(2) Reasonably expected variations in service from the established approach, landing and go-around procedures for the operation of the aeroplane must not result in unsafe flight characteristics during the go-around.

[Amdt 25/18]
[Amdt 25/21]

AMC 25.145(a) Longitudinal control - Control near the stall

ED Decision 2018/005/R

1 CS 25.145(a) requires that there be adequate longitudinal control to promptly pitch the aeroplane nose down from at or near the stall to return to the original trim speed. The intent is to ensure sufficient pitch control for a prompt recovery if the aeroplane is inadvertently slowed to the point of the stall. Although this requirement must be met with engine thrust or power off and at go-around setting, there is no intention to require stall demonstrations at engine thrusts or powers above that specified in CS 25.201(a)(2). Instead of performing a full stall at go-around thrust or power setting, compliance may be assessed by demonstrating sufficient static longitudinal stability and nose down control margin when the deceleration is ended at least one second past stall warning during a 0.5 m/s^2 (one knot per second) deceleration. The static longitudinal stability during the manoeuvre and the nose down control power remaining at the end of the manoeuvre must be sufficient to assure compliance with the requirement.

2 The aeroplane should be trimmed at the speed for each configuration as prescribed in CS 25.103(b)(6). The aeroplane should then be decelerated at 0.5 m/s^2 (1 knot per second) with wings level. For tests at idle thrust or power, it should be demonstrated that the nose can be pitched down from any speed between the trim speed and the stall. Typically, the most critical point is at the stall when in stall buffet. The rate of speed increase during the recovery should be adequate to promptly return to the trim point. Data from the stall characteristics test can be used to evaluate this capability at the stall. For tests at go-around thrust or power setting, the manoeuvre need not be continued for more than one second beyond the onset of stall warning. However, the static longitudinal stability characteristics during the manoeuvre and the nose down control power remaining at the end of the manoeuvre must be sufficient to assure that a prompt recovery to the trim speed could be attained if the aeroplane is slowed to the point of stall.

3 For aeroplanes with an automatic pitch trim function (either in manual control or automatic mode), the nose-up pitch trim travel should be limited before or at stall warning activation (or stall buffet onset, or before reaching the angle-of-attack (AOA) limit if a high AOA limiting function is installed), in order to prevent an excessive nose-up pitch trim position and ensure that it is possible to command a prompt pitch down of the aeroplane to recover control.

The applicant should demonstrate this feature during flight testing or by using a validated simulator.

Note 1: the behaviour of the automatic pitch trim function in degraded flight control laws should be evaluated under CS 25.1309 and CS 25.671.

Note 2: the applicant may account for certain flight phases where this limit is not appropriate, and provide a rationale that supports these exceptions to EASA for consideration.

[Amdt No: 25/21]

AMC 25.145(b)(2) Longitudinal control

ED Decision 2003/2/RM

Where high lift devices are being retracted and where large and rapid changes in maximum lift occur as a result of movement of high-lift devices, some reduction in the margin above the stall may be accepted.

AMC 25.145(b)(1), (b)(2) and (b)(3) Longitudinal control

ED Decision 2003/2/RM

The presence of gated positions on the flap control does not affect the requirement to demonstrate full flap extensions and retractions without changing the trim control.

AMC 25.145(e) Longitudinal control

ED Decision 2003/2/RM

If gates are provided, CS 25.145(e) requires the first gate from the maximum landing position to be located at a position corresponding to a go-around configuration. If there are multiple go-around configurations, the following criteria should be considered when selecting the location of the gate:

a. The expected relative frequency of use of the available go-around configurations.

b. The effects of selecting the incorrect high-lift device control position.

c. The potential for the pilot to select the incorrect control position, considering the likely situations for use of the different go-around positions.

d. The extent to which the gate(s) aid the pilot in quickly and accurately selecting the correct position of the high-lift devices.

