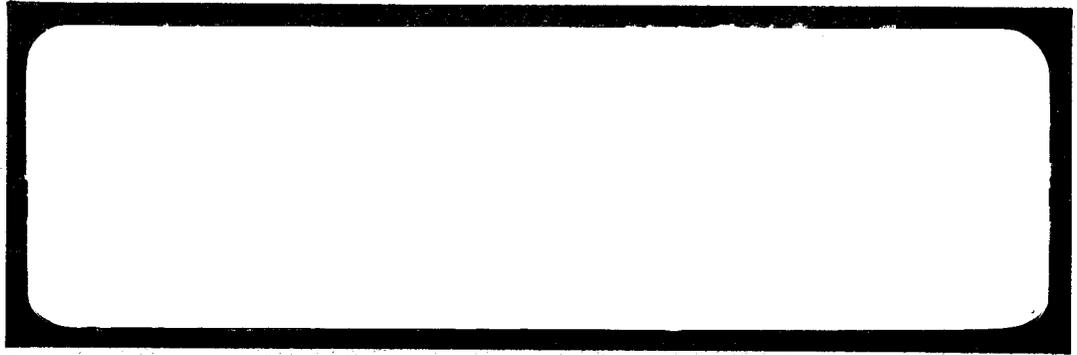


BOEING



TRANSPORT DIVISION

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1. SCOPE

This document describes standard flame test methods used to determine the burning characteristics of aircraft materials.

2. PURPOSE

To provide standard fire test methods of use on engineering drawings and specifications.

3. REFERENCES

- a. Federal Aviation Agency, Flight Standards Service Release No. 453 (F.A.A. FSSR #453) Fire Prevention Test Procedures For Airframe Materials"
- b. ASTM D-1692-59T, Test For Flammability of Plastics Foams and Sheeting.
- c. Federal Specification, CCC-T-191b, Test Method 5902, Flame Resistance of Cloth - Vertical.
- d. Document No. D6-8067, "Flame Test Specification For Flexible Hoses."

4. TEST METHODS

4.1 Flame Resistant Materials - Horizontal Test Methods

4.1.1 All Materials Except Plastic Foam

a. Apparatus

- (1) Duplicate metal frames. See Figure 1.
- (2) Bunsen or Tirrill gas burner. The burner shall have a tube of 3/8" inside diameter.

b. Test Specimens

The size of the specimens shall be approximately 3" x 14" x thickness of the material. At least three specimens shall be tested. In case of fabrics, three in the "warp," three in the "fill" and/or three in the direction of the weave corresponding to the most critical burn rate.

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4.1.1 All Materials Except Plastic Foam (Cont'd)

c. Conditioning

Test specimens that are in "Standard Condition" shall be tested. "Standard Condition" is defined as the condition reached by the material when in moisture equilibrium with an atmosphere having a relative humidity of 60% ± 5% and a temperature of 70° ± 5°F. Moisture equilibrium is considered to have been reached when, after free exposure of the material to air in motion, the change in weight in successive weighings made at intervals of one hour is no greater than 0.25%.

d. Test Procedure

Clamp each of the test specimens in duplicate metal frames (Figure 1) so that at least 1/2" of the specimen shall extend beyond the open end of the frames. The unclamped 1/2" of the specimen shall be used for ignition purposes.

The specimen-frame assembly shall be supported horizontally and tested in draft-free conditions. The surface that will be exposed when installed in the aircraft shall face down for the test. At start of test, preheat the metal frames to 100° ± 10°F. The specimen shall be ignited by a Bunsen or Tirrill Burner. The air supply to the burner shall be completely shut off and the flame height adjusted to 1 1/2". The flame shall be applied for 15 seconds, then withdrawn, and the duration of flaming on the specimen noted. If the material is not self-extinguishing, a minimum of 10 inches of the specimen should be used for timing purposes, and approximately 1 1/2 inches should burn before the burning front reaches the timing zone. The specimen should be long enough so that the timing is stopped at least one inch before the burning front reaches the end of the exposed specimen.

e. Report

The report shall include the following:

- (1) Material identification and thickness. In addition, attach approximately a 1 1/2" x 1 1/2" sample of the material to the report.
- (2) Duration of flaming on the specimen upon removal of the flame. If the specimen does not extinguish, report the burn rates in inches per minute.
- (3) Duration of afterglow after flaming has ceased.

