Part Binder

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Title 14—AERONAUTICS AND SPACE

Chapter I—Federal Aviation Administration, Department of Transportation

[Docket No. 9323; Amdt. 135-18]

PART 135—AIR TAXI OPERATORS AND COMMERCIAL OPERATORS OF SMALL AIRCRAFT

Additional Airworthiness Standards for Airplanes With 10 or More Passenger Seats

The purpose of this amendment to Part 135 of the Federal Aviation Regulations is to require that, after May 31, 1972, reciprocating-engine and turbopropeller powered small airplanes having 10 or more passenger seats meet certain additional airworthiness standards, and to require operation of those airplanes in compliance with specified performance operating limitations.

This amendment is based on a notice of proposed rule making (Notice 68-370 published in the FEDERAL REGISTER on January 7, 1969 (34 F.R. 210). Except for minor editorial changes and as specifically discussed below, this amendment and the reasons therefor are the same as those proposed in Notice 68-37.

This amendment is part of a three-step regulatory program, which is discussed in Notice 68-37, that is intended to upgrade the level of airworthiness for airplanes in Part 135 operations. The first step in this program was the issuance of Special Federal Aviation Regulation No. 23 (SFAR No. 23), which established additional airworthiness standards for small airplanes that are capable of carrying more than 10 occupants and that are intended to be used in operations under Part 135.

This amendment implements the second step of the program. This amendment requires that after May 31, 1972, reciprocating-engine and turbopropeller powered small airplanes that have 10 or more passenger seats must be type certificated in accordance with specified airworthiness standards in addition to the applicable airworthiness standards in Part 23 or predecessor regulations. After May 31, 1972, no person may operate such an airplane under Part 135 unless it is type certificated in the transport category or in accordance with the applicable regulations of Part 23 or predecessor regulations and the additional airworthiness standards in new Appendix A, which is adopted by this amendment. However, such an airplane may be operated under Part 135 after May 31, 1972, if it has been type certificated before July 1, 1970, in accordance with Part 23, or predecessor regulations, and special conditions issued by the Administrator or SFAR No. 23.

Interested persons have been afforded an opportunity to participate in the rule making through submission of written comments. Due consideration has been given to all relevant matter presented.

The Aerospace Industries Association of America, Inc., (AIA) and the National Air Transportation Conference (NATC) requested in response to Notice 68-37, that the FAA defer action on Notice 68-37 and convene a meeting with air taxi operators, manufacturers, the Civil Aeronautics Board, and the National Transportation Safety Board to establish a regulatory program, both from airworthiness and operating points of view, that would enhance commuter type airline service. The NATC stated the objective of such a meeting would be to determine the feasibility for a comprehensive study of the types of aircraft needed to assure the orderly growth and development of air carriers operating under Part 298 of the Economic Regulations of the Civil Aeronautics Board.

The AIA and the NATC contend that because of the variabilities involved in the commuter air carrier and air taxi/charter industry, from an economic point of view, the FAA alone cannot determine how much safety the public can afford. These commentators state that the level of safety provided by the FAA through SFAR No. 23 is, in fact, an adequate level of safety that meets the complete intent of the Federal Aviation Act of 1958; that is, to encourage and foster the development of civil aeronautics and air commerce in the United States and abroad and to consider the duty resting upon air carriers to perform their service with the highest possible degree of safety in the public interest. The AIA contends that a viable commuter service cannot in fact be established, or where established cannot continue to operate, in a manner that will serve the public if these regulations are adopted as proposed. The AIA contends that because of the 0.6 factor in the computation of landing distance, a 5,000-foot runway would be required for aircraft that now safely operate from a 3,000-foot runway and that communities that cannot afford airport improvements would no longer receive commuter airline service. The AIA further contends that the basic cost of the aircraft to the operator would be increased by the additional equipment and testing required for aircraft certification and this cost, in addition to increased operating costs, would have a serious dampening effect on expansion of service into communities now being served. The AIA also states that the accident history of the commuter airlines clearly shows that the record of the aircraft certificated in accordance with either the special conditions (upon which SFAR No. 23 is based) or SFAR No. 23 is without blemish, that aircraft accidents that have occurred involve aircraft certificated prior to 1956, and that the accident record of the commuter airlines using aircraft certificated under Part 23 of the Federal Aviation Regulations and Part 3 of the Civil Air Regulations is equivalent to that of certificated air carriers.

