AMC 25.201(d)(3) Stall demonstration

ED Decision 2003/2/RM

An acceptable interpretation of holding the pitch control on the aft stop for a short time is:

a. The pitch control reaches the aft stop and is held full aft for 2 seconds or until the pitch attitude stops increasing, whichever occurs later.

b. In the case of turning flight stalls, recovery may be initiated once the pitch control reaches the aft stop when accompanied by a rolling motion that is not immediately controllable (provided the rolling motion complies with CS 25.203(c)).

c. For those aeroplanes where stall is defined by full nose up longitudinal control for both forward and aft C.G., the time at full aft stick should be not less than was used for stall speed determination, except as permitted by paragraph (b) above.

CS 25.203 Stall characteristics

ED Decision 2003/2/RM

(See AMC 25.203.)

(a) It must be possible to produce and to correct roll and yaw by unreversed use of aileron and rudder controls, up to the time the aeroplane 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°.

(c) For turning flight stalls, the action of the aeroplane 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 aeroplane. The maximum bank angle that occurs during the recovery may not exceed –

  (1) Approximately 60° in the original direction of the turn, or 30° in the opposite direction, for deceleration rates up to 0.5 m/s^2 (1 knot per second); and

  (2) Approximately 90° in the original direction of the turn, or 60° in the opposite direction, for deceleration rates in excess of 0.5 m/s^2 (1 knot per second).

AMC 25.203 Stall characteristics

ED Decision 2003/2/RM

1 *Static Longitudinal Stability during the Approach to the Stall.* During the approach to the stall the longitudinal control pull force should increase continuously as speed is reduced from the trimmed speed to the onset of stall warning. At lower speeds some reduction in longitudinal control pull force will be acceptable provided that it is not sudden or excessive.

2 *Rolling Motions at the Stall*

  2.1 Where the stall is indicated by a nose-down pitch, this may be accompanied by a rolling motion that is not immediately controllable, provided that the rolling motion complies with CS 25.203(b) or (c) as appropriate.

  2.2 In level wing stalls the bank angle may exceed 20° occasionally, provided that lateral control is effective during recovery.

3 *Deep Stall Penetration*. Where the results of wind tunnel tests reveal a risk of a catastrophic phenomenon (e.g. superstall, a condition at angles beyond the stalling incidence from which it proves difficult or impossible to recover the aeroplane), studies should be made to show that adequate recovery control is available at and sufficiently beyond the stalling incidence to avoid such a phenomenon.

CS 25.207 Stall warning

ED Decision 2016/010/R

(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 must be furnished either through the inherent aerodynamic qualities of the aeroplane 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 aeroplane configurations prescribed in sub-paragraph (a) of this paragraph at the speed prescribed in sub-paragraphs (c) and (d) of this paragraph. Except for the stall warning prescribed in subparagraph (h)(3)(ii) of this paragraph, the stall warning for flight in icing conditions must be provided by the same means as the stall warning for flight in non-icing conditions. (See AMC 25.207(b).)

(c) When the speed is reduced at rates not exceeding 0.5 m/s^2 (one knot per second), stall warning must begin, in each normal configuration, at a speed, V_{SW}, exceeding the speed at which the stall is identified in accordance with CS 25.201(d) by not less than 9.3 km/h (five knots) or five percent CAS, whichever is greater. Once initiated, stall warning must continue until the angle of attack is reduced to approximately that at which stall warning began. (See AMC 25.207(c) and (d)).

(d) In addition to the requirement of subparagraph(c) of this paragraph, when the speed is reduced at rates not exceeding 0.5 m/s^2 (one knot per second), in straight flight with engines idling and at the centre-of-gravity position specified in CS 25.103(b)(5), V_{SW}, in each normal configuration, must exceed V_{SR} by not less than 5.6 km/h (three knots) or three percent CAS, whichever is greater. (See AMC 25.207(c) and (d)).

