



U.S. Department  
of Transportation  
**Federal Aviation  
Administration**

# Advisory Circular

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**Subject:** THERMAL/ACOUSTIC INSULATION  
FLAME PROPAGATION TEST METHOD  
DETAILS

**Date:** 6/24/05

**Initiated By:** ANM-115

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**Change:**

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1. **PURPOSE.** This advisory circular (AC) provides guidance concerning the test method to determine the flammability and flame propagation characteristics of thermal/acoustic insulation materials. This guidance applies to airplanes required to comply with § 25.856, and part VI of appendix F to Title 14 Code of Federal Regulations (14 CFR) part 25.

2. **APPLICABILITY.**

a. The guidance provided in this document is directed to airplane manufacturers, modifiers, foreign regulatory authorities, and Federal Aviation Administration (FAA) transport airplane type certification engineers and their designees.

b. This material is neither mandatory nor regulatory in nature and does not constitute a regulation. It describes acceptable means, but not the only means, for demonstrating compliance with the applicable regulations. The FAA will consider other methods of demonstrating compliance that an applicant may elect to present. While these guidelines are not mandatory, they are derived from extensive FAA and industry experience in determining compliance with the relevant regulations. On the other hand, if we become aware of circumstances that convince us that following this AC would not result in compliance with the applicable regulations, we will not be bound by the terms of this AC, and we may require additional substantiation or design changes as a basis for finding compliance.

c. This material does not change, create any additional, authorize changes in, or permit deviations from, regulatory requirements.

3. **RELATED REGULATIONS AND DOCUMENTS.**

a. Title 14 Code of Regulations 25.856 and part VI of appendix F to 14 CFR part 25; 14 CFR 91.613, 14 CFR 121.312, 14 CFR 125.113, and 14 CFR 135.170.

b. Advisory Circular 25.856-2, "Installation of Thermal Acoustic Insulation for Burnthrough Protection." An electronic copy of AC 25.856-2 can be downloaded from the

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Internet at <http://www.airweb.faa.gov/rgl>. A paper copy may be ordered from the U.S. Department of Transportation, Subsequent Distribution Office, M-30, Ardmore East Business Center, 3341 Q 75th Avenue, Landover, MD 20795.

#### 4. BACKGROUND.

a. General. Amendment 25-111 (68 FR 45046, July 31, 2003) added new fire protection requirements applicable to thermal/acoustic insulation materials. The term ‘thermal/acoustic’ means either thermal or acoustic, or both. The amendment added test requirements in parts VI and VII of Appendix F related to flame propagation and burnthrough penetration resistance, respectively. Experience has shown the Bunsen burner test that was required prior to the adoption of amendment 25-111 did not provide a sufficient measure of thermal/acoustic insulation’s resistance to flame propagation. In addition, since most thermal/acoustic insulation is installed in parts of the airplane that are not accessible for fire fighting, it is critical that the material combinations themselves will not propagate a fire if ignited.

b. Construction Details. Thermal/acoustic insulation typically consists of a thin film moisture barrier encapsulating a batting material. There are also foam insulation materials that may or may not use a separate moisture barrier. In any case, in addition to the basic materials that make up the insulation, there are frequently detail materials that need to be accounted for. These detail materials include thread, tapes, and hook and loop fasteners. With the exception of “small parts,” covered in part I of appendix F to part 25, detail materials such as these are considered part of the construction of the material and have been shown to have an influence on whether the material will propagate a fire. Since these detail features of the construction are not uniformly applied and may be used with several different basic materials, fabrication of test samples requires special consideration of these detail materials, in addition to that of the basic materials.

c. Test Method. The test described in part VI of appendix F to part 25 uses a radiant panel with an ignition source to measure the tendency of thermal/acoustic insulation to propagate a fire. The test requires consideration of two parameters as pass/fail criteria: flame propagation and flame time after removal of the ignition source. There is an important distinction between “flame propagation,” as assessed by this requirement, and “burn length,” as measured in the tests described in part I of appendix F. The radiant panel test is intended to measure the actual propagation of a flame along the test sample and must be observed as it is happening during a test. Burn length, on the other hand, can often be determined by inspecting a test specimen after a test is conducted. Burn length includes charring and consumption of the material, regardless of whether flaming is evident. Flame propagation is strictly an assessment of the propagation of flame from the point of application of the ignition source. The intent of the rule is to limit thermal/acoustic insulation to materials that do not propagate a fire. Since a “zero” propagation requirement is impractical to implement, reasonable pass/fail criteria were established to meet that intent.

