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Minimum Runway Width – for aeroplanes engaged in RPT and charter operations with a maximum take-off weight greater than 5700 kg

Civil Aviation Advisory Publications (CAAPs) provide guidance, interpretation and explanation on complying with the Civil Aviation Regulations (CAR) or Civil Aviation Orders (CAO).

This CAAP provides advisory information to the aviation industry in support of a particular CAR or CAO. Ordinarily, the CAAP will provide additional 'how to' information not found in the source CAR, or elsewhere.

A CAAP is not intended to clarify the intent of a CAR, which must be clear from a reading of the regulation itself, nor may the CAAP contain mandatory requirements not contained in legislation.

Note: *Read this advisory publication in conjunction with the appropriate regulations/orders.*

This CAAP will be of interest to:

- aeroplane operators and owners of multi-engine aeroplanes wanting to operate on runways narrower than stipulated in Chapter 3 of Annex 14, Aerodromes - Volume I, Reference Code to the Convention of International Civil Aviation (the Chicago Convention)
- aerodrome operators considering operations of applicable aeroplanes from and into narrow runways
- aeroplane manufacturers and organisations interested in developing narrow runway Aeroplane Flight Manual Supplements (AFMS)
- aeroplane operators and pilots conducting operations from and into narrow runways
- flight training organisations
- relevant Civil Aviation Safety Authority (CASA) personnel, delegates and industry.

Why this publication was written

The purpose of this CAAP is to identify the minimum runway width requirements that apply to aeroplanes with a Maximum Take-off Weight (MTOW) greater than 5,700kg engaged in regular public transport (RPT) or charter (CHTR) operations. This CAAP identifies the recommended processes and considerations for the initial production of the Aeroplane Flight Manual (AFM), AFMS and operational documentation for narrow runway operations.

Status of this CAAP

This is the first CAAP issued on the subject of minimum runway widths.

For further information

For application and policy advice contact your local CASA regional office (Telephone 131 757).

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1. The relevant regulations and other references

- Annex 14, Aerodromes, to the Chicago Convention
- International Civil Aviation Organization (ICAO) Aerodrome Design Manual (Doc 9157)
- ICAO Operation of New Larger Aeroplanes at Existing Aerodromes (Cir 305-AN/177)
- Regulation 92 of the *Civil Aviation Regulations 1988 (CAR 1988)*
- Regulation 235A of CAR 1988
- Regulation 21.006A of the *Civil Aviation Safety Regulations 1998 (CASR 1998)*
- Part 139 Manual of Standards (MOS) - Aerodromes
- Part 60 MOS - Synthetic Training Devices
- Instrument number CASA EX126/12: Exemption – against the requirements of regulation 235A of CAR 1988 in respect of aeroplanes engaged in private and aerial work operations
- Aeronautical Information Publication (AIP) – En Route 1.1 Suitability of Aerodromes
- CASA Advisory Circular (AC) 21-47(0) - Flight Test Safety
- CAO 20.7.1B - Aeroplane Weight and Performance Limitations - Specified Aeroplanes above 5,700 kg - All Operations (Turbine and Piston-Engine)
- AC 139-1(0) - Regulation of aerodromes used in air transport: an overview
- Federal Aviation Administration (FAA) AC 25-7C - Flight Test Guide
- Transport Canada AC 525-014 - Certification of Transport Aeroplanes on Narrow Runways
- Eurocontrol Aircraft Performance Database V2.0 can be found at: http://elearning.ians.lu/aircraftperformance/

2. Acronyms

AC	Advisory Circular
AFM	Aeroplane Flight Manual inclusive of AFMS
AFMS	Aeroplane Flight Manual Supplement
AOC	Air Operators Certificate
ARC	Aerodrome Reference Code
BFL	Balanced Field Length
CAAP	Civil Aviation Advisory Publication
CAO	Civil Aviation Order
CAR 1988	Civil Aviation Regulations 1988
CASA	Civil Aviation Safety Authority
CASR 1998	Civil Aviation Safety Regulations 1998
CHTR	Charter
CG	Centre of Gravity
DER	Designated Engineering Representative
FAA	Federal Aviation Administration (of the USA)
FAR	Federal Aviation Regulation
FFS	Full Flight Simulator
ICAO	International Civil Aviation Organization
ISA	International Standard Atmosphere
MEL	Minimum Equipment List
MOS	Manual of Standards
MTOW	Maximum Take-off Weight
NAA	National Aviation Authority
OEI	One Engine Inoperative
OEM	Original Equipment Manufacturer
OLS	Obstacle Limitation Surfaces
PAPI	Precision Approach Path Indicator
PIC	Pilot in Command
RPT	Regular Public Transport
SMS	Safety Management System
VASI	Visual Approach Slope Indicator

3. Definitions

For the purposes of this document:

AEROPLANE FLIGHT MANUAL (AFM) – Where applicable, reference in this CAAP to AFM nomenclature is also inferred as reference to AFMS.

AEROPLANE REFERENCE FIELD LENGTH – The shortest take-off distance (unfactored), commonly referred to as balanced field length (BFL), required for take-off by the aeroplane at its maximum certificated take-off weight:

- on a runway that is level and dry
- in still air
- in International Standard Atmosphere (ISA) at sea level.

FULL FLIGHT SIMULATOR (FFS) LEVEL D SIMULATOR – This is a simulator with accreditation to Level D standard in accordance with Part 60 MOS - Synthetic Training Devices or equivalent.

FLIGHT MANUAL – As defined in the Dictionary in Clause 37 of Part 2 of CASR 1998.

NARROW RUNWAY – A runway with a width less than the ICAO minimum runway width for the aeroplane in accordance with the ICAO Aerodrome Reference Code (ARC).

V_{MCG} – MINIMUM CONTROL SPEED – Ground, published in the approved AFM and determined during type certification flight testing in accordance with the particular authority's flight test guidance material (e.g. chapter 2, section 23, paragraph (3) of FAA AC 25-7C - Minimum Control Speed – Ground). An extract of FAA AC 25-7C is provided in Appendix B to this CAAP.

V_{EF} – speed at which the critical engine is assumed to fail during take-off.

V_{1MIN} – the minimum V_1 limited by V_{MCG}.

V_1 – take-off decision speed.

V_R – take-off rotation speed.

