Chapter 4
60-Degree Bunsen Burner Test for Electric Wire

4.1 Scope

This test method is intended for use in determining the resistance of electric wire insulation to flame when tested according to the 30-second, 60-degree Bunsen burner test specified in FAR 25.869.

4.2 Definitions

4.2.1 Ignition Time

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

4.2.2 Flame Time

Flame time is the time in seconds that the specimen continues to flame after the burner flame is removed from beneath the specimen. Surface burning that results in a glow but not in a flame is not included.

4.2.3 Drip Flame Time

Drip flame time is the time in seconds that any flaming material continues to flame after falling from the specimen to the floor of the chamber. If there is more than one drip, the drip flame time reported is that of the longest flaming drip. If succeeding flaming drips reignite earlier drips that flamed, the drip flame time reported is the total of all flaming drips.

4.2.4 Burn Length

Burn length is the length of damage along the wire above and below the point of burner flame impingement and due to that area's combustion, including areas of partial consumption, charring, or embrittlement, but not including areas sooted, stained, warped, or discolored nor areas where material has shrunk or melted away from the heat.

4.3 Apparatus

4.3.1 Test Enclosure and Setup

Tests will be conducted in a cabinet fabricated of sheet metal, approximately 24 inches (610 mm) high by 12 inches (305 mm) wide by 12 inches (305 mm) deep and open at the front and top. External conditions around the cabinet will be such that the cabinet is free of drafts during a test, but sufficient airflow will be available for complete combustion. Other cabinets may be used if they are draft free and have enough air to allow complete combustion. It is suggested that the cabinet be located inside an exhaust hood to facilitate removal of smoke and fumes after each test.

4.3.2 Specimen Holder

A specimen holder fabricated of corrosion-resistant metal in accordance with figure 4-1 will be used. The specimen holder will be placed so that the specimen is maintained at an angle of 60 degrees with the horizontal and is positioned parallel to and 6 inches (152 mm) back from the front of the enclosure.

4.3.2.1 Clamp and Pulley

The specimen will be attached to the specimen holder by a clamp at the lower end and a pulley or rod at the upper end. The span between the clamp and the rod or pulley will be 24 inches (610 mm).

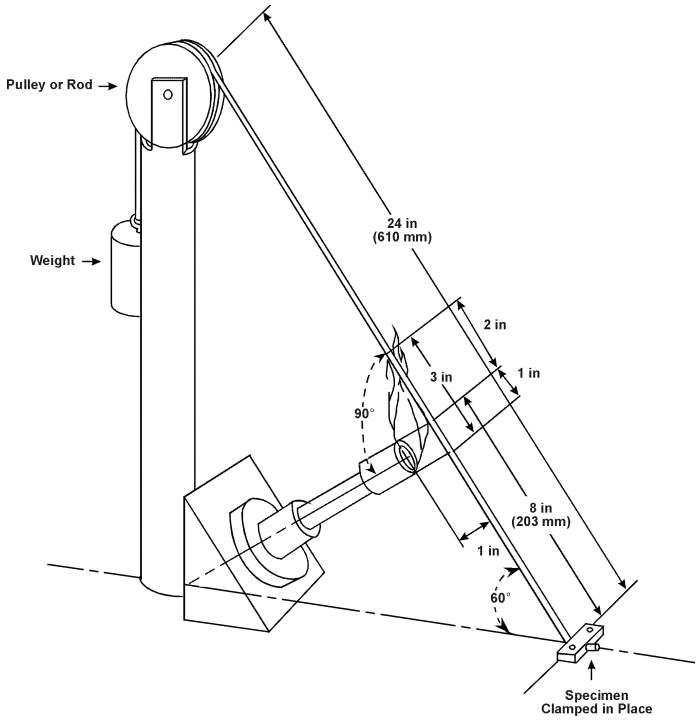

Figure 4-1. 60-Degree Electrical Wire Bunsen Burner Test Setup

4.3.2.2 Weight

A weight will be attached to the free end of the specimen to keep the specimen taut during the test (see figure 4-1). Suggested weights for various wire sizes are shown in table 4-1.

Table 4-1. Wire Size and Weight Suggestions

AWG	Pounds	Kg
20	0.8	0.4
14	2.0	0.9
8	3.0	1.4
1/0	11.0	5.0

4.3.3 Burner

The burner will be a Bunsen or Tirrill type, have a 3/8-inch (10-mm) inside diameter barrel and be equipped with a needle valve at the bottom of the burner barrel to adjust the gas flow rate (see figure 4-2). A means will be provided to move the burner into and out of the test position. Mounting the burner on a fixture that allows it to be rotated in the horizontal plane is suggested.