(1) As with any stringent test method, there will be materials that have slightly greater propagation characteristics and do not meet the requirement. In some cases this may be due to an improperly constructed test sample or variation in the test procedure. To allow for such an

anomaly, the following is an acceptable method of addressing failure of propagation length if one of the three samples does not pass. To reach a passing criteria, a minimum of 7 additional samples may be tested. None of these additional samples can fail either criterion. In addition, the average of all of the samples, including the sample that originally failed, must meet the pass/fail criteria.

(2) For after-flame time only, it is possible that certain materials with good propagation protection characteristics can show modest after-flame time, beyond the 3-second limit. There are two ways that this can be addressed to determine if the material is acceptable.

(a) In a manner similar to the procedure identified in paragraph 4c(1) above, test an additional 7 samples. If the average of the after-flame times for all 10 samples is 3 seconds or less the material can be accepted. Note that, as required in the rule, the propagation distance must not exceed 2 inches on any sample.

(b) In some cases, after-flame can be attributed to the specific 15-second exposure time in the test. Since the exposure time was mainly derived from tests on thin film materials, extended exposure may be meaningful for other types of materials. If the after-flame time is above the limit but the material does not propagate, it is acceptable to apply the burner flame for 30 seconds. The same pass/fail criteria are applied, and if the material passes with a 30-second exposure it can be used. The earlier tests with a 15-second exposure may be disregarded.

## 5. TEST SAMPLE CONSTRUCTION.

a. Except as noted in this paragraph, test samples are constructed as described in part VI of appendix F.

(1) Each combination of affected materials should comply with § 25.856(a). But it should be possible to reduce the number of combinations actually tested by establishing the critical combinations. For example, different thicknesses of core material, or combinations of core materials that are asymmetrical with respect to the outer faces, should not require tests of every combination to establish compliance. The same should be true of density of core material. The applicant should propose a compliance plan to address such variations.

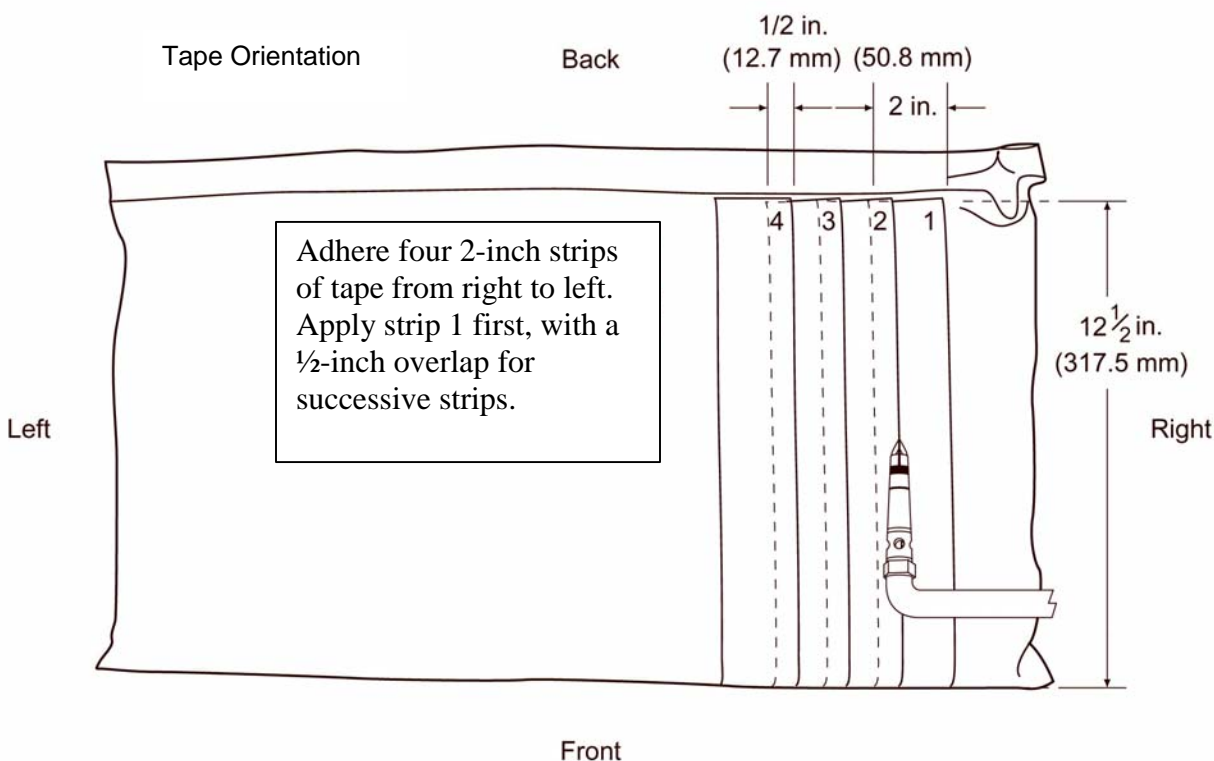
(2) A small slit should be cut into film coverings to permit ventilation of gases. The slit should be cut toward the end of the sample, away from the pilot burner. Appendix F part VI (f)(3) describes adding the approximately 2 inch slit to test samples with film/fiberglass composition. The slit is described as “longitudinal.” This can be confusing with respect to the orientation of the test sample, or the orientation of the test chamber. The intent was to cut the slit from front to rear of the chamber. The slit does not have to be precisely 2 inches. A ½-inch tolerance is acceptable. The slit is for test purposes only and is not a requirement for the installed insulation.

