Standard Specification for Installation of Powerplant Systems[1]

This standard is issued under the fixed designation F3062/F3062M; 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 the installation and integration of powerplant system units.

1.2 This specification is applicable to small aeroplanes as defined in the F44 terminology standard. Use of the term airplane is used throughout this specification and will mean "small airplane."

1.3 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 the ASTM F44 webpage (www.ASTM.org/COMITTEE/F44.htm) which includes CAA website links.

1.4 References within this standard normally refer to documents in United States legal system. Appendix X1 cross references documents in the legal system of other countries of corresponding content.

1.5 *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.

1.6 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F2339 Practice for Design and Manufacture of Reciprocating Spark Ignition Engines for Light Sport Aircraft

F2506 Specification for Design and Testing of Light Sport Aircraft Propellers

F2538 Practice for Design and Manufacture of Reciprocating Compression Ignition Engines for Light Sport Aircraft

F2840 Practice for Design and Manufacture of Electric Propulsion Units for Light Sport Aircraft

F3060 Terminology for Aircraft

F3066/F3066M Specification for Powerplant Systems Specific Hazard Mitigation

2.2 *Code of Federal Regulations (CFR):*[3]

14 CFR part 33 Airworthiness Standards: Aircraft Engines

14 CFR part 35 Airworthiness Standards: Propellers

14 CFR part 34 Fuel Venting and Exhaust Emission Requirements for Turbine Powered Airplanes

2.3 *Federal Aviation Administration (FAA) Publications:*[4]

AC 23-8C Flight Test Guide for certification of part 23 airplanes

CAR 13 Aircraft Engines Airworthiness

TSO C77 Technical Standard Order – Gas Turbine Auxiliary Power Units

2.4 *JAA Documents:*[5]

JAR-E Engines

JAR-P Propellers

JAR-22 Gliders and Powered Gliders

2.5 *EASA Documents:*[6]

CS-22 Certification Specifications for Gliders and Powered Gliders

CS-E Certification Specifications for Engines

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[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, www.access-.gpo.gov.

[4] Available from Federal Aviation Administration (FAA), 800 Independence Ave., SW, Washington, DC 20591, www.faa.gov.

[5] Available from Global Engineering Documents, 15 Inverness Way, East Englewood, CO 80112-5704, global.ihs.com.

[6] Available from EASA European Aviation Safety Agency, Postfach 10 12 53. D-50452 Koeln, Germany, easa.europa.eu.

CS-P Certification Specifications for Propellers
CS-APU Certification Specifications for Auxiliary Power Units

3. Terminology

3.1 The following are a selection of relevant terms. See Terminology F3060 for more definitions and abbreviations.

3.2 *Definitions:*

3.2.1 *powerplant, n*—all units and components necessary for propelling the aircraft or for providing auxiliary power for the aircraft (APU).

3.2.2 *powerplant installation, n*—the installation of an engine or auxiliary power unit including all components that are necessary for propulsion or for providing auxiliary power (APU) and affects the safety of the major propulsive units.

3.2.3 *reciprocating engine, n*—engines with the characteristics of a non-continuous flow piston engines.

3.2.3.1 *Discussion*—For the purpose of this standard the term reciprocating engine does include rotary piston engine due to the similar characteristics.

3.2.4 *supercharger, n*—an air compressor that increases the pressure of air supplied to an engine.

3.2.4.1 *Discussion*—For the purpose of this standard the term supercharger refers to both mechanical and turbine driven superchargers.

3.2.5 *turbocharger, n*—a supercharger driven by a turbine in the exhaust gas stream, short form of turbo supercharger.

3.2.6 *turbine engines, n*—turbopropeller, turbojet and turbofan engines.

3.3 *Abbreviations:*

3.3.1 *APU*—Auxilliary Power Unit

4. General

4.1 *Engines and APU:*

4.1.1 Each engine must either:

4.1.1.1 Meet the technical requirements of 14 CFR Part 33, or

4.1.1.2 If accepted by the authority, meet the technical requirements of CS-22 Subpart H.

4.1.2 Each APU must meet the technical requirements of TSO C77.

4.1.3 Each turbine engine must meet the applicable requirements of 14 CFR Part 34.

4.2 *Powerplant Installation:*

4.2.1 The powerplant installation must comply with the installation instructions of:

(1) the engine,
(2) the propeller, if applicable,
(3) the APU, if applicable.

4.2.2 Each powerplant installation must be constructed and arranged to ensure safe operation to the maximum altitude for which approval is requested.

4.2.3 Each turbine engine installation must be constructed and arranged to result in carcass vibration characteristics that do not exceed those established by the engine manufacturer.