4. Background

4.1 The following dates are important to minimum runway width requirements:

- 1982 – the ICAO Aerodrome Reference Code (ARC) was adopted in Australia as the default criteria for determining minimum runway width requirements for aeroplanes. The original publication of regulation 235A of CAR 1988 addressed the minimum runway width requirements for all aeroplane operations.
- 1987 – flight testing was adopted as an acceptable means of compliance to determine minimum runway width requirements for particular aeroplanes.
- June 2012 – CASA policy regarding runway width limitations was rationalised in accordance with the intent of Annex 14, Volume I to the Chicago Convention. It was necessary to identify and clarify that the Part 139 MOS applied to the provision of aerodrome facilities and was not intended to be applied to *limit or regulate the operations* of aeroplanes from and into aerodromes. As a result of consultation at the Standards Consultative Committee (SCC), CASA amended regulation 235A of CAR instructions on minimum runway widths.[1]

[1] Consultation draft for 235A of CAR was posted on the CASA website on 24 May 2013, for a four week period.

4.2 August 2012 – CASA issued a general exemption against the requirements of regulation 235A of CAR 1988, in respect of aeroplanes engaged in private and aerial work operations. Operators and pilots continue to be subject to the general requirement under regulation 92 of CAR 1988 that the aerodrome or other landing places must be suitable for the safe take-off and landing of aircraft. Part 139 MOS – Aerodromes, amendments were also made to delink the aerodrome design standards from the operational requirements of aeroplanes. Subsequently CASA issued the minimum runway width general exemption EX126/12 against regulation 235A of CAR 1988 for aeroplanes engaged in private and aerial work operations and those aeroplanes with MTOW less than or equal to 5,700 kg.

4.3 In co-ordination with the publication of this CAAP, regulation 235A of CAR 1988 was amended to provide conditions under which aeroplanes engaged in RPT and CHTR operations (with MTOW greater than 5,700kg) can operate to and from runways narrower than that required by the ICAO ARC.

4.4 Aeroplanes type certified prior to 1 March 1978 are ‘grandfathered’ from the requirements of regulation 235A of CAR 1988. As such, applicable aeroplanes are ‘exempt’ from the requirements regulation 235A of CAR 1988 and this CAAP. The operation of these affected aeroplanes into aerodromes shall be carried out safely in accordance with regulation 92 of CAR 1988.

Note: The 1 March 1978 was the applicability date of Federal Aviation Regulation (FAR) 25 Amendment 42. This amendment included new accountability of controllability on the ground (V_{MCG}) and scheduling take-off performance taking into account engine failure at V_{EF} with applicable time delays for retardation devices in the accelerate-stop performance. Amendment 42 also required the scheduling of take-off balanced field length. In addition, the ICAO ARC did not exist in its current form until the early 1980’s.

5. Multi-engine aeroplane runway width requirement

5.1 Runway width operational limitations are not supported by an aircraft certification standard. The current generic method of determining the minimum runway width, by sole reference to the ICAO ARC, can be operationally limiting for some aeroplanes. For example, Airbus and Boeing undertook specific flight testing to demonstrate that the A380 and B747-800 is capable of operating on 45m wide runways. Airbus subsequently issued a specific AFM 45m runway width limitation. Reference to the ICAO ARC indicates the A380 physical characteristics equate to a Code 4F runway - 60m runway width.

5.2 CASA has developed a performance-based assessment of aeroplane operational capability on narrow runways. The assessment is based specifically on aeroplane handling characteristics, taking into consideration:

- certified V_{MCG}
- lateral deviations from runway centreline
- crosswind
- take-off speed schedule
- take-off performance
- crosswind landing capability
- specific operational considerations.

5.3 This follows ICAO recommendations, along with the runway containment philosophy applied to the determination of accelerate-stop/go take-off distance with an engine failure at V_{EF}. The directional controllability and runway width capability of the aeroplane is assessed in a crosswind with an engine failure at V_{EF}.

5.4 Consideration of operations from narrow runways will require, as a minimum, assessment of the following:

- aeroplane physical characteristics and performance
- directional handling capabilities in crosswind conditions
- operational implications at the particular aerodrome(s) where operations are intended.

5.5 Subsection 3.1.10 of Chapter 3 (Physical Characteristics) to Annex 14 (Aerodromes) to the Chicago Convention recommends a minimum runway width for the largest expected aircraft of intended use; taking into account general aeroplane performance parameters and physical characteristics. Application of the ARC has historically been adopted as a generic default runway width limit for aeroplane operations. The aeroplane code is determined based on the unfactored MTOW BFL and specific aeroplane physical characteristics.

5.6 Certification flight testing to determine V_{MCG} is required for Transport Category aeroplanes with MTOW above 5,700 kg, and in the case of the FAA, turbo-jet aeroplanes with MTOW above 2,722kg (refer to FAA AC 25-7C in Appendix B to this CAAP).

5.7 The V_{MCG} speed may limit the minimum take-off speeds such as V_{EF} and V_{1MIN}. These speeds also determine the baseline minimum take-off speed schedule which is applicable to the determination of take-off performance, including accelerate-stop/go performance. The V_{MCG} flight testing is also an evaluation of the directional control handling characteristics. Throughout the V_{MCG} testing, the lateral deviation from the runway centreline, with an engine failure, is measured and is limited to 9.14m (30ft under the imperial system). Most aircraft demonstrate a deviation less than the maximum at the scheduled V_{MCG}.

5.8 The absolute minimum runway width (W) based exclusively on V_{MCG} certification flight test maximum allowable deviation (D), in zero crosswind conditions, dry runway is calculated as follows:

W = 2 x [(D) 9.14m + runway misalignment lateral displacement (M)] + gear track (T) to the outer most main gear tyre.

5.9 V_{MCG} testing is conducted and evaluated in zero crosswind conditions. As an example for a generic aeroplane, the minimum runway width based on maximum allowable V_{MCG} deviation (9.14m), a runway line-up track tolerance of 1m and a gear track of 7.5m will require a minimum runway width:

W= 2 x [9.14+1] + 7.5 = ~27m.

5.10 Therefore a 30m wide runway would be a guide for zero crosswind, based solely on V_{MCG} certification flight test. In this example, there would be ~ 1.5m available for crosswind accountability for 30m wide runway operations.

Note: For the remainder of this CAAP, certification flight testing of V_{MCG} is assumed to be in accordance with Federal Aviation Regulation (FAR) 25 post-Amendment 42. Prior to Amendment 42 of FAR 25, a limiting lateral deviation of 25ft was required; however there was no accountability for the time delay between V_{EF} and V_1. Amendment 42 incorporated a V_{EF} scheduled prior to V_1, with a maximum V_{MCG} lateral deviation of 30ft.