b. Tape. Tapes are used both during initial production and in the process of making repairs or facilitating material replacements on airplanes in service. It is not practical to test each possible configuration of tape and film/batting material. To simplify this process, the following

procedure has been developed to show compliance for the use of tape. It is, of course, also acceptable to test the tape in its installed configuration, which will qualify that configuration.

(1) Each type of tape requires qualification on each material on which it is used. It is acceptable, however, to use a standard batting material for all tape/film combinations.

(2) Four strips of 2-inch wide (as supplied by the manufacturer) tape should be placed on the test sample. The tape strips should be cut long enough to cover the sample from front to back. The first strip of tape is applied at the right side of the sample and each strip of tape overlaps the preceding strip by  $\frac{1}{2}$  +/-  $\frac{1}{8}$  inch in the right to left direction. The tape should be arranged so that the centerline of the pilot burner igniter flame contacts the seam of the first overlap. Figure 1 shows the general arrangement. It will be necessary to make a template in order to know how far from the right edge of the sample to place the first strip of tape. This is necessary to ensure that the burner flame contacts properly.



**Figure 1**

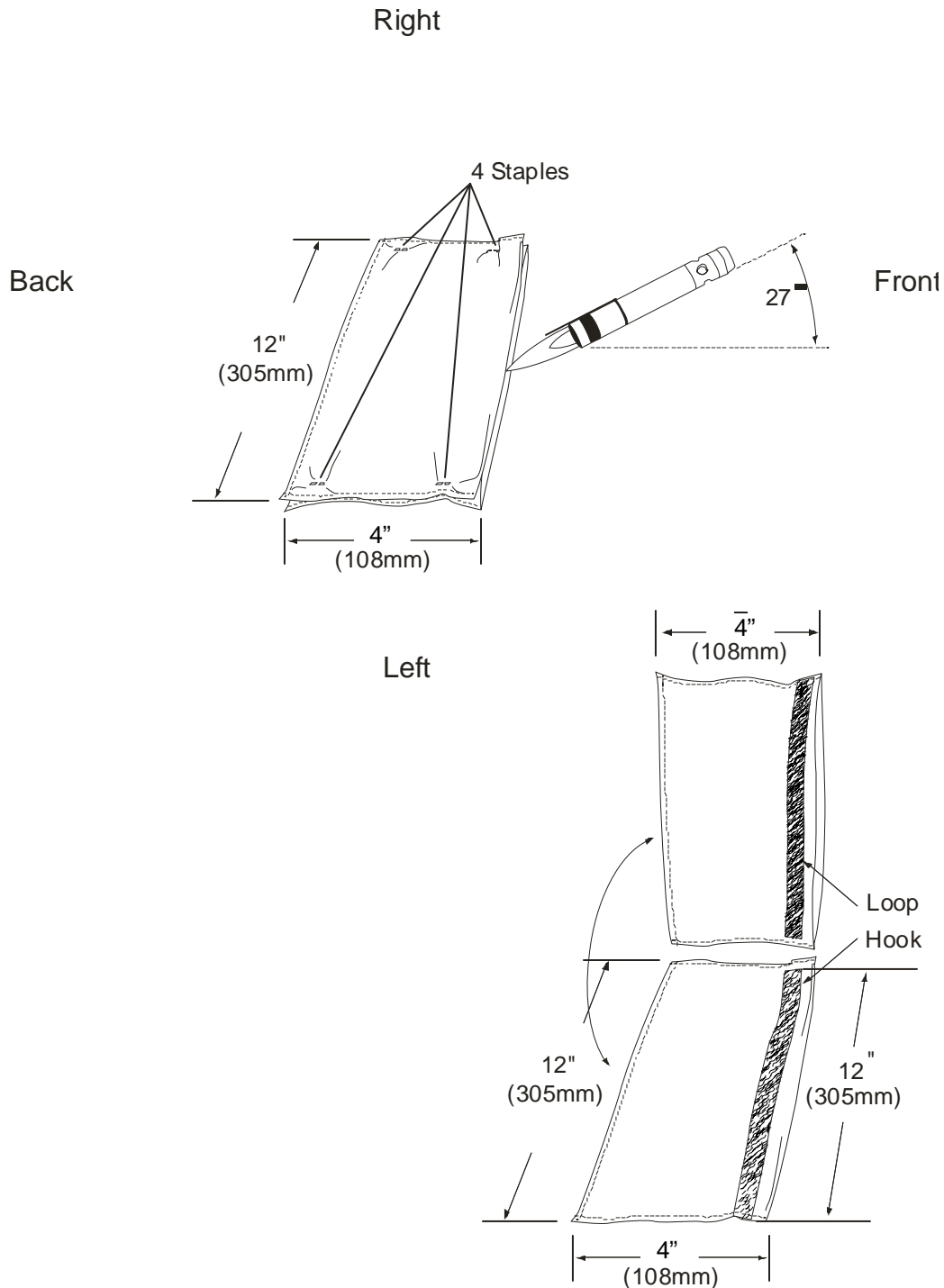
(3) If the tape is not supplied in 2-inch widths, but only in wider sizes, cut the tape down to 2 inches. If it is narrower than 2 inches, use the actual width.

c. Hook and Loop. Separate insulation blankets are often connected using hook and loop fastening systems. Depending on the installation, hook and loop fasteners could also be used to attach the insulation to the airplane structure. As with tape, there are many possible combinations and orientations of fastener and film/batting, so that testing each one could be impractical. Nonetheless, the influence of the hook and loop on fire safety is potentially

significant and must be addressed in testing. A test procedure has been developed to simplify the certification process. This procedure uses test samples that differ from that specified in part VI of appendix F. Because the regulation does specify a sample size, it would be acceptable to construct samples of that size where the entire surface is covered with hook and loop material as applicable. This is considered excessive, however, and the alternative procedure outlined below is recommended.

(1) In order to address the different uses of hook and loop materials, samples are tested as mated components. While hook and loop material is not always mated when installed (e.g., there may be small segments of unmated material), testing indicates that materials that pass when mated are satisfactory.