(e) In icing conditions, the stall warning margin in straight and turning flight must be sufficient to allow the pilot to prevent stalling (as defined in CS 25.201(d)) when the pilot starts a recovery manoeuvre not less than three seconds after the onset of stall warning. When demonstrating compliance with this paragraph, the pilot must perform the recovery manoeuvre in the same way as for the airplane in non-icing conditions. Compliance with this requirement must be demonstrated in flight with the speed reduced at rates not exceeding 0.5 m/sec^2 (one knot per second), with –

(1) The most critical of the take-off ice and final take-off ice accretions defined in Appendices C and O, as applicable, in accordance with CS 25.21(g), for each configuration used in the take-off phase of flight;

(2) The most critical of the en route ice accretion(s) defined in Appendices C and O, as applicable, in accordance with CS 25.21(g), for the en route configuration;

(3) The most critical of the holding ice accretion(s) defined in Appendices C and O, as applicable, in accordance with CS 25.21(g), for the holding configuration(s);

(4) The most critical of the approach ice accretion(s) defined in Appendices C and O, as applicable, in accordance with CS 25.21(g), for the approach configuration(s); and

(5) The most critical of the landing ice accretion(s) defined in Appendices C and O, as applicable, in accordance with CS 25.21(g), for the landing and go-around configuration(s).

(f) The stall warning margin must be sufficient in both non-icing and icing conditions to allow the pilot to prevent stalling when the pilot starts a recovery manoeuvre not less than one second after the onset of stall warning in slowdown turns with at least 1.5g load factor normal to the flight path and airspeed deceleration rates of at least 1 m/sec^2 (2 knots per second), When demonstrating compliance with this paragraph for icing conditions, the pilot must perform the recovery manoeuvre in the same way as for the airplane in non-icing conditions. Compliance with this requirement must be demonstrated in flight with –

(1) The flaps and landing gear in any normal position;

(2) The aeroplane trimmed for straight flight at a speed of 1.3 V_{SR}; and

(3) The power or thrust necessary to maintain level flight at 1.3 V_{SR}.

(g) Stall warning must also be provided in each abnormal configuration of the high lift devices that is likely to be used in flight following system failures (including all configurations covered by Aeroplane Flight Manual procedures).

(h) The following stall warning margin is required for flight in icing conditions before the ice protection system has been activated and is performing its intended function. Compliance must be shown using the most critical of the ice accretion(s) defined in Appendix C, part II(e), and Appendix O, part II(d), as applicable, in accordance with CS 25.21(g). The stall warning margin in straight and turning flight must be sufficient to allow the pilot to prevent stalling without encountering any adverse flight characteristics when:

(1) The speed is reduced at rates not exceeding 0.5 m/sec^2 (one knot per second);

(2) The pilot performs the recovery manoeuvre in the same way as for flight in non-icing conditions; and

(3) The recovery manoeuvre is started no earlier than:

(i) One second after the onset of stall warning if stall warning is provided by the same means as for flight in non-icing conditions; or

(ii) Three seconds after the onset of stall warning if stall warning is provided by a different means than for flight in non-icing conditions.

(i) In showing compliance with subparagraph (h) of this paragraph, if stall warning is provided by a different means in icing conditions than for non-icing conditions, compliance with CS 25.203 must be shown using the accretion defined in appendix C, part II(e). Compliance with this requirement must be shown using the demonstration prescribed by CS 25.201, except that the deceleration rates of CS 25.201(c)(2) need not be demonstrated.

[Amdt 25/3]
[Amdt 25/7]
[Amdt 25/16]
[Amdt 25/18]

AMC 25.207(b) Stall warning

ED Decision 2003/2/RM

1 A warning which is clear and distinctive to the pilot is one which cannot be misinterpreted or mistaken for any other warning, and which, without being unduly alarming, impresses itself upon the pilot and captures his attention regardless of what other tasks and activities are occupying his attention and commanding his concentration. Where stall warning is to be provided by artificial means, a stick shaker device producing both a tactile and an audible warning is an Acceptable Means of Compliance.