4.2.4 Each powerplant installation must be constructed and arranged to be accessible for necessary inspections and maintenance.

4.2.4.1 Engine cowls and nacelles must be easily removable or openable by the pilot to provide adequate access to and exposure of the engine compartment for preflight checks.

5. Air Induction System

5.1 *General:*

5.1.1 The air induction system for each engine and auxiliary power unit and their accessories must supply the air required by that engine and auxiliary power unit and their accessories under the operating conditions for which certification is requested.

5.2 *Induction Systems of Reciprocating Engine Powered Aeroplanes:*

5.2.1 Each engine installation must have at least two separate air intake sources.

5.2.2 Primary air intakes may open within the cowling if that part of the cowling is isolated from the engine accessory section by a fire-resistant diaphragm or if there are means to prevent the emergence of backfire flames.

5.2.3 Each alternate air intake must be located in a sheltered position and may not open within the cowling if the emergence of backfire flames will result in a hazard.

5.2.4 The supplying of air to the engine through the alternate air intake system may not result in a loss of excessive power in addition to the power loss due to the rise in air temperature.

5.2.5 Each automatic alternate air door must have an override means accessible to the flight crew.

5.2.6 Each automatic alternate air door must have a means to indicate to the flight crew when it is not closed.

5.3 *Induction Systems of Turbine Engine Powered Aeroplanes:*

5.3.1 There must be means to prevent quantities of fuel leakage or overflow from drains, vents, or other components of flammable fluid systems from entering the engine intake system that would cause the engine to exceed its operational limitations, cause a significant loss of power, or otherwise cause the engine to operate in an unsafe condition.

5.3.2 The airplane must be designed to prevent water or slush on the runway, taxiway, or other airport operating surfaces from being directed into the engine or auxiliary power unit air intake ducts in quantities that would cause the engine to exceed its operational limitations, cause a significant loss of power, or otherwise cause the engine to operate in an unsafe condition.

5.3.3 The air intake ducts must be located or protected so as to minimize the hazard of ingestion of foreign matter during takeoff, landing, and taxiing.

5.3.4 Each turbine engine installation must be constructed and arranged to 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 Specification F3066/F3066M.

5.4 *Induction System Ducts:*

5.4.1 Each induction system duct must have a drain to prevent the accumulation of fuel or moisture in the normal ground and flight attitudes. No drain may discharge where it will cause a fire hazard.

5.4.2 Each duct connected to components between which relative motion could exist must have means for flexibility.

5.4.3 Each flexible induction system duct must be capable of withstanding the effects of temperature extremes, fuel, oil, water, and solvents to which it is expected to be exposed in service and maintenance without hazardous deterioration or delamination.

5.4.4 For reciprocating engine installations, each induction system duct must be:

5.4.4.1 Strong enough to prevent induction system failures resulting from normal backfire conditions; and

5.4.4.2 Fire resistant in any compartment for which a fire extinguishing system is required.

5.4.5 Each inlet system duct for an auxiliary power unit must be:

5.4.5.1 Fireproof within the auxiliary power unit compartment;

5.4.5.2 Fireproof for a sufficient distance upstream of the auxiliary power unit compartment to prevent hot gas reverse flow from burning through the duct and entering any other compartment of the airplane in which a hazard would be created by the entry of the hot gases;

5.4.5.3 Constructed of materials suitable to the environmental conditions expected in service, except in those areas requiring fireproof or fire resistant materials; and

5.4.5.4 Constructed of materials that will not absorb or trap hazardous quantities of flammable fluids that could be ignited by a surge or reverse-flow condition.

5.4.6 Induction system ducts that supply air to a cabin pressurization system must be suitably constructed of material that will not produce hazardous quantities of toxic gases or isolated to prevent hazardous quantities of toxic gases from entering the cabin during a powerplant fire.

5.5 *Induction System Screens:*

5.5.1 Each screen must be upstream of the carburetor or fuel injection system.

5.5.2 No screen may be in any part of the induction system that is the only passage through which air can reach the engine, unless the available heat rise is at least 56°C [100°F]; and the screen can be deiced by heated air.

5.5.3 No screen may be deiced by alcohol alone.

5.5.4 It must be impossible for fuel to strike any screen.

5.6 *Induction System Filters:*

5.6.1 If an air filter is used to protect the engine against foreign material particles in the induction air supply:

5.6.1.1 Each air filter must be capable of withstanding the effects of temperature extremes, rain, fuel, oil, and solvents to which it is expected to be exposed in service and maintenance; and

5.6.1.2 Each air filter shall have a design feature to prevent material separated from the filter media from interfering with proper fuel metering operation.