AMC 25.145(f) Longitudinal control – go-around

ED Decision 2018/005/R

1. CS 25.145(f)(1) requires there to be adequate longitudinal control to promptly pitch the aeroplane (nose down and up) and adequate speed control in order to follow or maintain the targeted trajectory during the complete manoeuvre from any approved approach and landing configuration to a go-around, transition to the next flight phase and level off at the desired altitude.

   The objective is to assess, in particular, the combined effects of a thrust or power application and a nose-up trim pitching moment.

   The applicant should perform the evaluation throughout the range of thrust-to-weight ratios to be certified. This range should include, in particular, the highest thrust-to-weight ratio for the all-engines-operating condition, with the aeroplane at its minimum landing weight, all engines operating and the thrust or power at the go-around setting.

   The evaluation should show adequate:

   — pitch control (i.e. no risk of excessive pitch rate or attitude, maintaining an adequate stall margin throughout the manoeuvre, no excessive overshoot of the level-off altitude), and

   — speed control (i.e. no risk of speed instability or exceedance of VFE with the wing-flaps extended and VLE with the landing gear extended).

Refer also to AMC No. 1 to CS 25.1329, Section 14.1.3.3, which provides guidance related to the demonstration of the flight guidance system go-around mode.

2. The applicant shall evaluate reasonably expected variations in service from the established approach, landing and go-around procedures and ensure that they do not result in unsafe flight characteristics during a go-around.

   It is expected that these variations may include:

   a) non-stabilised speed conditions prior to the initiation of a go-around (e.g. approach speed - 5 kt), and

   b) adverse pitch trim positions:

      i) In manual mode with a manual pitch trim, a pitch trim positioned for the approach or landing configuration, and kept at this position during the go-around phase; and

      ii) in autopilot or manual mode with an automatic pitch trim function: the most adverse position that can be sustained by the autopilot or automatic pitch trim function, limited to the available protecting/limiting features or alert (if credit can be taken for it).

   The applicant should perform these demonstrations by conducting go-around manoeuvres in flight or during simulator test programmes.

[Amdt 25/21]

CS 25.147 Directional and lateral control

ED Decision 2017/015/R

(See AMC 25.147)

(a) *Directional control; general.* (See AMC 25.147(a).) It must be possible, with the wings level, to yaw into the operative engine and to safely make a reasonably sudden change in heading of up to 15° in the direction of the critical inoperative engine. This must be shown at 1·3 V_{SR1}, for heading changes up to 15° (except that the heading change at which the rudder pedal force is 667 N (150 lbf) need not be exceeded), and with –

   (1) The critical engine inoperative and its propeller (if applicable) in the minimum drag position;

   (2) The power required for level flight at 1.3 V_{SR1}, but not more than maximum continuous power;

   (3) The most unfavourable centre of gravity;

   (4) Landing gear retracted;

   (5) Wing-flaps in the approach position; and

   (6) Maximum landing weight.

(b) *Directional control; aeroplanes with four or more engines.* Aeroplanes with four or more engines must meet the requirements of sub-paragraph (a) of this paragraph except that –

   (1) The two critical engines must be inoperative with their propellers (if applicable) in the minimum drag position;

   (2) Reserved; and

   (3) The wing-flaps must be in the most favourable climb position.

(c) *Lateral control; general.* It must be possible to make 20° banked turns, with and against the inoperative engine, from steady flight at a speed equal to 1·3 V_{SR1}, with –

(1) The critical engine inoperative and its propeller (if applicable) in the minimum drag position;

(2) The remaining engines at maximum continuous power;

(3) The most unfavourable centre of gravity;

(4) Landing gear both retracted and extended;

(5) Wing-flaps in the most favourable climb position; and

(6) Maximum take-off weight;

(d) Lateral control; roll capability. With the critical engine inoperative, roll response must allow normal manoeuvres. Lateral control must be sufficient, at the speeds likely to be used with one engine inoperative, to provide a roll rate necessary for safety without excessive control forces or travel. (See AMC 25.147(d).)

