APPENDIX A TO PART 135—ADDITIONAL AIRWORTHINESS STANDARDS FOR 10 OR MORE PASSENGER AIRPLANES

Applicability

1. Applicability. This appendix prescribes the additional airworthiness standards required by §135.169.

2. References. Unless otherwise provided, references in this appendix to specific sections of part 23 of the Federal Aviation Regulations (FAR part 23) are to those sections of part 23 in effect on March 30, 1967.

Flight Requirements

3. General. Compliance must be shown with the applicable requirements of subpart B of FAR part 23, as supplemented or modified in §§4 through 10.

Performance

4. General. (a) Unless otherwise prescribed in this appendix, compliance with each applicable performance requirement in sections 4 through 7 must be shown for ambient atmospheric conditions and still air.

(b) The performance must correspond to the propulsive thrust available under the particular ambient atmospheric conditions and the particular flight condition. The available propulsive thrust must correspond to engine power or thrust, not exceeding the approved power or thrust less—

(1) Installation losses; and

(2) The power or equivalent thrust absorbed by the accessories and services appropriate to the particular ambient atmospheric conditions and the particular flight condition.

(c) Unless otherwise prescribed in this appendix, the applicant must select the takeoff configuration for the airplane.

(d) The airplane configuration may vary with weight, altitude, and temperature, to the extent they are compatible with the operating procedures required by paragraph (e) of this section.

(e) Unless otherwise prescribed in this appendix, in determining the critical engine inoperative takeoff performance, the accelerate-stop distance, takeoff distance, changes in the airplane’s configuration, speed, power, and thrust must be made under procedures established by the applicant for operation in service.

(f) Procedures for the execution of balked landings must be established by the applicant and included in the Airplane Flight Manual.

(g) The procedures established under paragraphs (e) and (f) of this section must—

(1) Be able to be consistently executed in service by a crew of average skill;

(2) Use methods or devices that are safe and reliable; and

(3) Include allowance for any time delays, in the execution of the procedures, that may reasonably be expected in service.

5. Takeoff. (a) General. Takeoff speeds, the accelerate-stop distance, the takeoff distance, and the one-engine-inoperative takeoff flight path data (described in paragraphs (b), (c), (d), and (f) of this section), must be determined for—

(1) Each weight, altitude, and ambient temperature within the operational limits selected by the applicant;

(2) The selected configuration for takeoff;

(3) The center of gravity in the most unfavorable position;

(4) The operating engine within approved operating limitations; and

(5) Takeoff data based on smooth, dry, hard-surface runway.

(b) Takeoff speeds. (1) The decision speed \( V_{1} \) is the calibrated airspeed on the ground at which, as a result of engine failure or other reasons, the pilot is assumed to have made a decision to continue or discontinue the takeoff. The speed \( V_{1} \) must be selected by the applicant but may not be less than—

(i) \( 1.10 V_{MC} \);

(ii) \( 1.10 V_{IEC} \);

(iii) \( 1.05 \) if \( V_{1} \) is less than 

(1) \( 1.2 V_{1,St} \), or

(2) \( 1.2 V_{1,St} \), and

(3) Other essential take off speeds necessary for safe operation of the airplane.

(c) Accelerate-stop distance. (1) The accelerate-stop distance is the sum of the distances necessary to—

(i) Accelerate the airplane from a standing start to \( V_{1} \) and

(ii) Come to a full stop from the point at which \( V_{1} \) is reached assuming that in the case of engine failure, failure of the critical engine is recognized by the pilot at the speed \( V_{1} \).

(2) Means other than wheel brakes may be used to determine the accelerate-stop distance if that means is available with the critical engine inoperative and—

(i) Is safe and reliable;

(ii) Is used so that consistent results can be expected under normal operating conditions; and

(iii) Is such that exceptional skill is not required to control the airplane.

(d) All engines operating takeoff distance. The all engine operating takeoff distance is the horizontal distance required to takeoff and climb to a height of 50 feet above the
takeoff surface under the procedures in FAR 23.51(a).

(e) One-engine-inoperative takeoff. Determine the weight for each altitude and temperature within the operational limits established for the airplane, at which the airplane has the capability, after failure of the critical engine at \( V_1 \) determined under paragraph (b) of this section, to take off and climb at not less than \( V_2 \), to a height 1,000 feet above the takeoff surface and attain the speed and configuration at which compliance is shown with the en route one-engine-inoperative gradient of climb specified in section 6(c).