6. Powerplant Exhuast System

6.1 *General:*

6.1.1 Each exhaust system must ensure safe disposal of exhaust gases without fire hazard or carbon monoxide contamination in any personnel compartment.

6.1.2 Each exhaust system part with a surface hot enough to ignite flammable fluids or vapors must be located or shielded so that leakage from any system carrying flammable fluids or vapors will not result in a fire caused by impingement of the fluids or vapors on any part of the exhaust system including shields for the exhaust system.

6.1.3 Each exhaust system must be separated by fireproof shields from adjacent flammable parts of the airplane that are outside of the engine and auxiliary power unit compartments.

6.1.4 No exhaust gases may discharge dangerously near any fuel or oil system drain.

6.1.5 For aeroplanes certified for night operation no exhaust gases may be discharged where they will cause a glare seriously affecting pilot vision at night.

6.1.6 Each exhaust system component must be ventilated to prevent points of excessively high temperature.

6.1.7 If significant traps exist, each turbine engine and auxiliary power unit exhaust system must have drains discharging clear of the airplane, in any normal ground and flight attitude, to prevent fuel accumulation after the failure of an attempted engine or auxiliary power unit start.

6.1.8 Each exhaust heat exchanger must incorporate means to prevent blockage of the exhaust port after any internal heat exchanger failure.

6.2 *Exhaust System Construction:*

6.2.1 Each exhaust system must be fireproof and corrosion-resistant, and must have means to prevent failure due to expansion by operating temperatures.

6.2.2 The suitability and durability of materials used for any exhaust part must:

6.2.2.1 Be established by experience or tests;

6.2.2.2 Meet approved specifications that ensure their having the strength and other properties assumed in the design data; and

6.2.2.3 Take into account the effects of environmental conditions, such as temperature and humidity, expected in service.

6.2.3 Each exhaust system must be supported to withstand the vibration and inertia loads to which it may be subjected in operation.

6.2.4 Parts of the system connected to components between which relative motion could exist must have means for flexibility.

6.3 *Exhaust Heat Exchangers:*

6.3.1 Each exhaust heat exchanger must be constructed and installed to withstand the vibration, inertia, and other loads that it may be subjected to in normal operation.

6.3.2 Each exchanger must be suitable for continued operation at high temperatures and resistant to corrosion from exhaust gases.

6.3.3 There must be means for inspection of critical parts of each exchanger.

6.3.4 Each exchanger must have cooling provisions wherever it is subject to contact with exhaust gases.

6.3.5 Each heat exchanger used for heating ventilating air must be constructed so that exhaust gases may not enter the ventilating air.

6.4 *Induction Air Preheater Design:*

6.4.1 Each exhaust-heated, induction air preheater must be designed and constructed to:

6.4.1.1 Ensure ventilation of the preheater when the induction air preheater is not being used during engine operation;

6.4.1.2 Allow inspection of the exhaust manifold parts that it surrounds; and

6.4.1.3 Allow inspection of critical parts of the preheater itself.

7. Forced Air Induction and Bleed Air Systems

7.1 *Turbocharger Systems:*

7.1.1 Each turbocharger must either be approved under the engine type certificate or it must be shown that the turbocharger system, while in its normal engine installation and operating in the engine environment:

7.1.1.1 Can withstand, without defect, the endurance test specified by the standard to which compliance was shown for the engine; and

7.1.1.2 Will have no adverse effect upon the engine.

7.1.2 Control system malfunctions, vibrations, and abnormal speeds and temperatures expected in service may not damage the turbocharger compressor or turbine.

7.1.3 Each turbocharger case must be able to contain fragments of a compressor or turbine that fails at the highest speed that is obtainable with normal speed control devices inoperative.

7.1.4 Engine power, cooling characteristics, operating limits, and procedures affected by the turbocharger system installations must be evaluated.

7.1.5 Turbocharger operating procedures and limitations must be included in the Airplane Flight Manual.

7.2 *Intercooler Installation:*

7.2.1 The mounting provisions of the intercooler must be designed to withstand the loads imposed on the system.

7.2.2 It must be shown that, under the installed vibration environment, the intercooler will not fail in a manner allowing portions of the intercooler to be ingested by the engine.

7.2.3 Airflow through the intercooler must not discharge directly on any airplane component (for example, windshield) unless such discharge is shown to cause no hazard to the airplane under all operating conditions.

7.3 *Turbocharger Bleed Air System for Cabin Pressurization:*

7.3.1 The cabin air system may not be subject to hazardous contamination following any probable failure of the turbocharger or its lubrication system.

