

CHAPTER A: FLAMMABILITY TESTS BASED ON A POST-CRASH FIRE THREAT

Chapter A1 **Vertical Bunsen Burner Test for Cabin and Cargo Compartment Materials**

A1.1 Scope

A1.1.1 Applicability

This test method evaluates the resistance of materials to flame when tested according to the 12-second or 60-second Vertical Bunsen Burner Test specified in 14 CFR 25.853 and 25.855.

A1.2 Definitions

A1.2.1 Ignition Time

Ignition time is either 12 or 60 seconds and is the length of time the burner flame is applied to the sample. The ignition time should start only after the flame has stabilized and is properly positioned under the test sample.

A1.2.2 Flame Time

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

A1.2.3 Drip Flame Time

Drip flame time is the time in seconds that any flaming material continues to flame after falling from the sample to the floor of the chamber. If no material falls from the sample, the drip flame time is reported to be 0 seconds, and the notation “No Drip” is also reported. In the event that multiple drips fuel a flame, then the longest continuous flame shall be recorded.

A1.2.4 Burn Length

Burn length is the distance from the original sample edge to the farthest evidence of damage to the test sample due to that area’s combustion. This includes areas of partial consumption, charring, or embrittlement but does not include areas sooted, stained, warped, or discolored, nor areas where material has shrunk or melted away from the heat.

A1.3 Test Apparatus

A1.3.1 Test Cabinet

Tests must be conducted in a draft-free cabinet or other enclosure acceptable to the FAA. The test cabinet must have a viewing window set up such that both sides of the sample can be observed during testing. Using a mirror to observe the back of the sample is allowed. It is suggested that the cabinet be located inside an exhaust hood to facilitate clearing the cabinet of smoke after each test. Refer to appendix I for more details on the test cabinet.

A1.3.2 Sample Holder

The sample holder must be fabricated of corrosion-resistant metal in accordance with Figure A1-1 or the equivalent. The holder must be able to accommodate samples up to 1 inch (25 mm) thick.