(1) One-engine-inoperative takeoff flight path data. The one-engine-inoperative takeoff flight path data consist of takeoff flight paths extending from a standing start to a point in the takeoff at which the airplane reaches a height 1,000 feet above the takeoff surface under paragraph (e) of this section.

6. Climb. (a) Landing climb: All-engines-operating. The maximum weight must be determined with the airplane in the landing configuration, for each altitude, and ambient temperature within the operational limits established for the airplane, with the most unfavorable center of gravity, and out-of-ground effect in free air, at which the steady gradient of climb will not be less than 3.3 percent, with:

(1) The engines at the power that is available 8 seconds after initiation of movement of the power or thrust controls from the minimum flight idle to the takeoff position.

(2) A climb speed not greater than the approach speed established under section 7 and not less than the greater of 1.05\( V_{MC} \) or 1.10\( V_{SO} \).

(b) Takeoff climb: one-engine-inoperative. The maximum weight at which the airplane meets the minimum climb performance specified in paragraphs (1) and (2) of this paragraph must be determined for each altitude and ambient temperature within the operational limits established for the airplane, out of ground effect in free air, with the airplane in the takeoff configuration, with the most unfavorable center of gravity, the critical engine inoperative, the remaining engines at the power or thrust, and the propeller of the inoperative engine windmilling with the propeller controls in the normal position except that, if an approved automatic feathering system is installed, the propellers may be in the feathered position:

(1) Takeoff: landing gear extended. The minimum steady gradient of climb must be measurably positive at the speed \( V_1 \).

(2) Takeoff: landing gear retracted. The minimum steady gradient of climb may not be less than 2 percent at speed \( V_2 \). For airplanes with fixed landing gear this requirement must be met with the landing gear extended.
(2) Wing flaps retracted;
(3) The maximum cruising power as selected by the applicant as an operating limitation for turbine engines or 75 percent of maximum continuous power for reciprocating engines except that the power need not exceed that required at \( V_{MO}/M_{MO} \);
(4) Maximum takeoff weight; and
(5) The airplane trimmed for level flight with the power specified in paragraph (3) of this paragraph.

\( V_{FC}/M_{FC} \) may not be less than a speed midway between \( V_{MO}/M_{MO} \) and \( V_{NE}/M_{NE} \) except that, for altitudes where Mach number is the limiting factor, \( M_{FC} \) need not exceed the Mach number at which effective speed warning occurs.

(c) Climb stability (turbopropeller powered airplanes only). In showing compliance with FAR 23.175(a), an applicant must, instead of the power specified in FAR 23.175(a)(4), use the maximum power or thrust selected by the applicant as an operating limitation for use during climb at the best rate of climb speed, except that the speed need not be less than \( 1.4V_{FC} \).

5. Stall warning. If artificial stall warning is required to comply with FAR 23.207, the warning device must give clearly distinguishable indications under expected conditions of flight. The use of a visual warning device that requires the attention of the crew within the cockpit is not acceptable by itself.

Central Systems

11. Electric trim tabs. The airplane must meet FAR 23.677 and in addition it must be shown that the airplane is safely controllable and that a pilot can perform all the maneuvers and operations necessary to effect a safe landing following any probable electric trim tab runaway which might be reasonably expected in service allowing for appropriate time delay after pilot recognition of the runaway. This demonstration must be conducted at the critical airplane weights and center of gravity positions.

Instruments: Installation

12. Arrangement and visibility. Each instrument must meet FAR 23.1321 and in addition:
(a) Each flight, navigation, and powerplant instrument for use by any pilot must be plainly visible to the pilot from the pilot’s station with the minimum practicable deviation from the pilot’s normal position and line of vision when the pilot is looking forward along the flight path.
(b) The flight instruments required by FAR 23.1303 and by the applicable operating rules must be grouped on the instrument panel and centered as nearly as practicable about the vertical plane of each pilot’s forward vision. In addition—
(1) The instrument that most effectively indicates the attitude must be in the panel in the top center position;
(2) The instrument that most effectively indicates the airspeed must be on the panel directly to the left of the instrument in the top center position;
(3) The instrument that most effectively indicates altitude must be adjacent to and directly to the right of the instrument in the top center position; and
(4) The instrument that most effectively indicates direction of flight must be adjacent to and directly below the instrument in the top center position.

