INTERNATIONAL

Designation: F3066/F3066M − 23

Standard Specification for Aircraft Powerplant Installation Hazard Mitigation[1]

This standard is issued under the fixed designation F3066/F3066M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers minimum requirements for hazard mitigation in propulsion systems installed on small aeroplanes.

1.2 The applicant for a design approval must seek the individual guidance to their respective CAA body concerning the use of this standard as part of a certification plan. For information on which CAA regulatory bodies have accepted this standard (in whole or in part) as a means of compliance to their Small Aircraft Airworthiness regulations (Hereinafter referred to as "the Rules"), refer to ASTM F44 webpage (www.ASTM.org/COMITTEE/F44.htm) which includes CAA website links.

1.3 *Units*—The values stated are SI units followed by imperial units in brackets. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F3060 Terminology for Aircraft

F3061/F3061M Specification for Systems and Equipment in Aircraft

F3062/F3062M Specification for Aircraft Powerplant Installation

F3114 Specification for Structures

F3116/F3116M Specification for Design Loads and Conditions

F3120/F3120M Specification for Ice Protection for General Aviation Aircraft

2.2 *Federal Aviation Regulations:*[3]

14 CFR Part 23 Amendment 62

3. Terminology

3.1 See Terminology F3060 for definitions and abbreviations.

4. Engines

4.1 *For Turbine Engine Installations:*

4.1.1 Design precautions must be taken to minimize the hazards to the aeroplane in the event of an engine rotor failure or of a fire originating inside the engine which burns through the engine case.

4.1.2 The powerplant systems associated with engine control devices, systems, and instrumentation must be designed to give reasonable assurance that those operating limitations that adversely affect turbine rotor structural integrity will not be exceeded in service.

4.1.3 For turbine engines installations embedded in the fuselage behind the cabin, the effects of a fan exiting forward of the inlet case (fan disconnect) must be addressed, the passengers must be protected, and the aeroplane must be controllable to allow for continued safe flight and landing.

4.2 *Engine Isolation*—The powerplants must be arranged and isolated from each other to allow operation, in at least one configuration, so that the failure or malfunction of any engine, or the failure or malfunction (including destruction by fire in the engine compartment) of any system that can affect an engine (other than a fuel tank if only one fuel tank is installed), will not:

[1] This specification is under the jurisdiction of ASTM Committee F44 on General Aviation Aircraft and is the direct responsibility of Subcommittee F44.40 on Powerplant.

Current edition approved June 1, 2023. Published July 2023. Originally approved in 2015. Last previous edition approved in 2018 as F3066/F3066M – 18. DOI: 10.1520/F3066_F3066M-23.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, http://www.access.gpo.gov.

4.2.1 Prevent the continued safe operation of the remaining engines; or

4.2.2 Require immediate action by any crewmember for continued safe operation of the remaining engines.

5. Powerplant Ice Protection

5.1 *Induction System Icing Protection:*

5.1.1 Reciprocating engines. Each reciprocating engine air induction system must have means to prevent and eliminate icing. Unless this is done by other means, it must be shown that, in air free of visible moisture at a temperature of –1 °C [30 °F].

5.1.2 Each aeroplane with sea level engines using conventional venturi carburetors has a preheater that can provide a heat rise of 50 °C [90 °F]. with the engines at 75 % of maximum continuous power.

5.1.3 Each aeroplane with altitude engines using conventional venturi carburetors has a preheater that can provide a heat rise of 67 °C [120 °F]. with the engines at 75 % of maximum continuous power.

5.1.4 Each aeroplane with altitude engines using fuel metering device (carburetor) tending to prevent icing has a preheater that, with the engines at 60 % of maximum continuous power, can provide a heat rise of:

5.1.4.1 56 °C [100 °F], or

5.1.4.2 22 °C [40 °F], if a fluid deicing system meeting the carburetor deicing requirements of Specification F3062/F3062M is installed.

5.1.5 Each aeroplane with a sea-level or altitude engine using fuel injection systems having metering components on which impact ice may accumulate has a preheater capable of providing a heat rise of 24 °C [75 °F] with the engine operating at 75 % of maximum continuous power; and

5.1.5.1 Each aeroplane with a sea level engine(s) using a fuel metering device tending to prevent icing has a sheltered alternate source of air with a preheat (higher than ambient) of not less than 16 °C [60 °F] with the engines at 75 % of maximum continuous power;

5.1.6 Each twin-engined aeroplane with sea-level engines using a carburetor tending to prevent icing has a preheater that can provide a heat rise (higher than ambient) of 50 °C [90 °F] with the engines at 75 % of maximum continuous power.

