering undetected from the outside have been reported, immediately after completion of the test programme on the test specimen, dismantle and examine the filling for progressive smouldering. If this is present, extinguish the test specimen and record ignition for the relevant ignition source. For safety reasons ensure that all smouldering has ceased before the rig is left unattended.

ANNEX D

(Clause 4.3)

METHOD FOR DETERMINATION OF DURABILITY OF FIRE RETARDANT PROPERTY OF UPHOLSTERY FABRIC

D-1 General

The method shall be used for assessing the possible effect of repeated commercial laundering on the fire-retardant property of upholstery fabrics. The effect of laundering is simulated using an automatic horizontal drum washing machine.

D-2 APPARATUS AND REAGENTS

D-2.1 Washing machine

D-2.1.1 Automatic Washing Machine, equipped with a horizontal rotating drum with reversing action. The drum shall have a diameter of 480 mm to 610 mm and shall be fitted with

three or four lifters. It shall rotate at 30 rev/min to 52 rev/min and reverse its direction every 10 revolutions to 20 revolutions. The liquor level shall be capable of being controlled to both low and high levels, giving liquor volumes of 0.3V, and 0.54V, where V is the volume of the rotating drum. Means shall be provided for heating and controlling the water temperature. This automatic washing machine shall be used in accordance with the procedures specified in **D-5**.

D-2.2 Soft Water, with a maximum hardness, expressed as calcium carbonate, of 20 mg/l.

D-2.3 Ballast, consisting of rectangular pieces in single layers of woven 100 percent bleached cotton or 100 percent polyester. Each piece shall measure at least 350 mm × 500 mm and shall be hemmed along the cut edges to prevent unravelling.

D-2.4 Low-Foaming Detergent, with perborates specified in **D-2.4.1**, may be used. Other similar detergents may also be used. Sodium perborate is added to the detergent immediately before use in the ratio of one part per borate to four parts of detergent. All detergent quantities quoted in **D-5** are for the detergent plus perborate.

D-2.4.1 Composition of the Reference Detergent (Informative)

As the names and compositions of reference detergents are constantly changing, it is not possible to specify the use of a fixed detergent. A recommended detergent is the ECE or IEC TAED reference detergent. This is a zeolite built detergent. Alternative detergents may be agreed upon between the interested parties.

The TAED reference detergent is supplied as three separate components which are mixed in the following mass fractions immediately before use:

<i>Parameters</i>	<i>Nominal Composition (as Percent mass)</i>
Spray-dried powder with enzyme prills	77.0
Sodium perboratetetrahydrate	20.0
Bleach activator, tetraacetylenediamine	3.0

Due to the variability of the manufacturing process and to ageing, the composition of the spray-dried powder may vary.

A typical composition of the ECE spray-dried powder is:

<i>Component</i>	<i>Nominal Composition (as mass fraction)</i>
Alkylbenzenesulfonate	7.5
C ₁₂₋₁₈ alcohol + 7 ethylene oxide	4.0
Soap (65 % C ₁₂₋₁₈ , 35 % C ₂₀₋₂₂)	2.8

Sodium aluminium silicate (zeolite 4A)	25.0
Sodium carbonate	10.0
Sodium salt of acrylic/maleic acid copolymer	4.0
Sodium silicate (SiO ₂ : Na ₂ O = 3, 3 : 1)	3.0
Carboxymethylcellulose	1.0
Sodium ethylenediaminetetraacetate	0.2
Sodium sulfate	9.4
Water	9.6
Protease enzyme prills	0.5

NOTE — The IEC TAED detergent contains 0.2 % of stilbene-type optical whitener with the quantity of sodium sulfate reduced to 9.2 %.

D-2.5 Iron, or Press, capable of being used at a temperature appropriate for the material being tested.

D-3 COMPOSITION OF LOAD

The test specimens shall be of sufficient size for the subsequent ignitability testing. The total dry mass of the load shall be as calculated in **D-4.2** and at least half the load shall consist of material under test or material of similar fibre type, the remainder consisting of polyester ballast (*see D-2.3*).

D-4 PRELIMINARY CALCULATIONS

D-4.1 Drum Volume

If it is not specified, calculate the volume V_1 , expressed in litres, of the rotating drum to the nearest litre, ignoring any space occupied by lifters, using the equation:

$$V_1 = lr^2\pi \times 10^{-6}$$

where

l = length of drum, in mm; and

r = radius of drum, in mm.