13. Airspeed indicating system. Each airspeed indicating system must meet FAR 23.1323 and in addition:
(a) Airspeed indicating instruments must be of an approved type and must be calibrated to indicate true airspeed at sea level in the standard atmosphere with a minimum practicable instrument calibration error when the corresponding pitot and static pressures are supplied to the instruments.
(b) The airspeed indicating system must be calibrated to determine the system error, i.e., the relation between IAS and CAS, in flight and during the accelerate-takeoff ground run. The ground run calibration must be obtained between 0.8 of the minimum value of \( V_{T} \) and 1.2 times the maximum value of \( V_{C} \), considering the approved ranges of altitude and weight. The ground run calibration is determined assuming an engine failure at the minimum value of \( V_{T} \).
(c) The airspeed error of the installation excluding the instrument calibration error, must not exceed 3 percent or 5 knots whichever is greater, throughout the speed range from \( V_{MO} \) to 1.3\( V_{C} \), with flaps retracted and from 1.3\( V_{MO} \) to \( V_{FC} \), with flaps in the landing position.
(d) Information showing the relationship between IAS and CAS must be shown in the Airplane Flight manual.

14. Static air vent system. The static air vent system must meet FAR 23.1325. The altimeter system calibration must be determined and shown in the Airplane Flight Manual.

Operating Limitations and Information

15. Maximum operating limit speed \( V_{MO}/M_{MO} \). Instead of establishing operating limitations based on \( V_{NE} \) and \( V_{MO} \) the applicant must establish a maximum operating limit speed \( V_{MO}/M_{MO} \) as follows:
(a) The maximum operating limit speed must not exceed the design cruising speed \( V_{C} \) and must be sufficiently below \( V_{MO}/M_{MO} \) to make it highly improbable that the latter speeds will be inadvertently exceeded in flight.
takeoff runway length within the range of weights between the maximum landing weight and takeoff weight limits specified in section 19(b).

20. Performance information. The Airplane Flight Manual must contain the performance information determined under the performance requirements of this appendix. The information must include the following:

(a) Sufficient information so that the takeoff weight limits specified in section 19(b) can be determined for all temperatures and altitudes within the operation limitations selected by the applicant.

(b) The conditions under which the performance information was obtained, including the airspeed at the 50-foot height used to determine landing distances.

(c) The performance information (determined by extrapolation and computed for the range of weights between the maximum landing and takeoff weights) for—

1. Climb in the landing configuration; and
2. Landing distance.

(d) Procedure established under section 4 related to the limitations and information required by this section in the form of guidance material including any relevant limitations or information.

(e) An explanation of significant or unusual flight or ground handling characteristics of the airplane.

(f) Airspeeds, as indicated airspeeds, corresponding to those determined for takeoff under section 5(b).

21. Maximum operating altitudes. The maximum operating altitude to which operation is allowed, as limited by flight, structural, powerplant, functional, or equipment characteristics, must be specified in the Airplane Flight Manual.

22. Stowage provision for airplane flight manual. Provision must be made for stowing the Airplane Flight Manual in a suitable fixed
container which is readily accessible to the pilot.


Airframe Requirements

Flight Loads

24. Engine torque. (a) Each turbopropeller engine mount and its supporting structure must be designed for the torque effects of:
   (1) The conditions in FAR 23.361(a).
   (2) The limit engine torque corresponding to takeoff power and propeller speed multiplied by a factor accounting for propeller control system malfunction, including quick feathering action, simultaneously with 1g level flight loads. In the absence of a rational analysis, a factor of 1.6 must be used.
   (b) The limit torque is obtained by multiplying the mean torque by a factor of 1.25.

25. Turbine engine gyroscopic loads. Each turbopropeller engine mount and its supporting structure must be designed for the gyroscopic loads that result, with the engines at maximum continuous r.p.m., under either—
   (a) The conditions in FARs 23.351 and 23.423; or
   (b) All possible combinations of the following:
      (1) A yaw velocity of 2.5 radians per second.
      (2) A pitch velocity of 1.0 radians per second.
      (3) A normal load factor of 2.5.
      (4) Maximum continuous thrust.

