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DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 23

[Docket No. 135CE, Special Conditions 23–ACE–87]

Special Conditions; Sino Swearingen Model SJ30–2 Airplane

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final special conditions.

SUMMARY: These special conditions are being issued to become part of the type certification basis for the Sino Swearingen Aircraft Company Model SJ30–2 airplane. This new airplane will have novel and unusual design features not addressed in the airworthiness standards for normal, utility, acrobatic, and commuter category airplanes. These design features include a high operating altitude (49,000 feet), swept wings and stabilizer, performance characteristics, large fuel capacity, and protection for the electronic engine control and flight and navigation systems from high intensity radiated fields, for which the applicable regulations do not contain adequate or appropriate airworthiness standards. These special conditions contain the additional airworthiness standards that the Administrator considers necessary to establish a level of safety equivalent to that existing in the current business jet fleet and expected by the user of this class of aircraft.

EFFECTIVE DATE: December 1, 1997.

FOR FURTHER INFORMATION CONTACT: Lowell Foster, Aerospace Engineer, Standards Office (ACE–110), Small Airplane Directorate, Aircraft Certification Service, Federal Aviation Administration, Room 1544, 601 East 12th Street, Kansas City, Missouri 64106; telephone (816) 426–5688.

SUPPLEMENTARY INFORMATION:

Background

On October 9, 1995, Sino Swearingen Aircraft Company, 1770 Sky Place Boulevard, San Antonio, Texas 78216, made application for normal category type certification of its Model SJ30–2 airplane, a six-to-eight place, all metal, low-wing, T-tail, twin turbofan engine powered airplane with fully enclosed retractable landing gear. The SJ30–2 will have a V_{MO}/M_{MO} of 320 kts/M=.83, and will have engines mounted aft on the fuselage.

Type Certification Basis

Type certification basis of the Model SJ30–2 airplane is: 14 CFR Part 23, effective February 1, 1965, through Amendment 23–52, effective July 25, 1996; 14 CFR Part 36, effective December 1, 1969, through the amendment effective on the date of type certification; 14 CFR Part 34; exemptions, if any; and the special conditions adopted by this rulemaking action.

Discussion

Special conditions may be issued and amended, as necessary, as part of the type certification basis if the Administrator finds that the airworthiness standards designated in accordance with 14 CFR Part 21, § 21.17(a)(1), do not contain adequate or appropriate safety standards because of novel or unusual design features of an airplane. Special conditions, as appropriate, are issued in accordance with 14 CFR Part 11, § 11.49, after public notice, as required by §§ 11.28 and 11.29(b), effective October 14, 1980, and become part of the type certification basis as provided by part 21, § 21.17(a)(2).

Protection of Systems From High Intensity Radiated Fields (HIRF)

Recent advances in technology have led to the application in aircraft designs of advanced electrical and electronic systems that perform functions required for continued safe flight and landing. Due to the use of sensitive solid state advanced components in analog and digital electronics circuits, these advanced systems are readily responsive to the transient effects of induced electrical current and voltage caused by the HIRF. The HIRF can degrade electronic systems performance by damaging components or upsetting system functions.

Furthermore, the HIRF environment has undergone a transformation that was not foreseen when the current requirements were developed. Higher energy levels are radiated from transmitters that are used for radar, radio, and television. Also, the number of transmitters has increased significantly. There is also uncertainty concerning the effectiveness of airframe shielding for HIRF. Furthermore, coupling to cockpit-installed equipment through the cockpit window apertures is undefined.

The combined effect of the technological advances in airplane design and the changing environment has resulted in an increased level of vulnerability of electrical and electronic systems required for the continued safe flight and landing of the airplane. Effective measures against the effects of exposure to HIRF must be provided by the design and installation of these systems. The accepted maximum energy levels in which civilian airplane system installations must be capable of operating safely are based on surveys and analysis of existing radio frequency emitters. These special conditions require that the airplane be evaluated under these energy levels for the protection of the electronic system and its associated wiring harness. These external threat levels, which are lower than previous required values, are believed to represent the worst case to which an airplane would be exposed in the operating environment.

These special conditions require qualification of systems that perform critical functions, as installed in aircraft, to the defined HIRF environment in paragraph 1 or, as an option to a fixed value using laboratory tests, in paragraph 2, as follows:

(1) The applicant may demonstrate that the operation and operational capability of the installed electrical and electronic systems that perform critical functions are not adversely affected when the aircraft is exposed to the HIRF environment defined below:

FIELD STRENGTH VOLTS/METER

Frequency	Peak	Average
10–100 KHz	50	50
100–500	60	60

FIELD STRENGTH VOLTS/METER—Continued

Frequency	Peak	Average
500–2000	70	70
2–30 MHz	200	200
30–70	30	30
70–100	30	30
100–200	150	30
200–400	70	70
400–700	700	80
700–1000	1700	240
1–2 GHz	5000	360
2–4	4500	360
4–6	7200	300
6–8	2000	330
8–12	3500	270
12–18	3500	330
18–40	780	20

or,

(2) The applicant may demonstrate by a system test and analysis that the electrical and electronic systems that perform critical functions can withstand a minimum threat of 100 volts per meter, peak electrical field strength, from 10 KHz to 18 GHz. When using this test to show compliance with the HIRF requirements, no credit is given for signal attenuation due to installation.

A preliminary hazard analysis must be performed by the applicant, for approval by the FAA, to identify electrical and/or electronic systems that perform critical functions. The term ''critical'' means those functions whose failure would contribute to, or cause, a failure condition that would prevent the continued safe flight and landing of the airplane. The systems identified by the hazard analysis that perform critical functions are candidates for the application of HIRF requirements. A system may perform both critical and non-critical functions. Primary electronic flight display systems, and their associated components, perform critical functions such as attitude, altitude, and airspeed indication. The HIRF requirements apply only to critical functions.

Compliance with HIRF requirements may be demonstrated by tests, analysis, models, similarity with existing systems, or any combination of these. Service experience alone is not acceptable since normal flight operations may not include an exposure to the HIRF environment. Reliance on a system with similar design features for redundancy as a means of protection against the effects of external HIRF is generally insufficient since all elements of a redundant system are likely to be exposed to the fields concurrently.

Performance

The Sino Swearingen Model SJ30–2 has a main wing with 30 degrees of leading-edge sweepback that employs leading-edge slats and Fowler-flaps. The airplane has a T-tail with trimmable horizontal stabilizer and 30 degrees of leading-edge sweepback. There are two medium bypass ratio turbofan engines mounted on the aft fuselage.

Previous certification and operational experience with airplanes of like design in the transport category reveal certain unique characteristics compared to conventional aircraft certificated under part 23. These characteristics have caused safety problems in the past when pilots attempted takeoffs and landings, particularly with a large variation in temperature and altitude, using procedures and instincts developed with conventional airplanes.

One of the major distinguishing features of a swept-wing design not considered in current part 23 is a characteristically flatter lift curve without a ''stall'' break near the maximum coefficient of lift, as in a conventional wing. The ''stall'' separation point may occur at a much higher angle of attack than the point of maximum lift and the angle of attack for maximum lift can be only recognized by precise test measurements or specific detection systems. This phenomenon is not apparent to a pilot accustomed to operating a conventional airplane where increasing angle of attack produces increased lift to the point where the wing stalls. In a swept-wing design, if the pilot does not operate in accordance with established standards developed through a dedicated test program, increasing angle of attack may produce very little lift yet increase drag markedly to the point where flight is impossible. These adverse conditions may be further compounded by the characteristics of turbofan engines, including specified N_1/N_2 rotational speeds, temperature, and pressure limits that make its variation in thrust output with changes in temperature and altitude more complex and difficult to predict. In recognition of these characteristics, Special Civil Air Regulations No. SR–422, and follow-on regulations, established weight-altitude-temperature (WAT) limitations and procedures for scheduling takeoff and landing for turbine powered transport category airplanes, so the pilot could achieve reliable and repeatable results under all expected conditions of operation. This entails specific tests such as minimum unstick speed, V_{MU}, to ensure that rotation and fly-out speeds are correct and that the airplane speed schedule will not allow the airplane to lift off in ground effect and then be unable to accelerate and continue to climb out. In conjunction with the development of takeoff and landing procedures, it was also necessary to establish required climb gradients and data for flight path determination under all approved weights, altitudes, and temperatures. This enables the pilot to determine, before takeoff, that a safe takeoff, departure, and landing at destination can be achieved.

Takeoff

Based upon the knowledge and experience gained with similar high speed, high efficiency, turbojet airplanes with complex high lift devices for takeoff and landing, special conditions require performance standards for takeoff, takeoff speeds, accelerate-stop distance, takeoff path, takeoff distance, takeoff run, and takeoff flight path.

Additionally, procedures for takeoff, accelerate-stop distance, and landing are proposed as those established for operation in service and must be executable by pilots of average skill and include reasonably expected time delays.

Climb

To maintain a level of safety that is equivalent to the current business jet fleet for takeoff, takeoff speeds, takeoff path, takeoff distance, and takeoff run, it is appropriate to require specific climb gradients, airplane configurations, and consideration of atmospheric conditions that will be encountered. These special conditions include climb with one engine inoperative, balked landing climb, and general climb conditions.

Landing

Landing distance determined for the same parameters is consistent with takeoff information for the range of weights, altitudes, and temperatures approved for operation. Further, it is necessary to consider time delays to provide for in-service variation in the activation of deceleration devices, such as spoilers and brakes.

Trim

Special conditions are issued to maintain a level of safety that is consistent with the use of V_{MO}/M_{MO} and the requirements established for previous part 23 jet airplanes. Current standards in part 23 did not envision this type of airplane and the associated trim considerations.

Demonstration of Static Longitudinal Stability

To maintain a level of safety consistent with existing business jet airplanes, it is appropriate to define applicable requirements for static longitudinal stability. Current standards in part 23 did not envision this type of airplane and the associated stability considerations. Special conditions will establish static longitudinal stability requirements that include a stick force versus speed specification and stability requirements applicable to high speed jet airplanes.