6. Aerodrome operators

6.1 It is recommended that aerodrome operators record, in the Aerodrome Manual, or equivalent documentation, the details of those AOC holders conducting narrow runway operations in accordance with regulation 235A of CAR 1988.

6.2 The aerodrome Safety Management System (SMS) should include narrow runway operations when details of such operations are included in the Aerodrome Manual or equivalent documentation, as referenced in 6.1 above.

7. AOC holder

7.1 This CAAP sets out a process and considerations for the issue of narrow runway approval.

7.2 Operators of RPT and CHTR aeroplanes, with MTOW greater than 5,700kg, must comply with narrow runway limitations set out in the AFM.

7.3 The runway width must be determined as follows:

(a) in accordance with the ICAO ARC, applicable to the particular variant of the aeroplane type at the type certificated MTOW (refer to Section 9 of this CAAP);
or

(b) as limited by the National Aviation Authority (NAA), original equipment manufacturer (OEM) or AFM (e.g. the A380);
or

(c) in accordance with approved AFMS for operations from narrow runways produced on the basis of; aeroplane flight testing, Full Flight Simulator (FFS) assessment and/or a combination of computer data reduction analysis and FFS assessment.

7.4 Document requirements:

- the Operations Manual must provide narrow runway operational requirements
- the Training and Checking Manual must provide specific training and checking requirements for narrow runway operations
- the operators SMS should include narrow runway operations when details of such operations are included in the AOC holders Operations Manual

8. Minimum runway width

8.1 The runway width must be adequate to safely contain an aeroplane during take-off and landing by flight crews of average skill, using procedures which can be consistently repeated in service. The runway width must be sufficient, at the crosswind limit, to prevent any aeroplane damage or subsequent malfunction, and any landing gear wheel from leaving the runway surface under the approved operating conditions after a sudden failure of the critical engine during take-off, or during a one engine inoperative (OEI) approach and landing. The take-off and landing technique shall be that recommended by the OEM and shall prevent any part of the aeroplane contacting the runway surface except for the landing gear i.e. engine nacelles, tail skids and flap trailing edges, (refer to Chapter 4 paragraph 4.1.1 to Part I ICAO Annex 6).

8.2 The minimum runway width for an aeroplane is the lesser of the runway widths determined as follows:

(a) in accordance with the ICAO ARC applicable to the particular variant of the aeroplane type at the type certificated MTOW, (refer to Section 9 of this CAAP);

or

(b) as limited by the NAA, OEM or AFM;

or

(c) in accordance with approved AFMS for operations from narrow runways produced on the basis of; aeroplane flight testing, FFS assessment and/or a combination of computer data reduction analysis and FFS assessment.

Note: For subparagraph 8.2(a) above, changes to MTOW and/or engine power (as a result of certificated aeroplane variant changes) can be taken into account for revising the ARC and applicable minimum runway width. However, arbitrarily reducing the runway width required, by reducing the BFL via a reduction of MTOW and/or maximum power setting so as to take advantage of a lower ARC number, will not be an acceptable means of compliance.

8.3 The AFMS is produced on the basis of OEM's data or in compliance with the conditions herein. The AFMS must be approved in accordance with requirements of regulations 21.420, 21.009 and 2.006A of CASR 1998. Some additional approval options are available under regulation 21.470 of CASR 1998.

8.4 In order to initiate an approval process for the narrow runway AFMS, an applicant must contact CASA Airworthiness and Engineering Standards Branch via email address: aircraft.certification@casa.gov.au.

8.5 Minimum runway width assessment takes into account, as a minimum:

- crosswind
- V_{MCG}
- Minimum Equipment List (MEL) limitations
- runway surface requirements
- operational weather minima
- flight crew requirements (including training and checking).

8.6 In addition, it is necessary to take into account the operation of the aeroplane on the aerodrome, especially consideration of aerodrome operational limitations such as:

- taxiway
- apron areas
- other associated aerodrome facilities and infrastructure.

8.7 The runway width determined in accordance with this CAAP is a runway width of homogenous runway surface material. For example, a runway with an 18m centre sealed surface and 2.5m of adjacent rolled gravel each side is not considered to be a 23m runway for the purposes of minimum width determination.

9. The method of determining minimum runway width by ICAO ARC

9.1 In the first instance, the ICAO ARC must be used to determine the runway width. The code number and letter is selected in accordance with the following two distinctive characteristics of the aeroplane:

- Code Number – Based on the aeroplane reference unfactored take-off BFL, at maximum certificated take-off weight for the particular variant of the aeroplane type, zero runway slope, sea level, ISA conditions, and zero wind.[2]
- Code Letter – Based on the aeroplane physical characteristics of wingspan and outer main gear wheel span (track). [3]

9.2 The minimum runway width for an aeroplane type is obtained by determining the aerodrome reference code (code number and code letter) as follows:

- The code number must be determined from Table 1 below. The code number corresponding to the aeroplane reference BFL range.
- The code letter must be determined from Table 1 below. The code letter corresponds to the aeroplane wingspan, or the outer main gear wheel span, whichever gives the later letter of the code. That is, if the aeroplane has characteristics applicable to both code letter C and D, then the latter alphabetical letter (D) would be chosen as the applicable code letter.
- In the case of an aeroplane where the combination of Wing span and Outer main gear wheel span (OMGWS) is in the 9m to14m range, and the OMGWS determining the later letter of the code, then the applicable code letter will be D (i.e. it is not required to apply code letter E in this case).

Table 1 – ICAO Annex 14 Aerodrome Reference Code

Aerodrome Reference Code				
Code Element 1		Code Element 2		
Code number	Aeroplane reference field length	Code letter	Wing span	Outer main gear wheel span
1	Less than 800 m	A	Up to but not including 15 m	Up to but not including 4.5 m
2	800 m up to but not including 1200 m	B	15 m up to but not including 24 m	4.5 m up to but not including 6 m
3	1200 m up to but not including 1800 m	C	24 m up to but not including 36 m	6 m up to but not including 9 m
4	1800 m and over	D	36 m up to but not including 52 m	9 m up to but not including 14 m
		E	52 m up to but not including 65 m	9 m up to but not including 14 m
		F	65 m up to but not including 80 m	14 m up to but not including 16 m

[2]Unfactored performance for specific aircraft type and/or variant should be obtained from the aeroplane manufacturers AFM or directly from the OEM.