We have determined that there is not sufficient justification for withdrawing Notice 68-37 or for holding the meeting as requested by the AIA and the NATC. Interested persons have been given the opportunity to submit data to support their positions. To this end the expiration date of Notice 68-37 was extended 30 days in response to the AIA and the NATC requests to enable them to submit technical data showing the effect of the proposed regulation on specific airplane designs. Such data were not submitted. The FAA believes that the meeting requested by the AIA and the NATC would lead to no constructive results and would only serve to delay action on needed regulations. Therefore, the FAA is proceeding with this amendment for the reasons set forth in Notice 68-37 and further amplified herein.

We do not agree with the view that no further regulatory action beyond SFAR No. 23 is needed, especially when the projected growth of operations with the new class of airplanes capable of carrying 10 or more passengers is considered. We believe that service experience does not support the views of the AIA and the NATC. As we indicated in Notice 68-37, we believe that since the operations with airplanes affected by the increased airworthiness requirements is a relatively small part of operations under Part 135, a satisfactory history of operations with these airplanes does not necessarily support the contention that the level of airworthiness is now adequate. Service experience with airplanes certificated under SFAR No. 23 represents even a smaller sample, and such a limited service experience should not be used to support the conclusion that SFAR No. 23 is adequate for future air taxi operations.

In developing the additional performance requirements in Appendix A, the FAA has drawn upon the experience gained in the development of the airworthiness standards for transport category airplanes and in the many years of operation of such airplanes. We believe that as sufficient exposure is accumulated with the affected airplanes, the need for a higher performance level for takeoff and landing will be demonstrated as it was for transport category airplanes. Present technology does not justify reaffirming this need by actual operating experience. In developing the rules in

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Notice 68–37, we also considered the operating experience with presently certificated air taxi airplanes. A review of the accidents with small multiengine air taxi airplanes reveals that there were 13 accidents in the 5-year period from the beginning of 1964 through the end of 1968 in which engine failure occurred in flight during takeoff. There were 6 injuries and 32 fatalities in those 13 accidents. During that period, there were no accidents in transport category airplanes in air carrier operations in which engine failure occurred in flight during takeoff. We believe that the safety record of the transport category airplanes is due, to a large extent, to airplane performance requirements that provide stay-up ability when an engine fails. Therefore, we believe that there is adequate justification for upgrading takeoff performance as proposed in the notice.

A review of landing accidents and incidents reveals that there have been enough long, short, and hard landings to justify upgrading landing performance requirements. The FAA is aware that the use of a 0.6 factor in establishing the landing field length operating limitation will have a significant economic impact. As pointed out by the AIA, this would require a runway length of 5,000 feet for an airplane that has a flight test landing distance of 3,000 feet. We believe the need for this runway length margin is verified by experience with transport category airplanes and by the relatively large number of accidents in air taxi operations during landings. We believe that curtailment of operations at airports where adequate runways do not exist is justified. Communities desiring air taxi service must provide adequate runways, be served by smaller and slower airplanes, or await the development of aircraft with appropriate charactertistics to serve limited facilities. There are airplanes currently available that have landing field lengths less than 3,500 feet. We do not agree with the AIA's contention that an airplane can land safely day-in and day-out on a runway that provides no margin over the landing distance determined in the performance flight tests, since the flight test distance does not account for variations in runway surface conditions and other operational variations. The landing field length operating limitation in Appendix A is therefore adopted as proposed for destination airports.

Furthermore, the FAA does not agree with the contention that the air taxi industry cannot afford to operate any airplane certificated in accordance with Appendix A. We believe that the technology and hardware now available will allow attainment of the level of performance provided by Appendix A at reasonable cost and will allow profitable operation by air taxi operators.

The Air Line Pilots Association (ALPA) expressed the view that Notice 68–37 did not go far enough and that a considerably higher level of airworthiness should be prescribed for all air taxi airplanes. The application of one level of airworthiness to all air carriers is a worthy long-range regulatory objective. However, we do not consider it practicable to impose standards comparable to those applicable to transport category airplanes at this time upon all air taxi airplanes. The air taxi industry has grown into a major industry under Parts 23 and 135 and predecessor regulations. The level of airworthiness prescribed by those regulations has changed little over the last 20 years. Approximately 75 percent of the 14,000 airplanes used in operations under Part 135 in 1968 were single-engine airplanes. We believe that the only practicable way to increase the level of airworthiness of air taxi airplanes to a level comparable to that of transport category airplanes is by an evolutionary process as provided by the FAA's three-step program. The NTSB has indicated its support for the FAA's three-step program.

