Designation: D5132 – 17

Standard Test Method for Horizontal Burning Rate of Polymeric Materials Used in Occupant Compartments of Motor Vehicles[1]

This standard is issued under the fixed designation D5132; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method is intended for use as a small-scale laboratory procedure for comparing the relative horizontal burning rates of polymeric materials used in occupant compartments of motor vehicles.

1.2 During the course of combustion, gases or vapors, or both, are evolved that are potentially hazardous to personnel. Adequate precautions shall be taken to protect the operator.

1.3 *Units*—The values stated in SI units are to be regarded as standard.

1.4 This test method, Federal Safety Standard MVSS 302, SAE J369, and ISO 3795 address the same subject matter, but differ in technical content.

1.5 *This standard is used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions, but does not by itself incorporate all factors required for fire hazards or fire risk assessment of materials, products, or assemblies under actual fire conditions.*

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* Specific hazard statements are given in Section 7.

1.7 *Fire testing is inherently hazardous. Adequate safeguards for personnel and property shall be employed in conducting these tests.*

NOTE 1—There is no known ISO equivalent to this standard.

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D5025 Specification for Laboratory Burner Used for Small-Scale Burning Tests on Plastic Materials

E176 Terminology of Fire Standards

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

2.2 *Federal Safety Standard:*

MVSS 302 (49 CFR 571.302) Flammability of Interior Materials-Passenger Cars, Multipurpose Passenger Vehicles, Trucks and Buses[3]

2.3 *SAE Standard:*

SAE J369 Flammability of Polymeric Interior Materials - Horizontal Test Method[4]

2.4 *ISO Standard:*

ISO 3795 Road vehicles, and tractors and machinery for agriculture and forestry—Determination of burning behavior of interior materials[5]

3. Terminology

3.1 *Definitions*—For definitions of fire-related terms used in this test method, refer to Terminology E176.

4. Summary of Test Method

4.1 This test method employs a standard test specimen (100 by 356 mm) with a thickness up to 13 mm, mounted in a U-shaped metal frame. The specimen is ignited by means of a 38 mm high flame from an appropriate burner, and the burning rate of the material is determined.

4.2 The rate of burning is determined by measurements of the horizontal distance burned in relation to the time of burning, and reported for each set of specimens.

[1] This test method is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.30 on Thermal Properties.

Current edition approved May 1, 2017. Published June 2017. Originally approved in 1990. Last previous edition approved in 2011 as D5132 – 11. DOI: 10.1520/D5132-17.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] United States Code of Federal Regulations, 49 CFR 571.302, 36 FR 28991, available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

[4] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

[5] Available from International Organization for Standardization (ISO), 1 rue de Varembé, Case postale 56, CH-1211, Geneva 20, Switzerland.

***A Summary of Changes section appears at the end of this standard**

5. Significance and Use

5.1 This test method provides a standard laboratory procedure for measuring and comparing the burning rates of polymeric materials under specified controlled conditions.

5.2 The rate of burning is affected by such factors as density, direction of rise, and type and amount of surface treatments. The thickness of the finished specimens must also be taken into account. These factors must be considered in order to compare materials on the same basis.

5.3 In this procedure, the specimens are subjected to one or more specific sets of laboratory test conditions. If different test conditions are substituted or the end-use conditions are changed, it is not always possible by or from this test method to predict changes in the fire-test-response characteristics measured. Therefore, the results are valid only for the fire test exposure conditions described in this procedure.

6. Apparatus

6.1 The apparatus shall be as shown in Figs. 1-6 and shall include the following:

6.1.1 *Test Chamber*—A chamber approximately 380 by 355 by 200 mm constructed of 1.25–1.50 mm steel sheet and fabricated in accordance with Fig. 1.

6.1.2 *Laboratory Burner*—Constructed in accordance with Specification D5025.

NOTE 2—It is acceptable to mount the burner on the door, as shown in Fig. 6, to ensure proper alignment.

6.1.3 *Gas Supply*—Methane or natural gas having a heating value of 37 ± 1 MJ/m^3 .

