DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

Advisory Circular 25–7, Flight Test Guide for Certification of Transport Category Airplanes

AGENCY: Federal Aviation Administration, DOT.

ACTION: Notice of changes to advisory circular.

SUMMARY: This notice describes the changes to Advisory Circular (AC) 25–7, ''Flight Test Guide for Certification of Transport Category Airplanes,'' that accompany Amendment 25–84, published elsewhere in this issue of the **Federal Register**.

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SUPPLEMENTARY INFORMATION:

Discussion

On May 22, 1990, the Aerospace Industries Association of America, Inc. (AIA) and the Association Europeenne des Constructeurs de Materiel Aerospatial (AECMA) jointly petitioned the FAA and the European Joint Aviation Authorities (JAA) to harmonize certain airworthiness requirements that apply to transport category airplanes. In their petition, a summary of which was published in the July 17, 1990, edition of the **Federal Register** (55 FR 137), AIA and AECMA also recommended changes to Advisory Circular (AC) 25–7, ''Flight Test Guide for Certification of Transport Category Airplanes,'' to ensure that the harmonized standards would be interpreted and applied consistently.

Part 25 of the Federal Aviation Regulations (FAR) prescribes the United States airworthiness standards for transport category airplanes. Advisory Circular (AC) 25–7 provides guidelines that the FAA has found acceptable for flight testing transport category airplanes to demonstrate compliance with those airworthiness standards. Revisions to part 25, in response to the AIA/AECMA petition, were proposed by the FAA in Notice of Proposed Rulemaking (NPRM) 94–15, which was published in the **Federal Register** on April 22, 1994 (59 FR 19296). The proposed revisions to AC 25–7 were published in the same issue of the **Federal Register** as NPRM 94–15 (59 FR 19303).

Amendment 25–84, which resulted from publication of Notice 94–15, is published elsewhere in this issue of the **Federal Register**. The changes to AC 25–7 that accompany Amendment 25–84 are detailed below. Copies of the affected pages will be available for distribution shortly after publication of this notice.

Revisions to AC 25–7 to Accompany Amendment 25–84

1. Replace Paragraph 16.a With the Following

a. Section 25.119(a) states that the engines are to be set at the power or thrust that is available eight seconds after initiating movement of the power or thrust controls from the minimum flight idle position to the go-around power or thrust setting. The procedures given are for the determination of this maximum thrust for showing compliance with the climb requirements of § 25.119.

2. Replace Paragraph 16.b.(3) With the Following

(3) *For the critical air bleed configuration,* stabilize the airplane in level flight with symmetric power on all engines, landing gear down, flaps in the landing position, at a speed of 1.3 V_{S0}, simulating the estimated minimum climb limiting landing weights at an altitude sufficiently above the selected test altitude so that the time to descend to the test altitude with the throttles closed equals the appropriate engine r.p.m. stabilization time determined in paragraph (2). Retard the throttles to the flight idle position and descend at 1.3 V_S to approximately the test altitude; when the appropriate time has elapsed, rapidly advance the power or thrust controls to the go-around power or thrust setting. The power or thrust controls may first be advanced to the forward stop and then retarded to the go-around power or thrust setting. At the applicant's option, additional less critical bleed configurations may be tested.

3. Add the Following Sections to Paragraph 20.a

(1) The maximum forces given in the table in § 25.143(c) for pitch and roll control for short-term application are applicable to maneuvers in which the control force is only needed for a short period. Where the maneuver is such that the pilot will need to use one hand to operate other controls (such as during the landing flare or a go-around, or during changes of configuration or power resulting in a change of control force that must be trimmed out) the single-handed maximum control forces will be applicable. In other cases (such as takeoff rotation, or maneuvering during en route flight), the two-handed maximum forces will apply.

(2) Short-term and long-term forces should be interpreted as follows:

(i) Short-term forces are the initial stabilized control forces that result from maintaining the intended flight path following configuration changes and normal transactions from one flight condition to another, or from regaining control following a failure. It is assumed that the pilot will take immediate action to reduce or eliminate such forces by re-trimming or changing configuration or flight conditions, and consequently short-term forces are not considered to exist for any significant duration. They do not include transient force peaks that may occur during the configuration change, change of flight conditions, or recovery of control following a failure.