   (a) Turbopropeller powered airplanes must be designed for the unsymmetrical loads resulting from a single malfunction of the propeller drag limiting system, considering the probable pilot corrective action on the flight controls:
      (1) At speeds between $V_{mo}$ and $V_a$, the loads resulting from power failure because of fuel flow interruption are considered to be limit loads.
      (2) At speeds between $V_{mo}$ and $V$, the loads resulting from the disconnection of the engine compressor from the turbine or from loss of the turbine blades are considered to be ultimate loads.
      (3) The time history of the thrust decay and drag buildup occurring as a result of the prescribed engine failures must be substantiated by test or other data applicable to the particular engine-propeller combination.
      (4) The timing and magnitude of the probable pilot corrective action must be conservatively estimated, considering the characteristics of the particular engine-propeller-airplane combination.
      (b) Pilot corrective action may be assumed to be initiated at the time maximum yawing velocity is reached, but not earlier than 2 seconds after the engine failure. The magnitude of the corrective action may be based on the control forces in FAR 23.397 except that lower forces may be assumed where it is shown by analysis or test that these forces can control the yaw and roll resulting from the prescribed engine failure conditions.

Ground Loads

27. Dual wheel landing gear units. Each dual wheel landing gear unit and its supporting structure must be shown to comply with the following:
   (a) Pivoting. The airplane must be assumed to pivot about one side of the main gear with the brakes on that side locked. The limit vertical load factor must be 1.0 and the coefficient of friction 0.1. This condition need apply only to the main gear and its supporting structure.
   (b) Unequal tire inflation. A 60–40 percent distribution of the loads established under FAR 23.471 through FAR 23.483 must be applied to the dual wheels.
   (c) Flat tire. (1) Sixty percent of the loads in FAR 23.471 through FAR 23.483 must be applied to either wheel in a unit.
      (2) Sixty percent of the limit drag and side loads and 100 percent of the limit vertical load established under FARs 23.493 and 23.485 must be applied to either wheel in a unit except that the vertical load need not exceed the maximum vertical load in paragraph (c)(1) of this section.

Fatigue Evaluation

28. Fatigue evaluation of wing and associated structure. Unless it is shown that the structure, operating stress levels, materials and expected use are comparable from a fatigue standpoint to a similar design which has had substantial satisfactory service experience, the strength, detail design, and the fabrication of those parts of the wing, wing carry-through, and attaching structure whose failure would be catastrophic must be evaluated under either—
   (a) A fatigue strength investigation in which the structure is shown by analysis, tests, or both to be able to withstand the repeated loads of variable magnitude expected in service; or
   (b) A fail-safe strength investigation in which it is shown by analysis, tests, or both that catastrophic failure of the structure is not probable after fatigue, or obvious partial failure, of a principal structural element, and that the remaining structure is able to withstand a static ultimate load factor of 75 percent of the critical limit load factor at $V_c$. These loads must be multiplied by a factor of 1.15 unless the dynamic effects of failure under static load are otherwise considered.
Pt. 135, App. A

14 CFR Ch. I (1–1–11 Edition)

Design and Construction

29. Flutter. For multiengine turbopropeller-powered airplanes, a dynamic evaluation must be made and must include—
(a) The significant elastic, inertia, and aerodynamic forces associated with the rotations and displacements of the plane of the propeller; and
(b) Engine-propeller-nacelle stiffness and damping variations appropriate to the particular configuration.

Landing Gear

30. Flap operated landing gear warning device. Airplanes having retractable landing gear and wing flaps must be equipped with a warning device that functions continuously when the wing flaps are extended to a flap position that activates the warning device to give adequate warning before landing, using normal landing procedures, if the landing gear is not fully extended and locked. There may not be a manual shut off for this warning device. The flap position sensing unit may be installed at any suitable location. The system for this device may use any part of the system (including the aural warning device) provided for other landing gear warning devices.

Personnel and Cargo Accommodations

31. Cargo and baggage compartments. Cargo and baggage compartments must be designed to meet FAR 23.783 (a) and (b), and in addition means must be provided to protect passengers from injury by the contents of any cargo or baggage compartment when the ultimate forward inertia force is 9g.

