Chapter 3
Horizontal Bunsen Burner Test for Cabin, Cargo Compartment, and Miscellaneous Materials

3.1 Scope

This test method is intended for use in determining the resistance of materials to flame when tested according to the 15-second horizontal Bunsen burner tests specified in FAR 25.853.

3.2 Definitions

3.2.1 Ignition Time

Ignition time is the length of time the burner flame is applied to the specimen. For this test, the ignition time is 15 seconds.

3.2.2 Burn Rate

Burn rate is the rate at which a flame front moves over a specified distance on a test specimen, under specified test conditions. In this test, it is the rate with which a flame front moves across a test specimen mounted horizontally.

3.3 Apparatus

3.3.1 Test Cabinet

Tests will be conducted in a draft-free cabinet fabricated in accordance with figures 3-1 to 3-3 or other equivalent enclosures acceptable to the FAA. It is suggested that the cabinet be located inside an exhaust hood to facilitate clearing the cabinet of smoke after each test. Stainless steel or other corrosion resistant metal, 0.04 inch (1 mm) thick will be used for the bottom surface of the chamber.

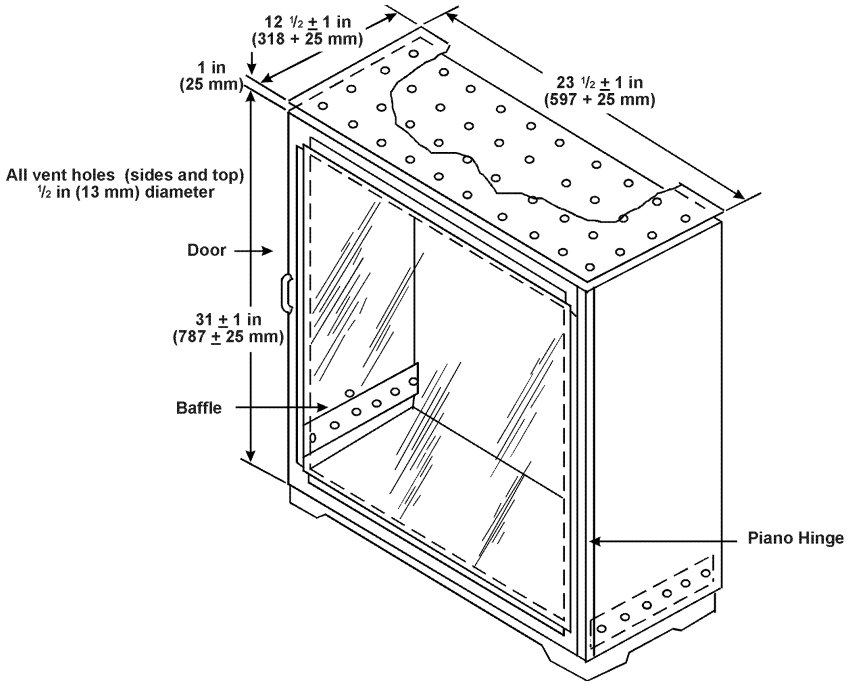

Figure 3-1. Sketch of Horizontal Bunsen Burner Test Cabinet

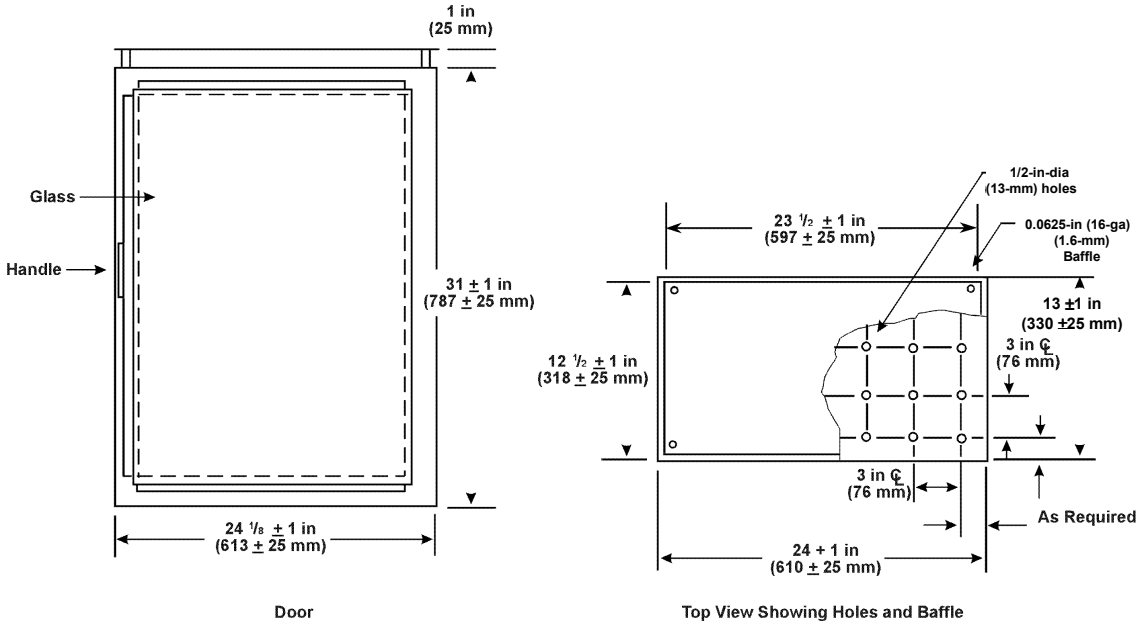