[3] Aeroplane physical and performance general information is detailed in ICAO Aerodrome Design Manual (Doc 9157), and Eurocontrol aircraft data website (referenced in section 1 of this CAAP). Aeroplane manufacturers will also be able to provide this detailed information. An example of reference material can be found in Appendix A to this CAAP.

9.3 The minimum runway width is obtained by entering the reference code number and code letter into Table 2 of this CAAP. The minimum runway width is located at the intersection of the row that specifies the code number and the column that specifies the code letter.

9.4 It is recommended that the ARC applicable to the BFL performance for the specific aeroplane type and/or variant is obtained from the aeroplane manufacturer.

Table 2 – ICAO Minimum Runway Width

Code number	Code letter					
	A	B	C	D	E	F
1	18 m	18 m	23 m	–	–	–
2	23 m	23 m	30 m	–	–	–
3	30 m	30 m	30 m	45 m	–	–
4	–	–	45 m	45 m	45 m	60 m

Example:

B767-200ER: Aerodrome reference field length is over 2,700m which corresponds to code number 4. The wingspan is 47.6m with an outer main gear wheel span of 10.8m (refer to Appendix A to this CAAP) which corresponds to code letter D.

Therefore the minimum runway width from Table 2 is 45m.

10. The method of determining minimum runway width by Flight Test

10.1 **Directional control characteristics – Multi-engine aeroplanes**

10.1.1 This CAAP sets out the flight testing to determine the AFM limitations and procedures for narrow runway operations.

10.1.2 The minimum runway width determined by flight test is the runway width which an average pilot accustomed to the aeroplane can prevent any aeroplane damage, abnormal contact with the runway surface, subsequent malfunction and any part of the outermost landing gear tyre from an excursion off the edge of the designated runway (without undue difficulty).

10.1.3 To determine the minimum runway width by aeroplane flight test requires an evaluation of directional control characteristics of the aeroplane and measurement of the lateral deviation from the runway centreline under specific conditions. The following provides the minimum flight test considerations encompassing the conditions and manoeuvres to be included in the flight test schedule:

(a) **conditions** – At all points during the take-off and landing ground-roll, conducted in accordance with the recommended flight test technique, it is possible to control lateral deviation from the runway centreline such that the outermost landing gear tyre remains within the designated width of the runway surface under the following conditions:

(i) for take-off sudden failure of the critical engine at $V_{EF,}$ where V_{EF} is no less than V_{EF} used during the type certification determination of dry runway V_1 (V_{1MIN})

Note: V_{1MIN} *is limited by* $V_{MCG.}$

(ii) no differential wheel braking, nor use of differential power on the operative engine(s), is used to maintain directional control during the continued take-off manoeuvre

(iii) directional control of the aeroplane during the take-off manoeuvre is accomplished by using rudder only. All other flight controls (such as ailerons spoilers, etc.) should only be used to make corrections to maintain the required pitch and roll attitude in accordance with standard operating procedures dictated by the manufacturer, and should not be used to supplement rudder effectiveness

Note: Rudder assistance control systems such as rudder boost (BE350) and thrust asymmetry compensation (B777) may be used to assist directional control throughout flight testing. If these systems are used during flight testing then the MEL must annotate that these systems must be serviceable for all operations from and into narrow runways.

(iv) the aeroplane is configured at the most critical weight, where V_{1MIN} may impact AFM V_1 speeds and the aft centre of gravity (CG) position within the allowable range, for at least one series of flight tests (see subparagraph 10.2.4(b) of this CAAP);

(v) take-off flaps set in the most critical position, the flap position to be used for the purpose of the narrow runway AFMS, or the take-off flap setting limit in the AFM

(vi) crosswind from the most critical direction equal to or greater than 7kts

(vii) at sea-level, ISA conditions or other combination of pressure altitude and temperature which provides for maximum asymmetric power, or thrust (whichever is applicable) within the allowable range of engine limitations

(viii) if wet runway approval is required, nose wheel and/or rudder pedal steering is made inoperative (unless otherwise restricted by the aeroplane system, AFM or MEL) or otherwise not used throughout the flight test[4]

(ix) runway surface conditions are applicable to the proposed operation, such as hard and dry sealed surface or dry and unpaved runway surface (e.g. gravel, grass etc).[5]

(b) **flight test manoeuvres** – The minimum runway width is determined and scheduled from the greater of the deviations and assessment, determined by flight test or FFS, and/or data analysis for the following manoeuvres, under the applicable conditions specified in subparagraph 10.1.3(a) above:

(i) rejected take-off

(ii) continued take-off

(iii) OEI landing, in the most critical landing configuration, after executing a side-step manoeuvre displaced laterally no less than 150m from the extended runway centre line. The side-step manoeuvre is to align the aeroplane with the runway centre line. The manoeuvre is completed at an altitude no lower

[4] Credit may be given for wet, sealed and dry unpaved runway of minimum runway widths if, throughout the aircraft flight testing, acceptable results have been achieved with the nose wheel steering system inoperative (refer subparagraph 10.1.3 (a)(viii) above) or by some other approved method.

[5] Credit may be given for dry unpaved runway of minimum runway widths if, throughout simulator flight testing, acceptable results have been achieved with the nose wheel steering system inoperative (refer subparagraph 10.1.3 (a)(ix) above and the aeroplane has an NAA, or OEM approved unpaved runway supplement. Wet unpaved operations will not be permitted.

than 500ft above the runway threshold, from which a stabilized approach can be carried out. This manoeuvre should be conducted such that the crosswind is from the most adverse direction.

Note: A waiver of the flight testing required in subparagraph 10.1.3(b)(iii) above is available if the OEM has scheduled in the AFM a OEI ***demonstrated*** *crosswind limit and throughout the determination of the demonstrated crosswind limit the lateral deviations from the centre line meet the requirements of this CAAP (see paragraph 11.9.9 of this CAAP).*

(c) runway width parameters are as follows:

W = Minimum runway width

T = Distance between outermost edges of the main gear tyres (track)

M = Misalignment distance of the nose wheel from the centreline of the runway at the take-off line-up position. M is determined as follows:

– by measuring the distance between the line-up position of the nose wheel assembly from the first point of alignment and the runway centreline demonstrated during the conduct of narrow runway flight testing; or
– one metre for aeroplanes with a gear track of 10m and above, decreasing linearly to a minimum of 0.5m for aeroplanes with an outermost gear track of two metres or less.

Note: For the demonstration of M , the aeroplane should enter the runway in one continuous manoeuvre and stop without using extra runway length to refine the line-up position.