The ALPA objected to the application of the additional airworthiness standards based on airplane capacity and expressed the view that such a basis for application of the standards would be difficult to justify to air taxi passengers. The FAA is using seating capacity because it is considered an appropriate means of identifying a class of airplanes on which it is considered necessary to impose additional airworthiness standards in upgrading the airworthiness of air taxi airplanes.

Applicability. Section 135.144 is a new section in Part 135 which states the applicability of these additional airworthiness standards. As adopted, § 135.144 is changed from the notice. Under the proposal all reciprocating-engine or turbopropeller powered small airplanes of a type which were type certificated as capable of carrying more than 10 occupants would have had to comply with the additional airworthiness standards. The effect of the proposal would have been to make the additional airworthiness requirements applicable to every airplane covered by a type certificate when the maximum number of occupants approved for any airplane covered by that type certificate was more than 10. Many type certificates cover several models, all of the same basic design, but having different maximum seating capacities. Under the proposal, if any model covered by a type certificate were approved for more than 10 occupants, all other models covered by that type certificate would have been required to comply with the additional airworthiness requirements when used in Part 135 operations, regardless of the number of passenger seats.

In the light of the comments received and upon further consideration, the FAA has concluded that the applicability portion of the proposal was not practicable and should be modified in the rule adopted. Accordingly, as adopted, the additional airworthiness standards required by § 135.144 apply to reciprocating-engine or turbopropeller powered small airplanes, as proposed, but only to airplanes that have a passenger seating configuration, excluding any pilot seat, of 10 seats or more. Therefore, under the regulations as amended herein an ATCO certificate holder may continue to operate an airplane that is type certificated with a seating configuration for 10 or more passengers without meeting the additional airworthiness standards if the passenger seating configuration is reduced to nine seats or less, excluding any pilot seat.

Section 5(c): Accelerate-stop distance. One comment questioned the need for determination of accelerate-stop distances for small airplanes on the basis of the history of transport category airplanes which has shown a reduced engine failure rate for turbine engines. We consider the need for the accelerate-stop distance to be justified. Takeoffs are aborted as often for reasons other than engine failure as they are for engine failure. Transport category airplane experience in air carrier operations has verified the need for the accelerate-stop distance.

One comment pointed out that the accelerate-stop distance as determined under Appendix A would be greater than under Part 25 of the Federal Aviation Regulations. As indicated by the commentator, the accelerate-stop distance for a twin turbopropeller powered airplane determined under Appendix A may be as much as 10 percent greater than the accelerate-stop distance determined under Part 25 for such an airplane. The increased accelerate-stop distance results from a V_1 speed that is higher than V_1 determined under Part 25. The higher V_1 speed compensates for the fact that Appendix A does not require the determination of the one-engine-inoperative takeoff distance that is required under Part 25.

One comment contended that the frequency of takeoffs from runways where the accelerate-stop distance is critical should be taken into consideration in establishing the accelerate-stop distance The comment was also made that the accelerate-stop distance should be different for scheduled operations and nonscheduled operations. The FAA believes that neither of the criteria suggested by these comments can be justifiably related to the determination or application of the accelerate-stop distance.

Section 5(e): One-engine-inoperative takeoff. One comment expressed the view that section 5(e) should allow one-engine-inoperative takeoff capability to be demonstrated in such a manner that the airplane maintains flight after engine failure by using ground effect. It was contended that the proposed requirement would penalize certain airplane designs that make better use of ground effect by their aspect ratio, wing loading, or wing location.

We believe that an airplane that cannot climb out of ground effect until it has accelerated to a speed at which it can be configured for cruise is an airplane with marginal performance. The cost for the additional power needed to climb within a reasonable time to a safe altitude is justifiable in the interest of the resulting gain in safety, and the FAA believes the resulting gain in safety is substantial.

Section 5(f): One-engine-inoperative takeoff flight path data. Section 5(f) requires the determination of one-engine-inoperative takeoff flight path

data. One commentator expressed a belief that this is a high performance requirement which would not materially improve the level of safety for operations under Part 135 and would make small airplanes uneconomical. Section 5(f) does not limit the weight of the airplane and is not an operating limitation. Section 5(f) provides data which is required, by section 20 of the Appendix, to be contained in the airplane flight manual as performance information for use by the pilot and is not an operating limitation.

