ADVISORY CIRCULAR (AC)

Approval of Steep Approach Landing Capability of Transport Category Aeroplanes

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1.0 INTRODUCTION

1.1 Purpose

The purpose of this Advisory Circular (AC) is to provide information on the requirements for the approval of steep approach landing capability of Transport Category aeroplanes using an approach path angle greater than or equal to 4.5 degrees (7.9 %). The requirements of this AC will be issued as Special Conditions in accordance with section 511.07 (1)(b) of the Canadian Aviation Regulations (CARs).

1.2 Guidance Applicability

This document is applicable to all Transport Canada personnel, delegates and industry.

1.3 Description of Changes

This document, formerly AMA No. 525/9A, is reissued as an AC. With the exception of minor editorial changes, the content is unaltered.

1.4 Termination

This document does not have a terminating action. It will however, be reviewed periodically for suitability of content.

2.0 REFERENCES

2.1 Reference Document

It is intended that the following reference material be used in conjunction with this document:

Chapter 525 of the Airworthiness Manual (AWM) — *Transport Category Aeroplanes*.

2.2 Cancelled Document

As of the effective date of this document, AMA No. 525/9A dated 25 February 2000 is cancelled.

3.0 BACKGROUND

In the last ten years various aircraft, mostly propeller driven, have been certified for passenger carrying using a steep approach landing technique. This has been with the use of special conditions or papers applied by various airworthiness authorities. Transport Canada has taken part in flight evaluations of steep approach landing capability on a number of aircraft and has approved the operation on the De Havilland DHC-7 and DHC-8.

The FAA issued Special Conditions for the DHC-7 (No. 25-5-3 of May 7, 1973 "STOL Mode of Operation Only"), and the CAA has proposed "JAR 25 Additional Short Landing Requirements" in Flight Working Paper No. 205, March 1983. Prior to the approval of the DHC-8, the above Special Conditions and requirements were reviewed and as a result AMA 525/9, dated 23 May 1989 was drafted.

Since that time there has been an international harmonization effort to provide a means of obtaining airworthiness approval for steep approach landing. Although, this effort has not yielded a harmonized position as yet, the JAA has issued a Final Rule for "Steep Approach Landing Requirements", dated March 1999, based on NPA 25B-267.

These requirements have been developed in response to a request from the manufacturing and operating industries for a common standard for the certification of aircraft capable of a steep approach landing. With the development of airports typically in congested city areas there is a need for large transport aircraft to operate safely into these airports whilst avoiding obstacles by use of a steep approach.

The lowest value of approach path angle to be considered for steep approach landing rules is 4.5°. In all cases approach path guidance is required and it is assumed that the normal 50 ft screen height will apply, except when guidance is such that the aircraft will be flown accurately

through a 35 ft point in which case a 35 ft screen height may be used. No upper limit on approach path angle is given, although 7.5° is considered the normal maximum.

The approach may be all engines or with one engine inoperative, however for the case where only an all engines approach is cleared it is assumed that a diversion will be necessary in the event of an engine failure prior to reaching the decision height. Landing distance benefits due to the steep approach are to be measured at the discretion of the applicant and are broadly in line with normal measurement methods with the exception of the vertical velocity at touchdown. This AC calls for 6 ft/sec, which is less extreme than the 8 ft/sec called up in the FAA AC 25-7 "Flight Test Guide for Certification of Transport Category Airplanes". Although this will penalise the steep approach landing distance slightly this is considered reasonable, being closer to the normal rate of sink at touchdown seen in service. Safe operation for a steep approach landing is verified firstly by flying abuse tests at extreme angles and also demonstrating go-around and safe landings following engine failure. The abuse tests at 2° are chosen to cover power changes due to head wind and tailwind variability and the ability of the pilot to regain the flight path, and approach at 5 kts below the reference speed, at the nominal angle, to check flare characteristics. For the all engines approach a demonstration landing and go-around must be made with an engine failure at decision height, and for the deliberate one-engine-inoperative approach a go-around from the decision height.

In harmonization discussions it was agreed to use a 2° abuse but permit this to be achieved with the throttles fully closed. As a limit case it was believed to be more clear cut and easier to establish whether the aircraft did or did not comply.