7.3.2 The turbocharger supply air must be taken from a source where it cannot be contaminated by harmful or hazardous gases or vapors following any probable failure or malfunction of the engine exhaust, hydraulic, fuel, or oil system.

7.4 *Turbine Engine Bleed Air System:*

7.4.1 No hazard may result if duct rupture or failure occurs anywhere between the engine port and the airplane unit served by the bleed air.

7.4.2 The effect on airplane and engine performance of using maximum bleed air must be established.

7.4.3 Hazardous contamination of cabin air systems may not result from failures of the engine lubricating system.

8. Oil System

8.1 *General:*

8.1.1 For oil systems and components that have been approved under the engine airworthiness requirements and where those requirements are equal to or more severe than the corresponding requirements of this standard, that approval need not be duplicated. Where the requirements of this standard are more severe, substantiation must be shown to the requirements of this standard.

8.1.2 Each powerplant oil system must be independent and capable of supplying the powerplant with an appropriate quantity of oil at a temperature not above that safe for continuous operation.

8.1.3 Each oil system must have a usable capacity adequate for the endurance of the aeroplane.

8.1.3.1 The usable oil tank capacity may not be less than the product of the endurance of the airplane under critical operating conditions and the maximum oil consumption of the engine under the same conditions, plus a suitable margin to ensure adequate circulation and cooling.

8.1.4 For an oil system without an oil transfer system, only the usable oil tank capacity may be considered. The amount of oil in the engine oil lines, the oil radiator, and the feathering reserve, may not be considered.

8.1.5 If an oil transfer system is used, and the transfer pump can pump some of the oil in the transfer lines into the main engine oil tanks, the amount of oil in these lines that can be pumped by the transfer pump may be included in the oil capacity.

8.1.6 Each oil system line must comply with 11.1.

8.1.7 If an engine depends upon a fuel/oil mixture for lubrication, then a reliable means of providing it with the appropriate mixture must be established.

8.1.7.1 In assessing the reliance that can be placed upon the means for providing the appropriate fuel/oil mixture to the engine to prevent a hazardous condition, account should be taken of, for example:

(a) The tolerance of the engine to fuel/oil mixture ratios other than the optimum;

(b) The procedure established for refuelling and introducing the appropriate amount of oil; and

(c) The means by which the pilot may check that the fuel contains an adequate mixture of oil.

8.2 *Oil Tanks:*

8.2.1 *Installation:*

8.2.1.1 Each oil tank must be installed to withstand any vibration, inertia, and fluid loads expected in operation.

8.2.1.2 Each oil tank must be supported so that tank loads are not concentrated.

8.2.1.3 There must be pads, if necessary, to prevent chafing between each tank and its supports.

8.2.1.4 Padding must be non-absorbent or treated to prevent the absorption of oil.

8.2.1.5 A positive pressure must be maintained within the expansion space of each flexible oil tank under all conditions of operation except for a particular condition for which it is shown that a zero or negative pressure will not cause the bladder cell to collapse.

8.2.1.6 Siphoning of oil (other than minor spillage) or collapse of flexible oil tanks may not result from improper securing or loss of the oil filler cap.

8.2.1.7 Each tank compartment must be ventilated and drained to prevent the accumulation of flammable fluids or vapors. Each compartment adjacent to a tank that is an integral part of the airplane structure must also be ventilated and drained.

8.2.2 *Expansion Space*—Oil tank expansion space must be provided so that:

8.2.2.1 Each oil tank used with a reciprocating engine has an expansion space of not less than the greater of 10 % of the tank capacity or 1.9 L (0.5 gal), and each oil tank used with a turbine engine has an expansion space of not less than 10 % of the tank capacity.

8.2.2.2 It must be impossible to fill the expansion space inadvertently with the airplane in the normal ground attitude.

8.2.3 *Filler Connection:*

8.2.3.1 Each oil tank filler connection must be marked.

8.2.3.2 Each recessed oil tank filler connection of an oil tank used with a turbine engine, that can retain any appreciable quantity of oil, must have provisions for fitting a drain.

8.2.3.3 Each oil tank filler cap of an oil tank that is used with an engine must provide an oil-tight seal.

8.2.4 *Vent*—Oil tanks must be vented as follows:

8.2.4.1 Each oil tank must be vented to the engine from the top part of the expansion space so that the vent connection is not covered by oil under any normal flight condition.

8.2.4.2 Oil tank vents must be arranged so that condensed water vapor that might freeze and obstruct the line cannot accumulate at any point.