(ii) Long-term forces are those control forces that result from normal or failure conditions that cannot readily be trimmed out or eliminated.

4. Add the Following Sections to Paragraph 20

d. *Acceptable Means of Compliance.* An acceptable means of compliance with the requirement that stick forces may not be excessive when maneuvering the airplane is to demonstrate that, in a turn for 0.5g incremental normal acceleration (0.3g above 20,000 feet) at speeds up to V_{FC}/M_{FC}, the average stick force gradient does not exceed 120 lbs/g.

e. *Interpretive Material.* (1) The objective of § 25.143(f) is to ensure that the limit strength of any critical component on the airplane would not be exceeded in maneuvering flight. In much of the structure, the load sustained in maneuvering flight can be assumed to be directly proportional of the load factor applied. However, this may not be the case for some parts of the structure, e.g., the tail and rear fuselage. Nevertheless, it is accepted that the airplane load factor will be a sufficient guide to the possibility of exceeding limit strength on any critical component if a structural investigation is undertaken whenever the design positive limit maneuvering load factor is closely approached. If flight testing indicates that the design positive limit maneuvering load factor could be exceeded in steady maneuvering flight with a 50-pound stick force, the airplane structure should be evaluated for the anticipated load at a 50-pound stick force. The airplane will be considered to have been overstressed if limit strength has been exceeded in any critical component. For the purposes of this evaluation, limit strength is defined as the larger of either the limit design loads envelope increased by the available margins of safety, or the ultimate static test strength divided by 1.5.

(2) Minimum Stick Force to Reach Limit Strength. (i) A stick force of at least 50 pounds to reach limit strength in steady maneuvers or wind-up turns in considered acceptable to demonstrate adequate minimum force at limit strength in the absence of deterrent buffeting. If heavy buffeting occurs before the limit strength condition is reached, a somewhat lower stick force at limit strength may be acceptable. The acceptability of a stick force of less than 50 pounds at the limit strength condition will depend upon the intensity of he buffet, the adequacy of the warning margin (i.e., the load factor increment between the heavy buffet and the limit strength condition), and the stick force characteristics. In determining the limit strength condition for each critical component, the contribution of buffet loads to the overall maneuvering loads should be taken into account.

(ii) This minimum stick force applies in the en route configuration with the airplane trimmed for straight flight, at all speeds above the minimum speed at which the limit strength condition can be achieved without stalling. No minimum stick force is specified for other configurations, but the requirements of § 25.143(f) are applicable in these conditions.

(3) Stick Force Characteristics. (i) At all points within the buffet onset boundary determined in accordance with § 25.251(e), but not including speeds above V_{FC}/M_{FC}, the stick force should increase progressively with increasing load factor. Any reduction in stick force gradient with change of load factor should not be so large or abrupt as to impair significantly the ability of the pilot to maintain control over the load factor and pitch attitude of the airplane.

(ii) Beyond the buffet onset boundary, hazardous stick force characteristics should not be encountered within the permitted maneuvering envelope as limited by paragraph 20.e.(3)(iii). It should be possible, by use of the primary longitudinal control alone, to pitch the airplane rapidly nose down so as to regain the initial trimmed conditions. The stick force characteristics demonstrated should comply with the following:

(A) For normal acceleration increments of up to 0.3g beyond buffet onset, where these can be achieved, local reversal of the stick force gradient may be acceptable, provided that any tendency to pitch up is mild and easily controllable.

(B) For normal acceleration increments of more than 0.3g beyond buffet onset, where these can be achieved, more marked reversals of the stick force gradient may be acceptable. It should be possible for any tendency to pitch up to be contained within the allowable maneuvering limits without applying push forces to the control column and without making a large and rapid forward movement of the control column.