Additionally a revised WAT curve is required, similar to that of Chapter 525, paragraph 525.121(d) but with further constraint on speed to reflect more closely the operational procedure. This is to ensure that a dangerous reduction in speed or a prolonged acceleration to a safe climb speed is avoided.

Flight Manual limitations, procedures and performance appropriate to a steep approach landing are required, and include cross- and tailwind limitations.

The airworthiness regulations described above should be used in conjunction with appropriate operational regulations to cover weather minima, one-engine inoperative diversion and reduced screen height.

This AC parallels the JAA final rule, except as noted hereafter:

(a) Screen heights greater than 50 feet are not allowed. In determining AFM landing distance, AWM 525.125(a)(2) requires that "A steady gliding approach, with a calibrated airspeed of not less than $1.3V_S$, must be maintained down to the 50 foot height". Transport Canada considers that an aircraft must be able to safely conduct an approach to landing using this criteria for any glidepath.

(b) A new paragraph (g) dealing with Performance Extrapolation is added to JAR 25 Appendix (SAL) Section 25. 3.

(c) Paragraph (c) dealing with relationship between the minimum one-engine-inoperative climb speed to V_{MCL} of JAR 25 Appendix (SAL) Section 25.4, Climb: One-Engine-Inoperative, has been rewritten.

(d) A new paragraph (e) dealing with Abuse Case Demonstrations is added to JAR 25 Appendix (SAL) Section 25.5, Safe Operational and Flight Characteristics.

4.0 DEFINITIONS (JAR 25 (SAL) 25.2)

For the purpose of this AC:

(a) The screen height means a height selected by the applicant at 50 ft, or another value from 35 to 50 ft.

(b) V_{REF} means the calibrated airspeed selected by the applicant, used during the stabilized approach at the selected approach path angle and maintained down to the screen height defined above. V_{REF} may not be less than 1.3 V_s or V_{MCL}, whichever is greater.

5.0 AIRWORTHINESS STANDARDS

The requirements contained in this AC apply in lieu of Chapter 525 section 525.121(d) and subchapter G dealing with Aeroplane Flight Manual if a reduced landing distance is sought, or if the landing procedure (speed, configuration) differs significantly from normal operation. Additional requirements may apply with respect to aircraft systems or equipment or any other item relevant like autopilot, guidances or GPWS. Also, the structural implications of the increased probability of high rates of descent at touch down must be considered.

If steep approach approval is required for flight in icing then the icing clearance must be substantiated for the steep approach condition.

An applicant may choose to schedule information for an all-engines approach or for an approach with one engine inoperative. If an all-engines approach is scheduled, it is assumed that a diversion is required if an engine failure occurs prior to the decision to land.

5.1 Steep Approach Landing Distance (JAR 25 (SAL) 25.3)

(Applicable only if a reduced landing distance is sought, or if the landing procedure (speed, configuration) differs significantly from normal operation).

(a) The steep approach landing distance is the horizontal distance necessary to land and to come to a complete stop from the landing screen height and must be determined (for standard temperatures, at each weight, altitude and wind within the operational limits established by the applicant for the aeroplane) as follows:

(i) The aeroplane must be in the all-engines-operating or one-engine inoperative steep approach landing configuration, as applicable.

(ii) A stabilized approach at the selected approach angle, at V_{REF}, must be maintained down to the screen height.

(iii) Changes in configuration, power or thrust, and speed must be made in accordance with the established procedures for service operation. (Refer to ACJ 25.125(a)(3)).

(iv) The landing must be made without excessive vertical acceleration, tendency to bounce, nose over or ground loop and with a vertical touchdown velocity not greater than 6 fl/sec.

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

(b) The landing distance must be determined on a level, smooth, dry, hard-surfaced runway (refer to ACJ 25.125(b)). In addition:

(i) The pressures on the wheel braking systems may not exceed those specified by the brake manufacturer;

(ii) The brakes may not be used so as to cause excessive wear of brakes or tires (refer to ACJ 25.125 (b) (2)); and

(iii) Means other than wheel brakes may be used if that means:

1) Is safe and reliable;

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

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

(c) (Reserved)

(d) (Reserved)

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

(f) 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 assumed to fail during the final stages of an all engines operating steep approach, the steep approach 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.

(g) Rates of descent associated with V_{REF} can increase significantly with higher landing elevations. Transport Canada allows the measured landing distance data to be extrapolated to a maximum of 3000 feet above and 2000 feet below the test altitude without conducting additional verification tests.