Figure 3-2. Front and Top View of Horizontal Bunsen Burner Test Cabinet

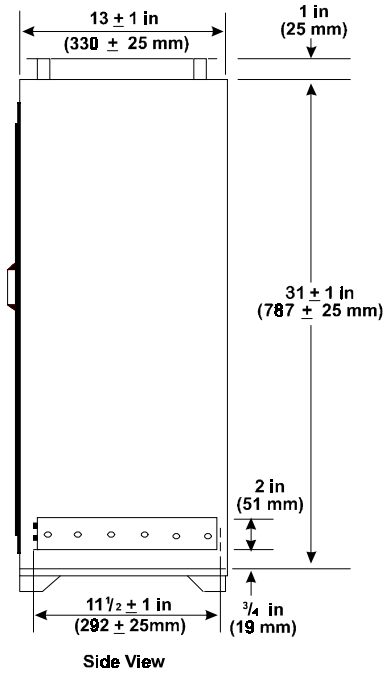

Figure 3-3. Side View of Horizontal Bunsen Burner Test Cabinet

3.3.2 Specimen Holder

A specimen holder fabricated of corrosion-resistant metal in accordance with figure 3-4 will be used. When performing the tests, the specimen will be mounted in the frame so that the two long edges are held securely. The exposed area of the specimen will be 2 inches (51 mm) in width and 12 inches (305 mm) in length.

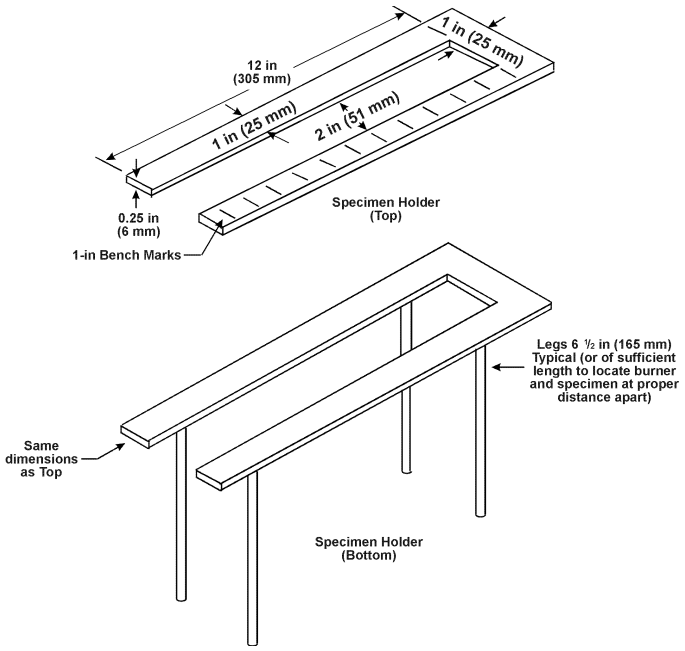

Figure 3-4. Horizontal Bunsen Burner Test Specimen Holder

3.3.3 Burner

The burner will be a Bunsen or Tirrill type, have a 3/8-inch (10-mm) inside diameter barrel, and will be equipped with a needle valve located at the bottom of the burner barrel to adjust the gas flow rate and, thereby, adjust the flame height. There will be a means provided to move the burner into and out of test position when the cabinet door is closed.

3.3.3.1 Burner Fuel

Methane gas (99 percent minimum purity) or other burner fuel acceptable to the FAA will be used. Methane is the preferred fuel. It can be used without adding air through the aspirating holes at the bottom of the burner barrel, i.e., a pure diffusion flame may be used.