Section 6(b)(2): Takeoff climb: landing gear retracted. One commentator asserted that the proposed two percent climb gradient is three times the gradient required by special conditions on small turbine-engine-powered aircraft which have a good safety record, and this requirement will make small airplanes uneconomical for Part 135 operations. A gradient of two percent is equal to a rate of climb of 200 feet per minute at 100 knots. This rate of climb is needed to insure that the airplane is capable of attaining a safe altitude within a reasonable time after failure of one engine during takeoff, and to provide some margin for gusts and other adverse factors. It is our view that the cost of the additional horsepower needed to meet the requirement will not prohibit economical use of airplanes to which Appendix A applies.

Section 7(b): Landing field length. The FAA agrees with a comment that the proposed factor of 0.6 for both intended destination and alternate destination landing field length is too restrictive in view of the fact that § 127.187 of Part 121 allows a factor of 0.7 for alternate airports. Therefore, section 7(b) is changed from the proposal to require a factor of 0.6 for the destination airport and 0.7 for an alternate airport.

The requirement for a gradient of descent not greater than 3° was questioned by commentators who contended that the slope for approach should be a function of the speed. The 3° glide slope is used as a standard for determining the landing distance and is based on the fact that 3° is the general value for the glide slope upon which most airplanes make their instrument approaches. We recognize that certain airplanes are being designed to operate with a steeper glide slope capability and the novel characteristics of such airplanes will be handled under § 21.16 of Part 21 by issuing special conditions.

Commentators claimed that there is no need for the 50-foot height and the factor of 0.6, both of which provide margins for operational variations. They pointed out that the margins for operational variations are unnecessary because of the maneuverability at low approach speeds and low inertia of small airplanes, and because of the position of the pilot near the ground during flare-out should lead to more precise touchdowns than is possible in large aircraft. The 50-foot height is based, in part, on obstacle clearance and this provision for obstacle clearance on approaches at the smaller airports, which are frequently used in operations under Part 135, may be more important than it is at larger airports, which usually have an instrument landing system with a cleared approach. The factor of 0.6 is based on touchdown dispersion and other variables including runway condition. Although the maneuverability of small airplanes may enable more precise touchdowns than can be made in transport category airplanes, it is doubtful that the ratios of touchdown dispersion to landing field length differs significantly for large and small airplanes.

Two commentators requested that the requirement for determination of landing field length not be applied to airplanes that have a speed of less than 100 knots at the 50-foot height. In view of the fact that the steady approach airspeed in section 7(b) is $1.3V_{S1}$ rather than the $1.5V_{S1}$ airspeed required in § 23.75(a)(1) and the fact that the effects of gusts are greater at lower airspeed, the FAA believes the landing distance requirements should not be eliminated for airplanes that have an approach speed of less than 100 knots.

Section 8: Trim. The symbol V_{MO}/V_{MO}, which appeared in § 8 (a) and (b) of the notice, should be V_{MO}/M_{MO}. The symbol is changed where it appears in § 8.

Section 25: Turbine-engine-gyroscopic loads. Under section 25 the engine mount and structure may be designed for the loads that result under either paragraph (a) or (b). One comment stated that there is no justification for allowing (b) to be used instead of (a) without limitation. Paragraph (b) contains yaw, pitch, load, and thrust factors that have been developed by experience in the issuance of special conditions for type certification. The FAA believes the use of (b) as an alternative to (a) is justified without limitation. The commentator also stated that the load factor under paragraph (b) should be not less than 3.2, the design maneuvering load factor. The FAA believes the combination of the design maneuvering load factor with the yaw and pitch velocities specified in (b) would be unlikely to occur in flight.

Section 28: Fatigue evaluation. One comment suggested that the fatigue evaluation requirements should apply to all major structures including the tail plane, fin, and rudder. The suggested expansion of the applicability of § 28 in this amendment would be beyond the scope of the notice. However, the FAA intends to expand the fatigue evaluation requirements to cover other flight structures in future rule making.

Section 32: Doors and exits. One comment questioned the need for an emergency exit on the same side of the airplane as the passenger entrance door. The need for this exit is based on the fact that the use of the passenger entrance as an emergency exit is restricted by the minimum aisle width specifications, the limited access to the door, the possibility of damage to the door, and the possibility that the door could not be opened in a water landing.

Although a reduction in the evacuation time of 90 seconds in section 32(d) would be outside the scope of the notice, consideration will be given to comments recommending such a reduction in a future rule-making action.

Several commentators objected to the requirement for a minimum aisle width and suggested that other aisle configurations could provide equivalent access to the exits. However, suggested configurations fail to provide for the obstruction that could be caused by a disabled passenger in a seat that must be folded to provide egress for some passengers. A seating configuration without the specified minimum aisle width which in fact provides an equivalent level of safety could be approved under § 21.21(b) of Part 21, which allows type certification if provisions with which an aircraft does not comply are compensated for by factors that provide an equivalent level of safety.

