

 AEROSPACE STANDARD	AS4273	REV. A
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Superseding AS4273		
(R) Fire Testing of Fluid Handling Components for Aircraft Engines and Aircraft Engine Installations		

RATIONALE

This SAE Aerospace Standard (AS) presents an improved fire test procedure sequence and changes to meet the new FAA requirements specified in AC 33.17 and AC 20-135.

1. SCOPE

This document establishes requirements, test procedures, and acceptance criteria for the fire testing of fluid handling components and materials used in aircraft fluid systems. It is applicable to fluid handling components other than those prescribed by AS1055 (e.g., hoses, tube assemblies, coils, and fittings).

It also is applicable to materials, wiring, and components such as reservoirs, valves, gearboxes, pumps, filter assemblies, accumulators, fluid-cooled electrical/electronic components, in-flight fluid system instrumentation, hydromechanical controls, actuators, heat exchangers, and manifolds. These components may be used in fuel, lubrication, hydraulic, or pneumatic systems.

1.1 Classifications

Component assemblies shall be classified according to fire test duration. The test methods described herein shall be applicable to each classification.

1.1.1 Fire Resistant

The capability of a material or component to perform those functions intended under the heat and other conditions likely to occur at the particular location during a fire and to withstand a 2000 °F flame (± 150 °F) for 5 minutes minimum.

1.1.2 Fireproof

The capability of a material or component to withstand a 2000 °F flame (± 150 °F) for 15 minutes minimum, while still performing those functions intended to be performed in case of fire.

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1.2 Applicability Guidelines

All flammable fluid conveying components that are located in a designated fire zone shall be at least fire resistant. All flammable fluid tanks and their associated shutoff valves located in a fire zone shall be fireproof. Components which convey flammable fluids can be evaluated to a fire resistant standard provided the supply of flammable fluid is stopped by a shutoff feature. Engine fuel system components can be considered to have a shutoff feature if the fuel flow would be shutoff with engine shutdown. Engine oil system components must consider that oil flow may continue after engine shutdown because of windmilling causing continued rotation of the oil pump. It should be noted that historically most oil system components have been evaluated to a fireproof standard. Other flammable fluid conveying components such as hydraulic and thrust augmentation systems should be evaluated in a similar manner.

Components adjacent to fire zones may be required to be fire resistant or fire proof (see AC20-135 Appendix 1).

1.3 Components Protected by Nonintegral Shields

Components to be fire tested that are protected from direct flame impingement by a nonintegral fireproof device such as a shield, box, baffle, etc., must employ this device in the fire test. The device must be positioned per the installation and the instrumentation that measures the flame temperature during the test be within 0.25 inches (6.36 mm) from the device. The burner is positioned as defined in 4.7, and the component must be positioned in its actual relationship to the device.

2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws, regulations, and associated FAA policy and guidance material unless a specific exemption has been obtained.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AS1055 Fire Testing of Flexible Hose, Tube Assemblies, Coils, Fittings, and Similar System Components

AS8028 Power Plant Fire Detection for Instruments, Thermal and Flame Contact Types

AIR1377 Fire Test Equipment for Flexible Hose and Tube Assemblies

2.2 ANSI Publications

Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ISO 2685 Aircraft-Environmental Condition and Test Procedures for Airborne Equipment-Resistance to Fire in Designated Zones

2.3 Federal Standards

Title 14 of the Code of Federal Regulations, Aeronautics and Space, Parts 23, 25, 27, 29, and 33 regarding flammable fluid-carrying components and compliance

FAA Powerplant Engineering Report No. 3A, Standard Fire Test Apparatus and Procedure, Revised March 1978.