8.2.4.3 For aeroplanes approved for aerobatics, there must be means to prevent hazardous loss of oil during acrobatic maneuvers, including short periods of inverted flight.

NOTE 1—For guidance on negative acceleration refer to AC 23-8.

8.2.5 *Outlet*—No oil tank outlet may be enclosed by any screen or guard that would reduce the flow of oil below a safe value at any operating temperature.

8.2.5.1 No oil tank outlet diameter may be less than the diameter of the engine oil pump inlet.

8.2.5.2 Each oil tank used with a turbine engine must have means to prevent entrance into the tank itself, or into the tank outlet, of any object that might obstruct the flow of oil through the system.

8.2.5.3 There must be a shutoff valve at the outlet of each oil tank used with a turbine engine, unless the external portion of the oil system (including oil tank supports) is fireproof.

8.2.6 *Flexible Liners:*

8.2.6.1 The flexible oil tank liner must be supported so that it is not required to withstand fluid loads.

8.2.6.2 Each flexible oil tank liner must be of an acceptable kind.

8.2.6.3 One of the following must be complied with:

(a) Interior surfaces adjacent to the liner must be smooth and free from projections that could cause wear; or

(b) Provisions are made for protection of the liner at those points; or

(c) The construction of the liner itself provides such protection.

8.2.7 Each oil tank must be tested under Section 12.

8.3 *Breather Lines:*

8.3.1 Breather lines must be arranged so that:

8.3.1.1 Condensed water vapor or oil that might freeze and obstruct the line cannot accumulate at any point.

8.3.1.2 The breather discharge will not constitute a fire hazard if foaming occurs, or cause emitted oil to strike the pilot's windshield.

8.3.1.3 The breather does not discharge into the engine air induction system.

8.3.1.4 For aeroplanes approved for acrobatics, there is no excessive loss of oil from the breather during acrobatic maneuvers, including short periods of inverted flight.

NOTE 2—For guidance on negative acceleration refer to AC 23-8.

8.3.1.5 The breather outlet is protected against blockage by ice or foreign matter.

8.4 *Oil Strainer or Filter:*

8.4.1 Each turbine engine installation must incorporate an oil strainer or filter through which all of the engine oil flows and which meets the following requirements:

8.4.1.1 Each oil strainer or filter that has a bypass, must be constructed and installed so that oil will flow at the normal rate through the rest of the system with the strainer or filter completely blocked.

8.4.1.2 The oil strainer or filter must have the capacity (with respect to operating limitations established for the engine) to ensure that engine oil system function is not impaired when the oil is contaminated to a degree (with respect to particle size and density) that is greater than that established for the engine for its type certification.

8.4.1.3 The oil strainer or filter, unless it is installed at an oil tank outlet, must incorporate a means to indicate contamination before it reaches the capacity established in accordance with 8.4.1.2.

8.4.1.4 The bypass of a strainer or filter must be constructed and installed so that the release of collected contaminants is minimized by appropriate location of the bypass to ensure that collected contaminants are not in the bypass flow path.

8.4.1.5 An oil strainer or filter that has no bypass, except one that is installed at an oil tank outlet, must have a means to warn the pilot of the occurrence of contamination of the strainer or filter screen before it reaches the capacity established in accordance with 8.4.1.2.

8.4.2 Each oil strainer or filter in a powerplant installation using reciprocating engines must be constructed and installed so that oil will flow at the normal rate through the rest of the system with the strainer or filter element completely blocked.

8.5 *Oil System Drains:*

8.5.1 A drain [or drains] must be provided to allow safe drainage of the oil system.

8.5.2 Each drain must:

8.5.2.1 Be accessible;

8.5.2.2 Have drain valves, or other closures, employing manual or automatic shut-off means for positive locking in the closed position; and

8.5.2.3 Be located or protected to prevent inadvertent operation.

8.6 *Oil Radiators*—Each oil radiator and its supporting structures must be able to withstand the vibration, inertia, and oil pressure loads to which it would be subjected in operation.

9. Liquid Cooling

9.1 *General:*

9.1.1 Each liquid-cooled engine must have an independent cooling system (including coolant tank).

9.1.2 Each coolant tank must be supported so that tank loads are distributed over a large part of the tank surface.

9.1.3 There must be pads or other isolation means between the tank and its supports to prevent chafing.

9.1.4 Pads or any other isolation means, that is used, must be nonabsorbent or must be treated to prevent absorption of flammable fluids.

9.1.5 No air or vapor can be trapped in any part of the system, except the coolant tank expansion space, during filling or during operation.

