Comparison of flame-spread tests

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SUBJECT Comparison of Flame-Spread Tests

This Note compares some aspects of certain flame-spread tests employed by laboratories such as Underwriters' Laboratories, the Joint Fire Research Organization of Great Britain, and the U.S. National Bureau of Standards. It also discusses the correspondence between the scales upon which the results of these tests are expressed. This information was compiled at the request of the Subcommittee on Flame Spread of the Canadian Standards Association in order to help the Subcommittee in its task of formulating a standard flame-spread test for Canada.

Tabular Comparison of Flame-spread Tests

I. Established Test Methods

Test	Remarks	Advantages	Disadvantages
Underwriters Tunnel (1) (Specimen 25 ft. x 18 in. faces downward into duct; ignition at end)		An ASTM tentative since 1950. Also measures smoke and heat produced and readily permits sampling for toxic hazard.	Apparatus costly. Only one exists. Conditions of testing unacceptable to some potential customers.
BS476/1953 (2) (Specimen 3 ft. x 9 in. lies in vertical plane, longer axis horizontal; ignition at end)		Standard in U.K. since 1945; also in Australia and New Zealand. "Preliminary" version available for use by materials manufacturers.	Doubtful whether severe enough.
SS-A-118a (3,4,5) (Specimen 3 ft. x 3 ft. faces downward; ignition by burner below centre)	Developed for tests on acoustic materials, but need not be restricted to these.	Severe. Simple.	Classification demands considerable judgment. Not very reproducible. (N.B. round robin tests)

II. Tests Suggested or Under Development

Test	Remarks	Advantages	Disadvantages
Forest Products Lab's Tunnel (Specimen 8 ft. x 1 ft (?) faces downward into duct; ignition at end)		Can measure smoke and heat produced and permits sampling for toxic hazard.	
Nat'l Bureau of Standards Radiant Panel (Specimen 6 in. x 12 in., sloping; ignition at top)		Fairly severe. Economical of materials and time.	Possibly misleading because heat released is not allowed to influence spread of flame.
Hubbard test (6,7) (Specimen 12 in. x 3 in. faces into vertical flue; ignition at base)	Developed for evaluation of retardant coatings	Very simple and economical.	May not be severe enough.
(Taken as representative of the numerous small-scale tests which exist)			
Model room	A test suggested but not yet tried.	Realistic and persuasive.	Would need considerable development work.

Correspondence between the Scales upon which the Results of the Various Flame-spread Tests are expressed.

It has not been possible to trace more than a very little information upon this subject. Letters sent to certain interested organizations did not add very much more. The notes which follow summarize what has been learned.

(a) Tunnel test and SS-A-118a

The following table was given by M.S. Carlson[8]

Tunnel Test	SS-A-118a
0 - 15	Incombustible
16 - 50	Fire-retardant
51 - 75	Slow-burning
76 - 150	Combustible, 10-minute test
151 - 250	Combustible, 5-minute test

In the succeeding issue of the same journal this table was condensed, as follows:

Tunnel Test	SS-A-118a
0 - 50	Fire-retardant
51 - 90	Slow-burning
91 - 250	Combustible

A similar table is given by B.L. Wood[9]

SS-A-118a	Tunnel Test	Examples
Incombustible	0 - 15	Gypsum plaster, foam glass asbestos cement
Fire-retardant	15 - 30	protectively treated wood
Slow-burning	30 - 75	protectively treated wood or canvas, treated cellulose board, and treated plywood
Combustible (qualified)	75 - 200	untreated wood and plywood
Combustible (not qualified)	Over 200	untreated low-density cellulose boards, untreated wood veneers, and untreated canvas.

Neither Carlson nor Wood gives any reference for his table, but if the tables are based on experiment they can only have resulted from unpublished work at Underwriters' Laboratories, Chicago, since the only tunnel-test apparatus is there. It will be noticed that the tables do not quite agree with one another.

(b) Tunnel Test and BS 476

As yet there is only one point at which a relation between these two tests can be established. This is by comparing an Underwriters' Laboratories report[10] with a report by R.C. Bevan[11]. In each of these the results of flame-spread tests on timber are given. The experience of the British station was that among untreated specimens of different species of timber, the flame-spread rate depended on the density. Thus the boundary between Classes 3 and 4 of the British test can be said to lie at or near a density of 25 lb. per cubic foot (lighter species burning more rapidly and falling in Class 4, heavier species more slowly in Class 3).

When the flame-spread figures of Underwriters' Laboratories are plotted against densities at 12 per cent moisture content obtained from "Wood Handbook"[12] for the species of timber used by them, the same trend is found, though admittedly there are wide variations. On this basis 25 lb. per cubic foot corresponds roughly to flame spread 150.

Thus, so far as this process of reasoning can be relied upon, U.L. flame spread 150 corresponds to the boundary between BS 476 Classes 3 and 4.

The data for filling in the rest of the scale are even more inadequate. Two materials believed to be in Class 1 give U.L. flame spreads 15 to 25 and 40 to 45. Nothing in U.L. listings can be related to Class 2.