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4.1.1 All Materials Except Plastic Foam (Cont'd)

c. Conditioning

Test specimens that are in "Standard Condition" shall be tested. "Standard Condition" is defined as the condition reached by the material when in moisture equilibrium with an atmosphere having a relative humidity of $60\% \pm 5\%$ and a temperature of $70^\circ \pm 5^\circ\text{F}$. Moisture equilibrium is considered to have been reached when, after free exposure of the material to air in motion, the change in weight in successive weighings made at intervals of one hour is no greater than 0.25%.

d. Test Procedure

Clamp each of the test specimens in duplicate metal frames (Figure 1) so that at least 1/2" of the specimen shall extend beyond the open end of the frames. The unclamped 1/2" of the specimen shall be used for ignition purposes.

The specimen-frame assembly shall be supported horizontally and tested in draft-free conditions. The surface that will be exposed when installed in the aircraft shall face down for the test. At start of test, preheat the metal frames to $100^\circ \pm 10^\circ\text{F}$. The specimen shall be ignited by a Bunsen or Tirrill Burner. The air supply to the burner shall be completely shut off and the flame height adjusted to 1 1/2". The flame shall be applied for 15 seconds, then withdrawn, and the duration of flaming on the specimen noted. If the material is not self-extinguishing, a minimum of 10 inches of the specimen should be used for timing purposes, and approximately 1 1/2 inches should burn before the burning front reaches the timing zone. The specimen should be long enough so that the timing is stopped at least one inch before the burning front reaches the end of the exposed specimen.

e. Report

The report shall include the following:

- (1) Material identification and thickness. In addition, attach approximately a 1 1/2" x 1 1/2" sample of the material to the report.
- (2) Duration of flaming on the specimen upon removal of the flame. If the specimen does not extinguish, report the burn rates in inches per minute.
- (3) Duration of afterglow after flaming has ceased.

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e. Report (Cont'd)

- (4) The amount (none, slight, moderate or heavy) and color of smoke, fumes and jetting.
- (5) Any melting and dripping and if drippings continue to burn.

4.1.2 Plastic Foams - Horizontal Test Method

a. Apparatus

- (1) Two ring stands
- (2) Bunsen Burner

The burner shall have a 3/8 inch inside diameter tube. It shall also be fitted with a 1 7/8 inch maximum width wing top.

- (3) Specimen Support

Hardware cloth, 1/4 inch mesh using 1/32 inch diameter steel wire. Cloth sample 3 x 8 1/2 inches shall have 1/2 inch of length bent to form a right angle. This will form the specimen support (See Figure 2).

- (4) Stop Watch

b. Test Specimens

- (1) At least five test specimens 2 x 6 inches shall be tested.

(a) Plastic foam specimens shall be cut from uniform density material. Materials supplied in thicknesses over 1/2 inch shall be cut to 1/2 inch thickness. Materials foamed in thicknesses of 1/2 inch or less shall be tested at the thickness supplied. Care shall be taken to remove all dust and cut particles from the foam surfaces.

(b) Sheet samples are cut from a thickness of sheet normally supplied or compression molded to a desired thickness. Edges of the cut specimens shall be filed smooth.

- (2) Each test specimen shall be marked across its width by two lines one and five inches from one end of the specimen.

c. Conditioning

Same as in Section 4.1.1.c.

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4.1.2 Plastic Foams - Horizontal Test Method (Cont'd)

d. Test Procedure *

Clamp the hardware-cloth specimen support horizontally between two ring stands as shown in Figure 2. Adjust the height of the bottom of the hardware-cloth support so as to be 1/2 inch above the top of the Bunsen burner wing top. Burn off any material remaining on the hardware cloth from previous tests, or use a new screen for each test. Place a specimen on the support with one end touching the 1/2 inch bent-up portion of the support and with the longitudinal axis parallel to that of the support.

Adjust the Bunsen burner with the wing top to provide a blue flame whose visible portion is 1 1/2 inch high. Place the burner under the bent-up end of the specimen support so that one edge of the flame is in line with the vertical section of hardware cloth and the other edge of the flame extends into the front edge of the specimen. The center of the width of the wing top shall be directly under the center of the specimen. At the end of one minute or when the flame front reaches the first gage mark, remove the burner at least 18 inches away from the test specimen.

If no evidence of ignition, such as flame or progressive glow, is seen after removal of the burner flame, the result is judged to be "nonburning by this test."

If the specimen continues to burn after removal of the flame, start the stop watch when the flame front reaches the first gage mark. Stop the watch when the flame front reaches the second gage mark and note the time in seconds. A specimen that reaches the second gage mark shall be judged to be "burning by this test."

