US Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: FLAMMABILITY TESTS
Date: August 20, 1984 **AC No:** 23-2
Initiated by: ACE-100 **Change:**

1. PURPOSE. This advisory circular provides information and guidance concerning acceptable means, but not the only means, of compliance with Part 3 of the Civil Air Regulations (CAR) and with Part 23 of the Federal Aviation Regulations (FAR) applicable to flammability tests for various materials, components and electrical wire.

2. RELATED FAR SECTIONS. For convenience, the FAR sections are listed first and the corresponding CAR sections follow in brackets.

a. 23.787(d)
b. 23.853(a),(e) [3.388(a)]
c. 23.859(b),(b)(1),(c)
d. 23.863(b)(4)
e. 23.865
f. 23.903(e)(2)
g. 23.1013(e)
h. 23.1091(b)(1) [3.605(b)]
i. 23.1121(c) [3.615(b)]
j. 23.1123(a) [3.616]
k. 23.1141(f)
l. 23.1183(a) [3.638(a),(b)]
m. 23.1189(b)(2)
n. 23.1191(c),(d),(e),(f),(g) [3.624(a),(b)]
o. 23.1192
p. 23.1193(c),(d),(e) [3.625(b)]
q. 23.1203(e)
r. 23.1365(b) [3.693]
s. 23.1385(e) [3.700(e)]

3. BACKGROUND. General flammability requirements for certain structure, electric cables and associated equipment, crew and passenger compartment materials, and cargo compartment materials are addressed in FAR Part 23 and CAR Part 3. However, specific acceptable criteria for demonstrating compliance with the fire protection requirements are not specified. Further, Flight Standards Service Release No. 453, which was used in certifying CAR Part 3 airplanes, was cancelled and never replaced with comparable material. This advisory circular incorporates the pertinent sections of Flight Standards Service Release No. 453, Federal Test Method Standard No. 191A, SAE Aerospace Standard (AS) 1055B, and SAE Aerospace Information Report (AIR) 1377A.

4. ACCEPTABLE MEANS OF COMPLIANCE. One method, but not the only method, for showing compliance for components requiring certification by flammability tests is as follows:

a. The following flammability test is considered acceptable for demonstrating compliance with regulations for flash-resistant materials (Ref. section 23.853(a)).

(1) The apparatus should be similar to the one that is defined in Section 4.1 through 4.9, Method 5906 of Federal Test Method Standard No. 191A. The minimum flame temperature measured by a calibrated thermocouple pyrometer in the center of the flame should be 1550°F.

(2) Three specimens, approximately 4 1/2 inches by 12 1/2 inches, with the long dimension parallel to the warp direction of the cloth, should be tested for each sample unit. It has been found that the pattern of some cloth may cause the cloth to be more hazardous in one direction than in the other, in which case the long dimension of the specimen should be parallel to the more hazardous direction.

(3) The specimens should be conditioned to a temperature of 65°F to 75°F and at 45 to 55 percent relative humidity until moisture equilibrium is reached, or for 24 hours, before testing. Only one specimen should be removed from the conditioning environment at a time and immediately subjected to the flame test.

(4) For plain cloth and rigid materials, the procedure described below should be followed.

(i) Insert the specimen into the holder with the surface that will be exposed, when installed in the airplane, facing down. It should be clamped such that a 2-inch wide center strip is exposed with a 1/2-inch clearance between the holder and each end of the specimen.

(ii) Adjust the burner to give a flame height of 1 1/2 inches.

(iii) Slide the specimen holder into the cabinet into the test position so that the end of the specimen is 3/4 inch above the top of the burner and the specimen then ignited. Approximately 1 1/2 inches of the specimen should be burned before the timing device is started. The timing should be stopped at least 1 inch before the burning front reaches the end of the specimen.

(iv) Determine the average burn rate of the three specimens, using the time required to travel along a minimum of 10 inches of each specimen. If the specimens do not support combustion after the ignition flame is applied for 15 seconds, if the average burn rate of the three specimens does not exceed 20 inches per minute, or if the flame extinguishes itself and subsequent burning without a flame does not extend into the undamaged areas, the material is acceptable.

(5) For napped or tufted cloth, the procedure below should be followed.

(i) Comb the cloth twice against the nap or tufting so that the nap or tufting is uniformly raised.

(ii) Use a stop to prevent a flash from traveling across the underside of the cloth and igniting the other end of the specimen before the flash has traveled across the upper surface if the cloth is double-napped. In all other respects, the procedure should be as described for plain cloth in paragraphs (4)(i) through (4)(iv) above.

b. The following flammability test is considered acceptable for demonstrating compliance with regulations for flame-resistant materials, except for electrical wire (Ref. sections 23.787(d), 23.853(a), 23.1385(e)).

