



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

Advisory Circular

Subject: FLAMMABILITY TESTS

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AC No: 23-2A

Initiated by: ACE-100

FOREWORD

This advisory circular (AC) sets forth an acceptable means of showing compliance with Title 14 Code of Federal Regulations (14 CFR) part 23 and Civil Air Regulations (CAR) 3 for the flammability testing of systems and equipment in normal, utility, acrobatic, and commuter category airplanes and airships. This AC applies to Subparts D and F of part 23 and applicable sections of CAR 3 as listed in Paragraph 6a. The revision addresses systems and equipment and references other general ACs that provide guidance for other subparts of part 23.

A handwritten signature in cursive script that reads "David Showers".

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1. What is the purpose of this AC?

This advisory circular (AC) provides an acceptable means, but not the only means, of showing compliance with part 3 of the Civil Air Regulations (CAR), with Title 14 of the Code of Federal Regulations (14 CFR) part 23, and with Sections 4.39 and 4.40 of the Airship Design Criteria (No. FAA-P-8110-2). This AC is applicable to flammability tests for various materials, components and electrical wire/cables. This material is neither mandatory nor regulatory in nature and does not constitute a regulation. You may follow an alternate FAA-approved method. However, if you use the means described in this AC, you must follow it in all respects. Mandatory words such as "must" apply only to those who seek to show compliance to a specific rule by use of a method prescribed in this AC without deviation.

2. Who does this AC apply to?

The guidance provided in this document is directed to airplane manufacturers, modifiers, foreign regulatory authorities, and FAA small airplane type certification engineers, and their designees. This AC applies to flammability tests in any part 23 airplane.

3. Cancellation

AC 23-2, Flammability Tests, dated August 20, 1984.

4. Background

General flammability requirements for certain structure, electrical wire and cables, and associated equipment, crew and passenger compartment materials, and cargo compartment materials are addressed in the Airship Design Criteria, 14 CFR part 23, and CAR part 3. This AC applies to all flammability requirements (fireproof, flame-resistant, self-extinguishing, etc.), but specific acceptable means of compliance with the fire protection requirements for self-extinguishing are specified in part 23, Appendix F rather than this AC. This AC or AC 20-135, Powerplant Installation and Propulsion System Component Fire Protection Test Methods, Standards, and Criteria, can be used for powerplant fireproof and fire-resistant requirements including composite cowling materials. The primary purpose of this AC is to address means of compliance for flammability of systems and equipment in part 23 airplanes and airships.

5. Applicability

This AC is applicable to new Type Certificate projects, Amended Type Certificate projects, Supplemental Type Certificate projects, Parts Manufacturer Approvals, as well as major alteration projects.

6. Definitions

Definitions of Fireproof, Fire Resistant, Flame Resistant and Flash Resistant are those in 14 CFR part 1. Self-extinguishing is defined by the average burn length, average flame time after removal of the flame source, and the time drippings flame after falling (times and burn lengths vary with applicable sections of the airworthiness standards) as found in the applicable 14 CFR part 23 airworthiness standards.

7. Related Regulations and Documents

a. Regulatory Sections

These acceptable means of compliance refer to the applicable sections of 14 CFR part 23. For airplanes certificated under CAR 3, we show the corresponding paragraphs of the former CAR in brackets.

§ 23.853(a), (d), and (f) [3.388(a)]	Passenger and crew compartment interiors
§ 23.855(b), and (c)	Cargo and baggage compartment fire protection
§ 23.859(a), (b), (b)(1), and (c) [3.388(b)]	Combustion heater fire protection
§ 23.863(b)(4)	Flammable fluid fire protection
§ 23.865	Fire protection of flight controls, engine mounts, and other flight structure
*§ 23.903(e)(2)	Engines
*§ 23.1091(b)(1) [3.605(b)]	Air induction system
*§ 23.1121(c) [3.615(b)]	Exhaust system-General
*§ 23.1141(f)	Powerplant controls: General
*§ 23.1183(a) [3.638(a), (b)]	Lines, fittings and components
*§ 23.1189(b)(2)	Shutoff means
*§ 23.1191(c), (e), (f), (g), [3.624(a), (b)]	Firewalls
*§ 23.1193(c), (d), (e) [3.624(a) and (b)]	Cowling and nacelle
*§ 23.1203(e)	Fire detector system
§ 23.1359	Electrical system fire protection
§ 23.1365(b) [3.693]	Electric cables and equipment
§ 23.1385(d) [3.700(e)]	Position light system installation
Part 23, Appendix F	Test Procedure

* Compliance to these rules can be shown by the tests in this AC or those in AC 20-135.

b. Advisory Circulars and Related Documents

You may access ACs, Orders, and policy statements on the FAA website: <http://rgl.faa.gov>. You may obtain copies of current editions of the following publications free from the U.S. Department of Transportation, Subsequent Distribution Office, M-30, Ardmore East Business Center, 3341 Q 75th Avenue, Landover, MD 20785.