If the specimen shows evidence of ignition or burns upon exposure to the flame but does not burn past the second gage mark, it shall be judged "self-extinguishing by this test." The "extent of burning" is equal to six inches minus the distance from the unburned end to the nearest evidence of the flame front, such as charring, along the upper surface of the specimen. Note the apparent cause which extinguished the flame such as melting, dripping or smoldering.

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4.1.2 Plastic Foams - Horizontal Test Method (Cont'd)

e. Report

The report shall include the following:

- (1) A description of the material tested, including any prior treatment or conditioning of the material before testing other than cutting and trimming.
- (2) Density of the foamed materials.
- (3) Thickness of the specimens.
- (4) Classification of the material as "nonburning", "self-extinguishing", or "burning".
- (5) Extent of burning when a material is reported as "self-extinguishing", and also the apparent cause such as melting, dripping and smoldering.
- (6) Burning rate in inches per minute when a material is reported as "burning by this test".

4.2 Flame Resistant Materials - Vertical Test Methods

4.2.1 All Materials Except Plastic Foams

a. Apparatus

This test apparatus shall be as specified per Section 4.1.1.a.

b. Test Specimen

Same as in Section 4.1.1.b. except specimen size shall be 3" x 10" x thickness of the material.

c. Conditioning

Same as Section 4.1.1.c.

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4.2.1 All Materials Except Plastic Foams (Cont'd)

d. Test Procedure

Same as 4.1.1.d. except for the following:

- (1) The test specimen shall be assembled flush with the open end of the frames.
- (2) The specimen-frame assembly shall be supported vertically with its lower end $3/4$ inch above the top of the Bunsen or Tirrill gas burner. The $1\ 1/2$ inch flame shall be applied vertically near the middle of the width of the lower end of the specimen for 12 seconds, then withdrawn and the duration of flaming on the specimen noted. If the material is not self-extinguishing, the burn rate shall be determined by noting the time required for the flame on the specimen to reach the top of the specimen after removal of the ignition flame. Ten inches divided by the noted time, in minutes, shall be the burn rate.

e. Report

Same as 4.1.1.e except in the case of fabrics, the length of the char shall be reported. The length of the char is defined as the distance from the end of the specimen which was exposed to the flame to the end of the tear made lengthwise in the specimen through the center of the charred area in the following way: A hook is inserted in the specimen, on one side of the charred area $1/4$ inch in from the adjacent outside edge. A weight, which inclusive of the hook is equal to that specified for the fabric in the following table, is attached to the hook.

Tearing Weights

<u>Weight of Fabric (Oz. per Sq.Yd.)</u>	<u>Total Tearing Weight For Determination of Length of Char (Lbs.)</u>
2 to 6 inclusive	0.25
Over 6 and not exceeding 15	0.50
Over 15	0.75

The specimen is then grasped on the opposite side of the charred area with the fingers, and raised gently until it supports the weight. The specimen will tear through the charred area until fabric strong enough to carry the load is reached.

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4.2.2 Plastic Foams - Vertical Test Method

a. Apparatus

Same as in Section 4.1.2.a.

b. Test Specimens

Same as in Section 4.1.2.b.

c. Conditioning

Same as in Section 4.1.1.c.

d. Test Procedure

Same as in Section 4.1.2.d except suspend the specimen screen assembly in the vertical position with the bent-up portion of the screen 1/2 inch from the burner. The uppermost portion of the test specimen should be fastened to the screen to prevent the specimen from being dislodged during the test. The ignition time to be one minute or less if the material ignites.

e. Report

Same as in Section 4.1.2.e.

4.3 Fire-Resistant Materials

a. Apparatus

- (1) Bunsen or Tirrill Burner
- (2) Metal Frame For Flexible Materials

b. Test Specimen

- (1) If the material is rigid the specimen size shall be 8" x 8" x thickness of the material.
- (2) If the material is flexible the specimen size shall be placed in a frame exposing an area of 8" x 8".
- (3) If a backing will be used in the airplane, the test specimen shall be provided with the same backing.