6.1.4 *Specimen Holder Support*—A device capable of maintaining the specimen holder horizontally in place so that the top of the burner tube is positioned 19 mm below the top surface of the bottom U-shaped frame when placed in the specimen holder support, as shown in Fig. 2 and Fig. 3. The base of the support shall not obstruct the ventilation holes in the base of the cabinet.

NOTE 3—Limited data indicates that the use of a "drip tray" under the specimen holder does not significantly affect the test results. If differences are observed by the testing laboratory, the drip tray shall be removed.

6.1.5 *Specimen Holder*—Two matching U-shaped frames of non-corroding metal stock 25 mm wide and 10 mm high. The interior dimensions of the U-shaped frames are 50 mm wide by 330 mm long. A specimen that softens and bends at the flaming end so as to cause erratic burning is kept horizontal by supports consisting of thin, heat-resistant wires, spanning the width of the U-shaped frame under the specimen at 25-mm intervals. A device that is suitable for use for supporting this type of material is an additional U-shaped frame containing the specimen, spanned by 0.25-mm wires of heat-resistant composition at 25 mm intervals starting 38 mm from the open end. The device is inserted over the bottom U-shaped frame. See Fig. 4 and Fig. 5.

6.1.6 *Timing Device*—A timer accurate to the nearest 0.1 s.

6.1.7 *Measuring Device*—A rule accurate to the nearest 1.0 mm.

7. Hazards

7.1 During the course of combustion, gases or vapors, or both, are evolved and have the potential to be hazardous. Precautions shall be taken to protect the operator.

8. Test Specimens

8.1 A minimum of five specimens 100 ± 5 mm wide by a minimum of 300 mm long by thickness up to a maximum of 13 mm are prepared by cutting from the test material. If the test material has a coating, covering, or construction that is considered directional in nature, and it has a directional effect on the burning rate, then specimens are produced by cutting five specimens in both the transverse and longitudinal directions.

8.2 Cut specimens from uniform density samples. The maximum thickness of any specimen shall be 13 mm. If any material to be tested exceeds this, it shall be cut to the above