5.1.7 Each aeroplane with sea level or altitude engine(s) using fuel injection systems not having fuel metering components projecting into the airstream on which ice may form, and introducing fuel into the air induction system downstream of any components or other obstruction on which ice produced by fuel evaporation may form, has a sheltered alternate source of air with a preheat of not less than 16 °C [60 °F] with the engines at 75 % of maximum continuous power.

5.2 *Turbine Engines:*

5.2.1 Each turbine engine and its air inlet system with all icing protection systems operating must:

5.2.1.1 Operate throughout its flight power range, including minimum descent idle speeds, in the icing and snow conditions specified in Specification F3120/F3120M, without the accumulation of ice on engine, inlet system components, or airframe components that would do any of the following:

(1) Adversely affect installed engine operation or cause a sustained loss of power or thrust; or an unacceptable increase in gas path operating temperature; or an airframe/engine incompatibility; or

(2) Result in unacceptable temporary power or thrust loss or unacceptable engine damage of the engine (including idling), without the accumulation of ice on engine or inlet system components that would adversely affect engine operation or cause a serious loss of power or thrust.

5.2.2 Each turbine engine must idle for 30 min on the ground, with the air bleed available for engine icing protection at its critical condition, without adverse effect, in the ground icing conditions specified in Specification F3120/F3120M.

5.2.2.1 Followed by momentary operation at takeoff power or thrust.

5.2.2.2 During the 30 min of idle operation, the engine may be run up periodically to a moderate power or thrust setting.

5.3 For aeroplanes with reciprocating engines having superchargers to pressurize the air before it enters the fuel metering device (carburetor), the heat rise in the air caused by that supercharging at any altitude may be utilized in determining compliance with 5.1.1 if the heat rise utilized is that which will be available, automatically, for the applicable altitudes and operating condition because of supercharging.

5.4 Propellers and other components of complete engine installations must be protected against the accumulation of ice (as specified in Specification F3120/F3120M) as necessary to enable satisfactory functioning without appreciable loss of thrust when operated in the icing conditions for which approval is sought.

5.5 All airframe areas of the aeroplane forward of the propeller, excluding spinners, that are likely to accumulate and shed ice into the propeller disc during any operating condition must be suitably protected to prevent ice formation (as defined in Specification F3120/F3120M), or it must be shown that any ice shed into the propeller disc will not create a hazardous condition.

5.5.1 Propeller ice impact results compliance may be used for showing compliance.

5.6 Each drain must be protected from hazardous ice accumulation under any operating condition.

5.7 *Engine Rain Hail Ice and Bird Ingestion:*

5.7.1 Each turbine engine installation must be constructed and arranged to:

5.7.1.1 Ensure that the capability of the installed engine to withstand the ingestion of rain, hail, ice, and birds into the engine inlet is not less than the capability established for the engine itself under 5.7.2.

5.7.2 Each turbine engine and its installation must comply with one of the following:

5.7.2.1 US 14 CFR Sections 33.76, 33.77 and 33.78 in effect on December 13, 2000, or as subsequently amended; or

5.7.2.2 US 14 CFR Sections 33.77 and 33.78 in effect on April 30, 1998, or as subsequently amended before December 13; 2000; or

5.7.2.3 US 14 CFR Section 33.77 in effect on October 31, 1974, or as subsequently amended before April 30, 1998, unless that engine's foreign object ingestion service history has resulted in an unsafe condition; or

5.7.2.4 Be shown to have a foreign object ingestion service history in similar installation locations which has not resulted in any unsafe condition.

6. Designated Fire Zones

6.1 *Designated Fire Zones*—Regions include:

6.1.1 For reciprocating engines:

6.1.1.1 The power section;

6.1.1.2 The accessory section;

6.1.1.3 Any complete powerplant compartment in which there is no isolation between the power section and the accessory section.

6.1.2 For turbine engines:

6.1.2.1 The compressor and accessory sections;

6.1.2.2 The combustor, turbine and tailpipe sections that contain lines or components carrying flammable fluids or gases;

6.1.2.3 Any complete powerplant compartment in which there is no isolation between compressor, accessory, combustor, turbine, and tailpipe sections.