AC 20-107A	Composite Aircraft Structure
AC 20-135	Powerplant Installation and Propulsion System Component Fire Protection Test Methods, Standards and Criteria
DOT/FAA/AR-00/12	Aircraft Materials Fire Test Handbook
Available from http://www.fire.tc.faa.gov/handbook.stm	

c. Other Documents

SAE Aerospace Information Report (AIR) 1377A, Fire Test Equipment for Flexible Hose and Tube Assemblies.

The document listed above is available for purchase from the Society of Automotive Engineers (SAE), Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

<http://aerospace.sae.org/> is another source.

SAE Aerospace Standard (AS) 1055D, Fire Testing of Flexible Hose, Tube Assemblies, Coils, Fittings, and Similar System Components.

The document listed above is available for purchase from the Society of Automotive Engineers (SAE), Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

<http://aerospace.sae.org/> is another source.

8. Acceptable Means of Compliance

This AC provides means of compliance for flash-resistant materials, flame-resistant materials, flame-resistant electrical wire, fireproof materials, fire-resistant materials, and self-extinguishing materials. Some methods, but not the only methods, for showing compliance for components requiring certification by flammability tests are as follows:

a. The following flammability test is considered acceptable for demonstrating compliance with regulations for flash-resistant materials (reference CAR 3.388(a)).

(1) The apparatus should be similar to that shown in Chapter 3, Section 3.3, Test Apparatus, of DOT/FAA/AR-00/12, Aircraft Materials Fire Test Handbook, dated April 2000.

(2) The minimum flame temperature measured by a calibrated thermocouple pyrometer in the center of the flame must be 1550 °F.

(3) For each sample unit, test three specimens, approximately 4-½ inches by 12-½ inches, with the long dimension parallel to the warp direction of the cloth.

Note: 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 must be parallel to the

more hazardous direction. If the more hazardous direction is unknown, then test in both directions.

(4) Condition the specimens 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. Remove only one specimen from the conditioning environment at a time, and immediately subject it to the flame test.

(5) For plain cloth and rigid materials, follow the procedure described below.

(a) Insert the specimen into the holder with the surface that will be exposed when installed in the airplane, facing down. Clamp it such that a two-inch wide center strip is exposed with a ½ inch clearance between the holder and each end of the specimen.

(b) Adjust the burner to give a flame height of 1-½ inches.

(c) Slide the specimen holder into the cabinet and into the test position so that the end of the specimen is ¾ inch above the top of the burner when ignited. Burn approximately 1-½ inches of the specimen before starting the timing device. Stop the timing at least 1 inch before the burning front reaches the end of the specimen.

(d) Determine the average burn rate of the three specimens, using the time required to travel along a minimum of 10 inches of each specimen. The material is acceptable if:

1. The specimens do not support combustion after the ignition flame is applied for 15 seconds; or

2. The average burn rate of the three specimens does not exceed 20 inches per minute; or

3. The flame extinguishes itself and subsequent burning without a flame does not extend into the undamaged areas.

(6) For napped or tufted cloth, follow the procedure below.

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

(b) If the cloth is double-napped, 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 exposed surface.

(c) In all other respects, the procedure must be as described for plain cloth in paragraphs 7a(5)(a) through 7a(5)(d), above.

b. The following flammability test is considered acceptable for demonstrating compliance with regulations for flame-resistant materials, except for electrical wire (reference §§ 23.853(a), 23.1365(b), and 23.1385(d)).

(1) The same apparatus, size of specimens and procedures as specified in paragraphs 7a(1) through 7a(6) above for testing flash-resistant materials can also be used for testing flame-resistant materials. The following exceptions replace paragraph 7a(5)(d) and are applicable to flame-resistant testing.

(a) Determine the average burn rate of the three specimens, using the time required to travel along a minimum of 10 inches on each specimen. The material is acceptable if:

1. The specimens do not support combustion after the ignition flame is applied for 15 seconds; or

2. The average burn rate of the three specimens does not exceed 4 inches per minute; or

3. The flame extinguishes itself and subsequent burning without a flame does not extend into the undamaged areas.

c. The following flammability test is considered acceptable for demonstrating compliance with regulations for flame-resistant electrical wire (reference §§ 23.853(a) and 23.1365(b)).

(1) The apparatus should be similar to that shown in Chapter 4, Section 4.3, Apparatus, of DOT/FAA/AR-00/12, Aircraft Materials Fire Test Handbook, dated April 2000.

(2) Mount the burner underneath the specimen so that the burner is perpendicular to the specimen.

(3) The minimum flame temperature measured by a calibrated thermocouple pyrometer in the center of the flame must be 1550 °F.

