Chapter 2
45-Degree Bunsen Burner Test for Cargo Compartment Liners and Waste Stowage Compartment Materials

2.1 Scope

This test method is intended for use in determining the resistance of materials to flame penetration and to flame and glow propagation when tested according to the 30-second, 45-degree Bunsen burner test specified in FAR 25.

2.2 Definitions

2.2.1 Ignition Time

Ignition time is the length of time the burner flame is applied to the specimen. For this test, the ignition time is 30 seconds.

2.2.2 Flame Time

Flame time is the time in seconds that the specimen continues to flame after the burner flame is removed from under the specimen.

2.2.3 Glow Time

Glow time is the length of time in seconds that the specimen continues to glow after any flaming combustion ceases following the removal of the ignition flame.

2.2.4 Flame Penetration

Flame penetration occurs if the Bunsen burner flame penetrates (passes through) the test specimen through a hole or crack in the specimen that forms during the test ignition time. Flaming combustion on the top of the specimen that results from auto ignition is not considered flame penetration in this test.

2.3 Test Apparatus

2.3.1 Test Cabinet

Tests will be conducted in a draft-free cabinet as shown in figures 2-1 to 2-3 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.

2.3.2 Specimen Holder

The specimen holder will be fabricated of corrosion-resistant metal and will be capable of securely positioning the specimen at a 45-degree angle, with the vertical as shown in figure 2-4. The holder will be able to accommodate specimens up to 1 inch (25 mm) thick.

2.3.3 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 (see figure 2-5). There will be a means provided to move the burner into and out of test position when the cabinet door is closed.