4.3.3.1 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.

4.3.3.2 Plumbing for Gas Supply

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

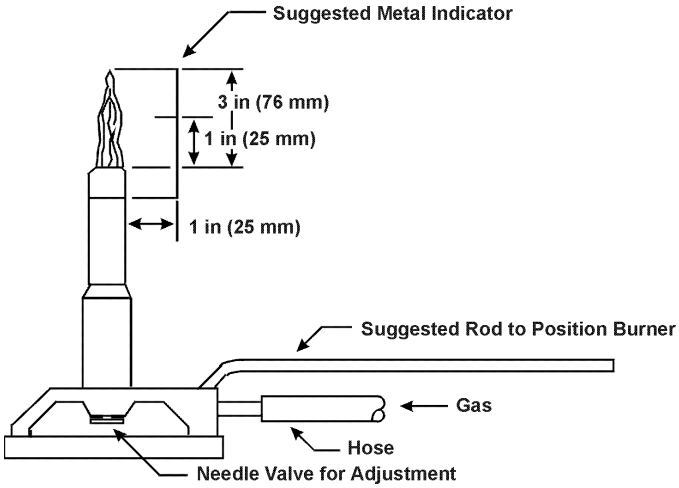

Figure 4-2. Burner Plumbing and Burner Flame Height Indicator

4.3.3.3 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 3 inches (76 mm) above the top of the barrel, is attached to the burner barrel, spaced 1 inch (25 mm) from the burner barrel, and extends above the burner, as shown in figure 4-2. It is desirable to have two prongs to measure 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 this test, it has been determined that when the height of the inner cone is 1 inch (25 mm) and the tip of the flame is 3 inches (76 mm), the proper flame profile is achieved.

4.3.4 Timer

A stopwatch or other device graduated 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.

4.3.5 Ruler

A ruler or scale graduated to the nearest 0.1 inch (2.5 mm) will be provided to measure the burn length.

4.4 Test Specimens

4.4.1 Specimen Number

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

4.4.2 Specimen Length

The specimens will be cut to a length of 30 inches (762 mm). The specimen span between the lower clamp and upper pulley or rod will be 24 inches (610 mm).

4.4.3 Specimen Preparation

Make a gauge mark 8 inches (203 mm) from one end of each specimen.

4.5 Conditioning

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

4.6 Procedure

4.6.1 Burner Adjustment

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

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

4.6.1.3 Adjust the burner flame to obtain a flame profile so that the outer cone of the flame is 3 inches (76 mm) in length and the inner cone is approximately 1 inch (25 mm) in length. The proper flame length will be obtained by adjusting the needle valve on the burner controlling the gas flow rate.

4.6.1.4 Burner Placement

For the test, place the burner into position so that the top end of the burner barrel is 1 inch from the mark on the specimen, and the centerline of the burner barrel is perpendicular to the specimen and intersects the specimen at the mark (see figure 4-1).

4.6.2 Test Procedure

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

4.6.2.2 The timer must be started immediately upon positioning the burner. Position the burner as described in section 4.6.1.4 so that the tip of the inner cone of the burner flame contacts the gauge mark on the wire.

4.6.2.3 Apply the flame for 30 seconds, and then withdraw it.

4.6.2.4 If flaming material falls from the test specimen, note the drip flame time for the specimen (see section 4.2.3).

4.6.2.5 Determine the flame time for the specimen (see section 4.2.2).

4.6.2.6 After all flaming ceases, remove the specimen and determine the burn length (see section 4.2.4). To facilitate determining the burn length, a dry soft cloth or tissue or a soft cloth or tissue dampened with a moderate solvent that does not dissolve or attack the specimen material, such as alcohol, may be used to remove soot and stain particles from tested specimens.

4.6.2.7 Remove any material from the bottom of the cabinet that fell from the specimen.

4.7 Report

4.7.1 Material Identification

Fully identify the wire tested.

4.7.2 Test Results

4.7.2.1 Report the flame time for each specimen tested. Determine and record the average value for flame time.

4.7.2.2 Report the drip flame time for each specimen tested. Determine and record the average value for drip flame time. For specimens that have no drips, record “0” for the drip flame time and also record “No Drips.”