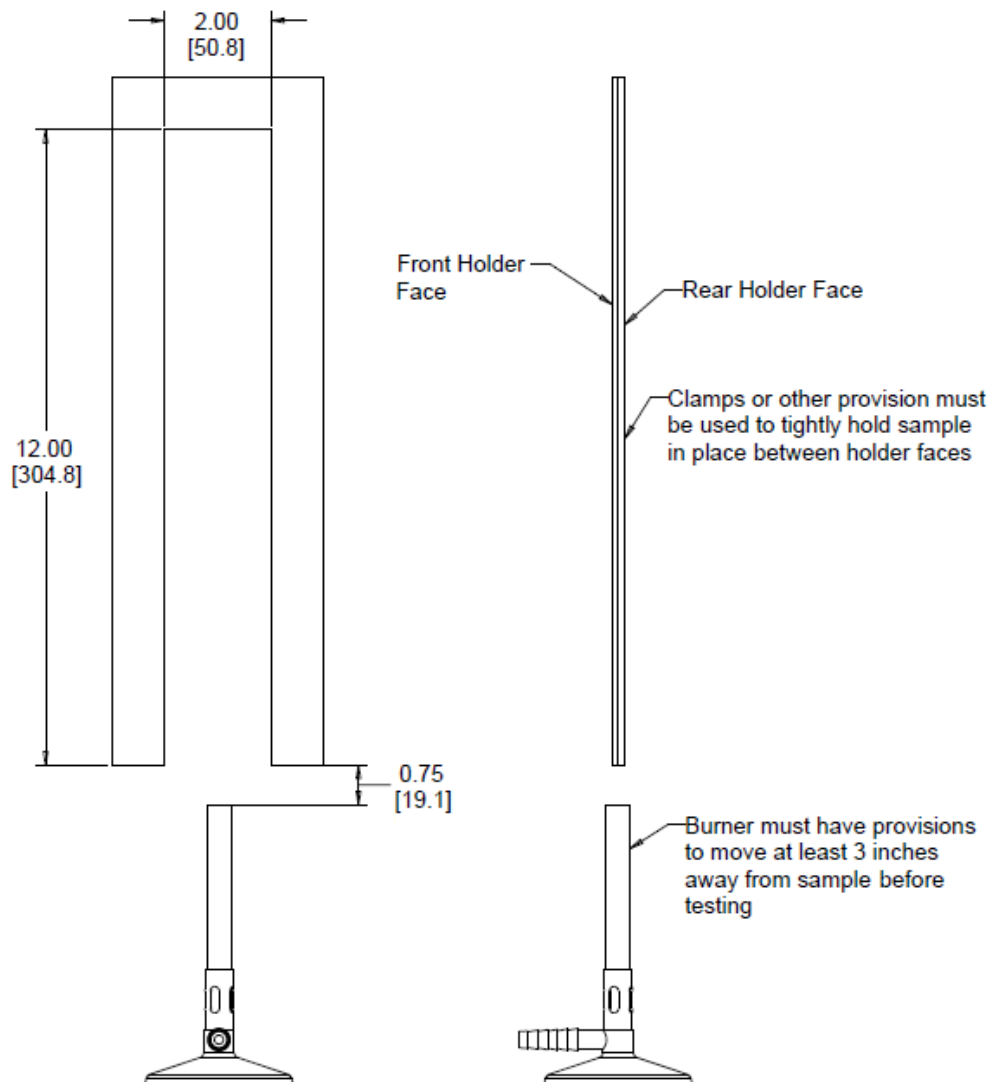


Figure A1-1. Vertical Bunsen burner test-sample holder

A1.3.3 Burner

The burner must be a Bunsen or Tirrill type. The burner must have a 0.375-inch (10 mm) inside diameter barrel. A Tirrill burner is 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. If using a Bunsen burner, there must be a means of regulating the gas flow (e.g., a needle valve) to achieve the flame height, and all aspirating holes at the bottom of the burner must be closed. Either burner should have a $0.036 + 0.0002/-0.0003$ -inch orifice. Refer to appendix I for more burner details.

A1.3.3.1 Burner Fuel

A diffusion flame using methane gas of 99 percent certified purity (CP) must be used (i.e., without adding air through the aspirating holes at the bottom of the burner barrel).

A1.3.3.2 Plumbing for Gas Supply

The necessary gas connections and the applicable plumbing will be essentially as shown in Figure A1-2. A control valve system with a delivery rate designed to furnish gas to the burner under a pressure of 2.5 ± 0.25 psi (17 ± 2 kPa) at the burner inlet must be installed between the gas supply and the burner. If using a Bunsen burner, a needle valve needs to be placed between the fuel pressure regulator and burner inlet to control the flame height.