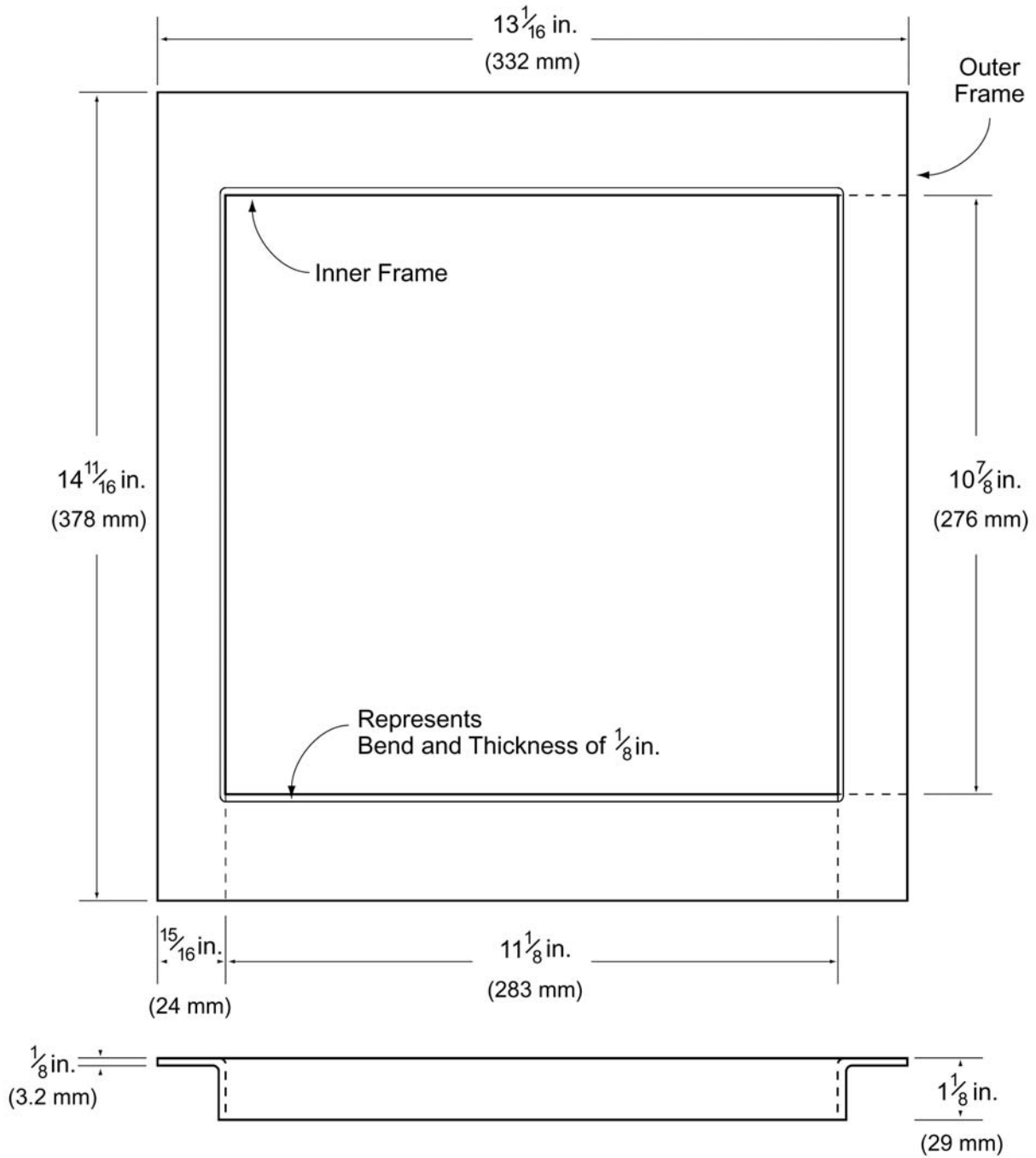
(2) Encapsulated material samples may be constructed by folding the material with the mated edge around the core material and then stapling the sample along the non-mated edges. Figure 2 shows the configuration for mated samples. Note that in this case the sample size and orientation relative to the pilot burner are different than for a typical test sample. The 1-inch hook and loop strips should be attached within 1/4 inch of the sample edge.