D = Maximum lateral deviation value determined from flight test[6]:

– under the *conditions* specified in subparagraph 10.1.3(a) above; and
– during the *flight test manoeuvres* specified in subparagraph 10.1.3(b) above.

(d) Runway Width (W) – Minimum runway width is calculated as follows:

W = 2(0.5T + M + D)

Note: See Figure 1: Runway Width Parameters.

Notes:

1. *Crosswind component extrapolation above the maximum crosswind obtained from actual narrow runway aircraft flight test should not exceed 25% of the crosswind achieved during flight test up to a maximum of 5kts. The maximum lateral deviation (D) shall remain within the limit for the particular aeroplane at the extrapolated crosswind value. The extrapolated maximum crosswind value shall not be greater than the demonstrated crosswind or other more restrictive crosswind limitations detailed in the AFM or Operations Manual. Extrapolation is only available for a crosswind determined by actual aeroplane flight test (refer paragraph 11.9.5 of this CAAP).*

2. *Extrapolation of the crosswind shall not be applied if, during flight testing, the crosswind was determined by a limiting factor (either aerodynamically or operationally).*

[6] Deviation (D) will be determined in accordance with the flight test methodology for VMCG determination (refer Appendix B to this CAAP).

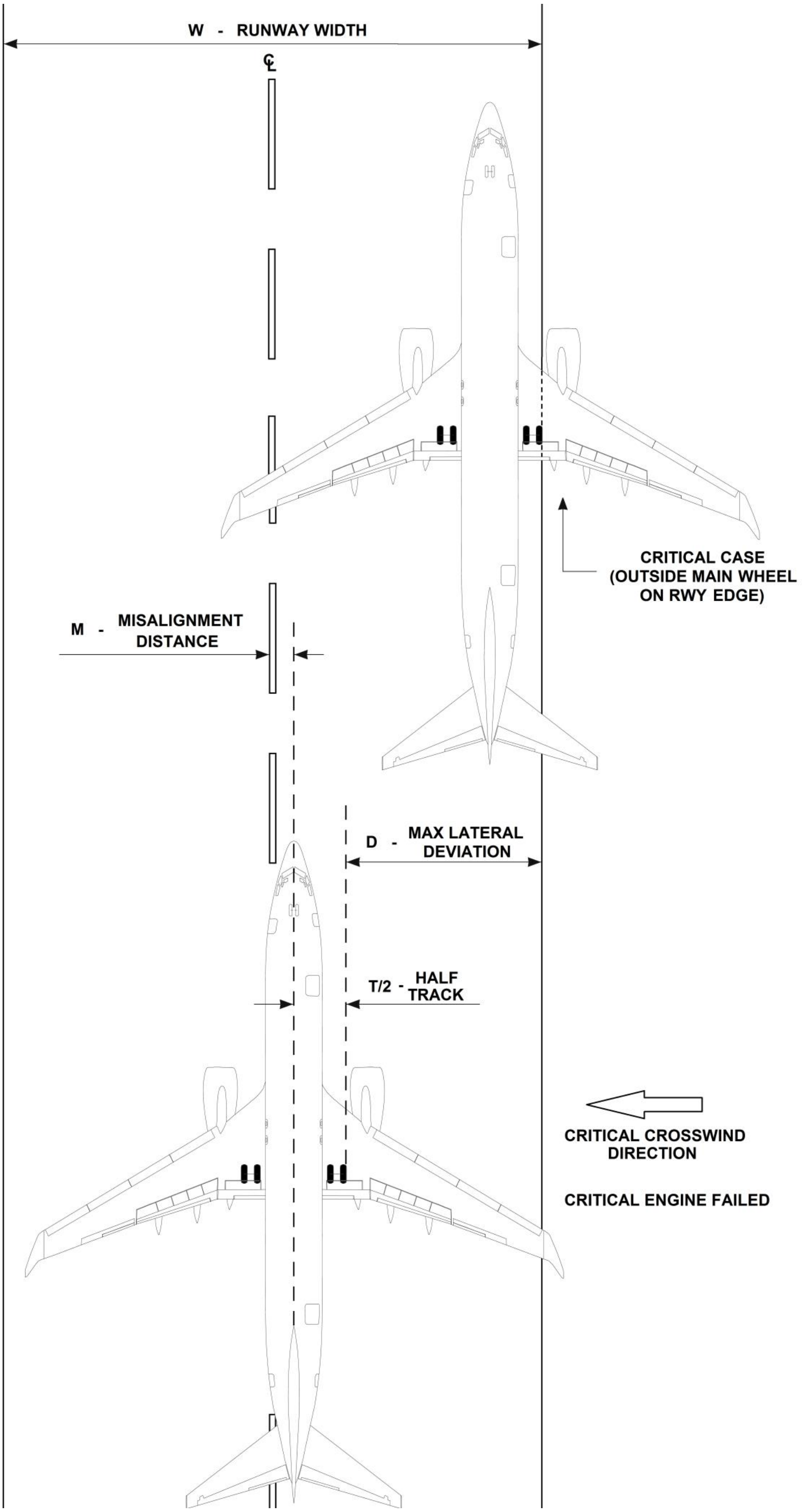

Figure 1 – Runway Width Parameters

10.2 Flight test schedule

10.2.1 Flight testing is carried out in accordance with safe practices and, as applicable, in accordance with CASA AC 21-47 - Flight Test Safety, or other NAA equivalent documents. Flight test schedule should be agreed with CASA or an authorised person before flight testing begins.

10.2.2 It is highly recommended that reference is made to appropriate regulatory authority flight test guides, such as FAA AC 25-7C Flight Test Guide for Certification of Transport Category Airplanes (see Appendix B to this CAAP).

10.2.3 Directional control flight testing (as in subparagraph 10.1.3(a) above) is carried out with a sudden engine failure, achieved by fuel cut-off. In the event that fuel cut-off voids warranty on any given engine components, then a rapid throttle closure 'chop' will be acceptable, provided an engine run down adjustment is made to adequately simulate engine failure by fuel cut-off.

10.2.4 Engine failure simulation for turbo-prop aeroplanes is to provide representative asymmetric controllability that occurs during an actual engine failure; taking into account the effects of the engine/propeller combination during an actual engine failure (i.e. with auto-feather).

(a) as a minimum, the following parameters are to be recorded during each flight test:

(i) aeroplane gross weight and CG

(ii) calibrated airspeed

(iii) runway misalignment lateral displacement (M)

Note: Pilot estimate is acceptable.