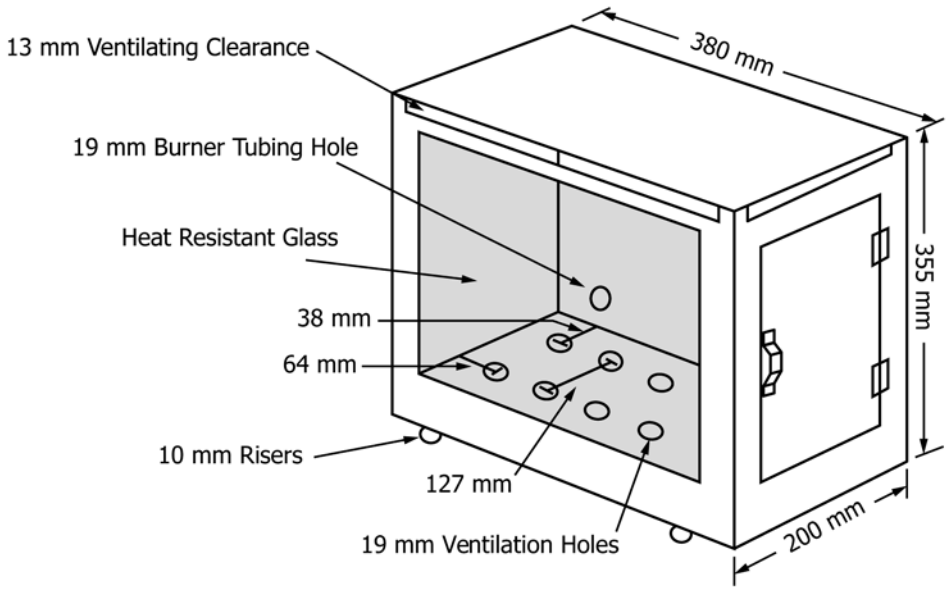


FIG. 1 Horizontal Flammability Chamber

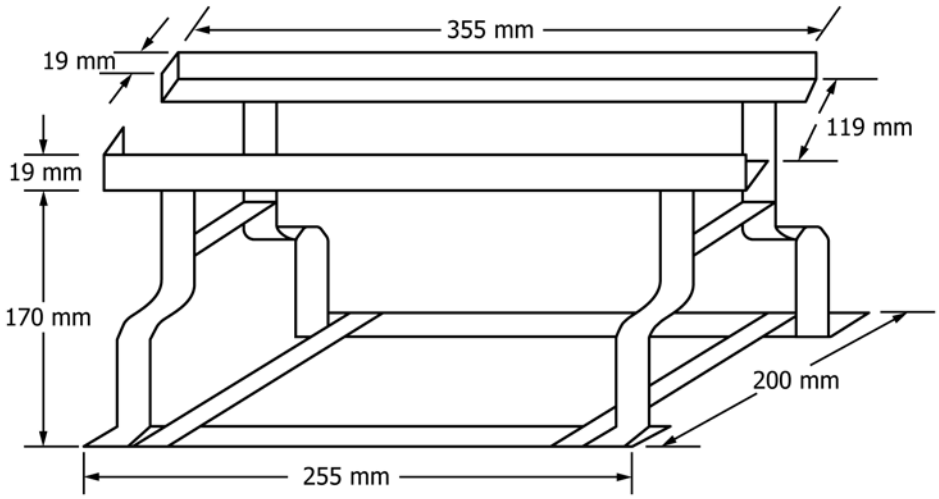


FIG. 2 Typical Specimen Holder Support

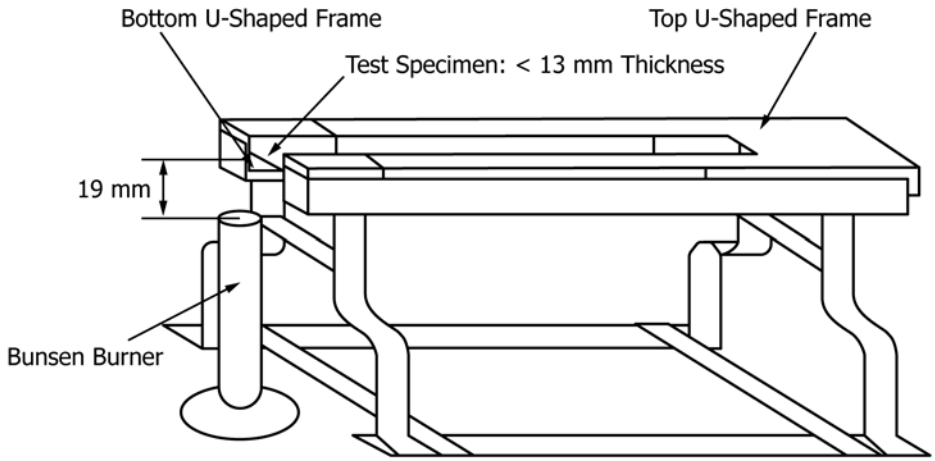


FIG. 3 Specimen Holder With Specimen Positioned in the Specimen Holder Support

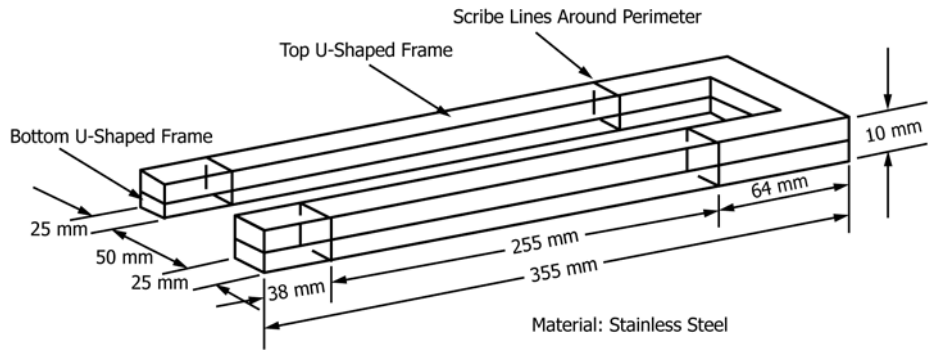


FIG. 4 Typical Specimen Holder—Two Identical U-Shaped Frames

thickness by a mechanical process applied to the side which does not face the occupant compartment, so that the specimen shall include the primary surface of the part. In case of materials made of different composition which are not composite materials, all the layers within a depth of 13 mm from the surface facing towards the occupant compartment shall be tested individually, as shown at the Fig. 7. Any material that does not adhere to other materials at every point of contact shall be tested separately. Any material that adheres to other materials at every point of contact shall be tested as a composite with other material(s). Record the information on specimen preparation in the test report.