6.1.3 Other types of aeroplane engines;

6.1.4 Any auxiliary power unit compartment; and

6.1.5 Any fuel-burning heater, and other combustion equipment installation described in 7.1.

6.2 No fuel tanks may reside in a fire zone.

6.2.1 There must be at least 13 mm [½ in.] of clearance between the fuel tank and the firewall. No part of the engine nacelle skin that lies immediately behind a major air opening from the engine compartment may act as the wall of an integral tank.

6.3 Each fuel/oil tank must be isolated from personnel compartments by a fume-proof and fuel-proof enclosure that is vented and drained to the exterior of the aeroplane. The required enclosure must sustain any personnel compartment pressurization loads without permanent deformation or failure under the conditions defined in (Specifications F3114 and F3116/F3116M). A bladder-type fuel cell, if used, must have a retaining shell at least equivalent to a metal fuel tank in structural integrity.

7. Fire Protection

7.1 *Combustion Heater:*

7.1.1 *Combustion Heater Fire Regions*—The following combustion heater fire regions must be protected from fire in accordance with the applicable provisions of 11.6 and Sections 8 and 9:

7.1.1.1 The region surrounding the heater, if this region contains any flammable fluid system components (excluding the heater fuel system) that could, be damaged by heater malfunctioning; or allow flammable fluids or vapors to reach the heater in case of leakage.

7.1.1.2 The region surrounding the heater, if the heater fuel system has fittings that, if they leaked, would allow fuel vapor to enter this region.

7.1.1.3 The part of the ventilating air passage that surrounds the combustion chamber.

7.1.2 *Ventilating Air Ducts*—Each ventilating air duct passing through any fire region must be fireproof. In addition:

7.1.2.1 Unless isolation is provided by fireproof valves or by equally effective means, the ventilating air duct downstream of each heater must be fireproof for a distance great enough to ensure that any fire originating in the heater can be contained in the duct; and

7.1.2.2 Each part of any ventilating duct passing through any region having a flammable fluid system must be constructed or isolated from that system so that the malfunctioning of any component of that system cannot introduce flammable fluids or vapors into the ventilating airstream.

7.1.3 *Combustion Air Ducts*—Each combustion air duct must be fireproof for a distance great enough to prevent damage from backfiring or reverse flame propagation. In addition:

7.1.3.1 No combustion air duct may have a common opening with the ventilating airstream unless flames from backfires or reverse burning cannot enter the ventilating airstream under any operating condition, including reverse flow or malfunctioning of the heater or its associated components; and

7.1.3.2 No combustion air duct may restrict the prompt relief of any backfire that, if so restricted, could cause heater failure.

7.1.4 Provision must be made to heater controls which prevent the hazardous accumulation of water or ice on or in any heater control component, control system tubing, or safety control.

7.1.5 *Heater Safety Controls:*

7.1.5.1 Each combustion heater must have the following safety controls including: Means independent of the components for the normal continuous control of air temperature, airflow, and fuel flow must be provided to automatically shut off the ignition and fuel supply to that heater at a point remote from that heater when any of the following occurs:

(1) The heater exchanger temperature exceeds safe limits.

(2) The ventilating air temperature exceeds safe limits.

(3) The combustion airflow becomes inadequate for safe operation.

(4) The ventilating airflow becomes inadequate for safe operation.

7.1.5.2 Means to warn the crew when any heater whose heat output is essential for safe operation has been shut off by the automatic means prescribed in this subsection.

7.1.5.3 The means for complying with 7.1.5.1 for any individual heater must be independent of components serving any other heater whose heat output is essential for safe operations; and keep the heater off until restarted by the crew.

7.1.6 Each combustion and ventilating air intake must be located so that no flammable fluids or vapors can enter the heater system during any operating condition:

7.1.6.1 During normal operation; or

7.1.6.2 As a result of the malfunctioning of any other component.

7.1.7 Heater exhaust systems must meet the provisions of 14 CFR Part 23. In addition, there must be provisions in the design of the heater exhaust system to safely expel the products of combustion to prevent the occurrence of:

7.1.7.1 Fuel leakage from the exhaust to surrounding compartments;

7.1.7.2 Exhaust gas impingement on surrounding equipment or structure;

7.1.7.3 Ignition of flammable fluids by the exhaust, if the exhaust is in a compartment containing flammable fluid lines; and

7.1.7.4 Restrictions in the exhaust system to relieve backfires that, if so restricted, could cause heater failure.

7.1.8 Each heater fuel system must meet each powerplant fuel system requirement affecting safe heater operation.

7.1.8.1 Each heater fuel system component within the ventilating airstream must be protected by shrouds so that no leakage from those components can enter the ventilating airstream.