In the block diagrams in Fig. 1, the horizontal scale is the flame-spread classification according to the Tunnel Test, plotted logarithmically. It will be appreciated, from the manner in which it was derived, that this diagram is highly speculative. Accordingly a shaded "uncertainty zone" is shown between each of the classes of the BS 476 test. The correct boundary between each two classes may lie anywhere within this zone, or even outside it. Note: In the 1953 edition of BS 476[2] the criteria of the classes have been modified somewhat and a correction for variability has been introduced. We understand that these alterations substantially cancel out, and that all materials tested according to the old standard fall in the same classes when tested according to the new one.

What has been said so far is based on an important presupposition: that all three tests would classify materials in the same order, and that the only problem remaining was to find what performance in Test A corresponded to what performance in Test B. This has not been proved, but it does not seem to be an absurd assumption.

It would certainly not be true, however, if some other tests were included. A radiant-panel test used at the U.S. National Bureau of Standards, for instance, gives a different order from that found in other tests, and reasons can be assigned for this.

Just one report on a careful experimental comparison of flame-spread tests has been traced. This is "Evaluation of Flame Spread Resistance of Fiber Insulation Boards", by A. van Kleeck and T.J. Martin[13]. The experimental work was confined to easy-burning materials, with and without retardant coatings. The three tests which were compared were the SS-A-118a test previously referred to, and two tests which have not been used in the form described at laboratories other than Madison. Thus the report does not help to relate the SS-A-118a test to the other generally used tests.

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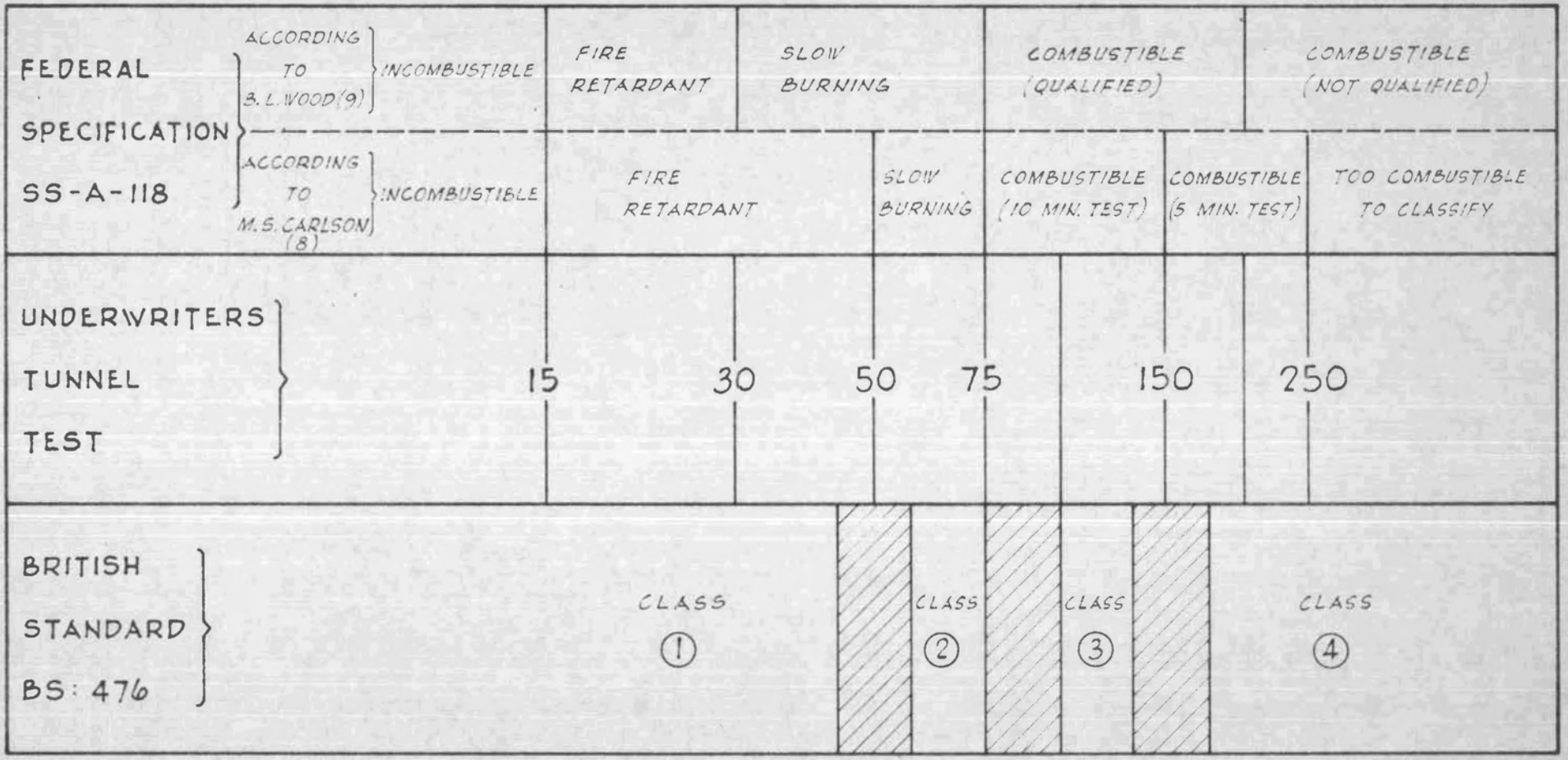

CORRESPONDENCE BETWEEN FLAME-SPREAD TESTS