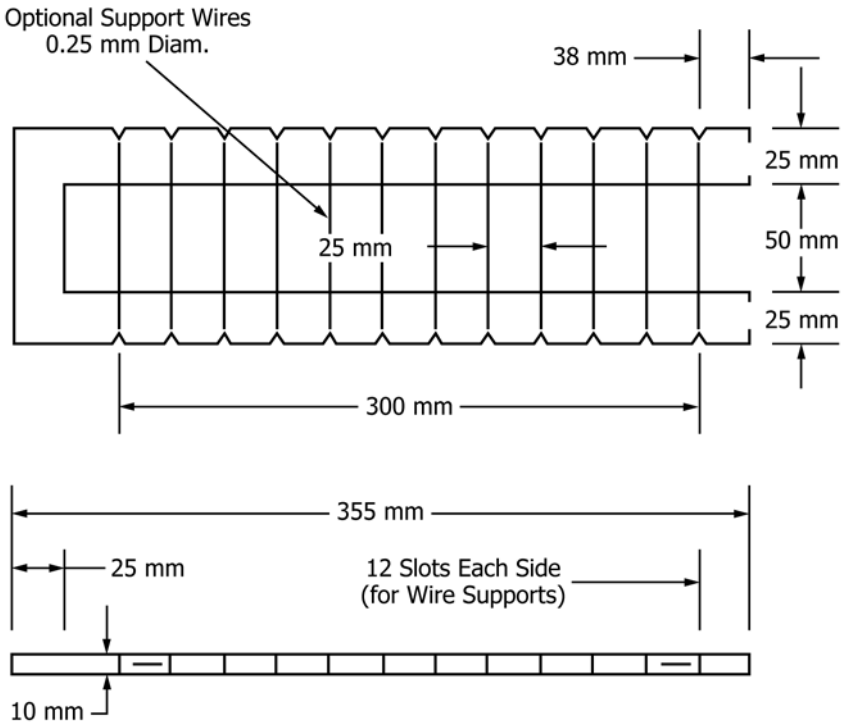


FIG. 5 Bottom U-Frame

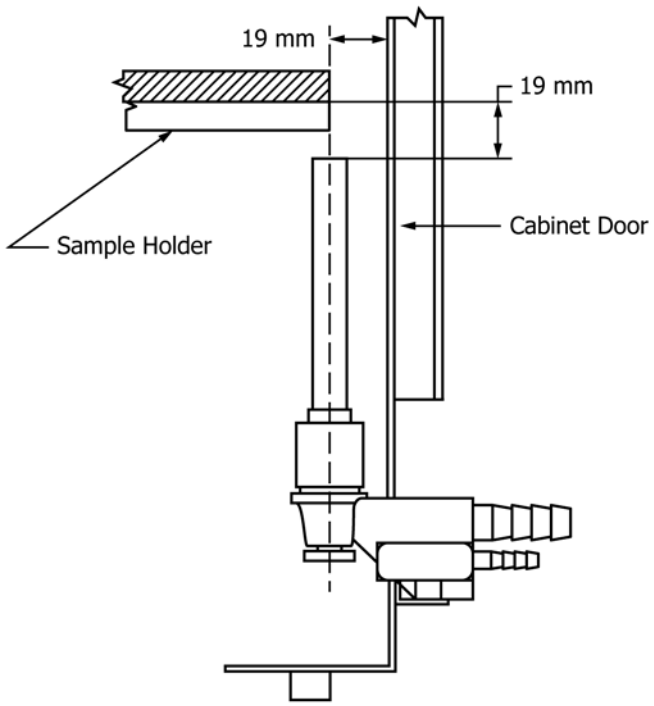
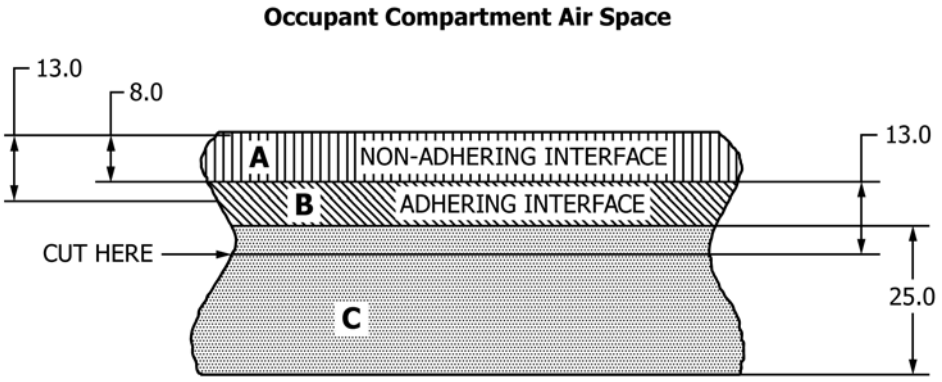


