

the directional control force must not exceed 50 pounds at V_2 with—

- (1) The critical engine inoperative and its propeller in the minimum drag position;
- (2) The remaining engine(s) at take-off power;
- (3) Landing gear retracted;
- (4) Wing flaps in the takeoff position(s); and
- (5) An angle of bank not exceeding 5 degrees.

[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-21, 43 FR 2318, Jan. 16, 1978; Amdt. 23-34, 52 FR 1828, Jan. 15, 1987; Amdt. 23-42, 56 FR 351, Jan. 3, 1991; 56 FR 5455, Feb. 11, 1991; Amdt. 23-50, 61 FR 5189, Feb. 9, 1996]

STABILITY

§ 23.171 General.

The airplane must be longitudinally, directionally, and laterally stable under §§ 23.173 through 23.181. In addition, the airplane must show suitable stability and control “feel” (static stability) in any condition normally encountered in service, if flight tests show it is necessary for safe operation.

§ 23.173 Static longitudinal stability.

Under the conditions specified in § 23.175 and with the airplane trimmed as indicated, the characteristics of the elevator control forces and the friction within the control system must be as follows:

- (a) A pull must be required to obtain and maintain speeds below the specified trim speed and a push required to obtain and maintain speeds above the specified trim speed. This must be shown at any speed that can be obtained, except that speeds requiring a control force in excess of 40 pounds or speeds above the maximum allowable speed or below the minimum speed for steady unstalled flight, need not be considered.
- (b) The airspeed must return to within the tolerances specified for applicable categories of airplanes when the control force is slowly released at any speed within the speed range specified in paragraph (a) of this section. The applicable tolerances are—

- (1) The airspeed must return to within plus or minus 10 percent of the original trim airspeed; and

- (2) For commuter category airplanes, the airspeed must return to within plus or minus 7.5 percent of the original trim airspeed for the cruising condition specified in § 23.175(b).

- (c) The stick force must vary with speed so that any substantial speed change results in a stick force clearly perceptible to the pilot.

[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-14, 38 FR 31820 Nov. 19, 1973; Amdt. 23-34, 52 FR 1828, Jan. 15, 1987]

§ 23.175 Demonstration of static longitudinal stability.

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 trim speed, with—

- (1) Flaps retracted;
- (2) Landing gear retracted;
- (3) Maximum continuous power; and
- (4) The airplane trimmed at the speed used in determining the climb performance required by § 23.69(a).

- (b) *Cruise.* With flaps and landing gear retracted and the airplane in trim with power for level flight at representative cruising speeds at high and low altitudes, including speeds up to V_{NO} or V_{MO}/M_{MO} , as appropriate, except that the speed need not exceed V_H —

- (1) For normal, utility, and acrobatic category airplanes, the stick force curve must have a stable slope at all speeds within a range that is the greater of 15 percent of the trim speed plus the resulting free return speed range, or 40 knots plus the resulting free return speed range, above and below the trim speed, except that the slope need not be stable—

- (i) At speeds less than $1.3 V_{S1}$; or
- (ii) For airplanes with V_{NE} established under § 23.1505(a), at speeds greater than V_{NE} ; or
- (iii) For airplanes with V_{MO}/M_{MO} established under § 23.1505(c), at speeds greater than V_{FC}/M_{FC} .

- (2) For commuter category airplanes, the stick force curve must have a stable slope at all speeds within a range of 50 knots plus the resulting free return speed range, above and below the trim

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speed, except that the slope need not be stable—

- (i) At speeds less than $1.4 V_{S1}$; or
- (ii) At speeds greater than V_{FC}/M_{FC} ; or
- (iii) At speeds that require a stick force greater than 50 pounds.

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

- (1) Flaps in the landing position;
- (2) Landing gear extended; and
- (3) The airplane trimmed at—
 - (i) V_{REF} , or the minimum trim speed if higher, with power off; and
 - (ii) V_{REF} with enough power to maintain a 3 degree angle of descent.

[Doc. No. 27807, 61 FR 5190, Feb. 9, 1996]

§ 23.177 Static directional and lateral stability.

(a) The static directional stability, as shown by the tendency to recover from a wings level sideslip with the rudder free, must be positive for any landing gear and flap position appropriate to the takeoff, climb, cruise, approach, and landing configurations. This must be shown with symmetrical power up to maximum continuous power, and at speeds from $1.2 V_{S1}$ up to the maximum allowable speed for the condition being investigated. The angle of sideslip for these tests must be appropriate to the type of airplane. At larger angles of sideslip, up to that at which full rudder is used or a control force limit in § 23.143 is reached, whichever occurs first, and at speeds from $1.2 V_{S1}$ to V_O , the rudder pedal force must not reverse.

(b) The static lateral stability, as shown by the tendency to raise the low wing in a sideslip, must be positive for all landing gear and flap positions. This must be shown with symmetrical power up to 75 percent of maximum continuous power at speeds above $1.2 V_{S1}$ in the take off configuration(s) and at speeds above $1.3 V_{S1}$ in other configurations, up to the maximum allowable speed for the configuration being investigated, in the takeoff, climb, cruise, and approach configurations. For the landing configuration, the power must be that necessary to maintain a 3 degree angle of descent in coordinated flight. The static lateral stability must not be negative at $1.2 V_{S1}$ in

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the takeoff configuration, or at $1.3 V_{S1}$ in other configurations. The angle of sideslip for these tests must be appropriate to the type of airplane, but in no case may the constant heading sideslip angle be less than that obtainable with a 10 degree bank, or if less, the maximum bank angle obtainable with full rudder deflection or 150 pound rudder force.

(c) Paragraph (b) of this section does not apply to acrobatic category airplanes certificated for inverted flight.

(d) In straight, steady slips at $1.2 V_{S1}$ for any landing gear and flap positions, and for any symmetrical power conditions up to 50 percent of maximum continuous power, the aileron and rudder control movements and forces must increase steadily, but not necessarily in constant proportion, as the angle of sideslip is increased up to the maximum appropriate to the type of airplane. At larger slip angles, up to the angle at which full rudder or aileron control is used or a control force limit contained in § 23.143 is reached, the aileron and rudder control movements and forces must not reverse as the angle of sideslip is increased. Rapid entry into, and recovery from, a maximum sideslip considered appropriate for the airplane must not result in uncontrollable flight characteristics.

[Doc. No. 27807, 61 FR 5190, Feb. 9, 1996]

§ 23.181 Dynamic stability.

(a) Any short period oscillation not including combined lateral-directional oscillations occurring between the stalling speed and the maximum allowable speed appropriate to the configuration of the airplane must be heavily damped with the primary controls—

- (1) Free; and
- (2) In a fixed position.

(b) Any combined lateral-directional oscillations (“Dutch roll”) occurring between the stalling speed and the maximum allowable speed appropriate to the configuration of the airplane must be damped to 1/10 amplitude in 7 cycles with the primary controls—

- (1) Free; and
- (2) In a fixed position.

(c) If it is determined that the function of a stability augmentation system, reference § 23.672, is needed to