Consistent with the concept of V_{MO}/M_{MO} being a maximum operational speed limit, rather than a limiting speed for the demonstration of satisfactory flight characteristics, it is appropriate to extend the speed for demonstration of longitudinal stability characteristics from the V_{MO}/M_{MO} of 14 CFR Part 23 to the maximum speed for stability characteristics, V_{FC}/M_{FC}, for this airplane.

Static Directional and Lateral Stability

Consistent with the concept of V_{MO}/M_{MO} being a maximum operational speed limit, rather than a limiting speed for the demonstration of satisfactory flight characteristics, it is appropriate to extend the speed for demonstration of lateral/directional stability characteristics from the V_{MO}/M_{MO} of part 23 to the maximum speed for stability characteristics, V_{FC}/M_{FC} for this airplane.

Current transport category regulations have eliminated the independent lateral stability demonstration requirement (picking up the low wing with rudder application). This requirement was originally intended to provide adequate controllability in the event of lateral control system failure. Because the SJ30–2 flight control system reliability requirement is not to current transport category levels, it is appropriate to retain the prior transport category requirements to retain the independent dihedral effect and skid recovery demonstration requirements.

Stall Characteristics

The stall characteristics requirements are relaxed from part 23 to be equivalent to that acceptable in current business jets. These special conditions reflect a higher expected pilot proficiency level, the remote chance that a stall will be encountered in normal operation, and are relaxed as compensation for meeting higher performance requirements in these special conditions.

Vibration and Buffeting

The Sino Swearingen Model SJ30–2 will be operated at high altitudes where stall-Mach buffet encounters (small speed margin between stall and transonic flow buffet) are likely to occur, which is not presently addressed in part 23. The special condition will require buffet onset tests and the inclusion of information in the Airplane Flight Manual (AFM) to provide guidance to the flightcrew. This information will enable the flightcrew to plan flight operations that will maximize the maneuvering capability during high altitude cruise flight and preclude intentional operations exceeding the boundary of perceptible buffet. Buffeting is considered to be a warning to the pilot that the airplane is approaching an undesirable and eventually dangerous flight regime, that is, stall buffeting, high speed buffeting or maneuvering (load factor) buffeting. In straight flight, therefore, such buffet warning should not occur at any normal operating speed up to the maximum operating limit speed, V_{MO}/M_{MO}.

High Speed Characteristics and Maximum Operating Limit Speed

The Sino Swearingen Model SJ30–2 will be operated at high altitude and high speeds. The proposed operating envelope includes areas in which Mach effects, which have not been considered in part 23, may be significant. The anticipated low drag of the airplane and the proposed operating envelope are representative of the conditions not envisioned by the existing part 23 regulations. These conditions may degrade the ability of the flightcrew to promptly recover from inadvertent excursions beyond maximum operating speeds. The ability to pull a positive load factor is needed to ensure, during recovery from upset, that the airplane speed does not continue to increase to a value where recovery may not be achievable by the average pilot or flightcrew.

Additionally, to allow the aircraft designer to conservatively design to higher speeds than may be operationally required for the airplane, the concept of V_{DF}/M_{DF}, the highest demonstrated flight speed for the type design, is appropriate for this airplane. This permits V_D/M_D, the design dive speed, to be higher than the speed actually required to be demonstrated in flight. Accordingly, the special conditions allow determination of a maximum demonstrated flight speed and to relate the determination of V_{MO}/M_{MO} to the speed V_{DF}/M_{DF}.

Flight Flutter Tests

Flight flutter test special conditions are proposed to V_{DF}/M_{DF} rather than to V_D, in keeping with the V_{DF}/M_{DF} concept.

Out-of-Trim Characteristics

High speed airplanes have experienced a number of upset incidents involving out-of-trim conditions. This is particularly true for swept-wing airplanes and airplanes with a trimmable stabilizer. Service experience has shown that out-of-trim conditions can occur in flight for various reasons and that the control and maneuvering characteristics of the airplane may be critical in recovering from upsets. The existing part 23 regulations do not address high speed out-of-trim conditions. These special conditions test the out-of-trim flight characteristics by requiring the longitudinal trim control be displaced from the trimmed position by the amount resulting from the three-second movement of the trim system at this normal rate with no aerodynamic load, or the maximum mis-trim that the autopilot can sustain in level flight in the high speed cruise condition, whichever is greater. Special conditions require the maneuvering characteristics, including stick force per g, be explored throughout a specified maneuver load factor speed envelope. The dive recovery characteristics of the aircraft in the out-of-trim condition specified would be investigated to determine that safe recovery can be made from the demonstrated flight dive speed V_{DF}/M_{DF}.

Pressure Vessel Integrity

Special conditions will be used to ensure pressure vessel integrity for operation at altitudes above 41,000 feet. The FAA uses 41,000 feet as the altitude where additional requirements for high altitude operations are necessary. Crack growth data are used to prescribe an inspection program that should detect cracks before an opening in the pressure vessel would allow rapid depressurization.

Fuel System Protection During Collapse of Landing Gear

The SJ30–2 maximum fuel weight is 39 percent of the maximum weight. This percentage is typical of the turbofan powered business jet class of airplanes. Part 23 did not envision that the applicable airplane designs would have such a large fraction of maximum weight as fuel. Part 23 does not contain fuel system protection requirements during landing gear collapse, except for § 23.721, which pertains to commuter category airplanes that have a passenger seating configuration of 10 seats or more. In the SJ30–2 design, there is a large fuselage fuel tank and the placement of the engines on the aft fuselage requires that the fuel lines be routed through the fuselage, making the fuel lines more vulnerable to damage, or rupture, if the landing gear collapses. The special condition is based on 14 CFR Part 25, § 25.721(a)(1), which is applicable to airplanes having a passenger seating configuration of nine seats or fewer.

Oxygen System Equipment and Supply

Continuous flow passenger oxygen equipment is certified for use up to 40,000 feet; however, for rapid decompressions above 34,000 feet, reverse diffusion leads to low oxygen partial pressures in the lungs to the extent that a small percentage of passengers may lose useful consciousness at 35,000 feet even with the use of the continuous flow system. To prevent permanent physiological damage, the cabin altitude must not exceed 25,000 feet for more than 2 minutes. The maximum peak cabin altitude of 40,000 feet is consistent with the standards established for previous certification programs. In addition, at high altitudes the other aspects of decompression sickness have a significant detrimental effect on pilot performance (for example, a pilot can be incapacitated by internal expanding gases).

Decompression above the 37,000 foot limit depicted in Figure 4 approaches the physiological limits of the average person; therefore, every effort must be made to provide the pilots with adequate oxygen equipment to withstand these severe decompressions. Reducing the time interval between pressurization failure and the time the pilots receive oxygen will provide a safety margin against being incapacitated and can be accomplished by the use of mask-mounted regulators. The proposed special condition, therefore, would require pressure demand masks with mask-mounted regulators for the flightcrew. This combination of equipment will provide the best practical protection for the failures covered by this special condition and for improbable failures not covered by the special conditions, provided the cabin altitude is limited.

Airspeed Indicating System

To maintain a level of safety consistent with that existing in the current business jet fleet, and to be consistent with the establishment of speed schedule performance requirements, it is appropriate to establish applicable requirements for determining and providing airspeed indicating system calibration information. Additionally, it is appropriate to establish special conditions requiring protection of the pitot tube from malfunctions associated with icing conditions. Special conditions will establish airspeed indicating system calibration and pitot tube ice protection requirements applicable to transport category jet airplanes.

Static Pressure System

Special conditions are appropriate to establish applicable requirements for providing static pressure system calibration information in the AFM. Since aircraft of this type are frequently equipped with devices to correct the altimeter indication, it is also appropriate to establish requirements to ensure the continued availability of altitude information where such a device malfunctions. Current standards in part 23 did not envision this type of airplane and the associated static pressure requirements.

Minimum Flightcrew

The Sino Swearingen Model SJ30–2 operates at high altitudes and speeds not envisioned in part 23 and must be flown in a precise speed schedule to achieve flight manual takeoff and landing distances. Therefore, it is appropriate to specify workload considerations. Special conditions will specify the items to be considered in workload determination.

Airplane Flight Manual (AFM) Information

To be consistent with the performance special conditions, it is also necessary to require that the maximum takeoff and landing weights, takeoff distances, and associated atmospheric conditions be made available to the pilot in the AFM and that the airplane be operated within its performance capabilities. Special conditions will add maximum takeoff weights, maximum landing weights, and minimum takeoff distances as limitations in the AFM. Additionally, special conditions are included to add takeoff flight path and procedures necessary to achieve the performance in the limitations section as information in the AFM.

Discussion of Comments

Notice of Proposed Special Conditions, Notice No. 23–ACE–87, Docket No. 135CE, was published in the **Federal Register** on February 21, 1997, and the comment period closed March 24, 1997. Following is a summary of the comments received and a response to each comment.

Only one commenter responded to the notice of proposed special conditions and that was the Sino Swearingen Aircraft Company. They offered 15 comments, of which 7 were either editorial in nature or the incorrect special condition numbers were referenced. These errors were corrected. The remainder of comments are addressed individually.

1. *Comment:* The certification basis should be changed to part 23 through Amendment 23–52.

FAA Response: The FAA agrees and the type certification basis for the special condition has been changed accordingly.

2. *Comment:* In the discussion material section, remove the words ‘‘double slotted’’ from the first sentence of the ‘‘Performance’’ discussion on page 7951, third column, first paragraph.

FAA Response: The FAA agrees and has removed the words.

3. *Comment:* Add the following statement to the ‘‘Discussion’’ material:

Demonstration of Static Longitudinal Stability

To maintain a level of safety consistent with that applied to previous part 23 jet airplanes, it is appropriate to define applicable requirements for static longitudinal stability. Current standards in part 23 did not envision this type of airplane with the associated stability considerations. Special conditions are proposed to establish static longitudinal stability requirements that include a stick force versus speed specification and stability requirements applicable to high speed jet airplanes.

FAA Response: The FAA concurs and has incorporated this comment into the section.

4. *Comment:* Special Condition No. 1 lacks specificity. The discussion material includes the two options that we may use to show compliance, but the proposed special condition is silent. Suggest that these options be included in the body of the special condition and not left in the discussion material.