FIG. 6 Burner Position Inside Cabinet

8.3 Where it is not possible to obtain a flat specimen because of the component configuration, cut the specimen to the maximum thickness of 13 mm at any point, from the area with the least curvature, and in such a manner as to include the face side.

8.4 The minimum width and length of the specimen shall be 95 and 300 mm, respectively. Use the maximum available length or width of a specimen (as described in 8.1) where either dimension is less than the specified values.



NOTE 1—Material A has a non-adhering interface with material B and is tested separately. Part of material B is within 13.0 mm of the occupant compartment air space, and materials B and C adhere at every point of contact; therefore B and C are tested as a composite. The cut is in material C as shown, to make a specimen 13.0 mm thick.

FIG. 7 Specimen Preparation (Illustrative Example)

8.5 For composites, laminates, or surface-treated samples, the side nearest to the compartment occupant shall be placed facing down during testing.

8.6 If the material's grain pattern or construction is such that it has a directional effect on the burning rate, conduct the testing in both the transverse and longitudinal directions, as described in 8.1. Test five specimens in each direction.

9. Conditioning

9.1 Unless otherwise agreed upon, materials shall be conditioned for at least 24 h at 23 ± 2°C and 50 ± 10 % relative humidity prior to testing.

9.2 All specimens shall be tested in a laboratory atmosphere of 15 to 35°C and 40 to 75 % relative humidity. For convenience, the specimens can be stored up to 1 h in closed polyethylene bags after conditioning and prior to testing.

10. Procedure

10.1 Place the test chamber inside a laboratory exhaust hood.

NOTE 4—The proper control of the hood is necessary to ensure the proper draft. Adjust the baffles or the exhaust motor speed, or both, so that the face velocity of the hood shall be constant in the range of 0.1 m/s [75 ft/min]. It is possible that the effectiveness of the hood will change when the door to the lab is opened and closed.

10.2 Place samples with napped or tufted surface on a flat surface and comb twice against the nap using the metal comb at least 110 mm in length, with seven to eight teeth per 25 mm.

10.3 Place the test specimen between the two matching U-shaped frames so that the frames hold both long sides and one end of the specimen.

10.4 Place the burner remote from the specimen, ignite, and adjust it to produce a blue flame 38 ± 2 mm high. Adjust the gas supply and the air ports of the burner until a yellow-tipped blue flame is produced and then increase the air supply until the yellow tip just disappears. Measure the height of the flame, and, if necessary, readjust to obtain a flame 38 mm high.

10.5 Place the burner inside the open end of the test chamber and position the burner to ensure that the center of the burner top is 19 ± 1 mm below the center of the bottom edge of the specimen at the open end of the specimen holder when the specimen is in the specimen testing position.

10.6 Place the mounted specimen in the horizontal testing position in the specimen holder support inside the test chamber.