9.1.6 For aeroplanes approved for aerobatics, the liquid cooling system must be able to function properly during all aerobatic flight maneuvres for which the aeroplane shall be certified.

9.1.7 Each coolant line must comply with 11.1.

9.2 *Coolant Tank:*

9.2.1 The tank capacity must be sufficient for all conditions of operation.

9.2.1.1 If it is not shown that a smaller tank capacity is sufficient, the tank capacity must be at least 3.8 L (1 US gal), plus 10 % of the cooling system capacity.

9.2.2 Each coolant tank must be able to withstand the vibration, inertia, and fluid loads to which it may be subjected in operation.

9.2.3 Each coolant tank must have an expansion space of at least 10 % of the total cooling system capacity.

9.2.4 It must be impossible to fill the expansion space inadvertently with the airplane in the normal ground attitude.

9.2.5 Each coolant tank must be tested under Section 12.

9.3 *Filler Connection:*

9.3.1 Each coolant tank filler connection must be marked.

9.3.2 Spilled coolant must be prevented from entering the coolant tank compartment or any part of the airplane other than the tank itself.

9.3.3 Each recessed coolant filler connection must have a drain that discharges clear of the entire airplane.

9.4 *Radiators:*

9.4.1 Each coolant radiator must be able to withstand any vibration, inertia, and coolant pressure load to which it may normally be subjected.

9.4.2 Each radiator must be supported to allow expansion due to operating temperatures and prevent the transmittal of harmful vibration to the radiator.

9.4.3 If flammable coolant is used, the air intake duct to the coolant radiator must be located so that (in case of fire) flames from the nacelle cannot strike the radiator.

9.5 *Drains:*

9.5.1 It must be possible to drain the entire cooling system (including the coolant tank, radiator, and the engine) when the airplane is in the normal ground attitude.

9.5.2 Each drain must discharge clear of the entire airplane.

9.5.3 Each drain must have means to positively lock it closed.

10. Turbojet and Turbofan Reversing Systems

10.1 Each system intended for ground operation only must be designed so that, during any reversal in flight, the engine will produce no more than flight idle thrust.

10.2 It must be shown by analysis or test, or both, that:

10.2.1 Each operable reverser can be restored to the forward thrust position; or

10.2.2 The airplane is capable of continued safe flight and landing under any possible position of the thrust reverser.

10.3 Each system intended for inflight use must be designed so that no unsafe condition will result during normal operation of the system, or from any failure, or likely combination of failures, of the reversing system under any operating condition including ground operation.

10.3.1 Failure of structural elements need not be considered if the probability of this kind of failure is extremely remote.

10.4 Each system must have a means to prevent the engine from producing more than idle thrust when the reversing system malfunctions; except that it may produce any greater thrust that is shown to allow directional control to be maintained, with aerodynamic means alone, under the most critical reversing condition expected in operation.

10.5 Thrust reverser systems must meet the requirements of:

10.5.1 Sec. 33.97 of 14 CFR part 33; or

10.5.2 CS-E 650 and CS-E 890; or

10.5.3 It must be demonstrated by tests that engine operation and vibratory levels are not affected.

11. Powerplant Accessories & Components

11.1 *Fluid System Lines and Fittings:*

11.1.1 Each fluid line must be installed and supported to prevent excessive vibration and to withstand loads due to fluid pressure and accelerated flight conditions.

11.1.2 Each fluid line connected to components of the airplane between which relative motion could exist must have provisions for flexibility.

11.1.3 Each flexible connection in fluid lines that may be under pressure and subjected to axial loading must use flexible hose assemblies.

11.1.4 Each flexible hose must be shown to be suitable for the particular application.

11.1.5 No flexible hose that might be adversely affected by exposure to high temperatures may be used where excessive temperatures will exist during operation or after engine shutdown.

11.1.6 Each oil line must accommodate a flow of oil at a rate and pressure adequate for proper engine functioning under any normal operating condition.

11.1.7 The inside diameter of the engine coolant inlet and outlet lines may not be less than the diameter of the corresponding engine inlet and outlet connections.

11.1.8 Each instrument line carrying flammable fluids under pressure must:

11.1.8.1 Have restricting orifices or other safety devices at the source of pressure to prevent the escape of excessive fluid if the line fails; and

11.1.8.2 Be installed and located so that the escape of fluids would not create a hazard.

11.2 *Powerplant Accessories:*

11.2.1 Each engine mounted accessory must:

11.2.1.1 Be approved for mounting on the engine involved and use the provisions on the engines for mounting; or have torque limiting means on all accessory drives in order to prevent the torque limits established for those drives from being exceeded; or

11.2.1.2 Be sealed to prevent contamination of the engine oil system and the accessory system.

11.2.2 If the continued rotation of any accessory remotely driven by the engine is hazardous when malfunctioning occurs, a means to prevent rotation without interfering with the continued operation of the engine must be provided.