FAA Response: This is the format used for HIRF special conditions. The FAA's goal is rules that contain minimum standards and not means of showing compliance. While this is hard to accomplish in certain instances, it is not the FAA's intention to dictate designs to manufacturers, but to offer compliance options through advisory circular. In this case, the HIRF minimum standards are the special conditions, which constitute a rule, and one acceptable means of showing compliance is discussed in the preamble.

5. *Comment:* Special Condition No. 24, Out-of-Trim Characteristics. The opening statement should be changed to ''the following applies'' instead of ''the Sino Swearingen model SJ30–2 must comply with the following.''

FAA: The FAA agrees and the statement has been changed.

6. *Comment:* Special Condition No. 26. Should be deleted and replaced with § 23.607, Amendment 23–48.

FAA Response: The FAA agrees and Special Condition No. 26 has been deleted. Later amendment levels are adequate for this airplane.

7. *Comment:* Special Condition No. 30—Pressurization. Special Condition No. 30 addresses the altitude-time histories of the cabin altitude following system and/or structural failures. The language and requirements defined in Special Condition No. 30, paragraphs (a)(2), (b)(1), and (b)(2), are a carry-over of early part 25 executive transport airplane special conditions developed for high altitude operation (above 40,000 feet). As discussed in the **Federal Register**, Volume 61, No. 109, dated June 5, 1996, part 25 special conditions were developed to address the consequences of decompression of executive transport airplanes operation at high altitudes. These early special conditions revised the requirements of § 25.365, *Pressurized Cabin Loads,* § 25.841, *Pressurized Cabins,* and § 25.1447, *Equipment Standards for Oxygen Dispensing Equipment* and were intended to provide an evaluation of the consequences of cabin depressurization due to system and/or structural failures.

However, the wording provided in Special Condition No. 30 is based on an earlier amendment (before Amendment 25–45) of § 25.571, which allowed a choice between safe-life and fail-safe substantiation for airplane primary structure. The airplane inspections defined for § 25.571 before Amendment 25–45 were not specifically based on crack growth for spectrum loading. Therefore, the executive transport airplane special conditions for operation at high altitudes specified a somewhat arbitrary criteria of structural failure considerations for a decompression event. Subsequent to the initial development of these executive transport high altitude special conditions, § 25.571 was amended by Amendments 25–45 (1978) and 25–52 (1980) to require a damage tolerance evaluation of the airplane primary structure. The damage tolerance evaluation requires the development of inspection intervals and procedures for the detection of crack lengths associated with the decompression of critical vent areas. Since the structural failures to be considered for the decompression event are defined by the damage tolerance evaluation, the language shown in Special Condition No. 30, paragraphs (a)(2), (b)(1), and (b)(2), is not part of the current part 25 regulatory requirements for High Altitude Operation of Subsonic Transport Airplanes.

The commenter believes that the structural failures to be considered of a decompression event should be defined by the damage tolerance evaluation of the SJ30–2 airplane pressure vessel required by Special Condition No. 25, Pressure Vessel Integrity, and not by the predefined conditions outlined in Special Condition No. 30, paragraphs (a)(2), (b)(1), and (b)(2). Therefore, the commenter suggests their words, which reflect the more recent structural approach.

FAA Response: The FAA agrees with the commenter and Special Condition No. 30 will be replaced.

8. *Comment:* Special Condition No. 37, Operating Limitations. Paragraph (a)(3) change read ''V_O'' to ''V_A''.

FAA Response: The FAA does not agree. V_A was correctly changed to V_O in an earlier part 23 amendment so it will remain unchanged in these special conditions.

Conclusion

In view of the design features discussed for the SJ30–2 Model airplane, the following special conditions are issued to provide a level of safety equivalent to current business jets certificated to transport standards and expected by the user of this class of aircraft. This action is not a rule of general applicability and affects only the model/series of airplane identified in these final special conditions.

List of Subjects in 14 CFR Part 23

Aircraft, Aviation safety, Signs and symbols.

Citation

The authority citation for these Special Conditions is as follows:

Authority: 49 U.S.C. 106(g); 40113, and 44701; 14 CFR 21.16 and 101; and 14 CFR 11.28 and 11.49.

Adoption of Special Conditions

Accordingly, pursuant to the authority delegated to me by the Administrator, the Federal Aviation Administration issues the following special conditions as part of the type certification basis for the Sino Swearingen Model SJ30–2 airplane:

1. Protection of Electrical and Electronic Systems From High Intensity Radiated Field

Each system that performs critical functions must be designed and installed to ensure that the operations, and operational capabilities of these systems to perform critical functions, are not adversely affected when the airplane is exposed to high intensity radiated electromagnetic fields external to the airplane.

For the purpose of these special conditions, the following definition applies:

Critical Functions: Functions whose failure would contribute to, or cause, a failure condition that would prevent the continued safe flight and landing of the airplane.

2. Performance: General

In addition to the requirements of § 23.45, the following apply:

(a) Unless otherwise prescribed, the applicant must select the takeoff, enroute, approach, and landing configurations for the airplane.

(b) The airplane configurations may vary with weight, altitude, and temperature, to the extent that they are compatible with the operating procedures required by paragraph (c) of this special condition.

(c) Unless otherwise prescribed, in determining the accelerate-stop distances, takeoff flight paths, takeoff distances, and landing distances, 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.

(d) Procedures for the execution of balked landings and discontinued approaches associated with the conditions prescribed in special condition 10, paragraph (d), and special condition 12 must be established.

(e) The procedures established under paragraphs (c) and (d) of this special condition must:

(1) Be able to be consistently executed in service by crews 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.

3. Takeoff

Instead of complying with § 23.53, the following apply:

(a) In special conditions 4, 5, 6, and 7, the takeoff speeds, the accelerate-stop distance, the takeoff path, the takeoff distance, and takeoff run described must be determined:

(1) At each weight, altitude, and ambient temperature within the operation limits selected by the applicant; and

(2) In the selected configuration for takeoff.

(b) No takeoff made to determine the data required by this section may require exceptional piloting skill or alertness.

(c) The takeoff data must be based on a smooth, dry, hard-surfaced runway.

(d) The takeoff data must include, within the established operational limits of the airplane, the following operational correction factors:

(1) Not more than 50 percent of nominal wind components along the takeoff path opposite to the direction of takeoff, and not less than 150 percent of nominal wind components along the takeoff path in the direction of takeoff.

(2) Effective runway gradients.

4. Takeoff Speeds

Instead of compliance with § 23.51, the following apply:

(a) V_1 must be established in relation to V_{EF}, as follows:

(1) V_{EF} is the calibrated airspeed at which the critical engine is assumed to fail. V_{EF} must be selected by the applicant, but may not be less than V_{MCG} determined under § 23.149(f).

(2) V_1, in terms of calibrated airspeed, is the takeoff decision speed selected by the applicant; however, V_1 may not be less than V_{EF} plus the speed gained with the critical engine inoperative during the time interval between the instant at which the critical engine failed and the instant at which the pilot recognizes and reacts to the engine failure, as indicated by the pilot's application of the first retarding means during the accelerate-stop test.

(b) $V_{2\,min}$, in terms of calibrated airspeed, may not be less than the following:

(1) 1.2 V_{S1}

(2) 1.10 times V_{MC} established under § 23.149.

(c) V_2, in terms of calibrated airspeed, must be selected by the applicant to provide at least the gradient of climb required by special condition 10, paragraph (b), but may not be less than the following:

(1) $V_{2\,min}$, and

(2) V_R plus the speed increment attained (in accordance with special condition 6, paragraph (c)(2)) before reaching a height of 35 feet above the takeoff surface.

(d) V_{MU} is the calibrated airspeed at and above which the airplane can safely lift off the ground and continue the takeoff. V_{MU} speeds must be selected by the applicant throughout the range of thrust-to-weight ratios to be certified. These speeds may be established from free-air data if these data are verified by ground takeoff tests.

(e) V_R, in terms of calibrated airspeed, must be selected in accordance with the following conditions of paragraphs (e)(1) through (e)(4) of this special condition:

(1) V_R may not be less than the following:

(i) V_1;

(ii) 105 percent of V_{MC};

(iii) The speed (determined in accordance with special condition 6, paragraph (c)(2)) that allows reaching V_2 before reaching a height of 35 feet above the takeoff surface; or

(iv) A speed that, if the airplane is rotated at its maximum practicable rate, will result in a V_{LOF} of not less than 110 percent of V_{MU} in the all-engines-operating condition and not less than 105 percent of V_{MU} determined at the thrust-to-weight ratio corresponding to the one-engine-inoperative condition.

(2) For any given set of conditions (such as weight, configuration, and temperature), a single value of V_R, obtained in accordance with this special condition, must be used to show compliance with both the one-engine-inoperative and the all-engines-operating takeoff provisions.

(3) It must be shown that the one-engine-inoperative takeoff distance, using a rotation speed of 5 knots less than V_R, established in accordance with paragraphs (e)(1) and (e)(2) of this special condition, does not exceed the corresponding one-engine-inoperative takeoff distance using the established V_R. The takeoff distances must be determined in accordance with special condition 7, paragraph (a)(1).

(4) Reasonably expected variations in service from the established takeoff procedures for the operation of the airplane (such as over-rotation of the airplane and out-of-trim conditions) may not result in unsafe flight characteristics or in marked increases in the scheduled takeoff distances established in accordance with special condition 7.

(f) V_{LOF} is the calibrated airspeed at which the airplane first becomes airborne.

5. Accelerate-Stop Distance

In the absence of specific accelerate-stop distance requirements, the following apply:

(a) The accelerate-stop distance is the sum of the distances necessary to—

(1) Accelerate the airplane from a standing start to V_{EF} with all engines operating;

(2) Accelerate the airplane from V_{EF} to V_1, assuming that the critical engine fails at V_{EF}; and

(3) Come to a full stop from the point at which V_1 is reached assuming that, in the case of engine failure, the pilot has decided to stop as indicated by application of the first retarding means at the speed V_1.