(e) *Lateral control; aeroplanes with four or more engines.* Aeroplanes with four or more engines must be able to make 20° banked turns, with and against the inoperative engines, from steady flight at a speed equal to 1·3 V_{SR1}, with maximum continuous power, and with the aeroplane in the configuration prescribed by sub-paragraph (b) of this paragraph.

(f) *Lateral control; all engines operating.* With the engines operating, roll response must allow normal manoeuvres (such as recovery from upsets produced by gusts and the initiation of evasive manoeuvres). There must be enough excess lateral control in sideslips (up to sideslip angles that might be required in normal operation), to allow a limited amount of manoeuvring and to correct for gusts. Lateral control must be enough at any speed up to V_{FC}/M_{FC} to provide a peak roll rate necessary for safety, without excessive control forces or travel. (See AMC 25.147(f).)

[Amdt 25/18]
[Amdt 25/19]

AMC 25.147(a) Directional control; general

ED Decision 2003/2/RM

The intention of the requirement is that the aircraft can be yawed as prescribed without the need for application of bank angle. Small variations of bank angle that are inevitable in a realistic flight test demonstration are acceptable.

AMC 25.147(d) Lateral control: Roll capability

ED Decision 2003/2/RM

An acceptable method of demonstrating compliance with CS 25.147(d) is as follows:

With the aeroplane in trim, all as nearly as possible,in trim, for straight flight at V_2, establish a steady 30° banked turn. It should be demonstrated that the aeroplane can be rolled to a 30° bank angle in the other direction in not more than 11 seconds. In this demonstration, the rudder may be used to the extent necessary to minimise sideslip. The demonstration should be made in the most adverse direction. The manoeuvre may be unchecked. Care should be taken to prevent excessive sideslip and bank angle during the recovery.

Conditions: Maximum take-off weight.

Most aft c.g. position.

Wing-flaps in the most critical take-off position.

Landing Gear retracted.

Yaw SAS on, and off, if applicable.

Operating engine(s) at maximum take-off power.

The inoperative engine that would be most critical for controllability, with the propeller (if applicable) feathered.

Note: Normal operation of a yaw stability augmentation system (SAS) should be considered in accordance with normal operating procedures.

AMC 25.147(f) Lateral control: All engines operating

ED Decision 2003/2/RM

An acceptable method of demonstrating that roll response and peak roll rates are adequate for compliance with CS 25.147(f) is as follows:

It should be possible in the conditions specified below to roll the aeroplane from a steady 30° banked turn through an angle of 60° so as to reverse the direction of the turn in not more than 7 seconds. In these demonstrations the rudder may be used to the extent necessary to minimise sideslip. The demonstrations should be made rolling the aeroplane in either direction, and the manoeuvres may be unchecked.

Conditions:

(a) En-route: Airspeed. All speeds between the minimum value of the scheduled all-engines-operating climb speed and V_{MO}/M_{MO}.

Wing-flaps. En-route position(s).

Air Brakes. All permitted settings from Retracted to Extended.

Landing Gear. Retracted.

Power. All engines operating at all powers from flight idle up to maximum continuous power.

Trim. The aeroplane should be in trim from straight flight in these conditions, and the trimming controls should not be moved during the manoeuvre.

(b) Approach: Airspeed. Either the speed maintained down to the 15 m (50 ft) height in compliance with CS 25.125(a)(2), or the target threshold speed determined in accordance with CS 25.125(c)(2)(i) as appropriate to the method of landing distance determination used.

Wing-flaps. In each landing position.

Air Brakes. In the maximum permitted extended setting.

Landing Gear. Extended.

Power. All engines operating at the power required to give a gradient of descent of 5·0%.

Trim. The aeroplane should be in trim for straight flight in these conditions, and the trimming controls should not be moved during the manoeuvre.