2 Where stall warning is provided by means of a device, compliance with the requirement of CS 25.21(e) should be established by ensuring that the device has a high degree of reliability. One means of complying with this criterion is to provide dual independent systems.

AMC 25.207(c) and (d) Stall warning

ED Decision 2003/2/RM

1 An acceptable method of demonstrating compliance with CS 25.207(c) is to consider stall warning speed margins obtained during stall speed demonstration (CS 25.103) and stall demonstration (CS 25.201(a)) (i.e. bank angle, power and centre of gravity conditions).

In addition, if the stall warning margin is managed by a system (thrust law, bank angle law, …), stall warning speed margin required by CS 25.207(c) should be demonstrated, when the speed is reduced at rates not exceeding 0.5 m/s^2 (one knot per second), for the most critical conditions in terms of stall warning margin, without exceeding 40° bank angle or maximum continuous power or thrust during the demonstrations. In the case where the management system increases, by design, the stall warning speed margin from the nominal setting (flight idle, wing level), no additional demonstration needs to be done.

2 The stall warning speed margins required by CS 25.207(c) and (d) must be determined at a constant load factor (i.e. 1g for 207(d)). An acceptable data reduction method is to calculate $k = \sqrt{(C_{LID}/C_{LSW})}$ where C_{LID} and C_{LSW} are the C_L values respectively at the stall identification and at the stall warning activation.

3 If the stall warning required by CS 25.207 is provided by a device (e.g. a stick shaker), the effect of production tolerances on the stall warning system should be considered when evaluating the stall warning margin required by CS 25.207(c) and (d) and the manoeuvre capabilities required by CS 25.143(g).

a. The stall warning margin required by CS 25.207(c) and (d) should be available with the stall warning system set to the most critical setting expected in production. Unless another setting would be provide a lesser margin, the stall warning margin required by CS 25.207(c) should be evaluated assuming the stall warning system is operating at its high angle of attack limit. For aeroplanes equipped with a device that abruptly pushes the nose down at a selected angle-of-attack (e.g. a stick pusher), the stall warning margin required by CS 25.207(c) may be evaluated with both the stall warning and stall identification (e.g. stick pusher) systems at their nominal angle of attack settings unless a lesser margin can result from the various system tolerances.

b. The manoeuvre capabilities required by CS 25.143(g) should be available assuming the stall warning system is operating on its nominal setting. In addition, when the stall warning system is operating at its low angle of attack limit, the manoeuvre capabilities should not be reduced by more than 2 degrees of bank angle from those specified in CS 25.143(g).

c. The stall warning margins and manoeuvre capabilities may be demonstrated by flight testing at the settings specified above for the stall warning and, if applicable, stall identification systems. Alternatively, compliance may be shown by applying adjustments to flight test data obtained at a different system setting.

GROUND HANDLING CHARACTERISTICS

CS 25.231 Longitudinal stability and control

ED Decision 2003/2/RM

(a) Aeroplanes may have no uncontrollable tendency to nose over in any reasonably expected operating condition or when rebound occurs during landing or take-off. In addition –

(1) Wheel brakes must operate smoothly and may not cause any undue tendency to nose over; and

(2) If a tail-wheel landing gear is used, it must be possible, during the take-off ground run on concrete, to maintain any attitude up to thrust line level, at 75% of V_{SR1}.

CS 25.233 Directional stability and control

ED Decision 2003/2/RM

(a) There may be no uncontrollable ground-looping tendency in 90° cross winds, up to a wind velocity of 37 km/h (20 kt) or 0·2 V_{SR0}, whichever is greater, except that the wind velocity need not exceed 46 km/h (25 kt) at any speed at which the aeroplane may be expected to be operated on the ground. This may be shown while establishing the 90° cross component of wind velocity required by CS 25.237.