Miscellaneous corrections. SFAR No. 23 was amended effective December 24, 1969 (Amendment No. SFAR 23-1; published in the FEDERAL REGISTER on Dec. 24, 1969 (34 F.R. 20176)) to clarify certain provisions of the regulation, to remove an unnecessary restriction, and to make minor editorial corrections. The changes made to SFAR No. 23 also apply to Appendix A:

(1) The reference to paragraph (f) in section 4(d) is changed to reference paragraph (e).

(2) Appropriate changes are made in paragraph (b) of section 5 to make it clear that the V_1 speed is not an airborne speed and the speed in 5(b)(1)(iv) is not the "rotation speed" used in operating the airplane.

(3) There is a slight inconsistency between the provisions of paragraphs (b) and (c) of section 5. Paragraph (b) defines V_1 as the decision speed, which, in the case of engine failure, would occur subsequent to the failure. But the accelerate-stop distance in paragraph (c), as proposed in the notice, is based on the assumption that the critical engine fails at V_1. Since paragraph (b) contains the correct definition of V_1 speed, paragraph (c) is changed to make it consistent with paragraph (b).

(4) Paragraph (a) of section 6 is changed to allow the landing climb to be demonstrated at a speed not greater than the approach to the 50-foot height speed, and to specify a lower limit on the speed, which is necessary to prevent the climb from being conducted at a speed less than the engine out minimum control speed or the stalling speed.

(5) The word "aircraft" is changed to "airplane" in paragraphs (h) and (i) of section 35.

(6) Section 12 states that required flight instruments must be grouped on the instrument panel and centered as nearly as practicable about the vertical plane of the pilot's forward vision. Section 12 is changed to make it clear that the flight instruments must be centered as nearly as practicable about the vertical plane of each pilot's forward vision,

since two pilots are required for operation of airplanes having a seating configuration for 10 or more passengers under Part 135.

One other miscellaneous correction is made by changing "attitude" to "airspeed" in section 12(b)(2).

It should be noted that the performance requirements are considered to apply only to two-engine airplanes. Special conditions for climb performance would be established for the certification of each type of airplane with more than two engines. It should also be noted that inasmuch as no single-engine airplane can meet the engine-out performance standards, no person may operate a single-engine airplane that has a passenger seating configuration, excluding any pilot seat, of 10 seats or more under Part 135 after May 31, 1972.

In consideration of the foregoing, Part 135 of the Federal Aviation Regulations is amended, effective July 19, 1970, as follows:

1. By adding a new § 135.144 to read as follows:

§ 135.144 Additional airworthiness requirements: 10 or more passenger airplanes.

After May 31, 1972, no person may operate a reciprocating engine or turbopropeller powered small airplane in operations to which this part applies that has a passenger seating configuration, excluding any pilot seat, of 10 seats or more unless that airplane is type certificated—

(a) In the transport category;

(b) Before July 1, 1970, in the normal category and meets special conditions issued by the Administrator for airplanes intended for use in operations under this part;

(c) Before July 1, 1970, in the normal category and meets the additional airworthiness standards in SFAR No. 23; or

(d) In the normal category and meets the additional airworthiness standards prescribed in Appendix A of this part.

2. By adding a new § 135.148 to read as follows:

§ 135.148 Small airplane performance operating limitations.

(a) No person may operate a reciprocating engine powered small transport category airplane unless he complies with the weight limitations prescribed in § 121.175 of this chapter, the takeoff limitations prescribed in § 121.173(e) and § 121.177 (except subparagraph (a)(3)), and the landing limitations prescribed in § 121.185 and § 121.187.

(b) No person may operate a turbine engine powered small transport category airplane unless he complies with the takeoff limitations prescribed in § 121.189 of this chapter (except paragraphs (d) and (f)) and the landing limitations prescribed in § 121.195 and § 121.197.

(c) No person may operate a reciprocating engine or turbopropeller powered small airplane that is certificated in accordance with paragraphs (b), (c), or (d) of § 135.144 unless he complies with the takeoff weight limitations prescribed in the Airplane Flight Manual for operations under this part, and if the airplane is certificated in accordance with paragraph (d) of § 135.144, with the landing weight limitations prescribed in the Airplane Flight Manual for operations under this part.