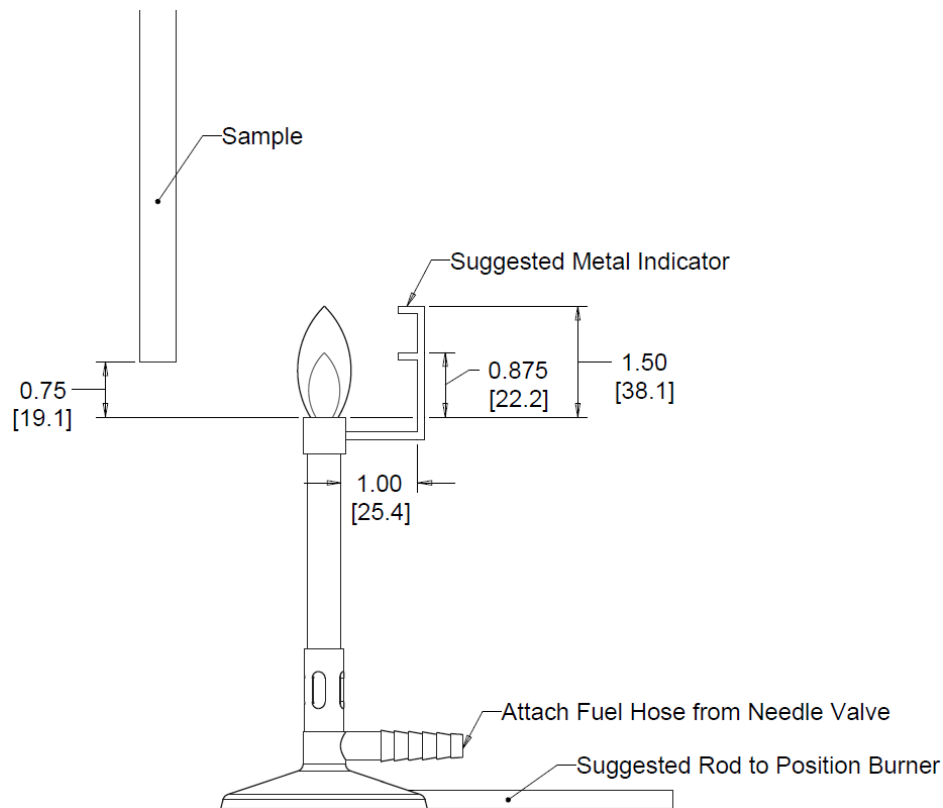


Figure A1-2. Burner plumbing and burner flame-height indicator

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 is spaced 1 inch (25 mm) from the burner barrel, as shown in Figure A1-3. Alternatively, a separate indicator that is held up next to the flame by hand to get the proper flame height may be used instead. Refer to appendix I for more details.