D-4.2 Test Load

Calculate the total dry mass m_1 expressed in kilogram, of the test load to the nearest 0.1 kg using the equation

$$m_1 = (0.060 \pm 0.004)V_1$$

D-4.3 Detergent Quantity

Calculate the mass m_2 , expressed in gram, of detergent to be added, to the nearest 0.5 g using the equation

$$m_2 = (0.30 \pm 0.02)V_1$$

D-4.4 Low Dip Level (L)

Determine the volume of water V_2 , expressed in litre, required to fill the machine to the low dip level (L) to the nearest 0.5 litre with no load present and with a stationary drum, using the equation

$$V_2 = (0.30 \pm 0.02) V_1$$

D-4.5 High Dip Level (H)

Determine the volume of water V_3 expressed in litre, required to fill the machine to the high dip level (H) to the nearest 0.5 litre with no load present and with a stationary drum, using the equation

$$V_3 = (0.54 \pm 0.04) V_1$$

D-4.6 Parameters for Typical Automatic Washing Machines (Informative)

SI No (1)	Type (2)	A ₁ (3)	A ₂ (4)
i	Volume, V_1 , (litre)	70	45
ii	Load, m_1 , (kg)	4.2 ± 0.3	2.7 ± 0.2
iii	Low dip volume, V_2 (litre)	21.0 ± 1.5	13.5 ± 1.0
iv	High dip volume, V_3 (litres)	38.0 ± 3.0	24.5 ± 2.0
v	Detergent, m_2 (g)	21.0 ± 1.5	13.5 ± 1.0

NOTE — For some machines the dip levels are preset. Other machines require the dip levels to be adjusted to give the specified volumes.

D-5 STANDARD WASHING PROCEDURE

D-5.1 Load the machine with a load of m_1 as calculated in **D-4.2** and of the specified composition (*see D-3*). Start the machine with reduced agitation and fill with soft water (*see D-2.2*) at a temperature of 15 °C to 40 °C to the low dip level (L), at the same time adding the mass m_2 of detergent (*see D-2.4*) as calculated in **D-4.3**.

D-5.2 If the inlet water temperature is below 37°C, heat to $40 \pm 3^\circ\text{C}$ with no agitation. Heat to $75 \pm 3^\circ\text{C}$ in 15 ± 3 min with reduced agitation. Switch to normal agitation and run at $75 \pm 3^\circ\text{C}$ for 15 ± 0.5 min and then drain.

D-5.3 Fill with cold soft water to the high dip level (*H*). Run for 3 min and then drain. Repeat three times to give a total of four rinses in all. Centrifuge for 6 min.

D-5.4 Repeat the washing, rinsing and centrifuging cycles 49 times, giving a total of 50 cycles.

NOTE — If the number of wash cycles specified cannot be completed without interruption, the load may be left wet after centrifuging for a maximum of 18 h.

D-5.5 Dry the specimens in air for the material. Press them (*see D-2.5*) at an appropriate temperature to remove creases (if the material is suitable for pressing).

D-6 REDUCED WASHING PROCEDURE

D-6.1 Load the machine with a load of mass m_1 , as calculated in **D-4.2** and of the specified composition (*see D-3*). Start the machine with reduced agitation and fill with soft water (*see D 2.2*) at a temperature of 15 °C to 40 °C to the low dip level (*L*), at the same time adding the mass m_2 of detergent (*see D-2.4*) as calculated in **D-4.3**.

D-6.2 If the inlet water temperature is below 37 °C, heat to $40 \pm 3^\circ\text{C}$ with no agitation. Run at $40 \pm 3^\circ\text{C}$ with reduced agitation for 15 ± 0.5 min and then drain.

D-6.3 Fill with cold soft water to the high dip level (*H*). Run for 3 min then drain. Repeat three times to give a total of four rinses in all. Centrifuge for 3 min.

D-6.4 Repeat the washing, rinsing and centrifuging cycle 49 times, giving a total of 50 cycles.

NOTE — If the number of wash cycles specified cannot be completed without interruption, the load may be left wet after centrifuging for a maximum of 18 h.

D-6.5 Dry the specimens in air. Press them (*see D-2.5*) at an appropriate temperature to remove creases (if the material is suitable for pressing).