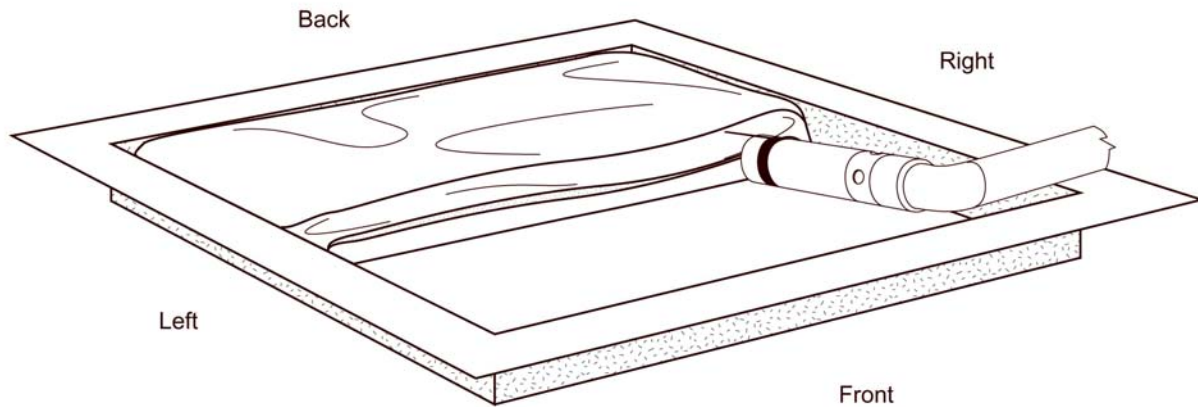
**Figure 2**

(3) A small retaining frame must be constructed in order to keep the sample in place. The frame is fabricated of mild steel with a thickness of 1/8 inch (3.2 mm). The sample retaining frame is shown in Figure 3. Adjusting the height of the sample may also be necessary to ensure that the relationship to the pilot burner is maintained to keep the junction of the hook and loop exposed to the tip of the burner flame. It is not necessary to adjust the radiant panel

calibration to compensate for the potential change in the location of the exposure upper surface. Figure 4 shows the sample with the retaining frame in place.



**Figure 3**



**Figure 4**

(4) Three tests are conducted with each combination of mated samples using the same pass/fail criteria as specified in part VI of appendix F. Once this combination of materials (hook and loop, whatever material it is attached to, and any other insulation materials contained in the sample) have been substantiated, that combination of materials may be mated to any other substantiated combination of materials without further test.

(5) Tests on a 1-inch-thick batting material may be used to substantiate the hook and loop on all other thicknesses and densities of that material. This thickness will keep the upper surface at the standard height below the radiant panel. Since each core/outer material combination will require substantiation in the standard configuration, the hook and loop test may be conducted with any acceptable core material. A 1-inch batting is recommended for simplicity. Thicker samples are not recommended, because this will increase the heat flux on the upper surface.

d. Insulation that is bonded to a substrate, including ducts, that is not required to comply with § 25.856(a) may be tested bonded to a thin (approximately 0.060 inch) aluminum sheet. Once qualified in this manner, the insulation may be bonded to any other substrate without further test, as long as the substrate itself is not required to meet § 25.856(a). For the purposes of compliance with § 25.856(a), insulation adhered to such substrates with double-backed tape may be addressed in a similar manner – by testing the sample adhered with the same tape onto an aluminum sheet.

e. Quilted blanket configurations need to be validated and may require separate testing, depending on the thread and stitch pattern used.

## 6. TEST CONDUCT CONSIDERATIONS.



a. The actual heat flux generated by the radiant panel has a direct influence on test results. Experiments suggest that variations in heat flux from the standard can influence both flame time (after removal of the pilot burner flame) and propagation length, although not necessarily in the same way. A slightly higher heat flux might be critical for one parameter, whereas a slightly lower heat flux might be critical for the other parameter. It is essential that heat flux be maintained as specified in the regulation. Calibration before and after each day of tests is recommended.

b. In addition to the procedural details described in part VI of appendix F, the test results can be significantly influenced by the condition of the chimney in the test chamber. The chimney should always be open and clear of obstruction for valid results.

c. Materials that melt can alter the flame profile of the pilot burner if the material melts to the point that the pilot burner flame is directly contacting the backing board. Tests of such materials need to be observed closely to determine whether the material is burning or simply melting. Material burning beyond the 2-inch limit is considered flame propagation, regardless of whether the influence of the flame profile on the backing board is involved.

d. Occasionally a material may exhibit “flashing” behavior. Flames appear on the test sample some distance (i.e., more than 2 inches) away from the zero point. This is also considered flame propagation.

## 7. APPLICABILITY TO CERTAIN MATERIALS AND INSTALLATIONS.

a. The regulation applies to thermal/acoustic insulation installed within the fuselage. There are four reasons that materials associated with thermal/acoustic insulation would not require testing under part VI of appendix F:

(1) The material is not in the fuselage.

(2) The material is not thermal/acoustic insulation.

(3) The material is not so extensive a part of the insulation system that it could have an effect on flame propagation.