3. By adding a new Appendix A to read as follows:

APPENDIX A

ADDITIONAL AIRWORTHINESS STANDARDS FOR 10 OR MORE PASSENGER AIRPLANES

Applicability

1. *Applicability.* This appendix prescribes the additional airworthiness standards required by § 135.144(d) of this part.

2. *References.* Unless otherwise provided, all references in this appendix to specific sections of Part 23 of the Federal Aviation Regulations are 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 Part 23 of the Federal Aviation Regulations in effect on March 30, 1967, as supplemented or modified in sections 4 through 10 of this appendix.

Performance

4. *General.* (a) Unless otherwise prescribed in this appendix, compliance with each applicable performance requirement in sections 4 through 7 of this appendix 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 en route, and landing configurations 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 in accordance with 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 described in paragraph (b), the accelerate-stop distance described in paragraph (c), the takeoff distance described in paragraph (d), and the one-engine-inoperative takeoff flight path data described in paragraph (f), 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) $1.10Vs_1$;

(ii) $1.10V_{MC}$;

(iii) A speed that permits acceleration to V_1 and stop in accordance with paragraph (c); or

(iv) A speed at which the airplane can be rotated for takeoff and shown to be adequate to safely continue the takeoff, using normal piloting skill, when the critical engine is suddenly made inoperative.

(2) The initial climb out speed V_2, in terms of calibrated airspeed, must be selected by the applicant so as to permit the gradient of climb required in section 6(b)(2), but it must not be less than V_1 nor less than $1.2Vs_1$.

(3) Other essential takeoff 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 according to 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 in accordance with 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 enroute one-engine inoperative gradient of climb specified in section 6(c).

(f) *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 in accordance with 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 of this appendix and not less than the greater of $1.05V_{MC}$ or $1.10V_{S1}$.

(b) *Takeoff climb; one-engine-inoperative* The maximum weight at which the airplane meets the minimum climb performance specified in subparagraphs (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 maximum takeoff 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.

(c) *En route climb; one-engine-inoperative.* The maximum weight must be determined for each altitude and ambient temperature within the operational limits established for the airplane, at which the steady gradient of climb is not less 1.2 percent at an altitude 1,000 feet above the takeoff surface, with the airplane in the en route configuration, the critical engine inoperative, the remaining engine at the maximum continuous power or thrust, and the most unfavorable center of gravity.

7. *Landing.* (a) The landing field length described in paragraph (b) must be determined for standard atmosphere at each weight and altitude within the operational limits established by the applicant.

(b) The landing field length is equal to the landing distance determined in accordance with FAR 23.75(a) divided by a factor of 0.6 for the destination airport and 0.7 for the alternate airport. Instead of the gliding approach specified in FAR 23.75(a)(1), the landing may be preceded by a steady approach down to the 50-foot height at a gradient of descent not greater than 5.2 percent (3°) at a calibrated airspeed not less than $1.3V_{S1}$.

Trim

8. *Trim* (a) *Lateral and directional trim.* The airplane must maintain lateral and directional trim in level flight at a speed of V_H or V_{MO}/M_{MO}, whichever is lower, with landing gear and wing flaps retracted.

(b) *Longitudinal trim.* The airplane must maintain longitudinal trim during the following conditions, except that it need not maintain trim at a speed greater than V_{MO}/M_{MO}:

(1) In the approach conditions specified in FAR 23.161(c) (3) through (5), except that instead of the speeds specified therein, trim must be maintained with a stick force of not more than 10 pounds down to a speed used in showing compliance with section 7 of this appendix or $1.4V_{S_1}$ whichever is lower.

(2) In level flight at any speed from V_H or V_{MO}/M_{MO}, whichever is lower, to either V_X or $1.4V_{S_1}$, with the landing gear and wing flaps retracted.

Stability

9. *Static longitudinal stability.* (a) In showing compliance with the provisions of FAR 23.175(b) and with paragraph (b) of this section, the airspeed must return to within ±7½ percent of the trim speed.

(b) *Cruise stability.* The stick force curve must have a stable slope for a speed range of ±50 knots from the trim speed except that the speeds need not exceed V_{FC}/M_{FC} or be less than $1.4V_{S_1}$. This speed range will be considered to begin at the outer extremes of the friction band and the stick force may not exceed 50 pounds with—

(i) Landing gear retracted;

(ii) Wing flaps retracted;

(iii) 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};

(iv) Maximum takeoff weight; and

(v) The airplane trimmed for level flight with the power specified in subparagraph (iii) of this paragraph.