(iv) aeroplane lateral deviation from the centreline after engine failure

Note: Pilot estimate of the lateral deviation is ***not*** *acceptable*

(v) rudder pedal force and/or rudder pedal deflection

(vi) engine thrust parameter such as engine pressure ratio (EPR), torque, exhaust gas temperature (EGT) or revolutions per minute (RPM) etc.

(vii) runway wind velocity, aerodrome temperature and pressure altitude.

Note: Wind velocity data will be recorded and corrected to an equivalent tower height (10m) by an acceptable method such as $V_{10}=V_h (10/H_h)^{1/7}$ *(where* V_h *and* H_h *are the anemometer wind and height values during flight test).*

(b) the most critical gross weight and CG will be determined and flight tested; as a minimum

(i) MTOW at the maximum aft CG

(ii) most critical gross weight and maximum aft CG in the range where V_{1MIN} may impact on AFM V_1 speeds.

At least **three** acceptable flight test data points, at each scheduled gross weight and CG combination, shall be used to verify the flight test results.

10.2.5 Flight testing is to be conducted under the supervision of the aeroplane manufacturer, or appropriately trained and qualified flight test personnel. In all cases, support from the OEM is strongly recommended.

10.3 OEI approach and landing assessment

10.3.1 Demonstration is required to ensure the aeroplane can land safely:

- within the runway width
- with average pilot skill
- with the most critical engine inoperative
- after executing a side-step manoeuvre of no less than 150m.

10.3.2 The side step manoeuvre is commenced from the most critical side of the extended runway centreline, taking into account the crosswind, and should be executed to align the aeroplane with the runway centreline. The standard stabilised approach criterion is to be adopted.

10.3.3 The approach and landing assessment is to represent the base/final turn during a circling approach or an offset runway approach.

10.3.4 The OEI approach and landing flight testing is to be demonstrated at the maximum demonstrated crosswind, or crosswind limit, as published in the AFM.

10.3.5 If it is not possible to achieve a satisfactory demonstration at crosswind values, as stipulated in paragraph 10.3.4 above, then the landing crosswind limit for narrow runway operations will be the maximum crosswind achieved during satisfactory flight testing carried out in accordance with this CAAP.

> *Note: The crosswind value will be equal to or greater than 7kts as measured at the aerodrome anemometer. Wind velocity data will be recorded and corrected to an equivalent tower height (10m) by an acceptable method such as* $V_{10=}V_h\,(10/H_h)^{1/7}$ *(where* V_h *and* H_h *are the anemometer wind speed and height values during flight test).*

10.4 Take-off performance

10.4.1 The take-off performance for narrow runway operations is determined by taking into account:

(a) take-off speed schedule based on $V_{EF,}$ and V_{1MIN} (determined in accordance with subparagraph 10.1.3 (a)(i) of this CAAP)

(b) aeroplane take-off configuration as determined in subparagraph 10.1.3 (a)(v) of this CAAP.

10.5 Analytical data analysis or FFS assessment

10.5.1 Analytical data analysis will be considered in circumstances where actual aeroplane or FFS flight testing is not possible. The OEM computer modelling should be applicable to the aerodynamic characteristics (engine/airframe combination) of the variant of the aeroplane type under assessment. Data analysis, without input from FFS flight testing, will be acceptable for assessment of runway widths 23m or greater.

10.5.2 The same level of data confidence cannot be achieved with computerised data analysis and/or FFS assessment in comparison to flight testing the actual aeroplane. Narrow runway assessment can be achieved by adequate computer data analysis, in combination with FFS testing. In situations where it is not possible to flight test the aeroplane, a conservative approach to the maximum cross wind limit will be applied.

10.5.3 FFS testing will be carried out by an approved and qualified test pilot, in accordance with the flight test schedule in Section 10.2 and guidance material detailed in this CAAP.

Note: *Reduction of the runway width by only* ***one*** *Code Letter or Code Number is permitted by analytical and/or simulator data analysis. For example, if the runway required by the ARC is 45m, then the minimum runway width determined by data analysis and/or FFS assessment will be 30m. In this example, further reduction of the runway width to 23m would require either actual aeroplane flight test, FFS assessment, or a combination of actual aeroplane flight test and FFS assessment.*

10.5.4 The production of data from a FFS, in support of narrow runway operations, should be undertaken with appropriate engineering flight test input. This would include a structured flight test program, the same as what would be required for testing carried out with the actual aeroplane.

10.5.5 The computer data analysis can be further qualified with associated FFS assessment. The FFS should meet the requirements of Level D or equivalent.

10.5.6 The FFS will be representative of the variant of the aeroplane/engine combination type under assessment for narrow runways.

10.5.7 A full understanding of the simulator modelling, and the data on which the simulator has been accredited, should be demonstrated. Any broad assumptions or other anomalies in the take-off, landing or other ground handling capabilities may restrict crosswind factoring as detailed in section 10.6 below.

10.5.8 The simulator will have a current statement of compliance, or equivalent, in accordance with the Part 60 MOS - Synthetic Training Devices. Equivalent simulator approval from an overseas NAA will also be acceptable.

10.5.9 FFS testing is carried out in accordance with this CAAP, commencing at paragraph 10.1. A proposed flight test schedule should be agreed on with CASA, or an authorised person before the flight testing begins.

10.5.10 Evaluation of the simulator ground modelling should be assessed by conducting a combination of comparative V_{MCG} flight test exercises and OEI crosswind landing exercises. The data from these exercises is compared against the actual manufacturer's certification flight test data. Equivalent simulator accreditation data will be an acceptable means of showing compliance against this requirement.

10.6 Crosswind factoring

10.6.1 Crosswind capability determined from computer analysis and/or FFS flight testing will be factored. The crosswind factor can be improved with FFS flight testing. Narrow runway crosswind is calculated as follows:

(a) computer analysis only - 50% of the determined cross wind will be credited;

Note: *Computer analysis without FFS and/or aeroplane flight test justification will be limited to provide assessment for 23m or wider runways up to a maximum crosswind of 15kts for a dry runway and 10kts for a wet runway.*

or

(b) computer analysis qualified and combined with partial FFS comparison flight testing - 60% of the crosswind determined will be credited;

or

(c) FFS assessment - 60% to 75% of the crosswind determined will be credited.

Note: The crosswind credit for 10.6.1 (c) above may be increased up to a maximum of 75% dependent on the correlation with manufacturer's V_{MCG} certification flight test data and FFS aerodynamic and ground modeling accreditation data (refer to paragraph 10.5.7 & 10.5.10 above).