5.2 Climb: One-Engine-Inoperative OEI (JAR 25 (SAL) 25

In the approach configuration corresponding to the normal all-engines-operating procedure in which V_s for this configuration does not exceed 110% of the Vs for the related all-engines-operating steep approach landing configuration, with the landing gear retracted, the steady gradient of climb may not be less than 2.1% for two-engined aeroplanes, 2.4% for three-engined aeroplanes, and 2.7% for four-engined aeroplanes, with:

(a) The critical engine inoperative and the remaining engines at the available take-off power or thrust;

(b) The maximum landing weight; and

(c) A climb speed which is:

(i) not less than $1.2V_{S;}$

(ii) not less than 1.1 V_{MCL}; and

(iii) not greater than V_{REF}.

5.3 Safe Operational and Flight Characteristics (JAR 25 (SAL) 25.5)

(a) It shall be demonstrated at the most critical weight and CG, either with all engines operating or with the critical engine inoperative, as appropriate, that it is possible in calm air to complete an approach down to the screen height, touch down and landing without displaying any hazardous characteristics in the following conditions:

(i) Selected approach path angle and approach path angle 2 degrees steeper, at V_{REF}; and

(ii) V_{REF} minus 5 knots, at the selected approach path angle.

For both conditions (i) and (ii):

1) the rate of descent must be reduced to 3 feet per second or less before touch down;

2) below a height of 200 ft, no action should be taken to increase power or thrust apart from those small changes as are necessary to maintain an accurate approach; and

3) the flare is not initiated before the screen height used for determination of landing distance.

(b) It shall be demonstrated at the most critical weight and C.G. that the aeroplane can safely transition from the all-engines-operating steep landing approach to the approach climb configuration with one engine made inoperative at minimum decision height. The initial landing approach must be performed with the selected nominal approach angle at V_{REF}.

For propeller driven aeroplanes the propeller of the inoperative engine must be at the position it automatically assumes following an engine failure at high power. In addition it shall be demonstrated that for propeller driven aeroplanes an engine failure at approach power will not result in a loss of control.

(c) It shall be demonstrated at the most critical weight and C.G. that the aeroplane is safely controllable in a landing with one engine made inoperative at minimum decision height. The landing approach must be performed with the selected nominal approach angle at V_{REF}. For propeller driven aeroplanes the propeller of the inoperative engine must be at the position it automatically assumes following an engine failure at approach power.

(d) For a deliberate one engine inoperative approach, it shall be demonstrated at the most critical weight and C.G. that the aeroplane can safely transition from the one-engine inoperative steep landing approach to the approach climb configuration at the minimum decision height. The initial landing approach must be performed with the selected nominal approach angle at V_{REF}. For propeller driven aeroplanes the propeller of the inoperative engine may be feathered.

(e) Notwithstanding the requirement for a maximum screen height of 50 feet for landing distance determination, the flare may have to be initiated at a height greater than the 50 feet in conducting a $+2^{o}$ abuse of the nominal glidepath with turbojets and higher speed turboprops.

5.4 Aeroplane Flight Manual (JAR 25 (SAL) 25.6)

The AFM supplement for steep approach landing shall include the following:

(a) The steep approach landing distance determined in accordance with paragraph 5.1 of this AC for each selected screen height and aeroplane configuration. The landing distance data may additionally include correction factors for runway slope and temperatures other than standard, within the operational limits of the aeroplane, and may provide the required landing field length including the appropriate factors for operational variations prescribed in the relevant operating regulation.

(b) The more limiting of the landing WAT limits derived in accordance with:

(i) Chapter 525, section 525.119; and

(ii) The one-engine-inoperative approach climb requirement of paragraph 5.2 of this AC.

(c) Appropriate limitations and detailed normal, abnormal and emergency procedures. Where an aircraft is not approved for deliberate one-engine inoperative steep approach landings, this limitation shall be stated.

(d) A statement that the presentation of the steep approach limitations, procedures and performance reflect the capability of the airplane to perform steep approach, but does not constitute operational approval.

(e) A statement of headwind and crosswind limitations and that the tail wind limitation is 5 kts. unless test evidence shows that more than 5 kts is acceptable.

(f) The reference glide slope angle and screen height used for determination of landing distance must be specified

6.0 HEADQUARTERS CONTACT

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