D-7 REPORT

The test report on the fire retardant property of upholstery fabric tested after washing by these procedures shall contain the following:

- a) Type of washing machine used that is automatic washing machine and its drum volume;
- b) Type of detergent used;
- c) Washing procedure employed (standard or reduced);
- d) Any deviation from the procedure specified.

ANNEX E

(Clause 4.4)

METHOD FOR DETERMINATION OF TOXICITY INDEX

E-1 GENERAL

This method explores the toxicity of the products of combustion in terms of small molecular species arising when a small sample of a material is completely burnt in excess air under specified conditions. The method does not necessarily determine the total toxicity of all the constituents of the products of combustion.

E-2 DEFINITION

E-2.1 Toxicity Index

The numerical summation of the toxicity factors of selected gases produced by complete combustion of the material in air under specified conditions. The toxicity factors are derived from the calculated quantity of each gas that would be produced when 100 g of the material is burnt in air in a volume of 1 m³ and the resulting concentration expressed as a factor of the concentration fatal to man in a 30 min exposure time. A toxicity index of 1.0 for a given volume will, on average bring about death in 30 min.

E-3 PRINCIPLE

Analytical data of certain small molecular gaseous species arising from the complete combustion under flaming conditions of the material under test are mathematically computed using the exposure level (in ppm) of each gas to produce fatality in 30 min as a base to derive a combined toxicity index.

E-4 APPARATUS

E-4.1 Toxicity Chamber – A toxicity chamber (*see* Fig. 1) consisting of the following:

- a)** An airtight enclosure of at least 1 m³ (approximately 100 × 100 × 100 cm³) volume lined with opaque plastic sheeting having a hinged or sliding door, fitted with a transparent plastic panel.

NOTE — As far as possible, all items of the equipment within the test chamber shall be constructed of, or coated with, an inert non-metallic material. Some gaseous products of combustion may react with or be absorbed on the walls of the chamber. The materials of construction must be chosen to minimize this. Lining of polypropylene has been found satisfactory with poly carbonate where transparency is required.

b) The chamber shall be fitted with a forced air extraction system which can be closed at the exit from the chamber when required.

c) The chamber shall be fitted with sampling positions, such that the air tightness of the chamber is not impaired.

d) The chamber shall contain a mixing fan capable of being switched on and off externally. A six-bladed axial fan of at least 200 mm diameter shall be mounted horizontally and centrally inside the chamber at roof level to ensure rapid mixing of combustion products.

E-4.2 Burner

E-4.2.1 The burner shall be capable of achieving a flame approximately 100 mm in height and having a temperature of $1\ 150 \pm 50^{\circ}\text{C}$ at its hottest point. The bunsen burner operating on natural gas (Methane) having a gross calorific value of approximately $40\ \text{MJ} / \text{m}^3$ and modified to provide an external supply of air connected to the burner collar shall be used.

E-4.2.2 In order to achieve the flame characteristics stated in **E- 4.2.1**, a bunsen burner of 125 mm overall height, 11 mm bore burner tube and 5 mm bore gas and air inlet tubes shall be used.

NOTE — Gas and air flow rates of 10 litre and 15litre/min respectively satisfy the requirements but some adjustments of the flow rates must be necessary to suit particular situation.

E-4.2.3 Provision shall be made for igniting and extinguishing the burner from outside the chamber using a small pin flame on a separate gas supply.

NOTE — Unsatisfactory results will be obtained using a conventional bunsen burner drawing air from within the chamber. The effect is oxygen depletion and a consequential reduction of burner flame temperature, or even extinguishment during the combustion period of a test causing loss of standard conditions.

E-4.3 Specimen Support

E-4.3.1 A device capable of supporting the test specimen over the bunsen burner without significantly moving it from the flame, shall be provided.

E-4.3.2 The support shall be an annulus cut from a non-combustible material such as sheet steel of nominal thickness 2 mm to 4 mm, of approximately 100 mm overall diameter with a 75 mm diameter hole carrying temperature resistant wires approximately 100 mm apart to form a lattice. The complete assembly shall be equipped with a non-combustible side support arm to give a “tennis racket” appearance.

E-4.4 Timing Device

The timing device shall be capable of measuring time periods up to 5 min to an accuracy $\pm 1\ \text{s}$.