(b) Means other than wheel brakes may be used to determine the accelerate-stop distance if that means—

(1) Is safe and reliable;

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

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

(c) The landing gear must remain extended throughout the accelerate-stop distance.

6. Takeoff Path

In the absence of specific takeoff path requirements, the following apply:

(a) The takeoff path extends from a standing start to a point in the takeoff at which the airplane is 1,500 feet above the takeoff surface, or at which the transition from the takeoff to the enroute configuration is completed and a speed is reached at which compliance with special condition 10, paragraph (c), is shown, whichever point is higher. In addition, the following apply:

(1) The takeoff path must be based on procedures prescribed in special condition 2.

(2) The airplane must be accelerated on the ground to V_{EF}, at which point the critical engine must be made inoperative and remain inoperative for the rest of the takeoff; and

(3) After reaching V_{EF}, the airplane must be accelerated to V_2.

(b) During the acceleration to speed V_2, the nose gear may be raised off the ground at a speed not less than V_R. However, landing gear retraction may not begin until the airplane is airborne.

(c) During the takeoff path determination, in accordance with paragraphs (a) and (b) of this special condition, the following apply:

(1) The slope of the airborne part of the takeoff path must be positive at each point;

(2) The airplane must reach V_2 before it is 35 feet above the takeoff surface and must continue at a speed as close as practical to, but not less than, V_2 until it is 400 feet above the takeoff surface;

(3) At each point along the takeoff path, starting at the point at which the airplane reaches 400 feet above the takeoff surface, the available gradient of climb may not be less than 1.2 percent;

(4) Except for gear retraction, the airplane configuration may not be

changed, and no change in power or thrust that requires action by the pilot may be made, until the airplane is 400 feet above the takeoff surface.

(d) The takeoff path must be determined by a continuous demonstrated takeoff or by synthesis from segments. If the takeoff path is determined by the segmental method, the following apply:

(1) The segments must be clearly defined and must be related to the distinct changes in the configuration, speed, and power or thrust;

(2) The weight of the airplane, the configuration, and the power or thrust must be constant throughout each segment and must correspond to the most critical condition prevailing in the segment;

(3) The flight path must be based on the airplane's performance without ground effect; and

(4) The takeoff path data must be checked by continuous demonstrated takeoffs, up to the point at which the airplane is out of ground effect and its speed is stabilized, to ensure that the path is conservative relative to the continuous path.

Note: The airplane is considered to be out of the ground effect when it reaches a height equal to its wing span.

7. Takeoff Distance and Takeoff Run

In the absence of specific takeoff distance and takeoff run requirements, the following apply:

(a) Takeoff distance is the greater of the following:

(1) The horizontal distance along the takeoff path from the start of the takeoff to the point at which the airplane is 35 feet above the takeoff surface, determined under special condition 6; or

(2) 115 percent of the horizontal distance along the takeoff path, with all engines operating, from the start of the takeoff to the point at which the airplane is 35 feet above the takeoff surface, as determined by a procedure consistent with special condition 6.

(b) If the takeoff distance includes a clear way, the takeoff run is the greater of:

(1) The horizontal distance along the takeoff path from the start of the takeoff to a point equidistant between the point at which V_{LOF} is reached and the point at which the airplane is 35 feet above the takeoff surface, as determined under special condition 6; or

(2) 115 percent of the horizontal distance along the takeoff path, with all engines operating, from the start of the takeoff to a point equidistant between the point at which V_{LOF} is reached and the point at which the airplane is 35 feet above the takeoff surface, determined by a procedure consistent with special condition 6.

8. Takeoff Flight Path

In the absence of specific takeoff flight path requirements, the following apply:

(a) The takeoff flight path begins 35 feet above the takeoff surface at the end of the takeoff distance determined in accordance with special condition 7.

(b) The net takeoff flight path data must be determined so that they represent the actual takeoff flight paths (determined in accordance with special condition 6 and with paragraph (a) of this special condition) reduced at each point by a gradient of climb equal to 0.8 percent.

(c) The prescribed reduction in climb gradient may be applied as an equivalent reduction in acceleration along that part of the takeoff flight path at which the airplane is accelerated in level flight.

9. Climb: General

Instead of compliance with § 23.63, the following applies: Compliance with the requirements of special conditions 10 and 12 must be shown at each weight, altitude, and ambient temperature within the operational limits established for the airplane and with the most unfavorable center of gravity for each configuration.

10. Climb: One Engine Inoperative

Instead of compliance with § 23.67, the following apply:

(a) *Takeoff; landing gear extended.* In the critical takeoff configuration existing along the flight path (between the points at which the airplane reaches V_{LOF} and at which the landing gear is fully retracted) and in the configuration used in special condition 6 without ground effect, unless there is a more critical power operating condition existing later along the flight path before the point at which the landing gear is fully retracted, the steady gradient of climb must be positive at V_{LOF} and with the following:

(1) The critical engine inoperative and the remaining engines at the power or thrust available when retraction of the landing gear begins in accordance with special condition 6, and

(2) The weight equal to the weight existing when retraction of the landing gear begins, determined under special condition 6.

(b) *Takeoff; landing gear retracted.* In the takeoff configuration existing at the point of the flight path at which the landing gear is fully retracted and in the configuration used in special condition 6, without ground effect, the steady gradient of climb may not be less than 2.4 percent at V_2 and with the following:

(1) The critical engine inoperative, the remaining engines at the takeoff power or thrust available at the time the landing gear is fully retracted, determined under special condition 6 unless there is a more critical power operating condition existing later along the flight path but before the point where the airplane reaches a height of 400 feet above the takeoff surface; and

(2) The weight equal to the weight existing when the airplane's landing gear is fully retracted, determined under special condition 6.

(c) *Final takeoff.* In the enroute configuration at the end of the takeoff path, determined in accordance with special condition 6, the steady gradient of climb may not be less than 1.2 percent at not less than 1.25 V_S and with the following:

(1) The critical engine inoperative and the remaining engines at the available maximum continuous power or thrust; and

(2) The weight equal to the weight existing at the end of the takeoff path, determined under special condition 6.

(d) *Approach.* In the approach configuration corresponding to the normal all-engines-operating procedure in which V_S for this configuration does not exceed 110 percent of the V_S for the related landing configuration, the steady gradient of climb may not be less than 2.1 percent with the following:

(1) The critical engine inoperative, the remaining engine at the available in-flight takeoff power or thrust;

(2) The maximum landing weight; and

(3) A climb speed established in connection with normal landing procedures, but not exceeding 1.5 V_S.

11. Landing

Instead of compliance with § 23.75, the following apply:

(a) The horizontal distance necessary to land and to come to a complete stop from a point 50 feet above the landing surface must be determined (for each weight, altitude, temperature, and wind within the operational limits established by the applicant for the airplane), as follows:

(1) The airplane must be in the landing configuration.

(2) A steady approach at a gradient of descent not greater than 5.2 percent (3 degrees), with an airspeed of not less than V_{REF}, determined in accordance with § 23.73(b), must be maintained down to the 50-foot height.

(3) Changes in configuration, power or thrust, and speed, must be made in accordance with the established procedures for service operation.

(4) The landing must be made without excessive vertical acceleration, tendency to bounce, nose over, ground loop, or porpoise.

(5) The landings may not require exceptional piloting skill or alertness.

(6) It must be shown that a safe transition to the balked landing conditions of special condition 12 can be made from the conditions that exist at the 50-foot height.

(b) The landing distance must be determined on a level, smooth, dry, hard-surfaced runway. In addition, the following apply:

(1) The brakes may not be used so as to cause excessive wear of brakes or tires; and

(2) Means other than wheel brakes may be used if that means is as follows:

(i) Is safe and reliable;

(ii) Is used so that consistent results can be expected in service; and

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

(c) The landing distance data must include correction factors for not more than 50 percent of the nominal wind components along the landing path opposite to the direction of landing and not less than 150 percent of the nominal wind components along the landing path in the direction of landing.

(d) If any device is used that depends on the operation of any engine, and if the landing distance would be noticeably increased when a landing is made with that engine inoperative, the landing distance must be determined with that engine inoperative unless the use of compensating means will result in a landing distance not more than that with each engine operating.

12. Balked Landing

Instead of compliance with § 23.77, the following apply:

In the landing configuration, the steady gradient of climb may not be less than 3.2 percent with the following:

(a) The engines at the power or thrust that is available eight seconds after initiation of movement of the power or thrust controls from the minimum flight idle to the inflight takeoff position; and

(b) A climb speed of not more than V_{REF}, as defined in § 23.73(a).

13. Stall Speed

Instead of compliance with § 23.49, the following apply:

(a) V_S is the calibrated stalling speed, or the minimum steady flight speed, in knots, at which the airplane is controllable with—

(1) Zero thrust at the stalling speed, or, if the resultant thrust has no appreciable effect on the stalling speed, with engines idling and throttles closed;

(2) The weight used when V_S is being used as a factor to determine compliance with a required performance standard; and

(3) The most unfavorable center of gravity allowable.

(b) The stalling speed V_S is the minimum speed obtained as follows:

(1) Trim the airplane for straight flight at any speed not less than 1.2 V_S or more than 1.4 V_S. At a speed sufficiently above the stall speed to ensure steady conditions, apply the elevator control at a rate so that the airplane speed reduction does not exceed one knot per second.

(2) Meet the flight characteristics provisions of special condition 19.

14. Trim

Instead of compliance with § 23.161, the following apply:

(a) *General.* Each airplane must meet the trim requirements of this special condition after being trimmed, and without further pressure upon or movement of the primary controls or their corresponding trim controls by the pilot or the automatic pilot.

(b) *Lateral and directional trim.* The airplane must maintain lateral and directional trim with the most adverse lateral displacement of the center of gravity within the relevant operating limitations during normally expected conditions of operation (including operation at any speed from 1.4 V_{S1} to V_{MO}/M_{MO}.)

(c) *Longitudinal trim.* The airplane must maintain longitudinal trim during the following:

(1) A climb with maximum continuous power at a speed not more than 1.4 V_{S1}, with the landing gear retracted, and the flaps in the following positions:

(i) Retracted, and

(ii) In the takeoff position.