11.2.3 Each accessory driven by a gearbox that is not approved as part of the engine driving the gearbox must:

11.2.3.1 Have torque limiting means to prevent the torque limits established for the affected drive from being exceeded;

11.2.3.2 Use the provisions on the gearbox for mounting; and

11.2.3.3 Be sealed to prevent contamination of the gearbox oil system and the accessory system.

11.3 *Engine Ignition System:*

11.3.1 Each battery ignition system must be supplemented by an alternate source of electrical energy that is automatically available as to allow continued engine operation if any battery becomes depleted.

11.3.1.1 A generator is considered an alternate source of electrical energy that is automatically available.

11.3.2 The capacity of batteries and generators must be large enough to meet the simultaneous demands of the engine ignition system and the greatest demands of any electrical system components that draw from the same source.

11.3.3 The design of the engine ignition system must account for:

11.3.3.1 The condition of an inoperative generator;

11.3.3.2 The condition of a completely depleted battery with the generator running at its normal operating speed; and

11.3.3.3 The condition of a completely depleted battery with the generator operating at idling speed, if there is only one battery.

11.3.4 There must be means to warn appropriate crewmembers if malfunctioning of any part of the electrical system is causing the continuous discharge of any battery used for engine ignition.

11.3.5 Each turbine engine ignition system must be independent of any electrical circuit that is not used for assisting, controlling, or analyzing the operation of that system.

11.3.6 In addition, for level 4 aeroplanes, each turbine engine ignition system must be an essential electrical load.

11.4 *Cowlings:*

11.4.1 Each cowling must be constructed and supported so that it can resist any vibration, inertia, and air loads to which it may be subjected in operation.

11.5 *Carburetor Deicing Fluid System:*

11.5.1 Each carburetor deicing fluid system must meet the applicable requirements for the design of a fuel system.

11.5.2 Each carburetor deicing fluid system must be able to simultaneously supply each engine with a minimum rate of fluid flow, *FF*:

$$FF = K^* \sqrt{P_{MC}} \tag{1}$$

where:

FF = fluid flow in pounds/hour or kg/hour,
K = 2.5 if FF is calculated in pounds/hour and P_{MC} is given in horse power,
K = 1.3 if FF is calculated in kg/hour and P_{MC} is given in kilowatts, and
P_{MC} = maximum continuous power of the engine given in kilowatts or horse power.

11.5.3 The fluid must be introduced into the air induction system:

11.5.3.1 Close to, and upstream of, the carburetor; and

11.5.3.2 So that it is equally distributed over the entire cross section of the induction system air passages.

11.5.4 The capacity of each carburetor deicing fluid system:

11.5.4.1 May not be less than the greater of that required to provide fluid at the rate specified in 11.5.2 for a time equal to 3 % of the maximum endurance of the airplane; or 20 min at that flow rate;

11.5.4.2 Need not exceed that required for 2 h of operation; and

11.5.4.3 May be decreased in proportion to the heat rise available in excess of 28°C [50°F], if the available heat rise exceeds 28°C [50°F], but is less than 56°C [100°F].

12. Tank Tests

12.1 *Tank tests:*

12.1.1 Each tank must be able to withstand these pressures without failure or leakage.

12.1.1.1 For each conventional metal tank and non-metallic tank with walls not supported by the airplane structure:

(a) For oil tanks 34 kPa [5 psi]; or

(b) For pressurized oil tanks used with a turbine engine, not less than 34 kPa [5 psi] plus the maximum operating pressure of the tank; or

(c) For coolant tanks the sum of the pressure developed during the maximum ultimate acceleration with a full tank or a pressure of 24 kPa [3.5 psi], whichever is greater, plus the maximum working pressure of the system.

12.1.1.2 For each integral tank, the pressure developed during the maximum limit acceleration of the airplane with a full tank, with simultaneous application of the critical limit structural loads.

12.1.1.3 For each non-metallic tank with walls supported by the airplane structure and constructed in an acceptable manner using acceptable basic tank material, and with actual or simulated support conditions, a pressure of 34 kPa [5 psi] for the first tank of a specific design. The supporting structure must be designed for the critical loads occurring in the flight or landing strength conditions combined with the fluid pressure loads resulting from the corresponding accelerations.