CS 25.149 Minimum control speed

ED Decision 2003/2/RM

(See AMC 25.149)

(a) In establishing the minimum control speeds required by this paragraph, the method used to simulate critical engine failure must represent the most critical mode of powerplant failure with respect to controllability expected in service.

(b) V_{MC} is the calibrated airspeed, at which, when the critical engine is suddenly made inoperative, it is possible to maintain control of the aeroplane with that engine still inoperative, and maintain straight flight with an angle of bank of not more than 5°.

(c) V_{MC} may not exceed 1·13 V_{SR} with –

(1) Maximum available take-off power or thrust on the engines;

(2) The most unfavourable centre of gravity;

(3) The aeroplane trimmed for take-off;

(4) The maximum sea-level take-off weight (or any lesser weight necessary to show V_{MC});

(5) The aeroplane in the most critical take-off configuration existing along the flight path after the aeroplane becomes airborne, except with the landing gear retracted;

(6) The aeroplane airborne and the ground effect negligible; and

(7) If applicable, the propeller of the inoperative engine –

(i) Windmilling;

(ii) In the most probable position for the specific design of the propeller control; or

(iii) Feathered, if the aeroplane has an automatic feathering device acceptable for showing compliance with the climb requirements of CS 25.121.

(d) The rudder forces required to maintain control at V_{MC} may not exceed 667 N (150 lbf) nor may it be necessary to reduce power or thrust of the operative engines. During recovery, the aeroplane may not assume any dangerous attitude or require exceptional piloting skill, alertness, or strength to prevent a heading change of more than 20°.

(e) V_{MCG}, the minimum control speed on the ground, is the calibrated airspeed during the take-off run at which, when the critical engine is suddenly made inoperative, it is possible to maintain control of the aeroplane using the rudder control alone (without the use of nose-wheel steering), as limited by 667 N of force (150 lbf), and the lateral control to the extent of keeping the wings level to enable the take-off to be safely continued using normal piloting skill. In the determination of V_{MCG}, assuming that the path of the aeroplane accelerating with all engines operating is along the centreline of the runway, its path from the point at which the critical engine is made inoperative to the point at which recovery to a direction parallel to the centreline is completed, may not deviate more than 9.1 m (30 ft) laterally from the centreline at any point. V_{MCG} must be established, with –

(1) The aeroplane in each take-off configuration or, at the option of the applicant, in the most critical take-off configuration;

(2) Maximum available take-off power or thrust on the operating engines;

(3) The most unfavourable centre of gravity;

(4) The aeroplane trimmed for take-off; and

(5) The most unfavourable weight in the range of take-off weights. (See AMC 25.149(e).)

(f) (See AMC 25.149(f)) V_{MCL}, the minimum control speed during approach and landing with all engines operating, is the calibrated airspeed at which, when the critical engine is suddenly made inoperative, it is possible to maintain control of the aeroplane with that engine still inoperative, and maintain straight flight with an angle of bank of not more than 5°. V^{MCL} must be established with –

(1) The aeroplane in the most critical configuration (or, at the option of the applicant, each configuration) for approach and landing with all engines operating;

(2) The most unfavourable centre of gravity;

(3) The aeroplane trimmed for approach with all engines operating;

(4) The most unfavourable weight, or, at the option of the applicant, as a function of weight;

(5) For propeller aeroplanes, the propeller of the inoperative engine in the position it achieves without pilot action, assuming the engine fails while at the power or thrust necessary to maintain a 3 degree approach path angle; and

(6) Go-around power or thrust setting on the operating engine(s).