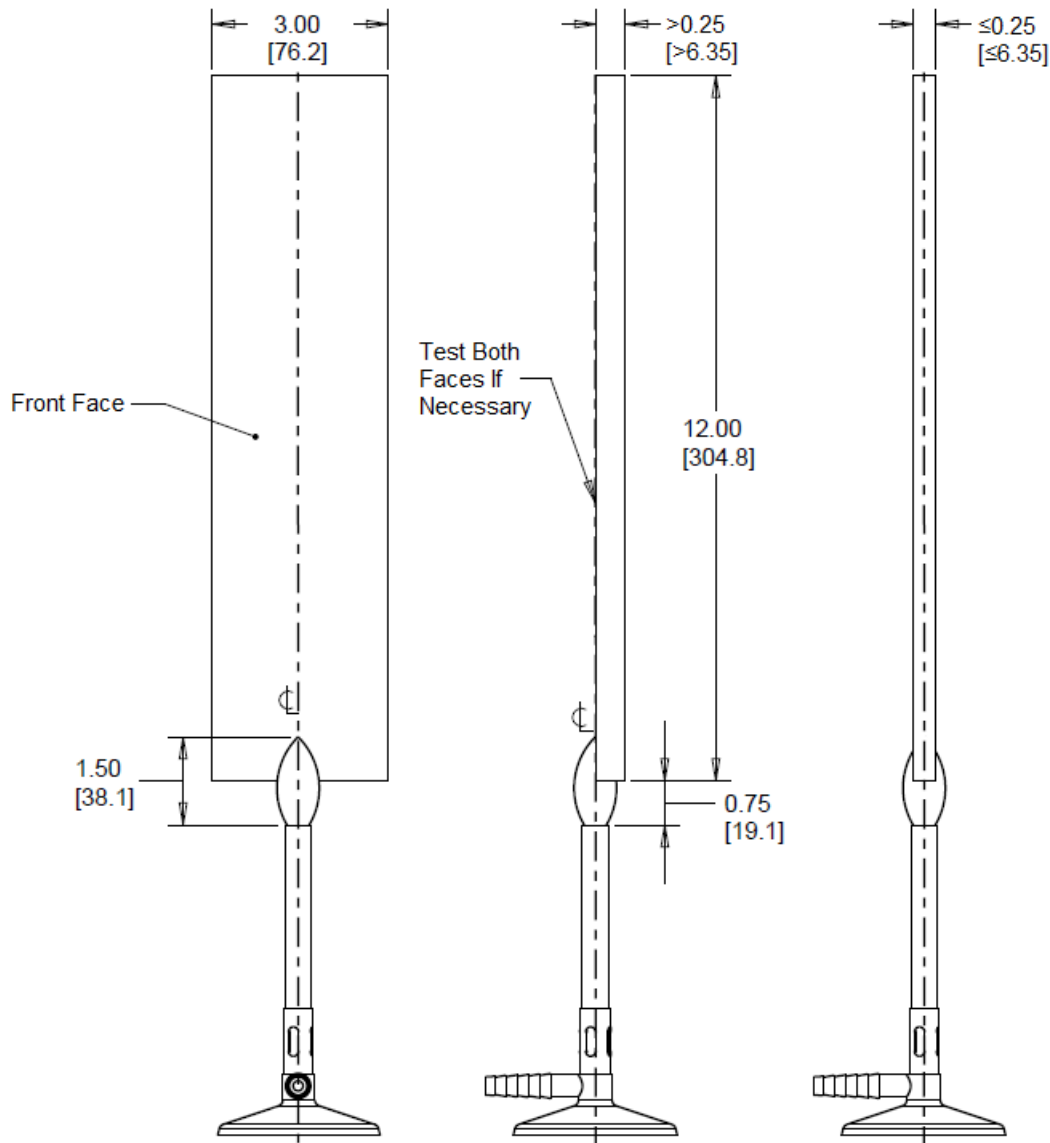


Figure A1-3. Flame position on vertical samples

NOTE: More information is available in DOT/FAA/CT-86/22, "An Investigation of the FAA Vertical Bunsen Burner Flammability Test Method."

When 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 the proper flame profile is achieved when the height of the inner cone is 0.875 inch (22 mm) and the tip of the flame is 1.5 inches (38 mm) long.

NOTE: 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. However, the inner cone of the flame is more visible and easily seen and can be used to monitor flame height. When the flame height (blue transparent tip) is set to 1.5 inches, the height of the inner cone has been found to vary slightly from burner to burner, but is generally about 7/8 inch. Therefore, if the inner cone height is used to monitor flame height, the inner cone height needs to be established for that burner.

A1.3.4 Timing Device

A stopwatch or other device, accurate to within ± 1 second per 8 hours (± 3 sec/day), must be used to measure the time of application of the burner flame, the flame time, and the drip flame time.

A1.3.5 Ruler

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

A1.4 Test Samples

A1.4.1 Sample Selection

Samples tested must 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 sample may be cut from any location in the fabricated part. However, the edge to which the burner is applied must not consist of the finished or protected edge of the sample. Fabricated units, such as sandwich panels, must not be separated into individual component layers for testing.

A1.4.1.1 Directionality

For parts that may have different flammability characteristics in different directions (e.g., textiles), separate sets of samples cut from each direction showing the greatest difference (e.g., warp and fill) must be provided and tested.

A1.4.2 Sample Number

Each separate set of samples prepared for testing must consist of at least three samples.

A1.4.3 Sample Size

The sample must be a rectangle at least 3 by 12 inches (75 by 305 mm), unless the actual size used in the aircraft is smaller.

NOTE 1: If the sample length is less than the burn length requirement, then, as long as the sample does not burn its full length, it passes the burn length requirement.

NOTE 2: By regulation, there must be at least 2 inches of the sample exposed; however, the text specifies a sample cut 3 inches in width. This allows enough material to ensure that the sample is securely held in the holder. From experience, it has been found that materials such as textiles and films are difficult to secure in the holder and, therefore, may be cut even wider than 3 inches. This allows the operator adequate material to pull or adjust so that the sample does not buckle or fall out of the holder.

A1.4.4 Sample Thickness

The sample thickness must be the same as that of the part qualified for use in the airplane, with the following exceptions:

A1.4.4.1 If the part construction is used in several thicknesses, the minimum thickness must be tested.

A1.4.4.2 Foam parts that are thicker than 0.5 inch (13 mm), such as seat cushions, must be tested in 0.5-inch (13-mm) thicknesses.

A1.4.4.3 Parts that are smaller than the size of a sample and cannot have samples 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.

NOTE: The sample thickness should 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 sample, then vertical testing may be conducted and test data recorded for further review.

A1.5 Conditioning

Samples will be conditioned at $70^{\circ} \pm 5^{\circ}\text{F}$ ($21^{\circ} \pm 3^{\circ}\text{C}$) and $55\% \pm 10\%$ relative humidity for a minimum of 24 hours prior to testing. Remove only one sample at a time from the conditioning environment immediately before testing.