(iii) In flight tests to satisfy paragraphs 20.e.(3) (i) and (ii), the load factor should be increased until either:

(A) The level of buffet becomes sufficient to provide a strong and effective deterrent to further increase of load factor; or

(B) Further increase the load factor requires a stick force in excess of 150 pounds (or in excess of 100 pounds when beyond the buffet onset boundary) or is impossible because of the limitations of the control system; or

(C) The positive limit maneuvering load factor established in compliance with § 25.337(b) is achieved.

(4) Negative Load Factors. It is not intended that a detailed flight test assessment of the maneuvering characteristics under negative load factors should necessarily be made throughout the specified range of conditions. An assessment of the characteristics in the normal flight envelope involving normal accelerations from 1g to zero g will normally be sufficient. Stick forces should also be assessed during other required flight testing involving negative load factors. Where these assessments reveal stick force gradients that are unusually low, or that are subject to significant variation, a more detailed assessment, in the most critical of the specified conditions, will be required. This may be based on calculations provided these are supported by adequate flight test or wind tunnel data.

5. Replace Paragraph 21.a.(e) With the Following

(3) *Section 25.145(c)* contains requirements associated primarily with attempting a go-around maneuver from the landing configuration. Retraction of the high-lift devices from the landing configuration should not result in a loss of altitude if the power or thrust controls are moved to the go-around setting at the same time that flap/slat retraction is begun. The design features involved with this requirement are the rate of flap/slat retraction, the presence of any flap gates, and the go-around power or thrust setting.

(i) Flap gates, which prevent the pilot from moving the flap selector through the gated position without a separate and distinct movement of the selector, allow compliance with these requirements to be demonstrated in segments. High lift device retraction must be demonstrated beginning from the maximum landing position to the first gated position, between gated positions, and from the last gated position to the fully retracted position.

(ii) The go-around power or thrust setting should be the same as is used to comply with the approach and landing climb performance requirements of §§ 25.121(d) and 25.119, and the controllability requirements of §§ 25.145(b)(3), 25.145(b)(4), 25.145(b)(5), 25.149(f), and 25.149(g). The controllability requirements may limit the go-around power or thrust setting.

6. Replace Paragraph 21.c.(3)(i)(E) With the Following

(E) Engine power at flight idle and the go-around power or thrust setting.

7. Replace Paragraph 21.c.(4)(ii) With the Following

(ii) The airplane should be trimmed at a speed of 1.4 V_S. Quickly set go-around power or thrust while maintaining the speed of 1.4 V_S. The longitudinal control force should not exceed 50 lbs. throughout the maneuver without changing the trim control.

8. Replace Paragraph 21.c.(6)(ii) With the Following

(ii) Test procedure: With the airplane stable in level flight at a speed of 1.1 V_S for propeller driven airplanes, or 1.2 V_S for turbojet powered airplanes, retract the flaps to the full up position, or the next gated position, while simultaneously setting go-around power. Use the same power or thrust as is used to comply with the performance requirement of § 25.121(d), as limited by the applicable controllability requirements. It must be possible, without requiring exceptional piloting skill, to prevent losing altitude during the maneuver. Trimming is permissible at any time during the maneuver. If gates are provided, conduct this test beginning from the maximum landing flap position to the first gate, from gate to gate, and from the last gate to the fully retracted position. (The gate design requirements are specified within the rule.) Keep the landing gear extended throughout the test.

9. Revise the First Sentence of Paragraph 23.a by Replacing ''Landing Approach (V_{MCL})'' by ''Approach and Landing V_{MCL} and V_{MCL-2}).'' Revise the Second Sentence in the Same Paragraph by Replacing ''V_{MCL}'' with ''V_{MCL} and V_{MCL-2}''

10. Replace Paragraph 23.b.(2)(iii) With the Following

(iii) 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 airplane, or

(B) The pilot seeing a directional divergence of the airplane with respect to the view outside the airplane.

11. Replace Paragraph 23.b.(3) With the Following

(3) Minimum Control Speed During Approach and Landing (V_{MCL})—§ 25.149(f).

(i) This section is intended to ensure that the airplane 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. Section 25.149(f) requires the minimum control speed to be determined that allows a pilot of average skill and strength to retain control of the airplane after the critical engine becomes inoperative and to maintain straight flight with less than five degrees of bank angle. Section 25.149(h) requires that sufficient lateral control be available at V_{MCL} to roll the airplane through an angle of 20 degrees, in the direction necessary to initiate a turn away from the inoperative engine, in not more than five seconds when starting from a steady flight condition.