(g) (See AMC 25.149(g)) For aeroplanes with three or more engines, V_{MCL-2}, the minimum control speed during approach and landing with one critical engine inoperative, is the calibrated airspeed at which, when a second critical engine is suddenly made inoperative, it is possible to maintain control of the aeroplane with both engines still inoperative, and maintain straight flight with an angle of bank of not more than 5°. V_{MCL-2} must be established with –

(1) The aeroplane in the most critical configuration (or, at the option of the applicant, each configuration) for approach and landing with one critical engine inoperative;

(2) The most unfavourable centre of gravity;

(3) The aeroplane trimmed for approach with one critical engine inoperative;

(4) The most unfavourable weight, or, at the option of the applicant, as a function of weight;

(5) For propeller aeroplanes, the propeller of the more critical engine in the position it achieves without pilot action, assuming the engine fails while at the power or thrust necessary to maintain a 3 degree approach path angle, and the propeller of the other inoperative engine feathered;

(6) The power or thrust on the operating engine(s) necessary to maintain an approach path angle of 3° when one critical engine is inoperative; and

(7) The power or thrust on the operating engine(s) rapidly changed, immediately after the second critical engine is made inoperative, from the power or thrust prescribed in sub-paragraph (g)(6) of this paragraph to –

(i) Minimum power or thrust; and

(ii) Go-around power or thrust setting.

(h) In demonstrations of V_{MCL} and V_{MCL-2} –

(1) The rudder force may not exceed 667 N (150 lbf);

(2) The aeroplane may not exhibit hazardous flight characteristics or require exceptional piloting skill, alertness or strength;

(3) Lateral control must be sufficient to roll the aeroplane, from an initial condition of steady straight flight, through an angle of 20° in the direction necessary to initiate a turn away from the inoperative engine(s), in not more than 5 seconds (see AMC 25.149(h)(3)); and

(4) For propeller aeroplanes, hazardous flight characteristics must not be exhibited due to any propeller position achieved when the engine fails or during any likely subsequent movements of the engine or propeller controls (see AMC 25.149(h)(4)).

AMC 25.149 Minimum control speeds

ED Decision 2003/2/RM

1 The determination of the minimum control speed, V_{MC}, and the variation of V_{MC} with available thrust, may be made primarily by means of 'static' testing, in which the speed of the aeroplane is slowly reduced, with the thrust asymmetry already established, until the speed is reached at which straight flight can no longer be maintained. A small number of 'dynamic' tests, in which sudden failure of the critical engine is simulated, should be made in order to check that the V_{MC}s determined by the static method are valid.

2 When minimum control speed data are expanded for the determination of minimum control speeds (including V_{MC}, V_{MCG} and V_{MCL}) for all ambient conditions, these speeds should be based on the maximum values of thrust which can reasonably be expected from a production engine in service.

The minimum control speeds should not be based on specification thrust, since this thrust represents the minimum thrust as guaranteed by the manufacturer, and the resulting speeds would be unconservative for most cases.

AMC 25.149(e) Minimum control speed

ED Decision 2003/2/RM

During determination of V_{MCG}, engine failure recognition should be provided by:

a. The pilot feeling a distinct change in the directional tracking characteristics of the aeroplane, or

b. The pilot seeing a directional divergence of the aeroplane with respect to the view outside the aeroplane.

AMC 25.149(f) Minimum Control Speed during Approach and Landing (V_{MCL})

ED Decision 2020/024/R

(a) CS 25.149(f) is intended to ensure that the aeroplane is safely controllable following an engine failure during an all-engines-operating approach and landing. From a controllability standpoint, the most critical case usually consists of an engine failing after the power or thrust has been increased to perform a go-around from an all-engines-operating approach.

(b) To determine V_{MCL}, the flap and trim settings should be appropriate to the approach and landing configurations, the power or thrust on the operating engine(s) should be set to the go-around power or thrust setting, and compliance with all the V_{MCL} requirements of CS 25.149(f) and (h) must be demonstrated.

(c) At the option of the applicant, a one-engine-inoperative landing minimum control speed, $V_{MCL\ (1\ out)}$, may be determined in the conditions appropriate to an approach and landing with one engine having failed before the start of the approach. In this case, only those configurations recommended for use during an approach and landing with one engine inoperative need be considered. The propeller of the inoperative engine, if applicable, may be feathered throughout.