V_{FC}/M_{FC} may not be less than a speed midway between V_{MO}/M_{MO} and V_{DF}/M_{DF}, 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. (For turbopropeller powered airplanes only).* In showing compliance with FAR 23.175(a), an applicant must, in lieu 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 $1.4V_{S_1}$.

Stalls

10. *Stall warning.* If artificial stall warning is required to comply with the requirements of 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.

Control Systems

11. *Electric trim tabs.* The airplane must meet the requirements of 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 the requirements of FAR 23.1321 and in addition—

(a) Each flight, navigation, and powerplant instrument for use by any pilot must be plainly visible to him from his station with the minimum practicable deviation from his normal position and line of vision when he 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 the requirements of 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_1 and 1.2 times the maximum value of V_1, considering the approved ranges of altitude and weight. The ground run calibration will be determined assuming an engine failure at the minimum value of V_1.

(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 $1.3V_{S_1}$ with flaps retracted and from $1.3V_{S0}$ to V_{FE} 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 the requirements of 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_{NO}, the applicant must establish a maximum operating limit speed V_{MO}/M_{MO} in accordance with the following:

(a) The maximum operating limit speed must not exceed the design cruising speed V_C and must be sufficiently below V_D/M_D or V_{DF}/M_{DF} to make it highly improbable that the latter speeds will be inadvertently exceeded in flight.

(b) The speed V_{MO} must not exceed $0.8V_D/M_D$ or $0.8V_{DF}/M_{DF}$ unless flight demonstrations involving upsets as specified by the Administrator indicates a lower speed margin will not result in speeds exceeding V_D/M_D or V_{DF}. Atmospheric variations, horizontal gusts, system and equipment errors, and airframe production variations will be taken into account.

16. *Minimum flight crew.* In addition to meeting the requirements of FAR 23.1523, the applicant must establish the minimum number and type of qualified flight crew personnel sufficient for safe operation of the airplane considering—

(a) Each kind of operation for which the applicant desires approval;

(b) The workload on each crewmember considering the following:

(1) Flight path control.

(2) Collision avoidance.

(3) Navigation.

(4) Communications.

(5) Operation and monitoring of all essential aircraft systems.

(6) Command decisions; and

(c) The accessibility and ease of operation of necessary controls by the appropriate crewmember during all normal and

emergency operations when at his flight station.

17. *Airspeed indicator.* The airspeed indicator must meet the requirements of FAR 23.1545 except that, the airspeed notations and markings in terms of V_{NO} and V_{NE} must be replaced by the V_{MO}/M_{MO} notations. The airspeed indicator markings must be easily read and understood by the pilot. A placard adjacent to the airspeed indicator is an acceptable means of showing compliance with the requirements of FAR 23.1545(c).

Airplane Flight Manual

18. *General.* The Airplane Flight Manual must be prepared in accordance with the requirements of FARs 23.1583 and 23.1587, and in addition the operating limitations and performance information set forth in sections 19 and 20 must be included.

19. *Operating limitations.* The Airplane Flight Manual must include the following limitations—

(a) *Airspeed limitations.* (1) The maximum operating limit speed V_{MO}/M_{MO} and a statement that this speed limit may not be deliberately exceeded in any regime of flight (climb, cruise, or descent) unless a higher speed is authorized for flight test or pilot training;

(2) If an airspeed limitation is based upon compressibility effects, a statement to this effect and information as to any symptoms, the probable behavior of the airplane, and the recommended recovery procedures; and

(3) The airspeed limits, shown in terms of V_{MO}/M_{MO} instead of V_{NO} and V_{NE}.

(b) *Takeoff weight limitations.* The maximum takeoff weight for each airport elevation, ambient temperature, and available takeoff runway length within the range selected by the applicant. This weight may not exceed the weight at which:

(1) The all-engine operating takeoff distance determined in accordance with section 5(b) or the accelerate-stop distance determined in accordance with section 5(c), whichever is greater, is equal to the available runway length;

(2) The airplane complies with the one-engine-inoperative takeoff requirements specified in § 5(e); and

(3) The airplane complies with the one-engine-inoperative takeoff and en route climb requirements specified in § 6 (b) and (c).

(c) *Landing weight limitations.* The maximum landing weight for each airport elevation (standard temperature) and available landing runway length, within the range selected by the applicant. This weight may not exceed the weight at which the landing field length determined in accordance with section 7(b) is equal to the available runway length. In showing compliance with this operating limitation, it is acceptable to assume that the landing weight at the destination will be equal to the takeoff weight reduced by the normal consumption of fuel and oil en route.