10.7 Turn on the exhaust hood.

10.8 Move the flame into contact with the specimen for a period of 15 s, then extinguish the exposure flame by turning off the gas supply or by removing the flame from under the specimen.

10.9 Observe the leading edge of the flame front, starting the timer when the scribed mark 38 mm from the open end of the sample holder is reached.

10.10 Measure the time it takes the leading edge of the flame front to progress to the line scribed 292 mm from the open end of the top or bottom U-shaped frame. If the flame does not reach this specified end point, time its progress to the furthest distance reached. If the specimen stops burning before it has burned for 60 s and has not burned more than 50 mm past the 38 mm scribed line, no burn rate is calculated.

11. Calculation

11.1 Calculate the burning rate from the following formula:

$$B = D/T \times 60 \quad (1)$$

where:

B = burning rate, mm/min,
D = length the flame traveled, starting from the first scribed line, mm, and
T = time for the flame to travel distance D, s

12. Report

12.1 Report the following information:

12.1.1 Complete identification of the material tested, including generic description, manufacturer, commercial designation, and lot number, color and other information as requested.

12.1.2 Directionality of the specimens, if pertinent. See 8.1 and 8.5.

12.1.3 The thickness and type of specimens tested, that is, composite, laminate, finished section, cellular foam, etc.

12.1.4 Conditioning treatment.

12.1.5 Any prior treatment before testing, other than cutting, trimming and conditioning.

12.1.6 Number of specimens tested.

12.1.7 Burnt distance in mm, and burning time, in seconds.

12.1.8 All calculated single values of burning rate, in mm / min.

12.1.9 Average burning rate in millimetres per minute when the flame reaches the specific end point. Report *D* and *T* separately for each specimen when the flame propagation stops before reaching the end point.

12.1.10 Describe observations of burning characteristics such as warping, melting, dripping, charring, etc.

12.2 The report shall contain the following statement: "In this procedure, the specimens are subjected to one or more specific laboratory test conditions. If different test conditions are substituted or the end-use conditions are changed, it is not always possible by or from this test to predict changes in the fire-test-response characteristics measured. Therefore, the results are valid only for the fire test exposure conditions described in this procedure."

13. Precision and Bias[6]

13.1 *Precision*—Table 1 is based on a round robin conducted in accordance with Practice E691. For each material, all the samples were prepared at one source, but the individual specimens were conditioned in accordance with 9.1 by the laboratories that tested them.

TABLE 1 Test Method D5132 without drip tray, Burn Rate (mm/min.)

Material	Values, s				
	Average	S_r[A]	S_R[B]	r[C]	R[D]
ABS	60.3	7.5	11.7	21.1	32.7
PVC	37.2	10.3	24.5	29.0	68.5
TPO	65.8	4.1	29.0	11.5	81.1
Polystyrene	80.5	7.8	10.1	21.7	28.2
Foam/Fabric 1A	66.3	12.3	26.5	34.5	74.2
Foam/Fabric 1B	74.0	7.9	25.1	22.1	70.4
Foam/Fabric 2A	51.4	10.8	18.4	30.2	51.5
Foam/Fabric 2B	53.2	12.6	17.2	35.4	48.3
Foam/PVC	5.9	11.2	14.8	31.4	41.5
Polyurethane	6.8	6.1	22.1	17.0	61.8

[A] S_r = within-laboratory standard deviation for the indicated material. It is obtained by pooling the within-laboratory standard deviations of the test results from all of the participating laboratories: $S_r = [\,[\,(S_1)^2 + (S_2)^2 \ldots 1\,(S_n)^2\,]/n\,]^{1/2}$

[B] S_R = between-laboratories reproducibility, expressed as standard deviation: $S_R = [\,S_r^2 + S_L^2\,]^{1/2}$

where:

S_L = standard deviation of laboratory means.

[C] r = within-laboratory critical interval between two test results = 2.8 × S_r.

[D] R = between-laboratories critical interval between two test results = 2.8 × S_R.

13.1.1 There were eleven laboratories involved in this study. Eight performed this test method without a drip tray, three were performed with a drip tray. The number of replicates per material per test method varied from four to five. One laboratory ran four replicates, all other labs tested five replicates. The round robin was done in late 2002.