7.1.9 There must be means to safely drain fuel that might accumulate within the heater combustion chamber or the heater exchanger.

7.1.9.1 Each part of any drain that operates at high temperatures must be protected in the same manner as heater exhausts.

7.1.9.2 Each drain must be protected from hazardous ice accumulation under any operating condition.

7.2 *Shutoff Means as Required in Subsection 11.6*—For each multiengine aeroplane the following apply:

7.2.1 Each engine installation must have means to shut off or otherwise prevent hazardous quantities of fuel, oil, deicing fluid, and other flammable liquids from flowing into, within, or through any engine compartment, except in lines, fittings, and components forming an integral part of an engine.

7.2.2 The closing of the fuel shutoff valve for any engine may not make any fuel unavailable to the remaining engines that would be available to those engines with that valve open.

7.2.3 Operation of any shutoff means may not interfere with the later emergency operation of other equipment such as propeller feathering devices.

7.2.4 Each shutoff must be outside of the engine compartment unless an equal degree of safety is provided with the shutoff inside the compartment.

7.2.5 Not more than 1 L [1 qt] of flammable fluid may escape into the engine compartment after engine shutoff. For those installations where the flammable fluid that escapes after shutdown cannot be limited to 1 L [1 qt], it must be demonstrated that this greater amount can be safely contained or drained overboard.

7.2.6 There must be means to guard against inadvertent operation of each shutoff means, and to make it possible for the crew to reopen the shutoff means in flight after it has been closed.

8. Firewalls

8.1 Each engine, auxiliary power unit, fuel burning heater, and other combustion equipment which creates a fire zone, must be isolated from the rest of the aeroplane by firewalls, shrouds, or equivalent means.

8.2 Each firewall or shroud must be constructed so that no hazardous quantity of liquid, gas, or flame can pass from the compartment created by the firewall or shroud to other parts of the aeroplane.

8.3 Each opening in the firewall or shroud must be sealed with close fitting, fireproof grommets, bushings, or firewall fittings.

8.4 Each firewall and shroud must be fireproof and protected against corrosion.

8.5 Compliance with the criteria for fireproof materials or components must be shown as follows:

8.5.1 The flame to which the materials or components are subjected must be 1093 °C ± 83 °C [2000 °F ± 150 °F].

8.5.2 Sheet materials approximately 25 cm [10 in.] square must be subjected to the flame from a suitable burner.

8.5.3 The flame must be large enough to maintain the required test temperature over an area approximately 13 cm [5 in.] square.

8.6 Firewall materials and fittings must resist flame penetration for at least 15 min.

8.7 The following materials may be used in firewalls or shrouds without being tested as required by this section:

8.7.1 Stainless steel sheet, 0.38 mm [0.015 in.] thick.

8.7.2 Mild steel sheet (coated with aluminum or otherwise protected against corrosion) 0.45 mm [0.018 in.] thick.

8.7.3 Terne plate, 0.45 mm [0.018 in.] thick.

8.7.4 Monel metal, 0.45 mm [0.018 in.] thick.

8.7.5 Steel or copper base alloy firewall fittings.

8.7.6 Titanium sheet, 0.41 mm [0.016 in.] thick.

8.8 *Cowling and Nacelle:*

8.8.1 Each nacelle of a multiengine aeroplane with supercharged engines must be designed and constructed so that with the landing gear retracted, a fire in the engine compartment will not burn through a cowling or nacelle and enter a nacelle area other than the engine compartment.

8.8.2 In addition, for all aeroplanes with engine(s) embedded in the fuselage, in pylons on the aft fuselage and for Level 4 aircraft, the aeroplane must be designed so that no fire originating in any engine compartment can enter, either through openings or by burn-through, any other region where it would create additional hazards.

9. Fire Detection

9.1 There must be means that ensure the prompt detection of a fire in:

9.1.1 An engine compartment of:

9.1.1.1 Multiengine turbine powered aeroplanes;

9.1.1.2 Multiengine reciprocating engine powered aeroplanes incorporating turbochargers;

9.1.1.3 Aeroplanes with engine(s) located where they are not readily visible from the cockpit; and

9.1.1.4 All Level 4 aeroplanes.

9.1.2 The auxiliary power unit compartment of any aeroplane incorporating an auxiliary power unit.

9.2 Each fire detector must be constructed and installed to withstand the vibration, inertia, and other loads to which it may be subjected in operation.

9.3 No fire detector may be affected by any oil, water, other fluids, or fumes that might be present.