3.3.3.2 Plumbing for Gas Supply

The necessary gas connections and the applicable plumbing will be essentially as shown in figure 3-5. A control valve system with a delivery rate designed to furnish gas to the burner under a pressure of 2 1/2 ± 1/4 psi (17 ± 2 kPa) at the burner inlet will be installed between the gas supply and the burner.

3.3.3.3 Flame Height Indicator

A flame height indicator may be used to aid in setting the height of the flame. A suitable indicator has a prong extending 1.5 inches (38 mm) above the top of the burner barrel, is attached to the burner barrel, and spaced 1 inch (25 mm) from the burner barrel, as shown in figure 3-5. If using methane as the burner fuel, it is desirable to have two prongs for measuring the flame height, one prong to indicate the height of the inner cone of the flame and one prong to indicate the height of the tip of the flame. For methane, it has been determined that when the height of the inner cone is 7/8 inch (22 mm) and the tip of the flame is 1.5 inches (38 mm) long, the proper flame profile is achieved.

3.3.4 Timer

A stopwatch or other device, calibrated to the nearest 0.1 second, will be used to measure the time of application of the burner flame, the flame time, and the drip flame time.

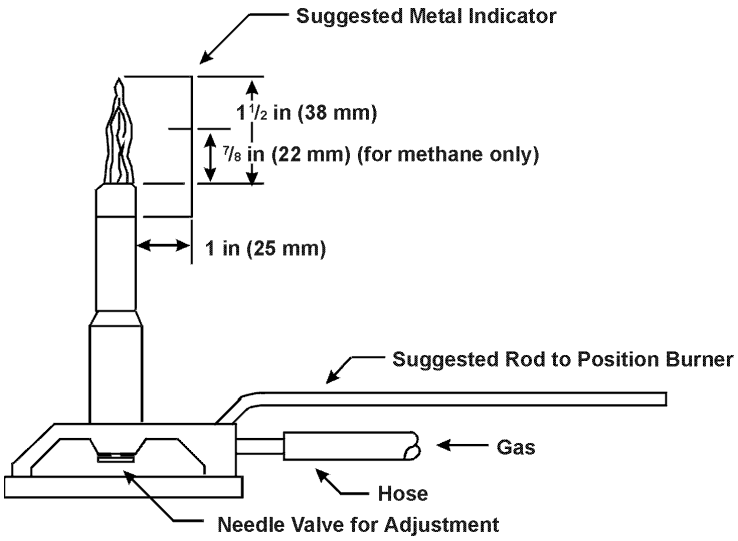

Figure 3-5. Burner Plumbing and Burner Flame Height Indicator

3.3.5 Ruler

A ruler or scale graduated to the nearest 0.1 inch (2.5 mm) will be provided to measure gage marks and flame front position.

3.4 Test Specimens

3.4.1 Specimen Selection

Specimens tested will be either cut from a fabricated part as installed in the aircraft or cut from a section simulating a fabricated part, e.g., cut from a flat sheet of material or from a model of the fabricated part. The specimen may be cut from any location in the fabricated part. Fabricated units, such as sandwich panels, will not be separated into individual component layers for testing.

3.4.2 Specimen Number

Each separate set of specimens prepared for testing will consist of at least three specimens (multiple places).

3.4.3 Specimen Size

The specimen will be a rectangle at least 3 by 12 inches (76 by 305 mm), unless the actual size used in the aircraft is smaller.

3.4.4 Specimen Thickness

The specimen thickness will be the same as that of the part qualified for use in the aircraft, with the following exceptions:

3.4.4.1 The specimen thickness must be no thicker than the minimum thickness to be qualified for use in the aircraft. The specimen thickness will not exceed 1/8 inch (3 mm).

3.4.4.2 Parts that are smaller than the size of a specimen and cannot have specimens cut from them may be tested using a flat sheet of the material used to fabricate the part in the actual thickness used in the aircraft. The sheet thickness will not exceed 1/8 inch (3 mm) if the test being run is the 4 inches per minute horizontal burn rate test.

3.4.5 Specimen Preparation

Mark gauge lines on the back surface (opposite the surface to be exposed to the flame) of the specimen 1.5 inches (38 mm) and 11.5 inches (292 mm) from the end of the specimen that will be subjected to the flame.

3.4.5.1 A fine-gauge wire mesh with large openings can be used to support test specimens that sag severely during testing so that the flame propagation may be determined accurately.

3.5 Conditioning

Condition specimens at 70 ± 5°F (21 ± 3°C) and 50% ± 5% relative humidity for 24 hours minimum. Remove only one specimen at a time from the conditioning environment immediately before being tested.