NOTE: Only one sample should 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 sample at a time only if each sample is placed in a closed container (a plastic stowage bag is acceptable) and protected from contamination, such as dirty lab tops and soot in the air, until the sample is subjected to the flame.

A1.6 Test Procedure

A1.6.1 Burner Adjustment

A1.6.1.1 Ensure that the air supply to the burner is shut off.

A1.6.1.2 Open the valve in the gas line fully and light the burner.

A1.6.1.3 Adjust the needle valve on the burner to achieve the proper 1.5-inch (38-mm) flame height, in accordance with section A1.3.3.3.

A1.6.2 Test Procedure

A1.6.2.1 Place the burner at least 3 inches (76 mm) from where the sample will be located during the test.

A1.6.2.2 Insert the sample with its lower edge 0.75 inch (19 mm) above the level of the top of the burner.

A1.6.2.3 Close the cabinet door or enclosure, and keep it closed during the test. It is important to note that the test must be watched carefully while it is being conducted. This applies to all samples.

A1.6.2.4 Start the timer immediately on positioning the burner. For sample thicknesses greater than 0.25 inch (6.35 mm), position the burner so that the flame impinges on the midpoint of the lower edge of the front face of the test sample. Test the front and back surfaces separately unless the surfaces are of the same materials and construction. For sample thicknesses of 0.25 inch (6.35 mm) or less, place the burner centered with the bottom surface of the sample. In this configuration, a single test can substantiate both surfaces of a test sample (see Figure A1-3).

A1.6.2.5 Apply the flame for 12 seconds (or 60 seconds) and then withdraw it by moving the burner at least 3 inches (76 mm) from the sample or by turning the gas off. Watch the test carefully while it is being conducted to more easily determine the extent of damage on the sample due to combustion.

NOTE: Rerun the test if the burner extinguishes during the ignition time for any reason. From experience, it has been found that this is necessary when running a 12-second test. However, experience has also shown that if the flame extinguishes during a 60-second test, the test is not compromised by relighting the flame up to 3 times and adding up the ignition times. If the flame does extinguish, the flame must be relighted immediately. Failure to do so could result in the sample cooling and compromising test results. The opposite end of the same sample can be used for the retest if the burn length for the aborted test is 3 inches (76 mm) or less. If the burn length for the aborted test is greater than 3 inches (76 mm), a new sample must be used.

NOTE: If testing a sample that needs both faces tested, the opposite face on the opposite end of the same sample can be used for a second test if the burn length on the first test is 3 inches (76 mm) or less. If the burn length for the first test is greater than 3 inches (76 mm), a new sample must be used.

A1.6.2.6 If flaming material falls from the test sample, determine the drip flame time for the sample.

A1.6.2.7 Determine the flame time for the sample.

A1.6.2.8 After all flaming ceases, open the cabinet or enclosure door slowly to clear the fumes and smoke. The exhaust fan should be turned on to facilitate clearing smoke and fumes.

NOTE: The operator should refer to the facility's safety manual for further information on dealing with smoke and flammability byproducts.

A1.6.2.9 Remove the sample and determine the burn length. The burn length shall be recorded from the sample face that had the longer burn length. If testing a sample that is greater than 0.25 inch thick, it is possible the longer burn length is from the non-tested face. It can be helpful to record the burn length from both faces, but it is not required. To aid in determining the burn length, a dry soft cloth or tissue, or a soft cloth or tissue dampened with a moderate solvent, such as methyl, ethyl, or isopropyl alcohol (which does not dissolve or attack the sample material), may be used to remove soot and stain particles from the tested samples.

NOTE: Because such a wide variety of materials require vertical Bunsen burner testing, areas that might obviously be included as burn length in some materials may not always be as well defined in others.

Whereas burn lengths of materials used in modern aircraft interiors generally fall well below the maximum limit, it is beneficial to develop criteria for those materials that occasionally approach the pass/fail limit.

For the most part, these materials may be divided into four general categories: polymeric materials (such as panels, partitions, or transparencies, which may be hybrid or single plastic material), textiles, carpeting, and foams.