(2) A power approach with a 3 degree angle of descent, the landing gear extended, and with the following:

(i) The wing flaps retracted and at a speed of 1.4 V_{S1}; and

(ii) The applicable airspeed and flap position used in showing compliance with special condition 11.

(3) Level flight at any speed from 1.4 V_{S1} to V_{MO}/M_{MO} with the landing gear and flaps retracted, and from 1.4 V_{S1} to V_{LE} with the landing gear extended.

(d) *Longitudinal, directional, and lateral trim.* The airplane must maintain longitudinal, directional, and lateral trim (for the lateral trim, the angle of bank may not exceed five degrees) at 1.4 V_{S1} during climbing flight with the following:

(1) The critical engine inoperative;

(2) The remaining engine at maximum continuous power or thrust; and

(3) The landing gear and flaps retracted.

15. Static Longitudinal Stability

Instead of compliance with § 23.173, the following apply:

Under the conditions specified in special condition 16, the characteristics of the elevator control forces (including friction) must be as follows:

(a) A pull must be required to obtain and maintain speeds below the specified trim speed, and a push must be required to obtain and maintain speeds above the specified trim speed. This must be shown at any speed that can be obtained except speeds higher than the landing gear or wing flap operating limit speeds or V_{FC}/M_{FC}, whichever is appropriate, or lower than the minimum speed for steady unstalled flight.

(b) The airspeed must return to within 10 percent of the original trim speed for the climb, approach, and landing conditions specified in special condition 16, paragraphs (a), (c), and (d), and must return to within 7.5 percent of the original trim speed for the cruising condition specified in special condition 16, paragraph (b), when the control force is slowly released from any speed within the range specified in paragraph (a) of this special condition.

(c) The average gradient of the stable slope of the stick force versus speed curve may not be less than 1 pound for each 6 knots.

(d) Within the free return speed range specified in paragraph (b) of this special condition, it is permissible for the airplane, without control forces, to stabilize on speeds above or below the desired trim speeds if exceptional attention on the part of the pilot is not required to return to and maintain the desired trim speed and altitude.

16. Demonstration of Static Longitudinal Stability

Instead of compliance with § 23.175, static longitudinal stability must be shown as follows:

(a) *Climb.* The stick force curve must have a stable slope at speeds between 85 and 115 percent of the speed at which the airplane—

(1) Is trimmed, with—

(i) Wing flaps retracted;

(ii) Landing gear retracted;

(iii) Maximum takeoff weight; and

(iv) The maximum power or thrust selected by the applicant as an operating limitation for use during climb; and

(2) Is trimmed at the speed for best rate of climb except that the speed need not be less than 1.4 V_{S1}.

(b) *Cruise.* Static longitudinal stability must be shown in the cruise condition as follows:

(1) With the landing gear retracted at high speed, the stick force curve must have a stable slope at all speeds within a range which is the greater of 15 percent of the trim speed plus the resulting free return speed range, or 50 knots plus the resulting free return speed range, above and below the trim speed (except that the speed range need not include speeds less than 1.4 V_{S1}, nor speeds greater than V_{FC}/M_{FC}, nor speeds that require a stick force of more than 50 pounds), with—

(i) The wing flaps retracted;

(ii) The center of gravity in the most adverse position;

(iii) The most critical weight between the maximum takeoff and maximum landing weights;

(iv) The maximum cruising power selected by the applicant as an operating limitation, except that the power need not exceed that required at V_{MO}/M_{MO}; and

(v) The airplane trimmed for level flight with the power required in paragraph (b)(1)(iv) of this special condition.

(2) With the landing gear retracted at low speed, the stick force curve must have a stable slope at all speeds within a range which is the greater of 15 percent of the trim speed plus the resulting free return speed range, or 50 knots plus the resulting free return speed range, above and below the trim speed (except that the speed range need not include speeds less than 1.4 V_{S1}, nor speeds greater than the minimum speed of the applicable speed range prescribed in paragraph (b)(1), nor speeds that require a stick force of more than 50 pounds), with—

(i) Wing flaps, center of gravity position, and weight as specified in paragraph (b)(1) of this special condition;

(ii) Power required for level flight at a speed equal to $(V_{MO} + 1.4\ V_{S1})/\ 2$; and

(iii) The airplane trimmed for level flight with the power required in paragraph (b)(2)(ii) of this special condition.

(3) With the landing gear extended, the stick force curve must have a stable slope at all speeds within a range which is the greater of 15 percent of the trim speed plus the resulting free return speed range, or 50 knots plus the resulting free return speed range, above and below the trim speed (except that the speed range need not include speeds less than 1.4 V_{S1}, nor speeds greater than V_{LE}, nor speeds that require a stick force of more than 50 pounds), with—

(i) Wing flap, center of gravity position, and weight as specified in paragraph (b)(1) of this section;

(ii) The maximum cruising power selected by the applicant as an operating limitation, except that the power need not exceed that required for level flight at V_{LE}; and

(iii) The aircraft trimmed for level flight with the power required in paragraph (b)(3)(ii) of this section.

(c) *Approach.* The stick force curve must have a stable slope at speeds between 1.1 V_{S1} and 1.8 V_{S1}, with—

(1) Wing flaps in the approach position;

(2) Landing gear retracted;

(3) Maximum landing weight; and

(4) The airplane trimmed at 1.4 V_{S1} with enough power to maintain level flight at this speed.

(d) *Landing.* The stick force curve must have a stable slope, and the stick force may not exceed 80 pounds, at speeds between 1.1 V_{S0} and 1.3 V_{S0} with—

(1) Wing flaps in the landing position;

(2) Landing gear extended;

(3) Maximum landing weight;

(4) Power or thrust off on the engines; and

(5) The airplane trimmed at 1.4 V_{S0} with power or thrust off.

17. Static Directional and Lateral Stability

Instead of compliance with § 23.177, the following apply:

(a) The static directional stability (as shown by the tendency to recover from a skid with the rudder free) must be positive for any landing gear and flap position, and it must be positive for any symmetrical power condition to speeds from 1.2 V_{S1} up to V_{FE}, V_{LE}, or V_{FC}/M_{FC} (as appropriate).

(b) The static lateral stability (as shown by the tendency to raise the low wing in a sideslip with the aileron controls free and for any landing gear position and flap position, and for any symmetrical power conditions) may not be negative at any airspeed (except speeds higher than V_{FE} or V_{LE}, when appropriate) in the following airspeed ranges:

(1) From 1.2 V_{S1} to V_{MO}/M_{MO}.

(2) From V_{MO}/M_{MO} to V_{FC}/M_{FC}, unless the Administrator finds that the divergence is—

(i) Gradual;

(ii) Easily recognizable by the pilot; and

(iii) Easily controllable by the pilot.

(c) In straight, steady, sideslips (unaccelerated forward slips) the aileron and rudder control movement and forces must be substantially proportional to the angle of the sideslip. The factor of proportionality must lie between limits found necessary for safe operation throughout the range of sideslip angles appropriate to the operation of the airplane. At greater angles, up to the angle at which full rudder control is used or when a rudder pedal force of 180 pounds is obtained, the rudder pedal forces may not reverse and increased rudder deflection must produce increased angles of sideslip. Unless the airplane has a yaw indicator, there must be enough bank accompanying sideslipping to clearly indicate any departure from steady unyawed flight.

18. Stall Demonstration

Instead of compliance with § 23.201, the following apply:

(a) Stalls must be shown in straight flight and in 30 degree banked turns with—

(1) Power off; and

(2) The power necessary to maintain level flight at 1.6 V_{S1} (where V_{S1} corresponds to the stalling speed with flaps in the approach position, the landing gear retracted, and maximum landing weight).

(b) In each condition required by paragraph (a) of this section, it must be possible to meet the applicable requirements of special condition 19 with—

(1) Flaps, landing gear, and deceleration devices in any likely combination of positions approved for operation;

(2) Representative weights within the range for which certification is requested;

(3) The most adverse center of gravity for recovery; and

(4) The airplane trimmed for straight flight at the speed prescribed in special condition 13.

(c) The following procedures must be used to show compliance with special condition 19:

(1) Starting at a speed sufficiently above the stalling speed to ensure that a steady rate of speed reduction can be established, apply the longitudinal control so that the speed reduction does not exceed one knot per second until the airplane is stalled.

(2) In addition, for turning flight stalls, apply the longitudinal control to achieve airspeed deceleration rates up to 3 knots per second.

(3) As soon as the airplane is stalled, recover by normal recovery techniques.

(d) The airplane is considered stalled when the behavior of the airplane gives the pilot a clear and distinctive indication of an acceptable nature that the airplane is stalled. Acceptable indications of a stall, occurring either individually or in combination, are—

(1) A nose-down pitch that cannot be readily arrested;

(2) Buffeting, of a magnitude and severity that is a strong and effective deterrent to further speed reduction; or

(3) The pitch control reaches the aft stop and no further increase in pitch attitude occurs when the control is held full aft for a short time before recovery is initiated.

19. Stall Characteristics

Instead of compliance with § 23.203, the following applies:

(a) It must be possible to produce and to correct roll and yaw by unreversed use of the aileron and rudder controls, up to the time the airplane is stalled. No abnormal nose up pitching may occur. The longitudinal control force must be positive up to and throughout the stall. In addition, it must be possible to promptly prevent stalling and to recover from a stall by normal use of the controls.

(b) For level wing stalls, the roll occurring between the stall and the completion of the recovery may not exceed approximately 20 degrees.

(c) For turning flight stalls, the action of the airplane after the stall may not be so violent or extreme as to make it difficult, with normal piloting skill, to effect a prompt recovery and to regain control of the airplane. The maximum bank angle that occurs during the recovery may not exceed—

(1) Approximately 60 degrees in the original direction of the turn, or 30 degrees in the opposite direction, for deceleration rates up to 1 knot per second; and

(2) Approximately 90 degrees in the original direction of the turn, or 60 degrees in the opposite direction, for deceleration rates in excess of 1 knot per second.