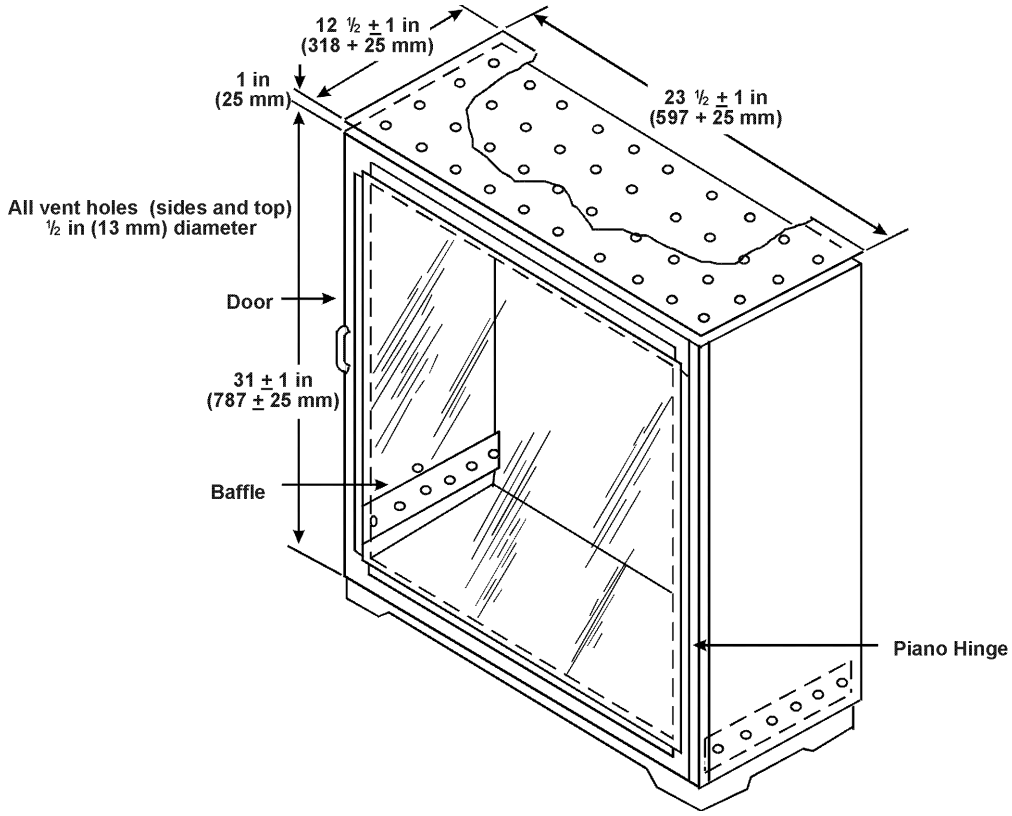

Figure 2-1. Sketch of 30-Second, 45-Degree Bunsen Burner Test Cabinet

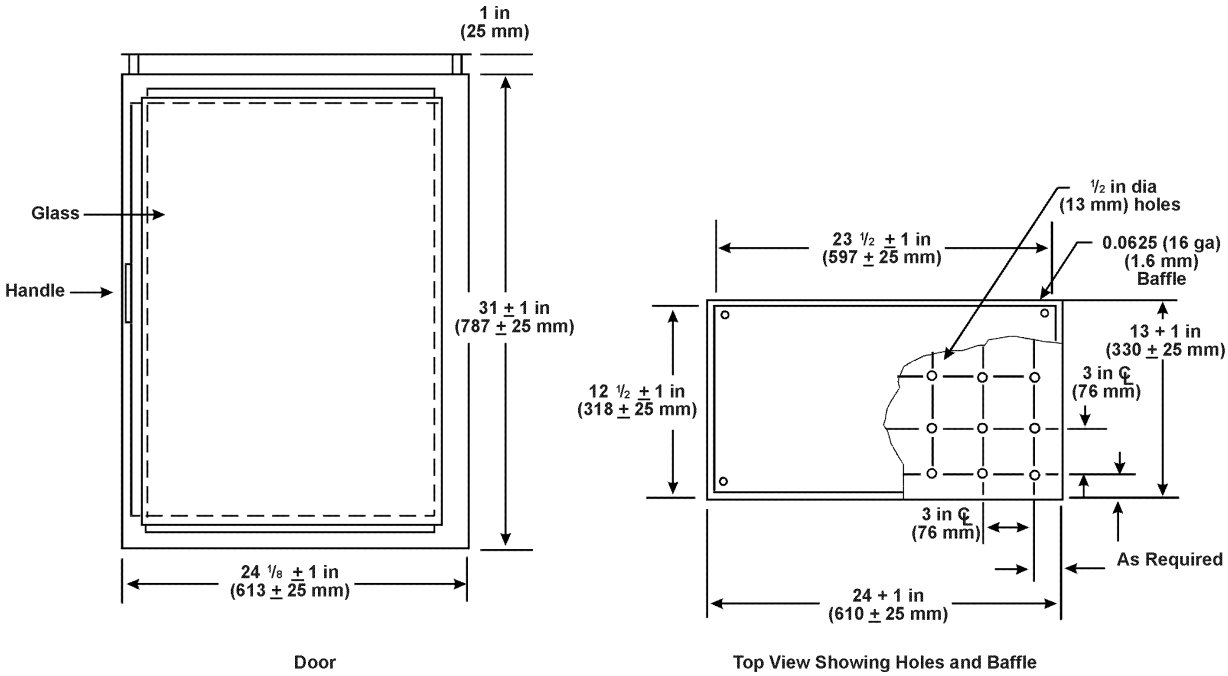

Figure 2-2. Front and Top View of 30-Second, 45-Degree Bunsen Burner Test Cabinet