E-4.5 Analytical Equipment

Any analytical system that will allow rapid detection and estimation of the gases in the products of combustion as detailed below:

- a) Carbon dioxide (CO₂)
- b) Carbon monoxide (CO)
- c) Formaldehyde (HCHO)
- d) Nitrogen oxides (NO, NO₂)
- e) Hydrogen Cyanide (HCN)
- f) Acrylonitrile (CH₂CHCN)
- g) Phosgene (COCl₂)
- h) Sulphur dioxide (SO₂)
- j) Hydrogen Sulphide (H₂S)
- k) Hydrogen Chloride (HCl)
- m) Ammonia (NH₃)
- n) Hydrogen Fluoride (HF)
- p) Hydrogen Bromide (HBr)
- q) Phenol (C₆H₅OH)

NOTES

1 This is not a complete list of all possible gases that can be products of combustion but it does represent those most commonly perceived upon which toxicity data can be based.

2 The use of colorimetric gases reaction tube is acceptable.

3 It is obvious that there is no need to determine the quantity of, say, hydrogen chloride in the products of combustion if the material being tested does not contain chloride. Therefore, as an aid to analysis it is desirable to determine the element present in the material before an assessment of the toxicity index is carried out. If nitrogen is not found, then there is no need to analyse nitrogen containing gases i.e. nitrogen oxides, hydrogen cyanides, acrylonitrile and ammonia.

4 For the purpose of calculating toxicity indices, the following values of concentration of gases in ppm are used:

Carbon-di oxide	100000
Carbon monoxide	4000
Hydrogen sulphide	750
Ammonia	750
Formaldehyde	500
Hydrogen chloride	500
Acrylonitrile	400
Sulphur dioxide	400
Nitrogen oxides	250
Phenol	250
Hydrogen cyanide	150
Hydrogen bromide	150
Hydrogen fluoride	100
Phosgene	25

E-4.6 Gas Sampling

In order to minimize losses of certain toxic products through absorption or condensation prior to measurement, all sampling lines shall be as short as possible. This may be conveniently achieved, where use is made of colorimetric gas reaction tubes for analysis, by siting the tubes within the chamber itself.

E-5 TEST SPECIMEN

E-5.1 Number and Size

A sufficient number of specimens (normally 3) shall be cut from the material under test. The mass of the test specimen shall be chosen to provide optimum analytical precision depending upon the nature of the combustion products and sensitivity of the analytical procedure. The size and shape of the specimen shall be such that it is entirely engulfed in the flame.

NOTE — In some instances, for example, highly fluorinated polymers, it shall be necessary to reduce the mass of the specimen to less than 0.1 g in order to achieve a concentration within the range of the currently available colorimetric gas reaction tubes for hydrogen fluoride.

E-6 CONDITIONING

Unless otherwise specified, the test specimens shall be conditioned at $27^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and 65 ± 4 percent relative humidity before testing (*see* IS 6359).

E-7 DETERMINATION OF BACKGROUND CORRECTION FACTOR

E-7.1 Position the burner in the centre of the test chamber floor and ignite it. Adjust the flow rates of gas and air to achieve the flame condition described in **E-4.2.1** and **E-4.2.2**. Record or otherwise control the flow rates in order that the conditions may be re-established when required. Extinguish the burner and ventilate the chamber.

E-7.2 Place carbon monoxide, carbon dioxide and oxides of nitrogen tubes in position, if this method of analysis has been adopted ensuring that all other sampling positions are sealed.

E-7.3 Seal the chamber, ignite the burner simultaneously starting the timing device. Maintain these conditions for 1 min, extinguish the flame and start mixing fan and allow this to continue for 30 s.

E-7.4 Using their respective sampling points, extract portion of the atmosphere from the test chamber to determine the concentrations of carbon monoxide, carbon dioxide and oxides of nitrogen.

E-7.5 Operate the extraction system of the test chamber, open the test chamber to free air and evacuate for 3 min. Repeat the procedure from **E-7.1** to **E-7.4**, but maintain the burning conditions stated in **E-7.3** for 2 min and 3 min in separate determinations.

E-7.6 The results obtained are graphically displayed to show the rate of build-up of carbon monoxide, carbon dioxide and oxides of nitrogen with time of burning due to the burner alone. Zero time can be shown as 0.03 percent carbon dioxide and nil for carbon monoxide and oxides of nitrogen.