(4) For each sample unit, test three specimens, with a test area length between the lower clamp and upper pulley of at least 24 inches.

(5) Condition the specimens 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. Remove only one specimen from the conditioning environment at a time, and immediately subject it to the flame test.

(6) Adjust the burner to give a flame height of 1-½ inches.

(7) Position the burner so that its top is ¾ inch from the specimen. Apply the flame to the specimen 8 inches from the lower clamped end for 30 seconds.

(8) Measure the burn length of each specimen to the nearest 0.10 inch and then determine the average burn length of the three specimens. The electrical wire is acceptable if:

(a) The specimens do not support combustion after the ignition flame is applied for 30 seconds; or

(b) The average burn length of the three specimens does not exceed 3 inches, 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.

(9) Breaking of the wire conductor is not considered a failure of flammability.

d. The following flammability test is considered acceptable for demonstrating compliance with regulations for fireproof materials (reference §§ 23.859(a), (b), (b)(1), (c); 23.863(b)(4); and 23.865).

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

(2) For sheet materials, subject one specimen 10 inches by 10 inches to a test flame of 2000 °F +/- 150 °F for 15 minutes. Apply a test flame at the center of the specimen that is large enough to maintain the required temperature over an area approximately 5 by 5 inches.

(3) For all other components, lines, fittings, seals, etc., envelop the actual part in the test flame of 2000 °F +/- 150 °F for 15 minutes on the side that would be exposed, or most adversely affected, in case of a fire.

(a) Mount them similar to their actual installation.

(b) Connect fluid fittings, lines, or conduits to both sides of fittings to simulate actual conditions.

(c) Operating¹ fluids or oil, as specified in SAE Aerospace Standard (AS) 1055D, must 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) Follow the test procedure defined in Section 4 of AS 1055D.

(5) The materials or components are acceptable if:

(a) There is no flame penetration or leakage; and

(b) They are capable of carrying the loads; and

(c) They satisfactorily perform the function for which they were designed while under test conditions or after the test is completed.

(6) The tester may use the Fire Test Equipment Standards and Test Criteria in Section 6 of AC 20-135 in place of this paragraph for fireproof testing.

e. The following flammability test is considered acceptable for demonstrating compliance with regulations for fire-resistant materials and components located in designated fire zones (reference CAR 3.388(b), and §§ 23.859(a) and 23.1359(b)).

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

(2) For sheet materials, subject three specimens to a test flame of 2000 °F +/- 50 °F for 15 minutes. Apply a test flame at the center of the specimen that is large enough to maintain the required temperature over an area approximately 5 by 5 inches.

(3) For fabricated parts/components, use three actual parts as specimens for the test. Envelop each specimen in the test flame of 2000 °F +/- 150 °F for 5 minutes on the side that would be exposed, or most adversely affected, in case of a fire. Mount the specimen similar to its actual installation.

(a) Connect fluid fittings, lines, or conduits to both sides of fittings to simulate actual conditions.

(b) Operating fluids or oil, as specified in SAE Aerospace Standard (AS) 1055D, must 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) Follow the test procedure defined in Section 4 of SAE Aerospace Standard (AS) 1055D.

(2) The components are acceptable if:

(a) There is no flame penetration or leakage;

(b) They are capable of carrying the structural or electrical loads; and

(c) They satisfactorily perform the function for which they were designed while under test conditions or after the test is completed.

(3) The applicant may use the Fire Test Equipment Standards and Test Criteria in Section 6 of AC 20-135 in place of this paragraph for fire-resistant testing.

f. Follow the test procedure defined in Appendix F of 14 CFR part 23 for showing compliance for self-extinguishing materials (reference §§ 23.853(d), (f), 23.855(b) and (c), and 23.1359(c)). There are requirements for vertical, horizontal, 45 degree and 60 degree testing in these rules. Chapter 1 of DOT/FAA/AR-00/12, Aircraft Materials Fire Test Handbook, dated April 2000, is an acceptable alternative for vertical testing, as are Chapter 2 for 45-degree testing, Chapter 3 for horizontal testing, and Chapter 4 for 60-degree testing.

Note: Per § 23.853(d)(3)(ii) Thermal/Acoustic Insulation Materials are required to meet the vertical test in part 23, Appendix F, for commuter category airplanes. If an applicant wishes to perform flame propagation testing for these materials, Chapter 23 of DOT/FAA/AR-00/12, Aircraft Materials Fire Test Handbook, dated April 2000, and revised in the FEDERAL REGISTER (68FR 45046) on July 31, 2003, is an acceptable means of compliance.

g. Section 23.859 calls for fire protection in accordance with §§ 23.1182 through 23.1191 and § 23.1203. Section 23.1359(a) requires compliance with § 23.1182. AC 20-135 provides acceptable means of compliance for these sections.