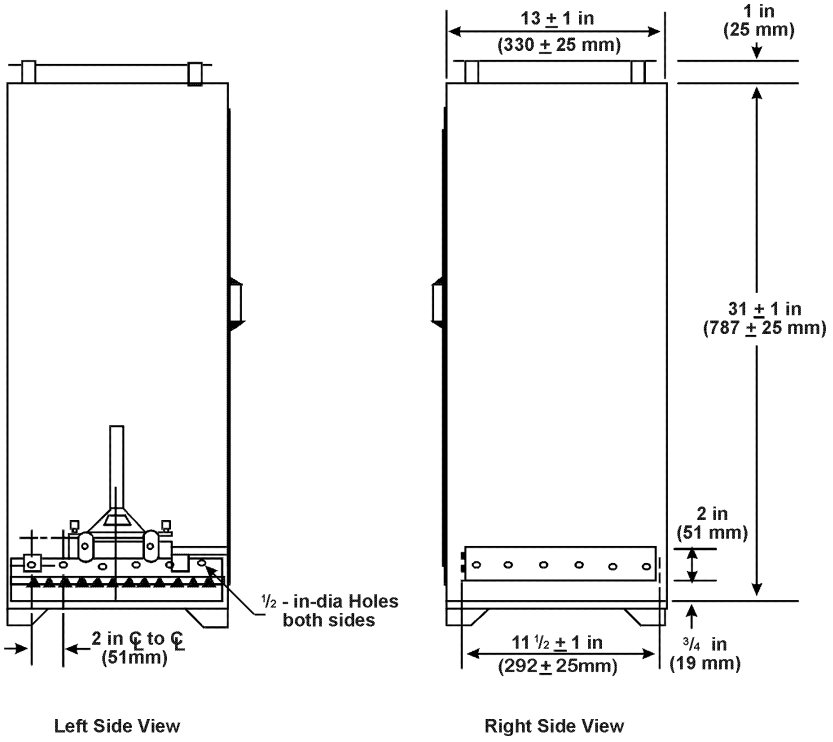

Figure 2-3. Side Views of 30-Second, 45-Degree Bunsen Burner Test Cabinet

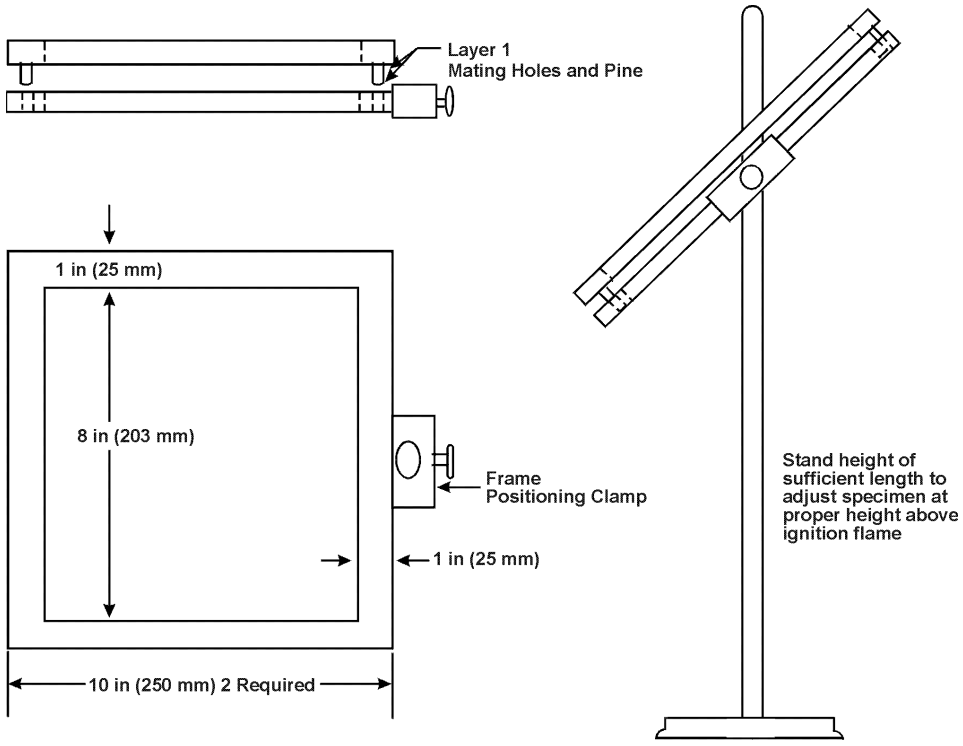

Figure 2-4. 30-Second, 45-Degree Bunsen Burner Test Specimen Frame and Stand

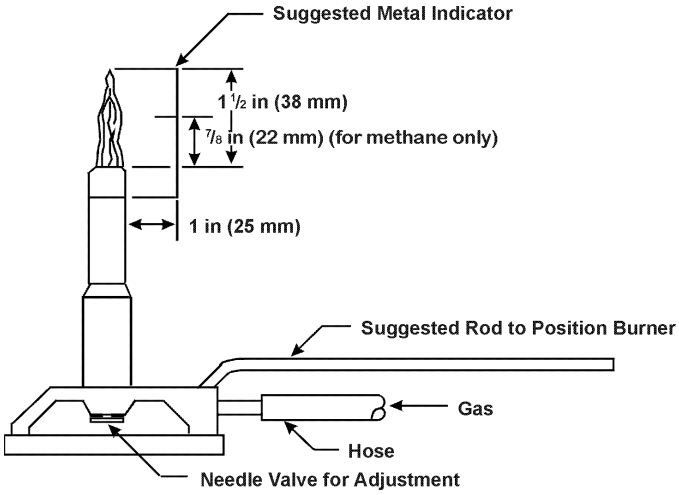

Figure 2-5. Burner Plumbing and Burner Flame Height Indicator

2.3.3.1 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.

2.3.3.2 Plumbing for Gas Supply

The necessary gas connections and the applicable plumbing will be essentially as shown in figure 2-5. A control valve system with a delivery rate designed to furnish gas to the burner inlet 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.

2.3.3.3 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) away from the burner barrel, as shown in figure 1-4. 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.

2.3.3.4 Burner Positioning

There will be means provided to position the burner directly below the center of the specimen and also to move it at least 3 inches (76 mm) from the specimen.

2.3.4 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 glow time.

2.4 Test Specimens

2.4.1 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.