(4) The material is installed in a manner that does not permit fire propagation, and this can be substantiated by equivalent level of safety finding.

b. Areas not considered to be in the fuselage include the wing, wing-to-body fairings, empennage, and wheel wells. Other areas, including unpressurized portions of the fuselage, are covered by the rule.

c. Certain items are installed in conjunction with thermal/acoustic insulation but are not themselves part of the thermal/acoustic insulation. These include small grommets to permit fastening of wire bundles or other systems, clamps, small moisture diverters, and small moisture

traps on structural components. Curtains in the cabin, regardless of what insulating properties they might possess, are not considered “thermal/acoustic insulation” for the purposes of § 25.856. Similarly, carpet padding is in some cases used to reduce noise. For the purposes of § 25.856, however, carpet padding is not considered thermal/acoustic insulation. It should be noted, though, that materials that satisfy § 25.856 are available for carpet padding.

d. Other materials may be bonded to the insulation but, unlike hook and loop and tapes, are not so extensive that they could affect the flame propagation properties of the insulation system. These are materials that are installed at limited locations in the airplane, are not contiguous with respect to each other, and are generally only a few square inches in area. Examples are moisture seals on structural penetrations, small foam standoffs, and ventilation hole reinforcement grommets. Additional testing under part VI of appendix F using those materials is not needed to demonstrate acceptable flame propagation characteristics.