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4.3 Fire-Resistant Materials (Cont'd)

c. Conditioning

Same as in Section 4.1.1.c.

d. Test Procedure

The test specimen shall be supported at an angle of 45° to a horizontal surface. The surface of the material that will be exposed, when installed in the aircraft, shall face down for the test. The specimen shall be exposed to either a Bunsen or a Tirrill burner, adjusted for no air intake, giving a yellow-tipped 1 1/2 inch flame when resting on a horizontal surface. Suitable precautions should be taken to avoid drafts. The period of flame application should be 30 seconds with one-third of the flame in contact with the material at the center of the specimen.

e. Report

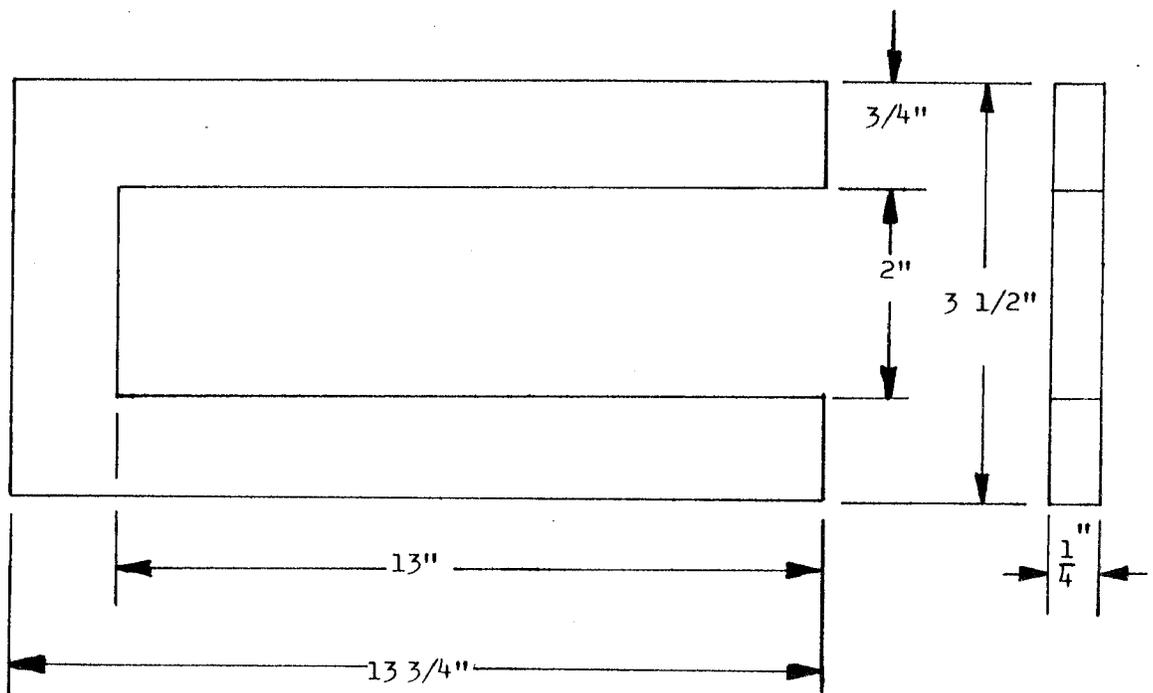
The report shall include the following:

Same as in Section 4.1.1.e.(1), (2), (3), (4) and (5).

4.4 Flame Test For Fuel Hose Assemblies

For test procedure, see reference (d).

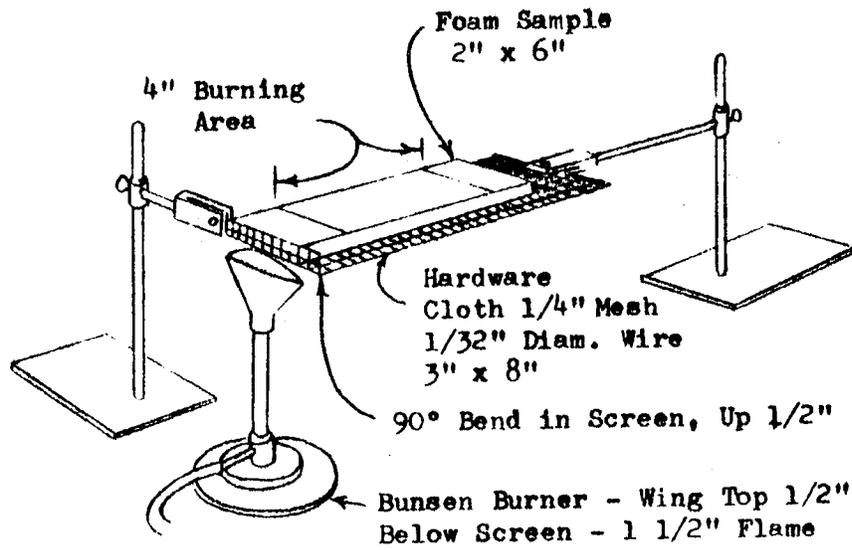
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METAL FRAME - 2 Required

FIGURE 1

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APPARATUS FOR FLAMMABILITY TEST
OF PLASTIC FOAM AND SHEETING

FIGURE 2

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