2.4.2 Specimen Number

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

2.4.3 Specimen Size

The specimen will be a square large enough to allow an exposed area of 8 inches (203 mm) by 8 inches (203 mm). A nominal specimen size of 10 inches (254 mm) by 10 inches (254 mm) has been found satisfactory; however, actual specimen size is dependent upon the details of the specimen holder selected for the test equipment.

2.4.4 Specimen Thickness

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

2.4.4.1 If the part construction is used in several thicknesses, the minimum thickness will be tested.

2.4.4.2 Parts that are smaller than the size of a specimen and cannot have specimens cut from them will be tested using a flat sheet of the material used to fabricate the part in the actual thickness used in the airplane.

2.5 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 testing.

2.6 Procedure

2.6.1 Burner Adjustment

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

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

2.6.1.3 Adjust the needle valve on the burner to achieve the proper 1.5-inch (38-mm) flame height in accordance with section 2.3.3.3.

2.6.2 Test Procedure

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

2.6.2.2 Place the specimen in the holder with the surface to be exposed when installed in the aircraft toward the flame. The specimen will be positioned so that one-third of the height of the flame is in contact with the material when the test is in progress.

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

2.6.2.4 The timer must be started immediately upon positioning the burner. Position the burner so that the center of the burner barrel is under the center of the bottom surface of the specimen, as shown in figure 2-6.

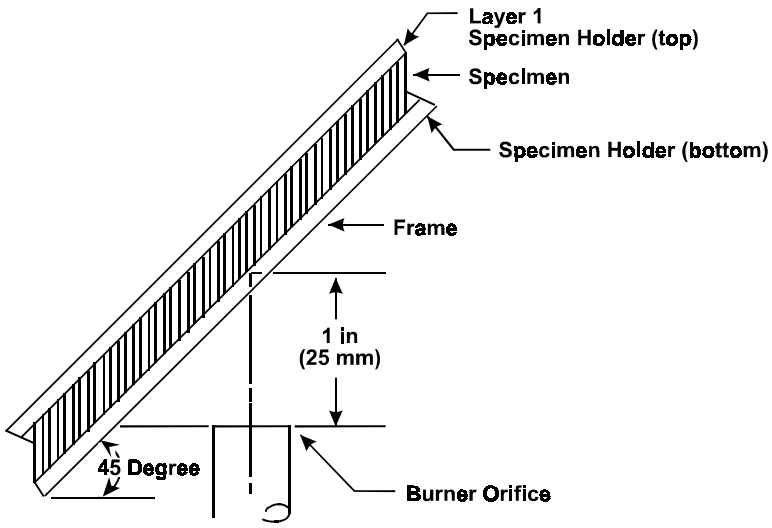

Figure 2-6. Flame Position on 30-Second, 45-Degree Bunsen Burner Test Specimen

2.6.2.5 Apply the flame for 30 seconds and then withdraw it by moving the burner at least 3 inches away from the specimen or by turning the gas off.

2.6.2.6 Determine the flame time for the specimen.

2.6.2.7 Determine the glow time for the specimen.

2.6.2.8 Determine if flame penetration occurs.

2.6.2.9 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.

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

2.7 Report

2.7.1 Material Identification

Fully identify the material tested, including thickness.

2.7.2 Flame Time

Report the flame time for each specimen to the nearest 0.2 second. Determine and record the average flame time for all specimens tested.

2.7.3 Glow Time

Report the glow time for each specimen tested to the nearest second. Determine and record the average glow time for all specimens tested.

2.7.4 Flame Penetration

Report whether the Bunsen burner flame penetrated the specimen for each specimen tested.

2.8 Requirements

2.8.1 Flame Time

The average flame time for all specimens tested will not exceed 15 seconds.

2.8.2 Flame Penetration

The Bunsen burner flame will not penetrate any of the specimens tested.

2.8.3 Glow Time

The average glow time for all specimens tested will not exceed 10 seconds.

Chapter 2 Supplement

This supplement contains advisory material pertinent to referenced paragraphs.

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

2.3.1 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 means a condition of no air currents in a closed in space for this test cabinet. 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 2-1 to 2-3 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 of the specimen.

2.3.3 A burner available as catalog number R3726A from Rascher & Betzold, Inc., 5410 N. Damen Ave., Chicago, Illinois 60625, has been found suitable.

2.3.3.1 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 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.

2.3.3.3 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.

2.4.4 According to the FAR 25.853, the specimen thickness must be no thicker than the minimum thickness to be qualified for use in the airplane. 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.

2.5 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.

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

2.6.2.5 Some laboratories turn the gas off upon completion of the test; however, the majority of test facilities, including the Original Equipment Manufacturers (OEMs), withdraw the flame by moving the burner away from the specimen.

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