20. Stall Warning

Instead of compliance with § 23.207, the following applies:

(a) Stall warning with sufficient margin to prevent inadvertent stalling with the flaps and landing gear in any normal position must be clear and distinctive to the pilot in straight and turning flight.

(b) The warning may be furnished either through the inherent aerodynamic qualities of the airplane or by a device that will give clearly distinguishable indications under expected conditions of flight. However, a visual stall warning device that requires the attention of the crew within the cockpit is not acceptable by itself. If a warning device is used, it must provide a warning in each of the airplane configurations prescribed in paragraph (a) of this special condition at the speed prescribed in paragraph (c) of this special condition.

(c) The stall warning must begin at a speed exceeding the stalling speed (i.e., the speed at which the airplane stalls or the minimum speed demonstrated, whichever is applicable under the provisions of special condition 18, paragraph (d)) by seven percent or at any lesser margin if the stall warning has enough clarity, duration, distinctiveness, or similar properties.

21. Vibration and Buffeting

Instead of compliance with § 23.251, the following apply:

(a) The airplane must be designed to withstand any vibration and buffeting that might occur in any likely operating condition. This must be shown by calculations, resonance tests, or other tests found necessary by the Administrator.

(b) Each part of the airplane must be shown in flight to be free from excessive vibration, under any appropriate speed and power conditions up to V_{DF}/M_{DF}. The maximum speeds shown must be used in establishing the operating limitations of the airplane in accordance with special condition 34.

(c) Except as provided in paragraph (d) of this special condition, there may be no buffeting condition in normal flight, including configuration changes during cruise, severe enough to interfere with the control of the airplane, to cause excessive fatigue to the flightcrew, or to cause structural damage. Stall warning buffeting within these limits is allowable.

(d) There may be no perceptible buffeting condition in the cruise configuration in straight flight at any speed up to V_{MO}/M_{MO}, except that stall warning buffeting is allowable.

(e) With the airplane in the cruise configuration, the positive maneuvering load factors at which the onset of perceptible buffeting occurs must be determined for the ranges of airspeed or Mach Number, weight, and altitude for which the airplane is to be certified. The envelopes of load factor, speed, altitude, and weight must provide a sufficient range of speeds and load factors for normal operations. Probable inadvertent excursions beyond the boundaries of the buffet onset envelopes may not result in unsafe conditions.

22. High Speed Characteristics

Instead of compliance with § 23.253, the following apply:

(a) *Speed increase and recovery characteristics.* The following speed increase and recovery characteristics must be met:

(1) Operating conditions and characteristics likely to cause inadvertent speed increases (including upsets in pitch and roll) must be simulated with the airplane trimmed at any likely cruise speed up to V_{MO}/M_{MO}. These conditions and characteristics include gust upsets, inadvertent control movements, low stick force gradient in relation to control friction, passenger movement, leveling off from climb, and descent from Mach to airspeed limit altitudes.

(2) Allowing for pilot reaction time after effective inherent or artificial speed warning occurs, it must be shown that the airplane can be recovered to a normal attitude and its speed reduced to V_{MO}/M_{MO} without the following:

(i) Exceptional piloting strength or skill;

(ii) Exceeding V_D/M_D, or V_{DF}/M_{DF}, or the structural limitations; and

(iii) Buffeting that would impair the pilot's ability to read the instruments or control the airplane for recovery.

(3) There may be no control reversal about any axis at any speed up to V_{DF}/M_{DF} with the airplane trimmed at V_{MO}/M_{MO}. Any tendency of the airplane to pitch, roll, or yaw must be mild and readily controllable, using normal piloting techniques. When the airplane is trimmed at V_{MO}/M_{MO}, the slope of the elevator control force versus speed curve need not be stable at speeds greater than V_{FC}/M_{FC}, but there must be a push force at all speeds up to V_{DF}/M_{DF} and there must be no sudden or excessive reduction of elevator control force as V_{DF}/M_{DF} is reached.

(b) *Maximum speed for stability characteristics. V_{FC}/M_{FC}.* V_{FC}/M_{FC} is the maximum speed at which the requirements of special conditions 15, 16, 17, and § 23.181 must be met with the flaps and landing gear retracted. It 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.

23. Flight Flutter Testing

Instead of the term/speed V_D in § 23.629(b), use V_{DF}/M_{DF}.

24. Out-of-Trim Characteristics

In the absence of specific requirements for out-of-trim characteristics, the following are applied:

(a) From an initial condition with the airplane trimmed at cruise speeds up to V_{MO}/M_{MO}, the airplane must have satisfactory maneuvering stability and controllability with the degree of out-of-trim in both the airplane nose-up and nose-down directions, which results from the greater of the following:

(1) A three-second movement of the longitudinal trim system at its normal rate for the particular flight condition with no aerodynamic load (or an equivalent degree of trim for airplanes that do not have a power-operated trim system), except as limited by stops in the trim system including those required by § 23.655(b) for adjustable stabilizers; or

(2) The maximum mis-trim that can be sustained by the autopilot while maintaining level flight in the high speed cruising condition.

(b) In the out-of-trim condition specified in paragraph (a) of this special condition, when the normal acceleration is varied from +1 g to the positive and negative values specified in paragraph (c) of this special condition, the following apply:

(1) The stick force versus g curve must have a positive slope at any speed up to and including V_{FC}/M_{FC}; and

(2) At speeds between V_{FC}/M_{FC} and V_{DF}/M_{DF}, the direction of the primary longitudinal control force may not reverse.

(c) Except as provided in paragraphs (d) and (e) of this special condition, compliance with the provisions of paragraph (a) of this special condition must be demonstrated in flight over the acceleration range as follows:

(1) −1 g to +2.5 g; or

(2) 0 g to 2.0 g, and extrapolating by an acceptable method to −1 g and +2.5 g.

(d) If the procedure set forth in paragraph (c)(2) of this special condition is used to demonstrate compliance and marginal conditions exist during flight test with regard to reversal of primary longitudinal control force, flight tests must be accomplished from the normal acceleration at which a marginal condition is found to exist to the applicable limit specified in paragraph (b)(1) of this special condition.

(e) During flight tests required by paragraph (a) of this special condition, the limit maneuvering load factors, prescribed in §§ 23.333(b) and 23.337, need not be exceeded. Also, the maneuvering load factors associated with probable inadvertent excursions beyond the boundaries of the buffet onset envelopes determined under special condition 21, paragraph (e), need not be exceeded. In addition, the entry speeds for flight test demonstrations at normal acceleration values less than 1 g must be limited to the extent necessary to accomplish a recovery without exceeding V_{DF}/M_{DF}.

(f) In the out-of-trim condition specified in paragraph (a) of this special condition, it must be possible from an overspeed condition at V_{DF}/M_{DF} to produce at least 1.5 g for recovery by applying not more than 125 pounds of longitudinal control force using either the primary longitudinal control alone or the primary longitudinal control and the longitudinal trim system. If the longitudinal trim is used to assist in producing the required load factor, it must be shown at V_{DF}/M_{DF} that the longitudinal trim can be actuated in the airplane nose-up direction with the primary surface loaded to correspond to the least of the following airplane nose-up control forces:

(1) The maximum control forces expected in service, as specified in §§ 23.301 and 23.397.

(2) The control force required to produce 1.5 g.

(3) The control force corresponding to buffeting or other phenomena of such intensity that is a strong deterrent to further application of primary longitudinal control force.

25. Pressure Vessel Integrity

(a) The maximum extent of failure and pressure vessel opening that can be demonstrated to comply with special condition 30 (Pressurization) of these special conditions must be determined. It must be demonstrated by crack propagation and damage tolerance analysis supported by testing that a larger opening or a more severe failure than demonstrated will not occur in normal operations.

(b) Inspection schedules and procedures must be established to ensure that cracks and normal fuselage leak rates will not deteriorate to the extent that an unsafe condition could exist during normal operation.

(c) With regard to the fuselage structure design for cabin pressure capability above 45,000 feet, the pressure vessel structure, including doors and windows, must comply with § 23.365(d), using a factor of 1.67 instead of the 1.33 factor prescribed.

26. Fasteners

This section has been deleted, current § 23.607 is adequate.

27. Landing Gear

The main landing gear system must be designed so that if it fails due to overloads during takeoff or landing (assuming the overloads to act in the upward and aft directions), the failure mode is not likely to cause the spillage of enough fuel from any fuel system in the fuselage to constitute a fire hazard.

28. Ventilation

In addition to the requirements of § 23.831(b), the ventilation system must be designed to provide a sufficient amount of uncontaminated air to enable the crewmembers to perform their duties without undue discomfort or fatigue and to provide reasonable passenger comfort during normal operating conditions and in the event of any probable failure of any system on the airplane that would adversely affect the cabin ventilating air. For normal operations, crewmembers and passengers must be provided with at least 10 cubic feet of fresh air per minute per person, or the equivalent in filtered recirculated air, based on the volume and composition at the corresponding cabin pressure altitude of no more than 8,000 feet.

29. Air Conditioning

In addition to the requirements of § 23.831, cabin cooling systems must be designed to meet the following conditions during flight above 15,000 feet MSL:

(a) After any probable failure, the cabin temperature/time history may not exceed the values shown in Figure 1. During this time, the humidity shall never exceed a level that corresponds to a water vapor pressure of 20mm Hg. Time = 0 minutes when the flightcrew recognizes the failure.

(b) After any improbable failure, the cabin temperature/time history may not exceed the values shown in Figure 2. During this time, the humidity shall never exceed a level that corresponds to a water vapor pressure of 20mm Hg. Time = 0 minutes when the flightcrew recognizes the failure.

30. Pressurization

Instead of compliance with § 23.841, the following apply:

(a) Pressurized cabins must be equipped to provide a cabin pressure altitude of not more than 8,000 feet at the maximum operating altitude of the airplane under normal operating conditions.

(1) If certification for operation above 25,000 feet is requested, the airplane must be designed so that occupants will not be exposed to cabin pressure altitudes in excess of 15,000 feet after any probable failure condition in the pressurization system.

(2) The airplane must be designed so that occupants will not be exposed to a cabin pressure altitude that exceeds that following after decompression from any failure conditions not shown to be extremely improbable:

(i) Twenty-five thousand (25,000) feet for more than 2 minutes; or

(ii) Forty thousand (40,000) feet for any duration.