The following methods have been suggested for determining burn length:

a. Polymeric Materials. To fix the boundary where the flame front was impinging on the sample surface and damaging the sample due to that area's combustion (i.e., the area below which combustion of the sample occurred and above which it did not), it is necessary to observe the sample continuously during the test. Flame impingement on the sample may lead to outgassing due to thermal decomposition. As these gases burn, radiating heat may cause discoloration, sooting, staining, and melting to areas above the flame front. This type of damage is not a result of thermal decomposition due to flaming and, therefore, would not be included in the burn length.

b. Textiles. Burn length may be determined by using weights as specified in Test Method 5903.1, "Flame Resistance of Cloth, Vertical" (12/28/87), as follows:

After removing the sample from the test cabinet, allow the sample to cool and then measure the burn length. The burn length is the distance from the end of the sample that was exposed to the flame to the top of the lengthwise tear made through the center of the charred area. Fold the sample lengthwise and crease it by hand along a line through the highest peak of

the charred area. Insert the hook into the sample (or insert it into a hole, 0.25 inch (6 mm) or less in diameter) at one side of the charred area 0.25 inch (6 mm) in from the lower end. Attach a weight to the hook of sufficient size (the weight and hook together should equal the total tearing load required, as shown in table A1-1).

Gently apply a tearing force to the sample by grasping the corner of the cloth at the opposite edge of the char from the load and raising the sample and weight clear of the supporting surface. Raise the sample in one smooth continuous motion; do not jerk or pull the sample forcefully upward. Mark the end of the tear on the edge of the sample and take the char length measurement along the undamaged edge.

Table A1-1. Loads for determining char length

The specific load applicable to the weight of the test cloth should be as follows:			
Specified weight per square yard of cloth before any fire-retardant treatment or coating		The tearing weight for determining the charred length	
Ounce/yd ²	g/m ²	Pounds	kg
2.0 to 6.0	68 to 203	0.25	0.1
More than 6.0 to 15.0	Over 203 to 508	0.5	0.2
More than 15.0 to 23.0	Over 508 to 780	0.75	0.3
More than 23.0	Over 780	1.0	0.45

c. Carpeting. Tear the sample with your hands. Use only enough force to tear the charred material. Stop when the fabric does not give way freely. The backing material may not be able to be torn while the front fabric still can.

d. Polyurethane Foams. Polyurethane foams are cellular in nature and, therefore, have low thermal conductivity. Because high surface temperatures are generated on exposure to the burner flame, an almost instantaneous conversion to flammable gases results. This, in turn, produces rapid surface flame spread with complete consumption of the foam immediately above the ignition source. By definition, complete consumption of an area is part of the burn length and should be included.

A1.6.2.10 Remove any material from the bottom of the cabinet or enclosure that fell from the sample. If necessary, clean the test cabinet or enclosure window/back face mirror prior to testing the next sample.

A1.7 Report

A1.7.1 Material Identification

Fully identify the material tested, including thickness. Also, include the sample length if a 12-inch sample is not available.

A1.7.2 Test Results

A1.7.2.1 Ignition Time

Report whether the ignition time was 12 or 60 seconds.

A1.7.2.2 Flame Time

Report the flame time for each sample tested. Determine and record the average value for flame time (see section A1.2.2).

A1.7.2.3 Drip Flame Time

Report the drip flame time for each sample tested. Determine and record the average value for the drip flame time (see section A1.2.3). For samples that have no drips, record “0” for the drip flame time and also record “No Drips.”

A1.7.2.4 Burn Length

Report the burn length to the nearest 0.1 inch for each sample tested. Determine and record the average value for burn length.

A1.8 Requirements

A1.8.3 Burn Length

The burn length for at least 80 percent of the samples tested cannot exceed 8 inches (203 mm) for the 12-second vertical test or 6 inches for the 60-second vertical test. If the minimum three samples fail to meet the above requirements, it is possible to run additional tests if 80 percent or more of the total number of samples meet the requirements. For example, if one of the three original samples fails the test requirement, two additional passing tests can be conducted for a total of four passing tests in five opportunities ($4/5 = 80\%$).

NOTE: The additional testing is intended for materials that typically meet the test requirements but experience an unexpected failure for unknown reasons. These failures, often referred to as rogue failures, are unanticipated and cannot be explained. Additional testing should not be viewed as a technique for meeting the requirement with inferior materials.