(b) Aeroplanes must be satisfactorily controllable, without exceptional piloting skill or alertness, in power-off landings at normal landing speed, without using brakes or engine power to maintain a straight path. This may be shown during power-off landings made in conjunction with other tests.

(c) The aeroplane must have adequate directional control during taxying. This may be shown during taxying prior to take-offs made in conjunction with other tests.

CS 25.235 Taxying condition

ED Decision 2003/2/RM

The shock absorbing mechanism may not damage the structure of the aeroplane when the aeroplane is taxied on the roughest ground that may reasonably be expected in normal operation.

CS 25.237 Wind velocities

ED Decision 2015/008/R

(a) The following applies:

(1) A 90° cross component of wind velocity, demonstrated to be safe for take-off and landing, must be established for dry runways and must be at least 37 km/h (20 kt) or 0·2 V_{SR0}, whichever is greater, except that it need not exceed 46 km/h (25 kt).

(2) The crosswind component for takeoff established without ice accretions is valid in icing conditions.

(3) The landing crosswind component must be established for:

(i) Non-icing conditions, and

(ii) Icing conditions with the most critical of the landing ice accretion(s) defined in appendix C and O, as applicable, in accordance with CS 25.21(g).

[Amdt 25/3]
[Amdt 25/16]

MISCELLANEOUS FLIGHT REQUIREMENTS

CS 25.251 Vibration and buffeting

ED Decision 2016/010/R

(See AMC 25.251)

(a) The aeroplane must be demonstrated in flight to be free from any vibration and buffeting that would prevent continued safe flight in any likely operating condition.

(b) Each part of the aeroplane must be demonstrated 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 aeroplane in accordance with CS 25.1505.

(c) Except as provided in sub-paragraph (d) of this paragraph, there may be no buffeting condition, in normal flight, including configuration changes during cruise, severe enough to interfere with the control of the aeroplane, to cause excessive fatigue to the crew, 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 the stall warning buffeting is allowable.

(e) For an aeroplane with M_D greater than 0·6 or with a maximum operating altitude greater than 7620 m (25,000 ft), the positive manoeuvring load factors at which the onset of perceptible buffeting occurs must be determined with the aeroplane in the cruise configuration for the ranges of airspeed or Mach number, weight, and altitude for which the aeroplane is to be certificated. 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. (See AMC 25.251(e).)

[Amdt 25/1]
[Amdt 25/18]

AMC 25.251(e) Vibration and Buffeting in Cruising Flight

ED Decision 2003/2/RM

1 *Probable Inadvertent Excursions beyond the Buffet Boundary*

1.1 CS 25.251(e) states that probable inadvertent excursions beyond the buffet onset boundary may not result in unsafe conditions.

1.2 An acceptable means of compliance with this requirement is to demonstrate by means of flight tests beyond the buffet onset boundary that hazardous conditions will not be encountered within the permitted manoeuvring envelope (as defined by CS 25.337) without adequate prior warning being given by severe buffeting or high stick forces.

1.3 Buffet onset is the lowest level of buffet intensity consistently apparent to the flight crew during normal acceleration demonstrations in smooth air conditions.

1.4 In flight tests beyond the buffet onset boundary to satisfy paragraph 1.2, the load factor should be increased until either –

a. The level of buffet becomes sufficient to provide an obvious warning to the pilot which is a strong deterrent to further application of load factor; or

b. Further increase of load factor requires a stick force in excess of 445 N (100 lbf), or is impossible because of the limitations of the control system; or

c. The positive limit manoeuvring load factor established in compliance with CS 25.337(b) is achieved.

1.5 Within the range of load factors defined in paragraph 1.4 no hazardous conditions (such as hazardous involuntary changes of pitch or roll attitude, engine or systems malfunctioning which require urgent corrective action by the flight crew, or difficulty in reading the instruments or controlling the aeroplane) should be encountered.