10.6.2 A factored crosswind limit determined solely by computer data analysis (reference subparagraph 10.6.1(a) above) is limited to a value less than or equal to 50% of the maximum certification demonstrated crosswind, up to 15kts, or other operational crosswind limit scheduled in the OEM approved AFM (reference subparagraph 11.9.6), whichever is less.

10.6.3 For computer analytical and/or FFS assessment, the following will be determined in accordance with the provisions of the flight test conditions and manoeuvres scheduled in this CAAP:

- lateral deviations
- associated take-off speed and crosswind limit

10.6.4 Associated limitations and operational data must be included in the AFM and the Operations Manual, in accordance with the provisions of Section 12 of this CAAP.

10.6.5 The maximum wet runway crosswind determined by computer data analysis shall not be greater than two thirds of the dry narrow runway crosswind limit, as determined in subparagraph 10.6.1 above.

10.7 NAA and OEM approved limitations – AFM or AFMS

10.7.1 The NAA or OEM may provide an operational **certificated** minimum runway width limit. This limit will be in the *Limitations* section of the AFM, and approved by the applicable NAA (e.g. A380 has an approved *minimum runway width limitation* included in the AFM Limitations section). If the NAA is listed in regulations 21.012 or 21.010A of CASR 1998 or accepted under subregulation 21.470(d) of CASR 1998, the approval is acceptable to CASA and a specific narrow runway AFMS is not required. Compliance with subparagraph 12.2 and Section 13 shall be in accordance with the OEM provided documentation.

10.7.2 Narrow runway flight testing, in accordance with Section 10 of this CAAP, is not required if narrow runway operations are NAA, or CASA approved with:

- AFM
- AFMS or
- operational documentation provided to support narrow runway operations.

10.7.3 Compliance with subparagraph 12.2 and Section 13 of this CAAP is required. The NAA must be listed in regulations 21.012 or 21.010A of CASR 1998; or accepted under subregulation 21.470(d) of CASR 1998.

10.7.4 Aerodrome operator liaison is required, in accordance with Section 14 of this CAAP.

10.8 Minimum runway width flow chart

10.8.1 The flow chart (Figure 2) details a summary of the required processes for determining the minimum runway width. Enter the flow chart from the top and flow through the chart through the action boxes and question diamonds via the applicable flow lines. The flow chart references the applicable sections of this CAAP.

10.9 Aeroplane modifications – increased power rating

10.9.1 If an aeroplane type that has a narrow runway approval is subsequently modified, with the modification approved in accordance with requirements of subpart 21D or 21M of CASR 1998, then the original narrow runway approval is considered valid without further specific narrow runway testing/analysis, if the V_{MCG} and the performance has been verified and validated.

10.9.2 If V_{MCG} has been revised, due to the increased power rating with subsequent incorporation of changes to performance (including re-scheduled min V_1 then no further action is required for narrow runway operations.

10.9.3 If, as a result of the verification and validation, there are changes to V_{MCG} and performance, then the applicable sections of the narrow runway documentation shall be amended accordingly (refer to Section 12 of this CAAP).

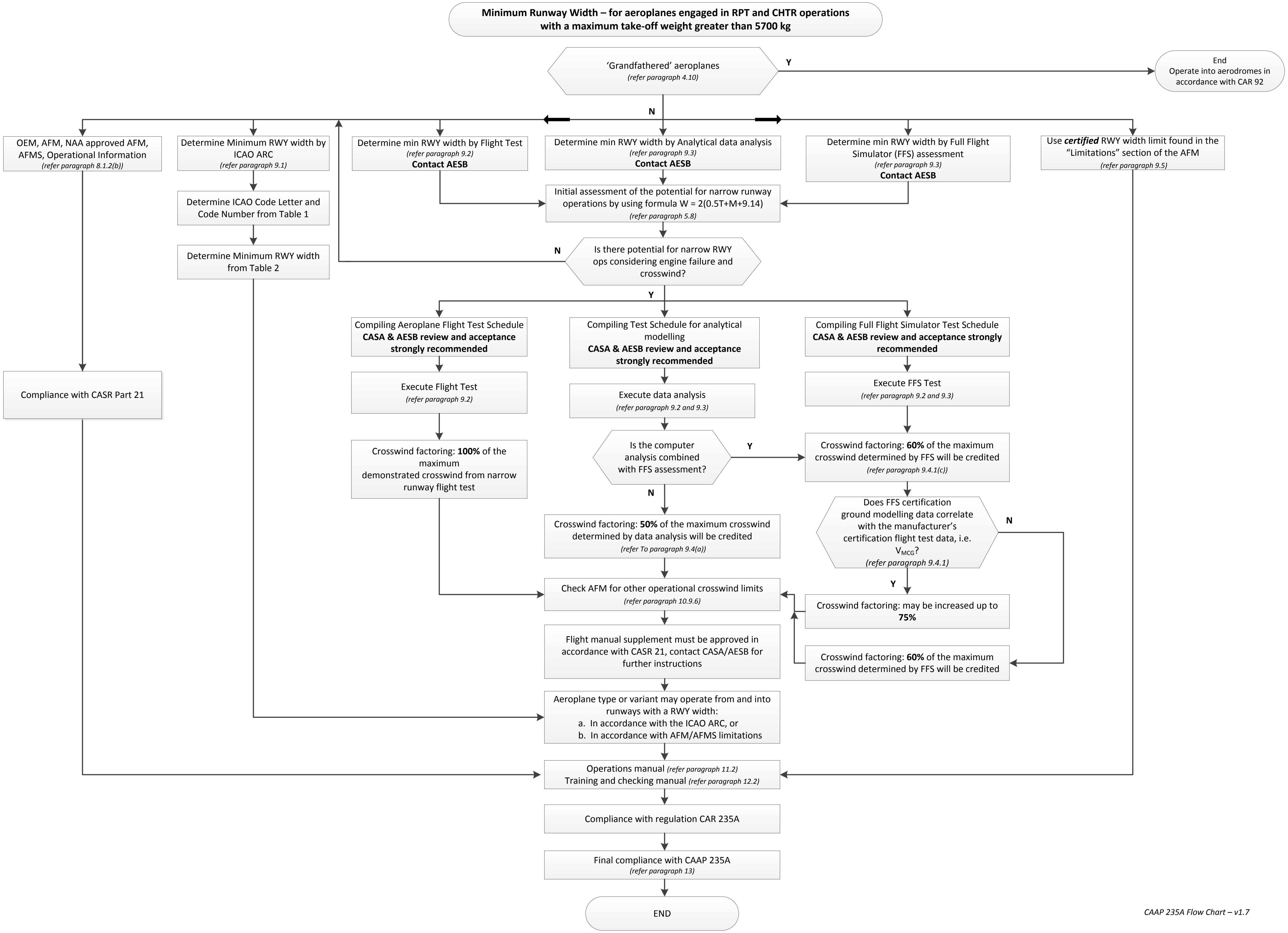

Figure 2 – Summary of methods to determine minimum runway width (under CAR 235A)

11. Flight test guidance material

11.1 Determination of the aeroplane's directional control characteristics is the primary aim of the narrow runway width flight testing. Directional control is assessed against the maximum deviation during an engine failure on take-off.