3.6 Procedure

3.6.1 Burner Adjustment

3.6.1.1 If using methane as the burner fuel, ensure that the air supply to the burner is shut off.

3.6.1.2 Open the stopcock in the gas line fully and light the burner.

3.6.1.3 Adjust the needle valve on the burner to achieve the proper 1.5-inch (38-mm) flame height in accordance with section 3.3.3.3.

3.6.2 Test Procedure

3.6.2.1 Place the burner at least 3 inches (76 mm) from where the specimen will be located during the test.

3.6.2.2 Insert the specimen face down (the exposed surface when installed in the aircraft) into the specimen holder so that the end of the specimen from which the 1.5-inch (38-mm) gauge mark was measured is flush with the open end of the specimen holder (see figure 3-6).

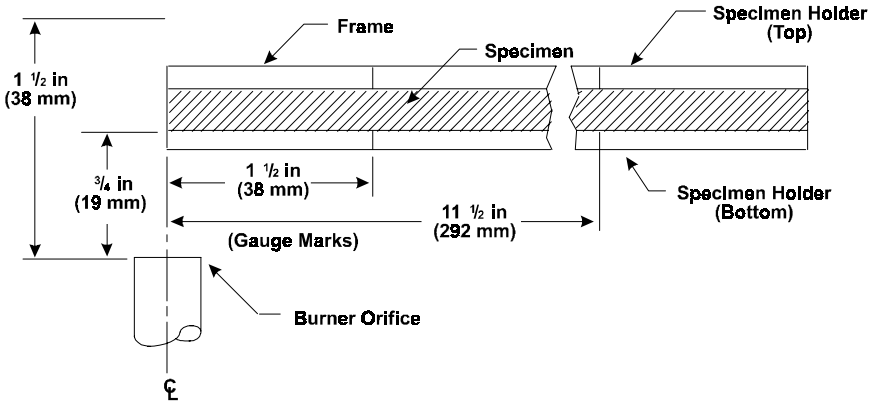

Figure 3-6. Typical Burner and Specimen Location

3.6.2.3 Close the cabinet door, and keep it closed during the test.

3.6.2.4 Start the timer immediately upon positioning the burner. Position the burner so that the centerline of the burner orifice is in line with the edge of the specimen holder and the centerline of the width of the specimen (see figure 3-6).

3.6.2.5 Apply the flame for 15 seconds and then withdraw it by moving the burner at least 3 inches (76 mm) from the specimen or by turning the gas off.

3.6.2.6 Note the times and/or locations on the specimen at which the following events occur:

3.6.2.6.1 If the flame front crosses the 1.5-inch (38-mm) gauge line, note the elapsed time in seconds, $t_e(1\ 1/2)$, at which the crossing occurs.

3.6.2.6.2 If the flame front crosses the 11.5-inch (292-mm) gauge line, note the elapsed time in seconds, $t_e(11\ 1/2)$, at which the crossing occurs.

3.6.2.6.3 If the specimen burns very slowly so that the flame front does not reach the 11.5-inch (292-mm) gauge line within 4 minutes after it passes the 1.5-inch (38-mm) gauge line, note the position in inches, d_f, of the flame front from the ignited end of the specimen and the elapsed time in seconds, $t_e(f)$, and terminate the test.

3.6.2.7 After all flaming ceases, open the cabinet door slowly to clear the test cabinet of fumes and smoke. The exhaust fan may be turned on to facilitate clearing of smoke and fumes. Remove any material from the bottom of the cabinet that fell from the specimen.

3.6.2.8 If necessary, clean the test cabinet window prior to testing the next specimen.

3.6.3 Test Results—Burn Rate

Determine the burn rate as follows:

3.6.3.1 If the flame front self-extinguished before crossing the 11.5-inch (292-mm) gauge line, record the burn rate as zero.

3.6.3.2 If the flame crosses the 11.5-inch (292-mm) gauge line, determine and record the burn rate as:

Burn rate (in/min) = $600/ t_e(10)$, where $t_e(10) = t_e(11\ 1/2) - t_e(1\ 1/2)$ = time in seconds for the flame front to burn from the 1.5-inch (38-mm) gauge line to the 11.5-inch (292-mm) gauge line.

3.6.3.3 If the specimen burned very slowly (see section 3.6.2.6.3), the burn rate may be estimated and recorded as:

$$\text{Burn rate (in/min)} = 60 \times \frac{(d_f - 1.5)}{(t_e(f) - t_e(1\ 1/2))}$$

3.7 Report

3.7.1 Material Identification

Fully identify the material tested, including thickness.

3.7.2 Test Results

Report the burn rate from section 3.6.3 for each specimen tested. Determine and record the average value for burn rate.