2 *Range of Load Factor for Normal Operations*

2.1 CS 25.251(e) requires that the envelopes of load factor, speed, altitude and weight must provide a sufficient range of speeds and load factors for normal operations.

2.2 An acceptable means of compliance with the requirement is to establish the maximum altitude at which it is possible to achieve a positive normal acceleration increment of 0·3 g without exceeding the buffet onset boundary.

CS 25.253 High-speed characteristics

ED Decision 2016/010/R

(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 aeroplane 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, levelling off from climb, and descent from Mach to air speed limit altitudes.

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

(i) Exceptional piloting strength or skill;

(ii) Exceeding V_D/M_D, 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 aeroplane for recovery.

(3) With the aeroplane trimmed at any speed up to V_{MO}/M_{MO}, there must be no reversal of the response to control input about any axis at any speed up to V_{DF}/M_{DF}. Any tendency to pitch, roll, or yaw must be mild and readily controllable, using normal piloting techniques. When the aeroplane 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.

(4) Adequate roll capability to assure a prompt recovery from a lateral upset condition must be available at any speed up to V_{DF}/M_{DF}. (See AMC 25.253(a)(4).)

(5) *Extension of speedbrakes.* With the aeroplane trimmed at V_{MO}/M_{MO}, extension of the speedbrakes over the available range of movements of the pilots control, at all speeds above V_{MO}/M_{MO}, but not so high that V_{DF}/M_{DF} would be exceeded during the manoeuvre, must not result in:

(i) An excessive positive load factor when the pilot does not take action to counteract the effects of extension;

(ii) Buffeting that would impair the pilot's ability to read the instruments or control the aeroplane for recovery; or

(iii) A nose-down pitching moment, unless it is small. (See AMC 25.253(a)(5).)

(6) Reserved

(b) *Maximum speed for stability characteristics, V_{FC}/M_{FC}.* V_{FC}/M_{FC} is the maximum speed at which the requirements of CS 25.143(g), 25.147(f), 25.175(b)(1), 25.177(a) through (c), and 25.181 must be met with wing-flaps and landing gear retracted. Except as noted in CS 25.253(c), V_{FC}/M_{FC} may not be less than a speed midway between V_{MO}/M_{MO} and V_{DF}/M_{DF}, except that, for altitudes where Mach Number is the limiting factor, M_{FC} need not exceed the Mach Number at which effective speed warning occurs.

(c) *Maximum speed for stability characteristics in icing conditions*. The maximum speed for stability characteristics with the most critical of the ice accretions defined in Appendices C and O, as applicable, in accordance with CS 25.21(g), at which the requirements of CS 25.143(g), 25.147(f), 25.175(b)(1), 25.177(a) through (c) and 25.181 must be met, is the lower of:

(1) 556 km/h (300 knots) CAS,

(2) V_{FC}, or

(3) A speed at which it is demonstrated that the airframe will be free of ice accretion due to the effects of increased dynamic pressure."

[Amdt. 25/3]
[Amdt 25/11]
[Amdt 25/16]
[Amdt 25/18]

AMC 25.253(a)(4) Lateral Control: Roll Capability

ED Decision 2003/2/RM

An acceptable method of demonstrating compliance with CS 25.253(a)(4) is as follows:

1 Establish a steady 20° banked turn at a speed close to V_{DF}/M_{DF} limited to the extent necessary to accomplish the following manoeuvre and recovery without exceeding V_{DF}/M_{DF}. Using lateral control alone, it should be demonstrated that the aeroplane can be rolled to 20° bank angle in the other direction in not more than 8 seconds. The demonstration should be made in the most adverse direction. The manoeuvre may be unchecked.

2 For aeroplanes that exhibit an adverse effect on roll rate when rudder is used, it should also be demonstrated that use of rudder in a conventional manner will not result in a roll capability significantly below that specified above.