The resulting value of $V_{MCL\ (1\ out)}$ may be used in determining the recommended procedures and speeds for a one-engine-inoperative approach and landing.

[Amdt 25/26]

AMC 25.149(g) Minimum Control Speed with Two Inoperative Engines during Approach and Landing (V_{MCL-2})

ED Decision 2020/024/R

(a) For aeroplanes with three or more engines, V_{MCL-2} is the minimum speed for maintaining safe control during the power or thrust changes that are likely to be made following the failure of a second critical engine during an approach initiated with one engine inoperative.

(b) In accordance with CS 25.149(g)(5) for propeller-driven aeroplanes, the propeller of the engine that is inoperative at the beginning of the approach may be in the feathered position. The propeller of the more critical engine must be in the position it automatically assumes following an engine failure.

(c) Tests should be conducted using either the most critical approved one-engine-inoperative approach or landing configuration (usually the minimum flap deflection), or at the option of the applicant, each of the approved one-engine-inoperative approach and landing configurations. The following demonstrations should be conducted to determine V_{MCL-2}:

(1) With the power or thrust on the operating engines set to maintain a -3 ° glideslope with one critical engine inoperative, the second critical engine is made inoperative and the remaining operating engine(s) are advanced to the go-around power or thrust setting. The V_{MCL-2} speed is established with the flap and trim settings appropriate to the approach and landing configurations, the power or thrust on the operating engine(s) set to the go-around power or thrust setting, and compliance with all the V_{MCL-2} requirements of CS 25.149(g) and (h) must be demonstrated.

(2) With the power or thrust on the operating engines set to maintain a -3 ° glideslope, with one critical engine inoperative:

(i) Set the airspeed at the value determined in paragraph (c)(1) above and, with a zero bank angle, maintain a constant heading using trim to reduce the control force to zero. If full trim is insufficient to reduce the control force to zero, full trim should be used, plus control deflection as required; and

(ii) Make the second critical engine inoperative and retard the remaining operating engine(s) to minimum available power or thrust without changing the directional trim. The V_{MCL-2} determined in paragraph (c)(1) is acceptable if a constant heading can be maintained without exceeding a 5 ° bank angle and the limiting conditions of CS 25.149(h).

(iii) Starting from a steady straight flight condition, demonstrate that sufficient lateral control is available at V_{MCL-2} to roll the aeroplane through an angle of 20 ° in the direction necessary to initiate a turn away from the inoperative engines in not more than five seconds. This manoeuvre may be flown in a bank-to-bank roll through a wings-level attitude.

(d) At the option of the applicant, a two-engine-inoperative landing minimum control speed, $V_{MCL-2\ (2\ out)}$ may be determined in the conditions appropriate to an approach and landing with two engines having failed before the start of the approach. In this case, only those configurations recommended for use during an approach and landing with two engines inoperative need be considered. The propellers of the inoperative engines, if applicable, may be feathered throughout.

The values of V_{MCL-2} or $V_{MCL-2\ (2\ out)}$ should be used as guidance in determining the recommended procedures and speeds for a two-engine inoperative approach and landing.

[Amdt 25/26]

AMC 25.149(h)(3) Minimum control speeds

ED Decision 2003/2/RM

The 20° lateral control demonstration manoeuvre may be flown as a bank-to-bank roll through wings level.

AMC 25.149(h)(4) Minimum control speeds

ED Decision 2003/2/RM

Where an autofeather or other drag limiting system is installed and will be operative at approach power settings, its operation may be assumed in determining the propeller position achieved when the engine fails. Where automatic feathering is not available the effects of subsequent movements of the engine and propeller controls should be considered, including fully closing the power lever of the failed engine in conjunction with maintaining the go-around power setting on the operating engine(s).