(ii) Conduct this test using the most critical of the all-engines-operating approach and landing configurations, or at the option of the applicant, each of the all-engines-operating approach and landing configurations. The procedures given in paragraph 23.b.(1)(ii) for V_{MCA} may be used to determine V_{MCL}, except that 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 V_{MCL} requirements of §§ 25.149 (f) and (h) must be demonstrated.

12. Add the Following New Sections to Paragraph 23.b.(3)

(iii) For propeller driven airplanes, the propeller must be in the position it achieves without pilot action following engine failure, assuming the engine fails while at the power or thrust necessary to maintain a three degree approach path angle.

(iv) 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.

13. Replace and Re-Designate Paragraphs 23.b.(4), 23.b.4(ii), and 23.b.4(ii)(A) With the Following

(4) Minimum Control Speed With One Engine Inoperative During Approach and Landing (V_{MCL-2})—§ 25.149(g).

(iii) Conduct this test using 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 are required to determine V_{MCL-2}:

(A) With the power or thrust on the operating engines set to maintain a minus 3 degree 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 by the procedures presented in paragraph 23.b.(1)(ii) for V_{MCA}, except that flap and trim setting 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 V_{MCL-2} requirements of §§ 25.149(g) and (h) must be demonstrated.

14. Add the Following New Section to Paragraph 23.b.(4)

(ii) For propeller driven airplanes, the propeller of the engine 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 engine failure.

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

(iv) At the option of the applicant, a two-engines-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-engines-inoperative approach and landing.

15. Add the Following New Section to Paragraph 23.b

(5) *Autofeather Effects.* 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).

16. Replace Paragraph 29.b.(3)(i) With the Following

(i) The pitch control reaches the aft stop is held full aft for two seconds, or until the pitch attitude stops increasing, whichever occurs later. 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 § 25.203 (c)).

17. Replace Paragraph 29.b.(3)(ii) With the Following

(ii) An uncommanded, distinctive and easily recognizable nose down pitch that cannot be readily arrested. This nose down pitch may be accompanied by a rolling motion that is not immediately controllable, provided that the rolling motion complies with § 25.203(b) or (c) as appropriate.

18. Remove Paragraph 29.b.(3)(iii) (and Redesignate Paragraph 29.b.(3) (iv) and (v) as 29.b.(3) (iii) and (iv), Respectively

(iii) A roll that cannot be readily arrested with normal use of lateral/directional control.

19. Replace Paragraph 29.d.(3)(i) With the Following

(i) The airplane should be trimmed for hands-off flight at a speed 20 percent to 40 percent above the stall speed, with the appropriate power setting and configuration. Then, using only the primary longitudinal control, establish and maintain a deceleration (entry rate) consistent with that specified in §§ 25.201(c)(1) or 25.201(c)(2), as appropriate, until the airplane is stalled. Both power and pilot selectable trim should remain constant throughout the stall and recovery (angle of attack has decreased to the point of no stall warning).

20. Replace Paragraph 29.d.(3)(iii) With the Following

(iii) In addition, for turning flight stalls, apply the longitudinal control to achieve airspeed deceleration rates up to 3 knots per second. The intent of evaluating higher deceleration rates is to demonstrate safe characteristics at higher rates of increase of angle of attack than are obtained from the 1 knot per second stalls. The specified airspeed deceleration rate, and associated angle of attack rate, should be maintained up to the point at which the airplane stalls.

21. Replace Paragraph 29.d.(3)(iv) With the Following

(iv) For those airplanes where stall is defined by full nose-up longitudinal control for both forward and aft c.g., the time at full aft stick during characteristics testing should be not less than that used for all speed determination. For turning flight stalls, however, 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 § 25.203(c)).

22. Add the Following New Section to Paragraph 29.d.(3)

(vi) In level wing stalls the bank angle may exceed 20 degrees occasionally, provided that lateral control is effective during recovery.

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