3.8 Requirements

3.8.1 Burn rate

The average burn rate for all the specimens tested will not exceed 2.5 inches/minute for FAR 25.853(b-2) or 4 inches/minute for FAR 25.853(b-3), per Code of Federal Regulations (CFR), Title 14, January 1, 1990.

Chapter 3 Supplement

This supplement contains advisory material pertinent to referenced paragraphs.

3.2.1 Ignition time should start only after the flame has stabilized and is properly positioned under the test specimen.

3.3.1 Suitable test cabinets of the type described are manufactured by the U.S. Testing Co., 1415 Park Ave., Hoboken, New Jersey 07030; Atlas Electric Devices Co., 4114 N. Ravenswood Ave., Chicago, Illinois 60613; and The Govmark Organization, Inc., P.O. Box 807, Bellmore, New York 11710.

Draft free implies a condition of no air currents in a closed in space. One way of determining whether the cabinet is draft free is to place a smoldering and smoking material, such as a lighted cigarette, in the test cabinet, then closing the door and observing the behavior of the smoke for signs of drafts. A test cabinet other than one fabricated in accordance with figures 3-1 to 3-3 may be found to be acceptable after review by the FAA.

The entire inside back wall of the chamber may be painted flat black to facilitate viewing of the test specimen, and a mirror may be located on the inside back surface to facilitate observation of the hidden surfaces.

3.3.3 A suitable burner is available from Rascher & Betzold, Inc., 5410 N. Damen Ave., Chicago, Illinois 60625, Catalog No. R3726A.

3.3.3.1 Gases such as natural gas and propane can be used as burner fuel. However, it should be required to show compliance with the 1550°F minimum flame temperature using a 24 AWG thermocouple.

B-gas, which is the burner fuel specified in Federal Test Method 5903, meets minimum temperature requirements and is still used in some laboratories. However, its use has resulted in problems, and is not recommended. See note below for more details.

NOTE: B-gas, a mixture of 55 percent hydrogen, 18 percent carbon monoxide, 24 percent methane, and 3 percent ethane, has shown inconsistent burning characteristics in steel cylinders. A “spike” of varying intensity is produced. It has been postulated that the carbon monoxide in the gas may react with the iron in the steel cylinders to produce iron pentcarbonyl ($Fe(CO)_5$), which is volatile and may cause interference with the normal flame characteristics and may be the cause of the erratic behavior. Because of the inconsistent flame characteristics, B-gas, at least if supplied in steel cylinders, is not recommended. No data are presently available about the suitability of B-gas supplied in cylinders of other materials, such as aluminum.

One noteworthy point that should be mentioned is the phenomenon that some labs have experienced with sharp decreases in flame temperature after the gas cylinders are approximately three-fourths empty. This has occurred primarily in labs that have single-stage regulators on their gas cylinders. Single-stage regulators differ from two-stage regulators in that control of the discharge pressure is not as accurate. Few designs maintain constant or near constant discharge pressures over the full range of cylinder pressures. Therefore, it is necessary to make adjustments periodically to allow for decreasing inlet pressures. Even the slightest drop in pressure should affect the flow rate of gas through the burner orifice. This, in turn, should cause temperature variation. By using a two-stage regulator or adjusting pressure on a single-stage regulator, as the cylinder gets low, this problem can be eliminated.

3.3.3.3 The tip of the methane flame is blue, transparent, and difficult to see. It is more easily seen if there is no light on the flame, as in a darkened room. The inner cone of the flame is, however, more visible and easily seen.

3.4.3 A 3-inch by 13-inch (76- by 330-mm) specimen can be used to secure the specimen at the end of the specimen holder.

3.4.4.1 According to the FAR 25.853, the specimen thickness must be no thicker than the minimum thickness to be qualified for use in the aircraft. If the test facility has found from experience or has questions concerning the flammability of a thicker specimen, then vertical testing may be conducted and test data recorded for further review.

3.5 As stated in the FAR 25.853, only one specimen may be removed at a time from the conditioning chamber prior to being subjected to the flame. Some facilities, however, have conditioning chambers located in areas remote from the testing area. In this case, it is permissible to remove more than one specimen at a time only if each specimen is placed in a closed container (a plastic stowage bag is acceptable) and protected from contamination such as dirty lab tops, soot in the air, etc., until the specimen is subjected to the flame.

3.6.2.3 It is important to note that the test should be watched carefully while it is being conducted. This applies to all samples.

3.6.2.5 Some laboratories turn the gas off upon completion of the test; however, the majority of test facilities, including the OEMs, withdraw the flame by moving the burner away from the specimen.

3.6.2.7 The operator should refer to the facility's safety manual for further information dealing with smoke and flammability by-products.