13.1.2 One lab performed this test method both with and without the tray. The data without the tray was used for the calculations.

13.1.3 The precision for this test method with the drip tray was not compared with the same test method without the tray because there were too few laboratories running the test with the tray.

13.2 *Concept of r and R*—**Warning—**The following explanations of *r* and *R* (13.2.1 – 13.2.3) are only intended to present a meaningful way of considering the approximate precision of this test method. Do not apply the data in Table 1 to the acceptance or rejection of materials, as these data apply only to the materials tested in the round robin and are unlikely to be rigorously representative of other lots, formulations, conditions, materials, or laboratories. Users of this test method need to apply the principles outlined in Practice E691 to generate data specific to their laboratory and materials, or between specific laboratories. The principles of 13.2.1 – 13.2.3 would then be valid for such data. If S_r and S_R have been calculated from a large enough body of data, and for test results that were averages from testing five specimens, then:

13.2.1 *Repeatability*—"*r*" is the interval representing the critical difference between two test results for the same material, obtained by the same operator using the same equipment on the same day in the same laboratory. The two test results shall be judged not equivalent if they differ by more than the r value for that material.

13.2.2 *Reproducibility*—"*R*" is the interval representing the critical difference between two test results for the same material, obtained by different operators using different equipment in different laboratories, not necessarily on the same day. The two test results shall be judged not equivalent if they differ by more than the *R* value for that material.

13.2.3 Any judgment in accordance with 13.2.1 and 13.2.2 would have an approximate 95 % (0.95) probability of being correct.

13.3 *Bias*—There are no recognized standards by which to estimate bias of this test method.

14. Keywords

14.1 burning rate; flame; flexible cellular materials; heat; motor vehicles; occupant compartments; polymeric materials; rubber

[6] Supporting data have been filed at ASTM International Headquarters and are obtainable by requesting Research Report RR:D20-1238.

ANNEX

(Mandatory Information)

A1. ROUND ROBIN RESULTS

A1.1 Table A1.1 is based on a round robin conducted in accordance with Practice E691 of the Federal Motor Vehicle Safety Standard (FMVSS) 302. This study was done in conjunction with the study done for this test method. The materials samples were the same as those used for the round robin study described in Section 13. For each material, all the samples were prepared at one source, but the individual specimens were conditioned in accordance with 9.1 by the laboratories that tested them.

A1.1.1 There were eleven laboratories involved in this study. The number of replicates per material per test method varied from three to five; seven labs tested five replicates, three labs tested four replicates, and one lab tested three replicates. Most laboratories performed the tests on five replicates. The round robin was done in late 2002.

TABLE A1.1 Burn Rate (mm/min)

Material	Values, s				
	Average	S_r[A]	S_R[B]	r[C]	R[D]
ABS	60.7	5.9	12.5	16.5	35.1
PVC	31.4	8.5	20.0	23.8	56.1
TPO	65.5	4.9	27.8	13.8	77.7
Polystyrene	73.6	11.8	20.2	33.1	56.6
Foam/Fabric 1A	68.0	6.7	28.6	18.7	80.2
Foam/Fabric 1B	73.9	5.3	27.5	14.8	76.9
Foam/Fabric 2A	51.6	15.0	25.4	42.0	71.0
Foam/Fabric 2B	53.0	14.0	19.3	39.2	54.2
Foam/PVC	5.0	10.9	14.0	30.4	39.1
Polyurethane	1.1	6.0	6.4	16.9	18.0

[A] S_r = within-laboratory standard deviation for the indicated material. It is obtained by pooling the within-laboratory standard deviations of the test results from all of the participating laboratories: $S_r = [\,[\,(S_1)^2 + (S_2)^2 \ldots 1\ (S_n)^2\,]/n\,]^{1/2}$

[B] S_R = between-laboratories reproducibility, expressed as standard deviation: $S_R = [\,S_r^2 + S_L^2\,]^{1/2}$

where:

S_L = standard deviation of laboratory means.

[C] r = within-laboratory critical interval between two test results = 2.8 × S_r.

[D] R = between-laboratories critical interval between two test results = 2.8 × S_R.