e. The following installations are considered to satisfy the requirements of § 25.856 by equivalent level of safety under § 21.21(b)(1) because the standards for those installations already provide protection against fire propagation. Thus the following installations do not require testing under part VI appendix F:

(1) Insulation installed in an area within the fuselage that is a designated fire zone under § 25.1181.

(2) Insulation within a six-sided box, such as an oven, service cart, or coffee maker, where the insulation is between walls, or captured by other structure. Insulation within a fuselage door, while typically the same as installed elsewhere in the fuselage, could be considered within a six-sided box.

NOTE: Galley equipment that contains insulation and is ventilated is not considered within a six-sided box. However, this insulation still may not have to meet the test of part VI of appendix F if the equipment is shown to prevent a fire from escaping the equipment. This latter condition will likely need to be shown by test.

(3) Insulation installed inside equipment currently qualified for compliance with § 25.853 on the basis of the guidance in paragraph 623.b. of Advisory Circular 25-17 ( a so-called “black box”).

(4) Insulation that is within a class C cargo compartment and fully contained by the cargo liner.

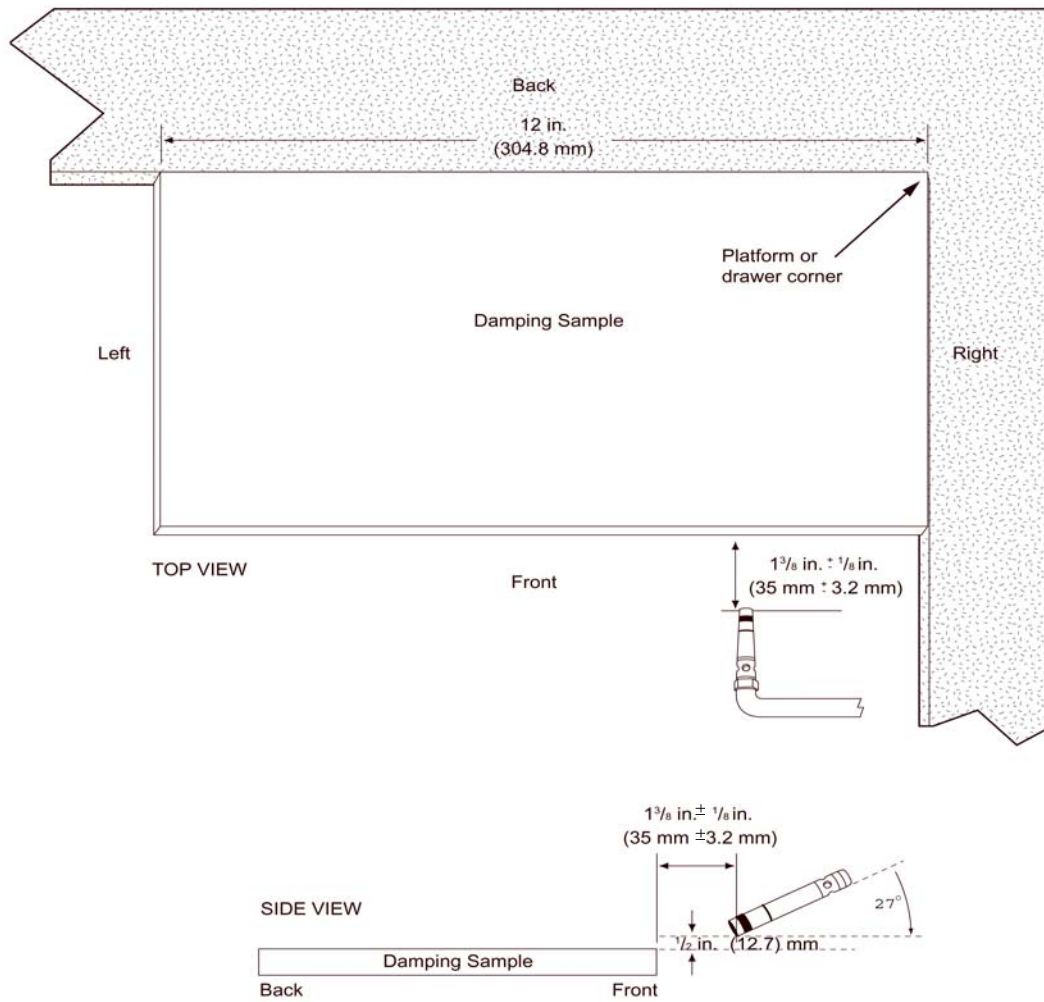
(5) Insulation that meets the requirements of § 25.853(a) and appendix F, part I, paragraph (a)(1)(ii) and is installed in the cabin so that it is visible and accessible with a hand fire extinguisher. This does not include insulation inside other compartments that involve