20. *Performance information.* The Airplane Flight Manual must contain the performance information determined in accordance with the provisions of the performance requirements of this appendix. The information must include the following:

(a) Sufficient information so that the takeoff weight limits specified in § 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 of this appendix 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 in accordance with section 5(b).

21. *Maximum operating altitudes.* The maximum operating altitude to which operation is permitted, 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.

23. *Operating procedures.* Procedures for restarting turbine engines in flight (including the effects of altitude) must be set forth in the Airplane Flight Manual.

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 set forth 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 1*g* 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 prescribed 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.

26. *Unsymmetrical loads due to engine failure.* (a) Turbopropeller powered airplanes must be designed for the unsymmetrical loads resulting from the failure of the critical engine including the following conditions in combination with a single malfunction of the propeller drag limiting system, considering the probable pilot corrective action on the flight controls:

(1) At speeds between V_{mc} and V_D, the loads resulting from power failure because of fuel flow interruption are considered to be limit loads.

(2) At speeds between V_{mc} and V_c, 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 specified 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 0.8. 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 in accordance with FAR 23.471 through FAR 23.483 must be applied to the dual wheels.

(c) *Flat tire.* (1) Sixty percent of the loads specified 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 in accordance with 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 carrythrough, 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.

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 the requirements of FAR 23.787 (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 9*g*.

32. *Doors and exits.* The airplane must meet the requirements of 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 exists 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 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 prior 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, be 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.

Total seating capacity	Minimum main passenger aisle width	
	Less than 25 inches from floor	25 inches and more from floor
10 through 23	9 inches	15 inches.

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 requirements 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 FAR 25, Appendix C.

(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 he 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.

Propulsion

General

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 researts 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 requirements:

(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) Prevent the continued safe operation of the remaining engines; or

(ii) Require immediate action by any crewmember for continued safe operation.

(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.

(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 ground operation 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 unsafe condition will result during normal operation of the system, or from any failure (or reasonably likely combination of failures) of the reversing system, under any anticipated condition of operation of the airplane. 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 flame-out) 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 provided by 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 (with respect to operating limitations established to insure proper service) and of appropriate mesh to insure proper engine operation, with the fuel contaminated to a degree (with respect to 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 the requirements of 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 in order 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 FAR 25. 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.

Exhaust System

50. *Exhaust system drains.* Turbopropeller engine exhaust systems having low spots or pockets must incorporate drains at such 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.

Powerplant Controls and Accessories

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 the requirements of FAR 23.1163, 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.

Powerplant Fire Protection

55. *Fire detector system.* For turbopropeller powered airplanes, the following apply:

(a) There must be a means that insures prompt detection of fire in the engine compartment. An overtemperature switch in each engine cooling air exit is an acceptable method of meeting this requirement.

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

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

(d) There must be means to allow the flight crew to check, in flight, the functioning of each fire detector electric circuit.

(e) Wiring and other components of each fire detector system in a fire zone must be at least fire resistant.

56. *Fire protection, cowling and nacelle skin.* For reciprocating engine powered airplanes, the engine cowling must be designed and constructed so that no fire originating in the engine compartment can enter, either through openings or by burn through, any other region where it would create additional hazards.

57. *Flammable fluid fire protection.* If flammable fluids or vapors might be liberated by the leakage of fluid systems in areas other than engine compartments, there must be means to—

(a) Prevent the ignition of those fluids or vapors by any other equipment; or

(b) Control any fire resulting from that ignition.

Equipment

58. *Powerplant instruments.* (a) The following are required for turbopropeller airplanes:

(1) The instruments required by FAR 23.1305(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.

Systems and Equipments

General

59. *Function and Installation.* The systems and equipment of the airplane must meet the requirements of 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, such 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 prime mover, power converter, or energy storage device.

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

(3) In determining the probable operating combinations and durations of essential loads for the power failure conditions described in subparagraphs (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 the requirements of 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.

Electrical Systems and Equipment

61. *General.* The electrical systems and equipment of the airplane must meet the requirements of 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 the requirements of 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 by this regulation, 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 the requirements of FAR 23.1357, and in addition circuits for loads which are essential to safe operation must have individual and exclusive circuit protection.

(Sec. 313(a), 601, and 603, Federal Aviation Act of 1958, 49 U.S.C. 1354(a), 1421, and 1423; sec. 6(c), Department of Transportation Act, 49 U.S.C. 1655(c))

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Administrator.