FAA Report No. FAA-RD-76-213 Re-evaluation of Burner Characteristics for Fire Resistance Tests, January 1977

FAA Advisory Circular No. 20-135 Powerplant Installation and Propulsion System Component Fire Protection Test Methods, Standards, and Criteria, dated February 6, 1990

FAA Advisory Circular No. 33.17-1 Fire Prevention, dated June 28 2002

FAA Aircraft Material Fire Test Handbook, Report No. DOT/FAA/CT-89/15, Sept. 1990

3. QUALIFICATION

Qualification or certification normally requires detailed test plans to be submitted to the purchaser and/or cognizant agency for approval prior to test. The test schedule must be coordinated with the appropriate agency to allow witnessing of the test unless witnessing is waived.

For FAA applications, conformity of the test specimen per FAA procedures and an FAA approved test plan will be required.

Components qualified or certified to this document shall be products which have passed the fire test requirements listed or which comply with the similarity criteria described herein.

Test report(s) proving qualification of products to this document shall be furnished by the supplier to the purchaser and to agencies designated by the purchaser.

Components that have been qualified to this document do not require retest to be qualified at lower pressures, lower fluid temperatures, and/or higher fluid flow rates unless those changes are more critical. Identical components with higher pressures, higher fluid temperatures, and/or lower flow rates or other significant changes shall be evaluated for retest.

Qualification by similarity to a component previously qualified by test under similar conditions shall include analyses to quantify the effects of any operating differences and physical differences from the original test parameters and test article. Factors to be considered shall include but not be limited to materials, construction, structural loading, installations, sealing of shafts and parting surfaces, flow rates and distribution for cooling, surface area exposed to the flame, and fluid pressure/temperature.

4. TEST PROCEDURE

4.1 Test Purpose

The tests prescribed herein are intended to verify that the test specimen will demonstrate compliance with fire resistance or fireproof requirements as defined in this document.

4.2 Test Requirements

Component operating conditions maintained during the fire test shall represent realistic worst case flight conditions with regard to fire-resistance/fireproof capability. Engine-related components and associated lines and fittings shall be conveying fluids at the minimum flow rate for flight operation, corresponding pressure, and the highest fluid temperature encountered over the normal flight envelope.

NOTE: For high-pressure hydraulic and pneumatic systems and other systems, the low flow condition may not be worst case; analysis to determine worst case may be required.

Flammable fluid tanks (i.e., oil tanks) shall be tested with a minimum flight idle fluid flow rate and maximum flight fluid temperature and system pressure for 5 minutes, and then immediately followed by a 10 minute engine shutdown fluid flow or windmill fluid flow depending on engine type and design. The fluid level shall be at the "minimum dispatch fluid level." Any gulping volume shall be removed for the 5 minute low flow portion of the test and returned to the tank at the start of the 10 minute shutdown flow portion of the test. For an oil system, "gulping" refers to the volume of oil typically evacuated from the main oil tank and retained within the oil system during normal engine operation. This "gulping" is generally evidenced by a decrease in oil tank quantity while the engine is operating normally, with the gulping volume retained within the engine sumps. The gulped oil is scavenged back to the oil tank after the engine is shutdown.

Rotational speeds and other applicable parameters shall also correspond to the selected defined and accepted flight condition.

For nonengine related components, requirements shall be established based on the operating envelope with consideration of loading, fluid pressures, and temperatures at the minimum sustained flow rate. All components shall be supplied with test fluid conforming to the primary fluid specified for the system in which the component is used. An explosive condition can conceivably be created by fuel leaks. A substitute test fluid may be used in place of the primary fuel if approved by the purchaser, and any leakage of the fluid meets the requirements of 4.3(a.3).

4.3 Success Criteria Guidelines

These guidelines represent success criteria that have provided satisfactory results for evaluating the flame resistance of fluid handling components for aircraft and aircraft engines. For more detailed certification guidelines (see FAA AC20-135 and AC33.17).

a. Fire Test Pass/Fail Criteria: In general, the following fire test criteria have been applied to the test article and accepted:

1. Maintain the ability to perform those functions intended to be provided in the case of fire, including fuel shut off when so commanded.
2. No leakage of hazardous quantities of flammable fluids, vapors or other materials. In general no leakage should occur. Small drips or weeps may be acceptable if a safety assessment of the installation shows the resulting leakage would not cause or contribute to a hazardous condition.
3. No support of a sustained fire (e.g., rapid self-extinguishing and no re-ignition) by the constituent material of the article being tested or by flammable fluid leaking from the test article.
4. No burn through of firewalls.
5. No other hazardous conditions should result.