opening a door or access panel, or in any location where the source of the fire cannot be observed.

f. Damping Systems.

(1) Structural damping materials may be considered thermal/acoustic insulation, depending on their specific configuration and use. These materials are often a soft aluminum sheet bonded to airplane structure. The aluminum sheet itself is not susceptible to flame propagation and is not itself “insulation.” Small aluminum sheets bonded directly to the airplane skin with a layer of adhesive would not be considered thermal/acoustic insulation. Damping materials that include a layer of foam or other material would be treated as thermal/acoustic insulation, and thus must be tested for flame propagation characteristics. Since the test method in appendix F part VI is not well suited to aluminum, we recommended that those types of materials be tested in a manner similar to the testing for mated hook and loop samples, so that the interface of the insulating material and substrate is exposed to the tip of the burner flame. But the test configuration specified in appendix F can be used. It is acceptable to test these materials bonded to an aluminum sheet as per paragraph 5d. They can then be used bonded to any other substrate.

(2) When testing at the interface of the insulating material and substrate, some adaptation is necessary to precisely size and position the test sample. In order to determine the correct width (front to back) for the test sample, place a piece of damping system (material) bonded to a 0.060-inch-thick piece of aluminum sheet in the radiant panel test apparatus drawer or sliding platform. The sample should be 12 inches long, and be placed so that it touches the back wall and right side (corner) of the drawer or platform. With the pilot burner in the down position and the burner guide removed, the distance from the bottom of the burner to the front edge of the sample should be  $1\frac{3}{8} \pm \frac{1}{8}$  inch. Samples can then be sized accordingly. Once this is determined, all samples may be cut to that width for a particular test apparatus. This measurement and sample size determination are needed for each lab because slight variations may exist from one apparatus to another. Figure 5 shows the position of the sample and burner. The top of the sample should be at the proper height ( $7\frac{1}{2}$  inches from the radiant panel at the “zero” position). Since the igniter angle is 27 degrees, the flame then impinges the interface of the sample.



**Figure 5**

g. Ducts: Ducts can fall into two basic categories: ducts that have separate insulation, and ducts where the duct wall has some insulating properties. Ducts that do not have separate insulation on them (in other words, the duct itself provides whatever insulation capability exists) can be treated simply as ducting. Section 25.856 would not apply. Ducting with insulation encapsulated in a rigid shell, which can be considered a 'duct within a duct,' enclosed in a manner similar to the insulation in an enclosed box described in paragraph 7e(2), would also not be subject to § 25.856. This presumes that the insulation between the inner and outer walls of

the duct is separate from the outer wall. Separate insulation covering would have to meet § 25.856. However, as noted in paragraph 6d, if the insulation is bonded to the duct, the duct may be represented by thin sheet aluminum.

h. Thermal/acoustic insulation that meets the requirements of § 25.856(a) is considered to satisfy the requirements of § 25.853(a) on those airplanes for which the certification basis would otherwise require testing in accordance with § 25.853. This determination can be made using the criteria of § 25.853, which permits “other approved equivalent methods.”

/s/

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