(1) The same apparatus, size of specimens and procedures as specified in paragraph a(1) through a(5) above for testing flash-resistant materials should also be used for testing flame-resistant materials, except for the following:

(i) Determine the average burn rate of the three specimens, using the time required to travel along a minimum of 10 inches of each specimen. If the specimens do not support combustion after the ignition flame is applied for 15 seconds, if the average burn rate of the three specimens does not exceed 4 inches per minute, or if the flame extinguishes itself and subsequent burning without a flame does not extend into the undamaged areas, the material is acceptable.

c. The following flammability test is considered acceptable for demonstrating compliance with regulations for flame-resistant electrical wire (Ref. section 23.1365(b)).

(1) The apparatus should be similar to the one that is defined in Section 4.1 through 4.3, 4.6 and 4.7 of Method 5903 of Federal Test Method Standard No. 191A, except the specimen holder should be capable of holding electrical wire at 60° to the horizontal and taut while being tested. The burner should be mounted underneath the specimen so that the flame impinges perpendicular onto the specimen. The minimum flame temperature measured by a calibrated thermocouple pyrometer in the center of the flame should be 1550°F.

(2) Three specimens, with a test area length of at least 24 inches, should be tested for each sample unit.

(3) The specimens should be conditioned to a temperature of 65°F to 75°F and at 45 to 55 percent relative humidity until moisture equilibrium is reached, or for 24 hours, before testing. Only one specimen should be removed from the conditioning environment at a time and immediately subjected to the flame test.

(4) Adjust the burner to give a flame height of 1 1/2 inches.

(5) Position the burner so that its top is 3/4 inch from the specimen. The flame should be applied to the specimen 8 inches from the lower clamped end for 30 seconds.

(6) Measure the burn length of each specimen to the nearest 0.10 inch and then determine the average burn length of the three specimens. If the specimens do not support combustion after the ignition flame is applied for 30 seconds or if the average burn length of the three specimens does not exceed 3 inches, if the flame time after removal of the flame source does not exceed 30 seconds, and drippings do not continue to flame for more than 3 seconds after falling, the electrical wire is acceptable.

(7) Breaking of the wire specimens is not considered a failure.

d. The following flammability test is considered acceptable for demonstrating compliance with regulations for fire-resistant components located in engine compartments (Ref. sections 23.903(e)(2); 23.1091(b)(1); 23.1141(f); 23.1183(a); 23.1191(d); 23.1193(c), (d); 23.1203(e)).

(1) The apparatus should be similar to the one that is defined in SAE Aerospace Information Report (AIR) 1377A.

(2) Three actual parts should be used as specimens for the test. Each specimen should be enveloped in the test flame of 2000°F ±50°F for 5 minutes on the side that would be exposed, or most adversely affected, in case of a fire. The specimen should be mounted similar to its actual installation. Fluid lines or conduits should be connected to both sides of fittings to simulate actual conditions. Operating fluids or oil as specified in SAE AS 1055B should be in the lines and at operating pressures unless the design and function of the system prevent the fluids from being in the lines during an actual fire in the airplane.

(3) The test procedure defined in Section 4 of SAE Aerospace Standard (AS) 1055B should be followed.

(4) The components are acceptable if there is no flame penetration or leakage and if they are capable of carrying the loads (structural or electrical) and of satisfactorily performing the function for which they were designed while under test conditions or after the test is completed.

e. The following flammability test is considered acceptable for demonstrating compliance with regulations for fireproof materials (Ref. sections 23.859(b), (b)(1), (c); 23.863(b)(4); 23.865; 23.1013(e); 23.1121(c); 23.1123(a); 23.1183(a); 23.1189(b)(2); 23.1191(c), (e), (f), (g); 23.1192; 23.1193(e)).

(1) The apparatus should be similar to the one that is defined in SAE Aerospace Information Report (AIR) 1377A.

(2) For sheet materials, one specimen 10 inches by 10 inches should be subjected to a test flame of 2000°F ±50°F for 15 minutes. The test flame should be applied at the center of the specimen and be large enough to maintain the required temperature over an area approximately 5 inches by 5 inches.

(3) For all other components, lines, fittings, seals, etc., the actual part should be enveloped in the test flame of 2000°F ±50°F for 15 minutes on the side that would be exposed, or most adversely affected, in case of a fire. They should be mounted similar to their actual installation. Fluid fittings, lines, or conduits should be connected to both sides of fittings to simulate actual conditions. Operating fluids or oil as specified in SAE AS 1055B should be in the lines and at operating pressures unless the design and function of the system prevents the fluids from being in the lines during an actual fire in the airplane.

(4) The test procedure defined in Section 4 of SAE Aerospace Standard (AS) 1055B should be followed.

(5) The materials or components are acceptable if there is no flame penetration or leakage and if they are capable of carrying the loads and of satisfactorily performing the function for which they were designed while under test conditions or after the test is completed.

f. The test procedure defined in Appendix F of FAR Part 23 should be followed for showing compliance for self-extinguishing materials (Ref. section 23.853(e)).

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