32. Doors and exits. The airplane must meet FAR 23.783 and FAR 23.807 (a)(3), (b), and (c), and in addition:
(a) There must be a means to lock and safeguard each external door and exit against opening in flight either inadvertently by persons, or as a result of mechanical failure. Each external door must be operable from both the inside and the outside.
(b) There must be means for direct visual inspection of the locking mechanism by crewmembers to determine whether external doors and exits, for which the initial opening movement is outward, are fully locked. In addition, there must be a visual means to signal to crewmembers when normally used external doors are closed and fully locked.
(c) The passenger entrance door must qualify as a floor level emergency exit. Each additional required emergency exit except floor level exits must be located over the wing or must be provided with acceptable means to assist the occupants in descending to the ground. In addition to the passenger entrance door:
(1) For a total seating capacity of 15 or less, an emergency exit as defined in FAR 23.807(b) is required on each side of the cabin.
(2) For a total seating capacity of 16 through 23, three emergency exits as defined in FAR 23.807(b) are required with one on the same side as the door and two on the side opposite the door.
(d) An evacuation demonstration must be conducted utilizing the maximum number of occupants for which certification is desired. It must be conducted under simulated night conditions utilizing only the emergency exits on the most critical side of the aircraft. The participants must be representative of average airline passengers with no previous practice or rehearsal for the demonstration. Evacuation must be completed within 90 seconds.
(e) Each emergency exit must be marked with the word “Exit” by a sign which has white letters 1 inch high on a red background 2 inches high, self-illuminated or independently internally electrically illuminated, and have a minimum luminescence (brightness) of at least 160 microlamberts. The colors may be reversed if the passenger compartment illumination is essentially the same.
(f) Access to window type emergency exits must not be obstructed by seats or seat backs.
(g) The width of the main passenger aisle at any point between seats must equal or exceed the values in the following table:

<table>
<thead>
<tr>
<th>Total seating capacity</th>
<th>Minimum main passenger aisle width</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 through 23</td>
<td>9 inches</td>
</tr>
<tr>
<td>25 inches from floor</td>
<td>15 inches</td>
</tr>
</tbody>
</table>

Miscellaneous

33. Lightning strike protection. Parts that are electrically insulated from the basic airframe must be connected to it through lightning arrestors unless a lightning strike on the insulated part—
(a) Is improbable because of shielding by other parts; or
(b) Is not hazardous.
34. Ice protection. If certification with ice protection provisions is desired, compliance with the following must be shown:
(a) The recommended procedures for the use of the ice protection equipment must be set forth in the Airplane Flight Manual.
(b) An analysis must be performed to establish, on the basis of the airplane's operational needs, the adequacy of the ice protection system for the various components of the airplane. In addition, tests of the ice protection system must be conducted to demonstrate that the airplane is capable of operating safely in continuous maximum and intermittent maximum icing conditions as described in appendix C of part 25 of this chapter.
Federal Aviation Administration, DOT

(c) Compliance with all or portions of this section may be accomplished by reference, where applicable because of similarity of the designs, to analysis and tests performed by the applicant for a type certificated model.

35. Maintenance information. The applicant must make available to the owner at the time of delivery of the airplane the information the applicant considers essential for the proper maintenance of the airplane. That information must include the following:
   (a) Description of systems, including electrical, hydraulic, and fuel controls.
   (b) Lubrication instructions setting forth the frequency and the lubricants and fluids which are to be used in the various systems.
   (c) Pressures and electrical loads applicable to the various systems.
   (d) Tolerances and adjustments necessary for proper functioning.
   (e) Methods of leveling, raising, and towing.
   (f) Methods of balancing control surfaces.
   (g) Identification of primary and secondary structures.
   (h) Frequency and extent of inspections necessary to the proper operation of the airplane.
   (i) Special repair methods applicable to the airplane.
   (j) Special inspection techniques, such as X-ray, ultrasonic, and magnetic particle inspection.
   (k) List of special tools.

36. Vibration characteristics. For turbopropeller powered airplanes, the engine installation must not result in vibration characteristics of the engine exceeding those established during the type certification of the engine.

37. In flight restarting of engine. If the engine on turbopropeller powered airplanes cannot be restarted at the maximum cruise altitude, a determination must be made of the altitude below which restarts can be consistently accomplished. Restart information must be provided in the Airplane Flight Manual.