(3) Fuselage structure, engine and system failures are to be considered in evaluating the cabin decompression.

(b) Pressurized cabins must have at least the following valves, controls, and indicators for controlling cabin pressure:

(1) Two pressure relief valves to automatically limit the positive pressure differential to a predetermined value at the maximum rate of flow delivered by the pressure source. The combined capacity of the relief valves must be large enough so that the failure of any one valve would not cause an appreciable rise in the pressure differential. The pressure differential is positive when the internal pressure is greater than the external.

(2) Two reverse pressure differential relief valves (or their equivalents) to automatically prevent a negative pressure differential that would damage the structure. One valve is enough, however, if it is of a design that reasonably precludes its malfunctioning.

(3) A means by which the pressure differential can be rapidly equalized.

(4) An automatic or manual regulator for controlling the intake or exhaust airflow, or both, for maintaining the required internal pressure and airflow rates.

(5) Instruments at the pilot station to show the pressure differential, the cabin pressure altitude, and the rate of change of the cabin pressure altitude.

(6) Warning indication at the pilot station to indicate when the safe or preset pressure differential and cabin pressure altitude limits are exceeded. Appropriate warning marking on the cabin pressure differential indicator meets the warning requirement for pressure differential limits and an aural or visual signal (in addition to cabin altitude indicating means) meets the warning requirement for cabin pressure altitude limits if it warns the flight crew when the cabin pressure altitude exceeds 10,000 feet.

(7) A warning placard at the pilot station, if the structure is not designed for pressure differentials up to the maximum relief valve setting in combination with landing loads.

(8) The pressure sensors necessary to meet the requirements of paragraphs (b)(5) and (b)(6) of this section and § 23.1447, paragraphs (e) and (f), must be located and the sensing system must be designed so that, in the event of low of cabin pressure, the warning and automatic presentation devices, required by those provisions, will be actuated without any delay that would significantly increase the hazards resulting from decompression.

31. Airspeed Indicating System

In addition to the requirements of § 23.1323, the following apply:

(a) The airspeed indicating system must be calibrated to determine the system error in flight and during the accelerate-takeoff ground run. The ground run calibration must be determined as follows:

(1) From 0.8 of the minimum value of V_1 to the maximum value of V_2,, considering the approved ranges of altitude and weight; and

(2) With the flaps and power settings corresponding to the values determined in the establishment of the takeoff path under special condition 6, assuming that the critical engine fails at the minimum value of V_1.

(b) The information showing the relationship between IAS and CAS, determined in accordance with paragraph (a) of this special condition, must be shown in the Airplane Flight Manual.

32. Static Pressure System

In addition to the requirements of § 23.1325, the following apply:

(a) The altimeter system calibration required by § 23.1325(e) must be shown in the Airplane Flight Manual.

(b) If an altimeter system is fitted with a device that provides corrections to the altimeter indication, the device must be designed and installed in such manner that it can be by-passed when it malfunctions, unless an alternate altimeter system is provided. Each correction device must be fitted with a means for indicating the occurrence of reasonably probable malfunctions, including power failure, to the flightcrew. The indicating means must be effective for any cockpit lighting condition likely to occur.

33. Oxygen Equipment and Supply

(a) In addition to the requirements of § 23.1441(d), the following applies: A quick-donning oxygen mask system with a pressure-demand, mask mounted regulator must be provided for the flightcrew. It must be shown that each quick-donning mask can, with one hand and within 5 seconds, be placed on the face from its ready position, properly secured, sealed, and supplying oxygen upon demand.

(b) In addition to the requirements of § 23.1443, the following applies: A continuous flow oxygen system must be provided for the passengers.

(c) In addition to the requirements of § 23.1445, the following applies: If the flightcrew and passengers share a common source of oxygen, a means to separately reserve the minimum supply required by the flightcrew must be provided.

34. Maximum Operating Limit Speed

Instead of compliance with § 23.1505(c), the following applies: The maximum operating limit speed (V_{MO}/M_{MO} airspeed or Mach number, whichever is critical at a particular altitude) is a speed that 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 operations. V_{MO}/M_{MO} must be established so that it is not greater than the design cruising speed, V_C, and so that it is 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 operations. The speed margin between V_{MO}/M_{MO} and V_D/M_D, or V_{DF}/M_{DF}, may not be less than that determined under § 23.335(b) or found necessary during the flight tests conducted under special condition 22.

35. Minimum Flightcrew

Instead of compliance with § 23.1523, the following apply:

The minimum flightcrew must be established so that it is sufficient for safe operation considering:

(a) The workload on individual flightcrew members and each flightcrew member workload determination must consider the following:

(1) Flight path control,

(2) Collision avoidance,

(3) Navigation,

(4) Communications,

(5) Operation and monitoring of all essential airplane systems,

(6) Command decisions, and

(7) The accessibility and ease of operation of necessary controls by the appropriate flightcrew member during all normal and emergency operations when at the flightcrew member station.

(b) The accessibility and ease of operation of necessary controls by the appropriate flightcrew member; and

(c) The kinds of operation authorized under § 23.1525.

36. Airplane Flight Manual

Instead of compliance with § 23.1581, the following applies:

(a) *Furnishing information.* An Airplane Flight Manual must be furnished with each airplane, and it must contain the following:

(1) Information required by special conditions 37, 38, and 39.

(2) Other information that is necessary for safe operation because of design, operating, or handling characteristics.

(3) Any limitation, procedure, or other information established as a condition of compliance with the applicable noise standards of part 36 of this chapter.

(b) *Approved Information.* Each part of the manual listed in special conditions 37, 38, and 39, that is appropriate to the airplane, must be furnished, verified, and approved, and must be segregated, identified, and clearly distinguished from each unapproved part of that manual.

(c) *Airplane Flight Manual.* Each Airplane Flight Manual must include a table of contents if the complexity of the manual indicates a need for it.

(d) *Airplane Flight Manual.* Each page of the Airplane Flight Manual containing information prescribed in this section must be of a type that is not easily erased, disfigured, or misplaced, and is capable of being inserted in a manual provided by the applicant, or in a folder, or in any other permanent binder.

(e) *Airplane Flight Manual.* Provision must be made for stowing the Airplane Flight Manual in a suitable fixed container that is readily accessible to the pilot.

(f) *Revisions and amendments.* Each Airplane Flight Manual (AFM) must contain a means for recording the incorporation of revisions and amendments.

37. Operating Limitations

Instead of the requirements of § 23.1583, the following apply:

(a) *Airspeed limitations.* The following airspeed limitations and any other airspeed limitations necessary for safe operation must be furnished:

(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.

(3) The maneuvering speed, V_O, and a statement that full application of rudder and aileron controls, as well as maneuvers that involve angles of attack near the stall, should be confined to speeds below this value.

(4) The maximum speed for flap extension, V_{FE}, for the takeoff, approach, and landing positions.

(5) The landing gear operating speed or speeds, V_{LO}.

(6) The landing gear extended speed, V_{LE} if greater than V_{LO}, and a statement that this is the maximum speed at which the airplane can be safely flown with the landing gear extended.

(b) *Powerplant limitations.* The following information must be furnished:

(1) Limitations required by § 23.1521.

(2) Explanation of the limitations, when appropriate.

(3) Information necessary for marking the instruments, required by § 23.1549 through § 23.1553.

(c) *Weight and loading distribution.* The weight and extreme forward and aft center of gravity limits required by §§ 23.23 and 23.25 must be furnished in the Airplane Flight Manual. In addition, all of the following information and the information required by § 23.1589 must be presented either in the Airplane Flight Manual or in a separate weight and balance control and loading document, which is incorporated by reference in the Airplane Flight Manual:

(1) The condition of the airplane and the items included in the empty weight, as defined in accordance with § 23.29.

(2) Loading instructions necessary to ensure loading of the airplane within the weight and center of gravity limits, and to maintain the loading within these limits in flight.

(d) *Maneuvers.* A statement that acrobatic maneuvers, including spins, are not authorized.

(e) *Maneuvering flight load factors.* The positive maneuvering limit load factors for which the structure is proven, described in terms of accelerations, and a statement that these accelerations limit the angle of bank in turns and limit the severity of pull-up maneuvers must be furnished.

(f) *Flightcrew.* The number and functions of the minimum flightcrew determined under special condition 35 must be furnished.

(g) *Kinds of operation.* The kinds of operation (such as VFR, IFR, day, or night) and the meteorological conditions in which the airplane may or may not be used must be furnished. Any installed equipment that affects any operating limitation must be listed and identified as to operational function.

(h) *Additional operating limitations must be established as follows:* (1) The maximum takeoff weights must be established as the weights at which compliance is shown with the applicable provisions of part 23 (including the takeoff climb provisions of special condition 10, paragraphs (a) through (c), for altitudes and ambient temperatures).

(2) The maximum landing weights must be established as the weights at which compliance is shown with the applicable provisions of part 23 (including the approach climb and balked landing climb provisions of special conditions 10, paragraph (d), and 12 for altitudes and ambient temperatures).

(3) The minimum takeoff distances must be established as the distances at which compliance is shown with the applicable provisions of part 23 (including the provisions of special conditions 5 and 7 for weights, altitudes, temperatures, wind components, and runway gradients).

(4) The extremes for variable factors (such as altitude, temperature, wind, and runway gradients) are those at which compliance with the applicable provision of part 23 and these special conditions is shown.

(i) *Maximum operating altitude.* The maximum altitude established under § 23.1527 must be furnished.

(j) *Maximum passenger seating configuration.* The maximum passenger seating configuration must be furnished.

38. Operating Procedures

Instead of the requirements of § 23.1585, the following applies:

(a) Information and instruction regarding the peculiarities of normal operations (including starting and warming the engines, taxiing, operation of wing flaps, slats, landing gear, speed brake, and the automatic pilot) must be furnished, together with recommended procedures for the following:

(1) Engine failure (including minimum speeds, trim, operation of the remaining engine, and operation of flaps);

(2) Restarting turbine engines in flight (including the effects of altitude);

(3) Fire, decompression, and similar emergencies;

(4) Use of ice protection equipment;

(5) Operation in turbulence (including recommended turbulence penetration airspeeds, flight peculiarities, and special control instructions);

(6) The demonstrated crosswind velocity and procedures and information pertinent to operation of the airplane in crosswinds.