4.7.2.3 Report the burn length for each specimen tested. Determine and record the average value for burn length.

4.8 Requirements

4.8.1 Extinguishing Time

The average extinguishing time for all the specimens tested will not exceed 30 seconds.

4.8.2 Drip Extinguishing Time

The average drip extinguishing time for all the specimens tested will not exceed 3 seconds.

4.8.3 Burn length

The average burn length for all the specimens tested will not exceed 3 inches (76 mm).

4.8.4 Wire Breakage

It will not be considered a failure if the wire breaks during the test.

Chapter 4 Supplement

This supplement contains advisory material pertinent to referenced paragraphs.

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

4.3.1 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 described in section 4.3.1 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.

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

4.3.3.1 Gases such as natural gas and propane can be used as burner fuel. However, it should be required to show compliance with the 1750°F minimum flame temperature using a 24 AWG thermocouple.

B-gas, which is the burner fuel specified in Federal Test Method Standard 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.

A phenomenon that some labs have experienced is a sharp decrease in flame temperature after about three-fourths of the gas originally in the cylinder has been used. 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 should 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 essentially be eliminated.

4.5 As stated in 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.

4.6.1.4 Alternative Burner Placement

Place the burner into position so that the top end of the burner barrel is 1 inch from the mark on the specimen. Make sure the centerline of the burner barrel is perpendicular to the underside of the mark on the specimen, that the centerline of the burner barrel forms an angle of 30 degrees with the line that is in the vertical plane containing both ends of the specimen, is perpendicular to the specimen, and passes through the mark on the specimen. It has been

found convenient to fabricate a fixture to position and hold the location of the burner quickly and repeatably (see figure 4-3).

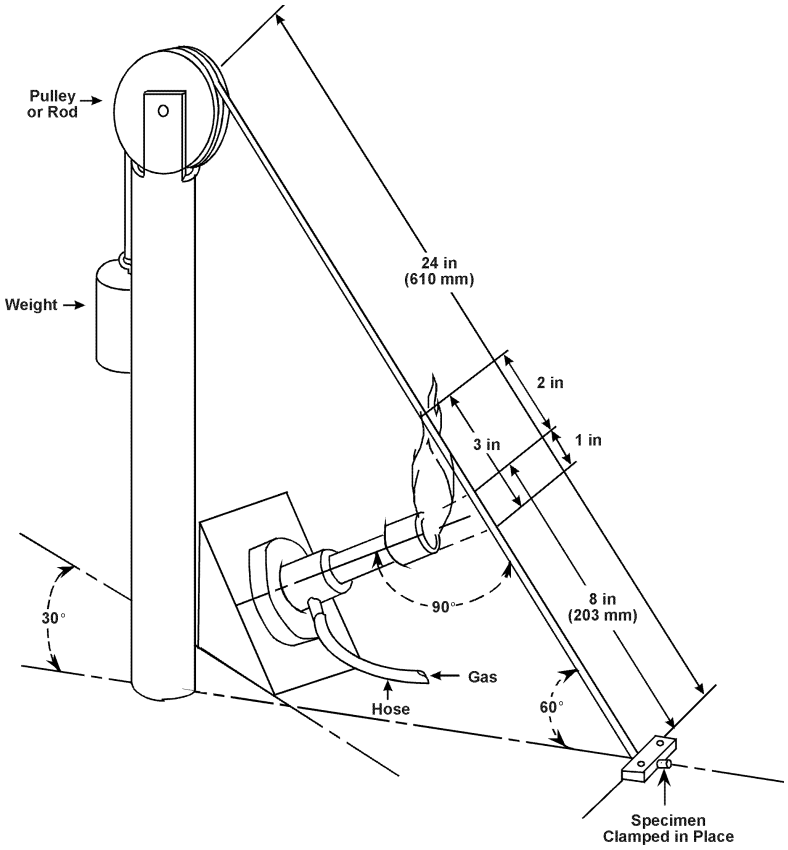

Figure 4-3. Alternative Setup for 60-Degree Electrical Wire Bunsen Burner Test

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

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

NOTE: The Alternative Burner Placement conforms to the 30-second, 60-degree Bunsen burner test described in FAR 25, Appendix F, Part I through Amendment 25-72. The FAA William J. Hughes Technical Center has determined that the Burner Placement in section 4.6.1.4 produces equivalent test results.