38. Engines. (a) For turbopropeller powered airplanes. The engine installation must comply with the following:
   (1) 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 of any system that can affect the engine, will not—
      (i) Require immediate action by any crewmember for continued safe operation.
      (ii) Prevent the continued safe operation of the remaining engines; or
   (2) Control of engine rotation. There must be a means to individually stop and restart the rotation of any engine in flight except that engine rotation need not be stopped if continued rotation could not jeopardize the safety of the airplane. Each component of the stopping and restarting system on the engine side of the firewall, and that might be exposed to fire, must be at least fire resistant. If hydraulic propeller feathering systems are used for this purpose, the feathering lines must be at least fire resistant under the operating conditions that may be expected to exist during feathering.
   (b) Turbopropeller reversing systems. (a) Turbopropeller reversing systems intended for ground operation must be designed so that no single failure or malfunction of any engine, or of any system that can affect that engine, will not—
      (1) Prevent the continued safe operation of the remaining engines; or
      (2) Require immediate action by any crewmember for continued safe operation.
      (3) Engine speed and gas temperature control devices. The powerplant systems associated with engine control devices, systems, and instrumentation must provide reasonable assurance that those engine operating limitations that adversely affect turbine rotor structural integrity will not be exceeded in service.
   (b) For reciprocating engine powered airplanes. To provide 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 of any system that can affect that engine, will not—
      (1) Prevent the continued safe operation of the remaining engines; or
      (2) Require immediate action by any crewmember for continued safe operation.

39. Turbopropeller reversing systems. (a) Turbopropeller reversing systems intended for in flight use must be designed so that no single failure or malfunction of the system will result in unwanted reverse thrust under any expected operating condition. Failure of structural elements need not be considered if the probability of this kind of failure is extremely remote.
   (b) Turbopropeller reversing systems intended for in flight use must be designed so that no single failure or malfunction of the system will result in unwanted reverse thrust under any expected operating condition. Failure of structural elements need not be considered if the probability of this kind of failure is extremely remote.
   (c) Compliance with this section may be shown by failure analysis, testing, or both for propeller systems that allow propeller blades to move from the flight low-pitch position to a position that is substantially less than that at the normal flight low-pitch stop position. The analysis may include or be supported by the analysis made to show compliance with the type certification of the propeller and associated installation components. Credit will be given for pertinent analysis and testing completed by the engine and propeller manufacturers.

40. Turbopropeller drag-limiting systems. Turbopropeller drag-limiting systems must be designed so that no single failure or malfunction of any of the systems during normal or
emergency operation results in propeller drag in excess of that for which the airplane was designed. Failure of structural elements of the drag-limiting systems need not be considered if the probability of this kind of failure is extremely remote.

41. **Turbine engine powerplant operating characteristics.** For turbopropeller powered airplanes, the turbine engine powerplant operating characteristics must be investigated in flight to determine that no adverse characteristics (such as stall, surge, or flameout) are present to a hazardous degree, during normal and emergency operation within the range of operating limitations of the airplane and of the engine.

42. **Fuel flow.** (a) For turbopropeller powered airplanes—

1. The fuel system must provide for continuous supply of fuel to the engines for normal operation without interruption due to depletion of fuel in any tank other than the main tank; and

2. The fuel flow rate for turbopropeller engine fuel pump systems must not be less than 125 percent of the fuel flow required to develop the standard sea level atmospheric conditions takeoff power selected and included as an operating limitation in the Airplane Flight Manual.

(b) For reciprocating engine powered airplanes, it is acceptable for the fuel flow rate for each pump system (main and reserve supply) to be 125 percent of the takeoff fuel consumption of the engine.

**Fuel System Components**

43. **Fuel pumps.** For turbopropeller powered airplanes, a reliable and independent power source must be provided for each pump used with turbine engines which do not have provisions for mechanically driving the main pumps. It must be demonstrated that the pump installations provide a reliability and durability equivalent to that in FAR 23.991(a).

44. **Fuel strainer or filter.** For turbopropeller powered airplanes, the following apply:

(a) There must be a fuel strainer or filter between the tank outlet and the fuel metering device of the engine. In addition, the fuel strainer or filter must be—

1. Between the tank outlet and the engine-driven positive displacement pump inlet, if there is an engine-driven positive displacement pump;

2. Accessible for drainage and cleaning and, for the strainer screen, easily removable; and

3. Mounted so that its weight is not supported by the connecting lines or by the inlet or outlet connections of the strainer or filter itself.