E-8 SAFETY OF OPERATORS

When the toxicity index test is being carried out, there is a risk that flammable and/or toxic fumes will be given off from the specimen under test. Operators are required to take appropriate precautions to avoid exposure to the evolved fumes.

E-9 TEST PROCEDURE

E-9.1 Ensure that air temperature is $27 \pm 2^\circ\text{C}$.

E-9.2 Select a test specimen and determine its mass to the nearest mg.

E-9.3 Position the burner in the centre of the test chamber floor and establish the flame conditions described in **E-4.2.1**. Extinguish the burner.

E-9.4 Place the test specimen on the support approximately in the centre of the test chamber floor and adjust the support height so that the specimen will be sited within the flame boundary and subjected to the temperature given in **E-4.2.1** that is $1\ 150 \pm 50^\circ\text{C}$.

E-9.5 For materials which are liable to melt and drip, test specimens may be supported on a thin bed of glass wool placed on the wire mesh sample support to prevent sample losses during the combustion.

NOTE — The glass wool found suitable for this purpose is that commonly employed as a filter membrane by analytical laboratories.

E-9.6 Ensure that the forced extraction ventilation system is off and sealed from the chamber.

E-9.7 Insert series of colorimetric gas reaction tubes in to the chamber.

E-9.8 Close the test chamber access door, turn on the fuel supply to the burner and ignite simultaneously and start the timing device.

E-9.9 The burn period shall be continued for the duration considered sufficient to ensure complete combustion of the whole specimen and record the same and extinguish the burner.

E-9.10 Start the mixing fan and continue mixing for 30 s and then switch off the fan.

E-9.11 Immediately commence sampling the atmosphere from the chamber by drawing the gas mixture through each respective detection tube in turn. It is imperative that if the presence of

halogen acids is suspected, then these must be tested before other gases in order to reduce losses through absorption or condensation which may be experienced through a delayed estimation.

E-9.12 On completion of the analysis, the remaining products of combustion are removed from the chamber using the forced extraction exhaust system, initially opening the access door. Continue the forced ventilation for at least 3 min.

E-9.13 Examine the residue of the test specimen to ensure that all of the combustion material has been consumed. If any portion remains unburnt or appears to be, the whole test must be repeated using a fresh sample.

E-9.14 Repeat the procedure specified in **E-9.1** to **E-9.13** with a fresh specimen to obtain a duplicate determination, for as many times as necessary (*see E-5.1*).

E-10 CALCULATION

E-10.1 Using the graph prepared as described in **E-7**, determine the quantity of carbon monoxide, carbon dioxide and oxides of nitrogen formed by the burner in the time recorded in **E-9.9**. Subtract these values from the total carbon monoxide, carbon dioxide and oxides of nitrogen contents determined by analysis (*see E-9.11*) to give the amounts actually produced by combustion of the test specimen.

E-10.2 Using the formula given below, calculate the concentration of each gas in ppm (C_g) produced when 100 g of material is burnt and the combustion products diffused in air in a volume of 1 m³:

$$C_g = \frac{C \times 100 \times V}{m}$$

where

C = concentration of gas in test chamber, in ppm;

V = volume of test chamber in m³; and

m = fire test mass, in g.

E-10.3 Calculate C_g for each gas in the duplicate determination. Calculate average of the values of C_g for each gas.

E-10.4 Calculate the Toxicity Index as follows:

$$\text{Toxicity Index} = \frac{C_{g1}}{C_{f1}} + \frac{C_{g2}}{C_{f2}} + \frac{C_{g3}}{C_{f3}} + \dots + \frac{C_{gn}}{C_{fn}}$$

where

1, 2, 3..... n represent each of the gas detected; and

C_f = Concentration of the gas in ppm considered fatal to masses for a 30 min exposure time.

NOTE — Values of C_f for various gases are given in Note 4 under E-4.5.

E-11 REPORT

The test report shall include the following:

- a) Full description of the material tested, including type, grade, reference number, etc.
- b) The toxicity index per 100 g of material.
- c) The following statement:

‘This test result alone does not assess the fire hazard of the material, or a product made from this material, under actual fire conditions. Consequently, the results of this test alone shall not be quoted in support of claims with respect to the fire hazard of the material or the product in actual fire conditions. The results when used shall only be for research and development of quality control and material specifications.’