(b) Information identifying each operating condition in which the fuel system independence prescribed in § 23.953 is necessary for safety must be furnished, together with instructions for placing the fuel system in a configuration used to show compliance with that section.

(c) For each airplane showing compliance with § 23.1353(g)(2) or (g)(3), the operating procedures for disconnecting the battery from its charging source must be furnished.

(d) If the unusable fuel supply in any tank exceeds 5 percent of the tank capacity, or 1 gallon, whichever is greater, information must be furnished indicating that, when the fuel quantity indicator reads ''zero'' in level flight, any fuel remaining in the fuel tank cannot be used safely in flight.

(e) Information on the total quantity of usable fuel for each fuel tank must be furnished.

(f) The buffet onset envelopes determined under special condition 21 must be furnished. The buffet onset envelopes presented may reflect the center of gravity at which the airplane is normally loaded during cruise if corrections for the effect of different center of gravity locations are furnished.

39. Performance Information

Instead of the requirements of § 23.1587, the following applies:

(a) Each Airplane Flight Manual must contain information to permit conversion of the indicated temperature to free air temperature if other than a free air temperature indicator is used to comply with the requirements of § 23.1303(d).

(b) Each Airplane Flight Manual must contain the performance information computed under the applicable provisions of this part for the weights, altitudes, temperatures, wind components, and runway gradients, as applicable, within the operational limits of the airplane, and must contain the following:

(1) The conditions under which the performance information was obtained, including the speeds associated with the performance information.

(2) V_S determined in accordance with special condition 13.

(3) The following performance information (determined by extrapolation and computed for the range of weights between the maximum landing and maximum takeoff weights):

(i) Climb in the landing configuration.

(ii) Climb in the approach configuration.

(iii) Landing distance.

(4) Procedures established under special condition 2, paragraphs (c), (d), and (e), that are related to the limitations and information required by paragraph (h) of special condition 37 and by this paragraph. These procedures must be in the form of guidance material, including any relevant limitations or information.

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

Issued in Kansas City, Missouri on October 15, 1997.

Mary Ellen A. Schutt,

Acting Manager, Small Airplane Directorate, Aircraft Certification Service.

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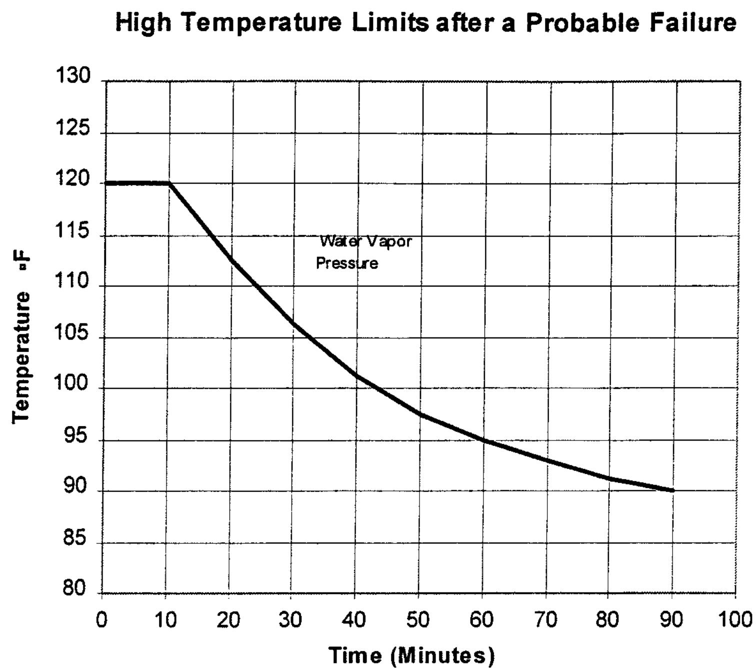

Figure 1

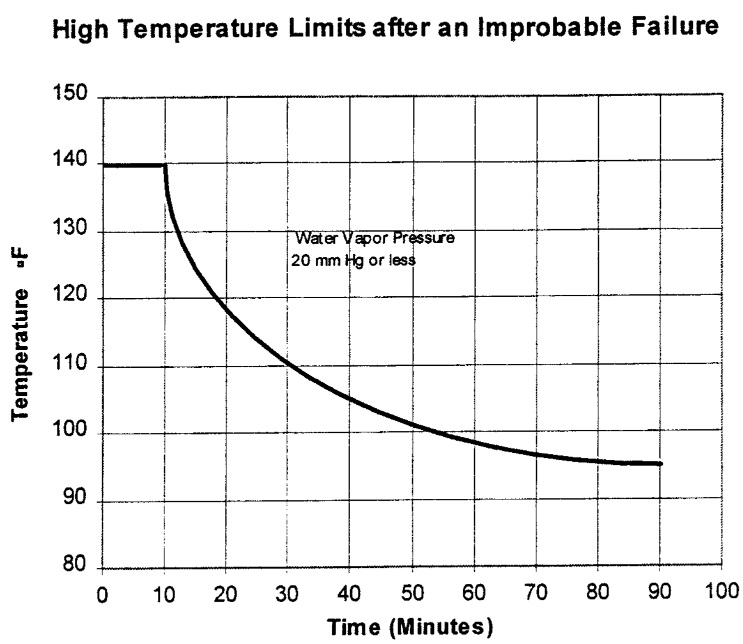

Figure 2

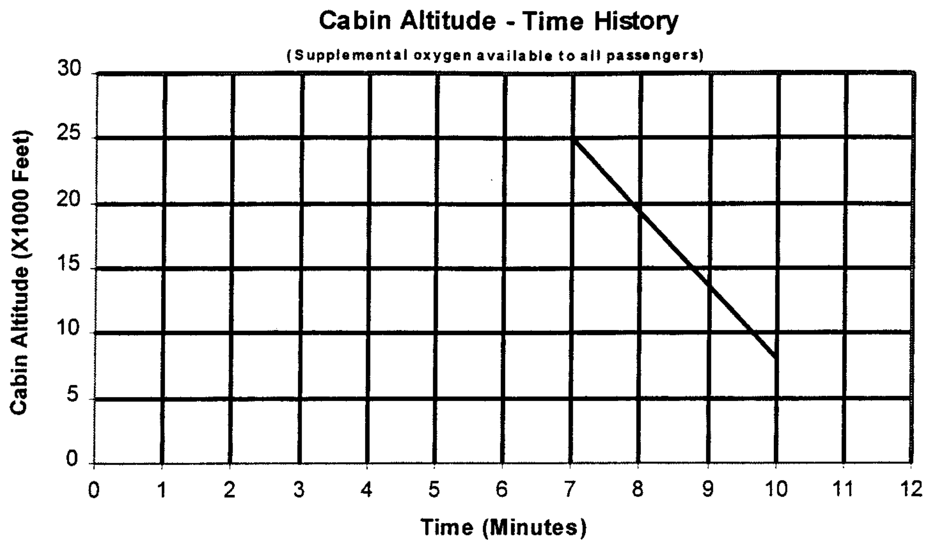

Figure 3

NOTE: For figure 3, time starts at the moment cabin altitude exceeds 8,000 feet during depressurization. If depressurization analysis shows that the cabin altitude limit of this curve is exceeded, the following alternate limitations apply: After depressurization, the maximum cabin altitude exceedence is limited to 30,000 feet. The maximum time the cabin altitude may exceed 25,000 feet is 2 minutes; time starting when the cabin altitude exceeds 25,000 feet and ending when it returns to 25,000 feet.

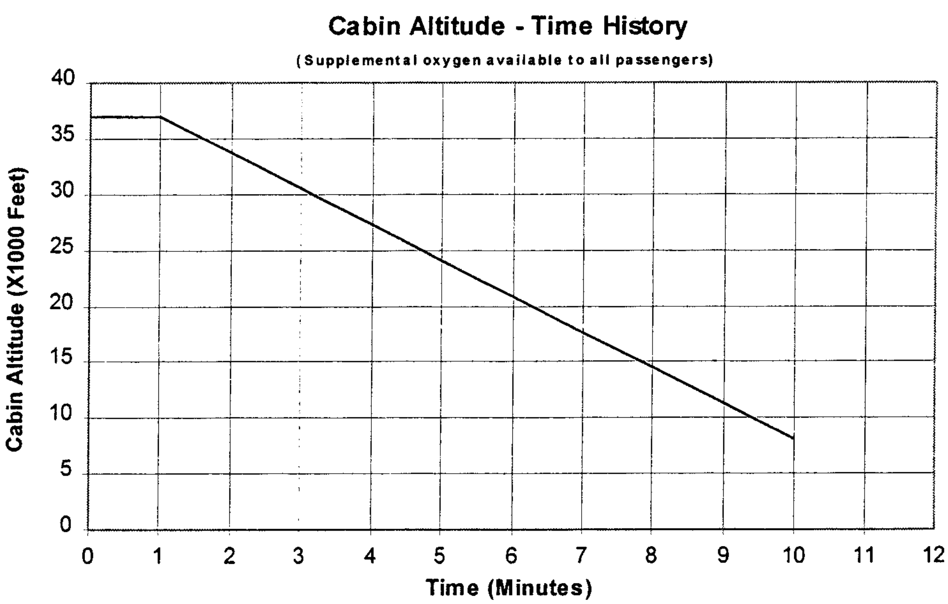

Figure 4

NOTE: For figure 4, time starts at the moment cabin altitude exceeds 8,000 feet during depressurization. If depressurization analysis shows that the cabin altitude limit of this curve is exceeded, the following alternate limitations apply: After depressurization, the maximum cabin altitude exceedence is limited to 40,000 feet. The maximum time the cabin altitude may exceed 25,000 feet is 2 minutes; time starting when the cabin altitude exceeds 25,000 feet and ending when it returns to 25,000 feet.

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