NOTE: Hazardous Quantity: An amount of flammable fluid which could sustain a fire of sufficient severity and duration so as to significantly increase the overall fire hazard or result in a hazardous condition.

b. Additional Fire Test Pass/Fail Criteria: Firewall isolation valves and their controls shall be capable of closing off the supply of flammable fluid after 5 minutes of fire testing. If the valve is in the fire zone, the valve shall be exposed to flame for an additional 10 minutes after being closed. During additional 10 minute exposure the valve shall remain closed. The valve shall continue to perform its intended function of shutting off the supply of flammable fluid to the fire zone at the end of the test.

4.4 Instrumentation

Instrumentation with corresponding accuracies, recording devices, and equipment calibration requirements shall be used to measure and record all necessary test parameters. These shall include but not be limited to the following:

- a. Fluid flow rate
- b. Fluid temperature
- c. Fluid pressure
- d. Burner orientation
- e. Burner calibration water flow rate¹
- f. Burner calibration water temperature in¹

¹ Or calorimeter readout.

- g. Burner calibration water temperature out¹
- h. Burner flame temperature
- i. Component drive speed (if required)
- j. Air velocity (if airflow simulation used)
- k. Loading (if required)
- l. Surface temperature (if required)
- m. Vibration instrumentation (if required)
- n. Test article functional outputs (e.g., FMU fuel metering valve position or shutoff valve position)

4.4.1 Calibration

Descriptions of test equipment to be used for each fire test shall be included in the detailed test plan and test report. The next required calibration dates shall be recorded on the equipment list for each item of test equipment. The burner shall be calibrated prior to each test. The burner temperature and intensity requirements are covered in 4.6.

Calibration of the flame heat flux density may be accomplished with either a water tube or a calorimeter.

The procedures for both methods are covered by this document and can be found in 4.9. Figures 3 and 4 show the flame heat flux density calibration.

If a water tube is used to calibrate the heat flux density, the burner shall input the minimum required heat flux density into a 15 inch (381 mm) exposed length of 0.5 inch OD x 0.032 inch wall (13 mm x 0.8 mm) copper tubing with a water flow rate of 500 lb (227 kg)/hour $\pm$ 5% reference AS1055 and AIR1377. There shall be no backup plate behind the copper tube.

4.5 Environmental Conditions

The environmental conditions for all tests, unless otherwise specified, shall be as follows:

- a. Ambient temperature: 40 to 110 °F (4.4 to 43 °C)
- b. Ambient pressure: Local barometric

4.6 Flame Temperature and Intensity

4.6.1 Flame Temperature

The flame shall have a temperature of 2000 °F $\pm$ 150 °F (1093 °C $\pm$ 83 °C) as measured per 4.7 while maintaining the flame intensity required per 4.6.2. Figure 1 and 3 show arrangement for calibration of the test flame with typical traverse burner. Figure 2 shows a horizontal flame path. In either case, the calibration shall be accomplished in the same plane/orientation as will be used for the test specimen.

A minimum of three calibration thermocouples shall be used. The thermocouples shall be located 4 inches $\pm$ 1/4 inch (102 mm $\pm$ 6 mm) from the end of the burner on liquid fuel burners and 3 inches $\pm$ 1/4 inch (75 mm $\pm$ 6 mm) for gas burners. The thermocouples should be bare junction 1/16 to 1/8 inch metal sheathed, ceramic packed chromel-alumel thermocouples with nominal 22 to 30 AWG (American Wire Gage) size conductors, or equivalent. The three thermocouples shall be located on a horizontal line with one on the centerline of the burner discharge nozzle and with the other two located on either side, halfway between the center thermocouple and the longest edge of the burner.