(b) Unless there are means in the fuel system to prevent the accumulation of ice on the filter, there must be means to automatically maintain the fuel-flow if ice-clogging of the filter occurs; and

(c) The fuel strainer or filter must be of adequate capacity (for operating limitations “stabilized” to ensure proper service) and of appropriate mesh to insure proper engine operation, with the fuel contaminated to a degree (for particle size and density) that can be reasonably expected in service. The degree of fuel filtering may not be less than that established for the engine type certification.

45. **Lightning strike protection.** Protection must be provided against the ignition of flammable vapors in the fuel vent system due to lightning strikes.

**Cooling**

46. **Cooling test procedures for turbopropeller powered airplanes.** (a) Turbopropeller powered airplanes must be shown to comply with FAR 23.1041 during takeoff, climb, en route, and landing stages of flight that correspond to the applicable performance requirements. The cooling tests must be conducted with the airplane in the configuration, and operating under the conditions that are critical relative to cooling during each stage of flight. For the cooling tests a temperature is “stabilized” when its rate of change is less than 2 °F per minute.

(b) Temperatures must be stabilized under the conditions from which entry is made into each stage of flight being investigated unless the entry condition is not one during which component and engine fluid temperatures would stabilize, in which case, operation through the full entry condition must be conducted before entry into the stage of flight being investigated to allow temperatures to reach their natural levels at the time of entry. The takeoff cooling test must be preceded by a period during which the powerplant component and engine fluid temperatures are stabilized with the engines at ground idle.

(c) Cooling tests for each stage of flight must be continued until—

1. The component and engine fluid temperatures stabilize;

2. The stage of flight is completed; or

3. An operating limitation is reached.

**Induction System**

47. **Air induction.** For turbopropeller powered airplanes—

(a) There must be means to prevent hazardous quantities of fuel leakage or overflow from drains, vents, or other components of flammable fluid systems from entering the engine intake systems; and

(b) The air inlet ducts must be located or protected so as to minimize the ingestion of foreign matter during takeoff, landing, and taxiing.
48. Induction system icing protection. For turbopropeller powered airplanes, each turbine engine must be able to operate throughout its flight power range without adverse effect on engine operation or serious loss of power or thrust, under the icing conditions specified in appendix C of part 25 of this chapter. In addition, there must be means to indicate to appropriate flight crewmembers the functioning of the powerplant ice protection system.

49. Turbine engine bleed air systems. Turbine engine bleed air systems of turbopropeller-powered airplanes must be investigated to determine—
   (a) That no hazard to the airplane will result if a duct rupture occurs. This condition must consider that a failure of the duct can occur anywhere between the engine port and the airplane bleed service; and
   (b) That, if the bleed air system is used for direct cabin pressurization, it is not possible for hazardous contamination of the cabin air system to occur in event of lubrication system failure.

50. Exhaust system drains. Turbopropeller engine exhaust systems having low spots or pockets must incorporate drains at those locations. These drains must discharge clear of the airplane in normal and ground attitudes to prevent the accumulation of fuel after the failure of an attempted engine start.

51. Engine controls. If throttles or power levers for turbopropeller powered airplanes are such that any position of these controls will reduce the fuel flow to the engine(s) below that necessary for satisfactory and safe idle operation of the engine while the airplane is in flight, a means must be provided to prevent inadvertent movement of the control into this position. The means provided must incorporate a positive lock or stop at this idle position and must require a separate and distinct operation by the crew to displace the control from the normal engine operating range.

52. Reverse thrust controls. For turbopropeller powered airplanes, the propeller reverse thrust controls must have a means to prevent their inadvertent operation. The means must have a positive lock or stop at the idle position and must require a separate and distinct operation by the crew to displace the control from the flight regime.

53. Engine ignition systems. Each turbopropeller airplane ignition system must be considered an essential electrical load.

54. Powerplant accessories. The powerplant accessories must meet FAR 23.1183, and if the continued rotation of any accessory remotely driven by the engine is hazardous when malfunctioning occurs, there must be means to prevent rotation without interfering with the continued operation of the engine.