12.2 *Vibration Test:*

12.2.1 Each tank with large, unsupported, or unstiffened flat surfaces, whose failure or deformation could cause leakage, must be able to withstand the vibration test specified in 12.2.3.4 without leakage, failure or excessive deformation of the tank walls.

12.2.2 Each integral tank using methods of construction and sealing not previously proven to be adequate by test data or service experience must be able to withstand the vibration test specified in 12.2.3.

12.2.3 *Test Setup and Procedure:*

12.2.3.1 Each complete tank assembly and its support must be vibration tested while mounted to simulate the actual installation.

12.2.3.2 Except as specified in 12.2.3.4, the tank assembly must be vibrated for 25 h at a total displacement of not less than 0.8 mm [1⁄32 in.] (unless another displacement is substantiated) while 2⁄3 filled with water or other suitable test fluid.

12.2.3.3 The test frequency of vibration must be as specified in 12.2.4.

12.2.3.4 Under 12.2.4.2 and 12.2.4.3, the time of test must be adjusted to accomplish the same number of vibration cycles that would be accomplished in 25 h at the frequency specified in 12.2.4.1.

12.2.3.5 During the test, the tank assembly must be rocked at a rate of 16 to 20 complete cycles per minute, through an angle of 15° on either side of the horizontal (30° total), about an axis parallel to the axis of the fuselage, for 25 h.

12.2.4 *Vibration Test Frequency:*

12.2.4.1 If no frequency of vibration resulting from any rpm within the normal operating range of engine or propeller speeds is critical, the test frequency of vibration is:

(a) The number of cycles per minute obtained by multiplying the maximum continuous propeller speed in rpm by 0.9 for propeller-driven aeroplanes, and

(b) For non-propeller driven aeroplanes the test frequency of vibration is 2000 cycles per minute.

12.2.4.2 If only one frequency of vibration resulting from any rpm within the normal operating range of engine or propeller speeds is critical, that frequency of vibration must be the test frequency.

12.2.4.3 If more than one frequency of vibration resulting from any rpm within the normal operating range of engine or propeller speeds is critical, the most critical of these frequencies must be the test frequency.

12.3 *Tank Sloshing Test:*

12.3.1 Each tank with a non-metallic liner must be subjected to the sloshing test with the fluid at room temperature.

12.3.1.1 A specimen liner of the same basic construction as that to be used in the airplane must, when installed in a suitable test tank, withstand the sloshing test outlined in 12.2.3.5 with:

(a) Oil at 121°C [250°F] for oil tanks; and

(b) The coolant at operating temperature for coolant tanks.

APPENDIXES

(Nonmandatory Information)

X1. CORRESPONDING SPECIFICATIONS

X1.1 This appendix lists specifications that have been evaluated by the subcommittee and are accepted as corresponding to the referenced specifications.

X1.2 There may be other corresponding specifications which have not been evaluated by the subcommittee.

X1.3 Airworthiness Codes referencing to or citing the specifications listed in Table X1.1 as a whole are considered corresponding.

TABLE X1.1 Corresponding Specifications

Referenced Specification	Corresponding Specifications
14 CFR part 33	CAR 13, CS-E, JAR-E
CS 22 Subpart H	JAR 22 Subpart H, ASTM F2339, ASTM F2538, ASTM F2840
14 CFR part 35	CS-P, JAR-P
CS 22 Subpart J	JAR 22 Subpart J, ASTM F2506
TSO C77	CS-APU
14 CFR part 34	Volume II of Annex 16 to the Chicago Convention, CS-34

X2. SUMMARY AND RATIONALE FOR CHANGES

X2.1 Summary of Changes for Revision F3062/F3062M – 16

X2.1.1 *Section 4.2.1*—"Applicable" added to add clarification because use of the word "and" could be misinterpreted as only applying if all three items are present. Adding applicable clarifies the intent.

X2.1.2 *Section 5.2.1*—Wording improved.

X2.1.3 Sections 5.3.1 and 5.3.2 amended by replacing the term "hazardous quantity" with the guidance given in AC 23-16A on section 23.1091(c).

X2.1.4 *Section 5.3.4 and 5.3.5*—Section 5.3.4 amended and 5.3.5 deleted to harmonize the difference between the engine ingestion requirements of paragraph 23.901(d)(2) of CS-23 amendment 4 and 14 CFR Part 23 Amendment 62.

X2.1.5 Section 5.5.2 and 11.5.4.3 revised by replacing "preheat" by "heat rise" to clarify that the listed temperatures are temperature differences.

X2.1.6 *Section 11.5.2*—Text formula in 11.5.2 replaced by explicit formula.