55. Powerplant Fire Protection

(a) The following are required for turbopropeller powered airplanes:
   (1) The instruments required by FAR 25.1305 (a) (1) through (4), (b) (2) and (4).
   (2) A gas temperature indicator for each engine.
   (3) Free air temperature indicator.
   (4) A fuel flowmeter indicator for each engine.
   (5) Oil pressure warning means for each engine.
   (6) A torque indicator or adequate means for indicating power output for each engine.
   (7) Fire warning indicator for each engine.
   (8) A means to indicate when the propeller blade angle is below the low-pitch position corresponding to idle operation in flight.
   (9) A means to indicate the functioning of the ice protection system for each engine.

(b) For turbopropeller powered airplanes, the turbopropeller blade position indicator...
must begin indicating when the blade has moved below the flight low-pitch position.

c. The following instruments are required for reciprocating engine powered airplanes:

(1) The instruments required by FAR 23.1305.

(2) A cylinder head temperature indicator for each engine.

(3) A manifold pressure indicator for each engine.

59. Function and installation. The systems and equipment of the airplane must meet FAR 23.1301, and the following:

(a) Each item of additional installed equipment must—

(1) Be of a kind and design appropriate to its intended function;

(2) Be labeled as to its identification, function, or operating limitations, or any applicable combination of these factors, unless misuse or inadvertent actuation cannot create a hazard;

(3) Be installed according to limitations specified for that equipment; and

(4) Function properly when installed.

(b) Systems and installations must be designed to safeguard against hazards to the aircraft in the event of their malfunction or failure.

c. Where an installation, the functioning of which is necessary in showing compliance with the applicable requirements, requires a power supply, that installation must be considered an essential load on the power supply, and the power sources and the distribution system must be capable of supplying the following power loads in probable operation combinations and for probable durations:

(1) All essential loads after failure of any one engine on two-engine airplanes.

(2) All essential loads after failure of any prime mover, power converter, or energy storage device.

(3) In determining the probable operating combinations and durations of essential loads for the power failure conditions described in paragraphs (1) and (2) of this paragraph, it is permissible to assume that the power loads are reduced in accordance with a monitoring procedure which is consistent with safety in the types of operations authorized.

60. Ventilation. The ventilation system of the airplane must meet FAR 23.831, and in addition, for pressurized aircraft, the ventilating air in flight crew and passenger compartments must be free of harmful or hazardous concentrations of gases and vapors in normal operation and in the event of reasonably probable failures or malfunctioning of the ventilating, heating, pressurization, or other systems, and equipment. If accumulation of hazardous quantities of smoke in the cockpit area is reasonably probable, smoke evacuation must be readily accomplished.

61. General. The electrical systems and equipment of the airplane must meet FAR 23.1351, and the following:

(a) Electrical system capacity. The required generating capacity, and number and kinds of power sources must—

(1) Be determined by an electrical load analysis; and

(2) Meet FAR 23.1301.

(b) Generating system. The generating system includes electrical power sources, main power busses, transmission cables, and associated control, regulation and protective devices. It must be designed so that—

(1) The system voltage and frequency (as applicable) at the terminals of all essential load equipment can be maintained within the limits for which the equipment is designed, during any probable operating conditions;

(2) System transients due to switching, fault clearing, or other causes do not make essential loads inoperative, and do not cause a smoke or fire hazard;

(3) There are means, accessible in flight to appropriate crewmembers, for the individual and collective disconnection of the electrical power sources from the system; and

(4) There are means to indicate to appropriate crewmembers the generating system quantities essential for the safe operation of the system, including the voltage and current supplied by each generator.

62. Electrical equipment and installation. Electrical equipment, controls, and wiring must be installed so that operation of any one unit or system of units will not adversely affect the simultaneous operation of any other electrical unit or system essential to the safe operation.

63. Distribution system. (a) For the purpose of complying with this section, the distribution system includes the distribution busses, their associated feeders, and each control and protective device.

(b) Each system must be designed so that essential load circuits can be supplied in the event of reasonably probable faults or open circuits, including faults in heavy current carrying cables.

(c) If two independent sources of electrical power for particular equipment or systems are required under this appendix, their electrical energy supply must be ensured by means such as duplicate electrical equipment, throwover switching, or multichannel or loop circuits separately routed.

64. Circuit protective devices. The circuit protective devices for the electrical circuits of the airplane must meet FAR 23.1357, and in addition circuits for loads which are essential to safe operation must have individual and exclusive circuit protection.