11.2 In general, the parameters which tend to become limiting during flight testing are as follows:

- the minimum runway width required
- V_{MCG}, as determined by certification flight testing and/or subsequent data evaluation
- V_{1MIN}, wet and dry runway
- the crosswind limit
- asymmetric control capabilities
- runway surface conditions (i.e. a wet or unpaved runway).

11.3 It should be recognised that individual aeroplanes have different directional control characteristics. Maximum deviation (D) may be influenced by a combination of these characteristics.

11.4 It is not intended that this section of the CAAP be an all-encompassing description of how to arrive at a particular runway width for all aeroplane types. This section will identify those parameters that can be varied to optimise the flight testing and/or data evaluation.

11.5 The parameters detailed below address the take-off flight test schedule for the runway width assessment. This CAAP details other aspects of the aeroplane operation that may limit the runway width, in isolation to the handling characteristics determined by flight test.

11.6 **Minimum runway width required**

11.6.1 The minimum runway width required is based on a logical assessment of the aeroplane directional control capabilities, along with the operational reasoning for obtaining a narrow runway AFMS.

Notes:

1. *It is unlikely that an aeroplane certificated in the transport category will be able to operate from 18m runways without substantial flight testing and possible re-certification of V_{MCG}. For this reason, it is recommended that a detailed assessment be made of the operational requirements of the aeroplane prior to carrying out a flight test assessment.*
2. *Assessment exclusively by data analysis is acceptable for operations from runway widths 23m or greater.*

11.7 V_{MCG} determined by certification flight test

11.7.1 The limiting parameter may, in fact, be the actual handling characteristics of the aeroplane. Turbo-prop aeroplanes tend to exhibit large deviations during engine failure, as a result of the engine/propeller combination and associated asymmetric characteristics. Turbo-prop aeroplanes tend to have a limiting V_{MCG} coincidental with the maximum 9.14m deviation allowed during certification testing.

11.7.2 In addition, several turbo-prop aeroplanes integrate the undercarriage into the engine nacelles, which tends to increase the gear track (T) parameter. Gear track has a significant effect on the runway width required (e.g. the Bombardier Dash 8-Q400 has a gear track of ~9.6m, which is only marginally less than a B767 gear track of ~10.8m). Aeroplanes with wide gear track have less runway width available for deviations.

11.7.3 Asymmetric handling characteristics of jet aeroplanes tend to be better than turbo-prop aeroplanes, especially those jet aeroplanes with fuselage mounted engines.

11.7.4 In some cases, aeroplane manufacturers optimise the determination of V_{MCG} to obtain the absolute minimum V_{MCG}, thereby influencing the take-off performance. In these cases, the lateral deviation reaches the maximum allowed during certification (i.e. 9.14m).

11.7.5 It must also be emphasised that certification V_{MCG} flight testing is carried out in zero wind for aeroplanes certified to FAA FAR 25 standards. Some authorities determine V_{MCG}, taking into account light crosswind up to 7kt.

11.7.6 If the lateral deviation determined during V_{MCG} certification testing is substantially less than 9.14m, then it is possible that further flight testing and/or data evaluation can be carried out to evaluate the introduction of crosswinds until the maximum allowable deviation is reached.

11.7.7 A certified V_{MCG} associated with relatively small lateral deviations may provide a level of confidence for operations from 23m runways with some crosswind capability.

11.7.8 Evaluation of a lower V_{MCG} value than that determined during initial certification would generally not be acceptable. However, a manufacturer can recertify V_{MCG} if they so desire. This would require NAA re-certification of the new V_{MCG}, along with the applicable rescheduling of the flight manual performance (inclusive of a rescheduling of the take-off speeds).

11.7.9 Reducing V_{MCG} without a reduction in maximum take-off thrust will result in larger centreline deviations.

> *Note:* *Determination of narrow runway width by reducing certified take-off power will not be an acceptable means of compliance.*
>
> *This also applies to rescheduling V_{MCG} by reducing take-off power with the application of take-off de-rates or assumed temperature methods.*

11.8 Minimum V_1

11.8.1 Increasing minimum V_1 is potentially the most effective way to reduce the lateral deviation. The V_1 can be increased such that the aeroplane deviation at engine failure can be contained within the runway surface.

11.8.2 In the case where the aeroplane is limited by the 9.14m deviation at V_{MCG}, improved directional control can be achieved by increasing V_{EF} and subsequent V_{1MIN}. Manufacturers use this technique to optimise the deviations by increasing the take-off speeds, taking into account the associated rescheduling of the take-off performance requirements. This re-scheduling of take-off performance will not impact the BFL used to determine the ARC (refer to section 10 of this CAAP) runway width.

11.8.3 The operator must realise that there is a maximum and minimum limit to V_1. This is in addition to the take-off performance limits which occur with an increase of V_1. The maximum V_1 becomes, in this case, the maximum limiting speed to achieve the required minimum runway width.

11.8.4 It should also be noted that increasing take-off weight will, in most cases, increases the associated V_1 speed. This increase in take-off speeds will improve the directional handling characteristics, and essentially reduce the lateral deviation during take-off with an engine failure; however, there are some instances where at MTOW, the difference between V_{1MIN} and V_R will result in significant lateral deviations in the continued take-off case. This case is required to be investigated in accordance with this CAAP. This situation usually occurs on a wet runway, where accelerate-stop performance becomes limiting.

11.8.5 Take-off speed schedule in the case where V_1/V_R =1 often results in minimal lateral deviations in OEI continued take-off cases.

11.9 **Crosswind limit**

11.9.1 The maximum demonstrated crosswind established during certification flight test, or the crosswind limitation in the AFM (whichever is less) is the baseline crosswind value for narrow runway flight testing. Additionally, the narrow runway approach and landing crosswind limit will be referenced to the manufacturer's OEI demonstrated crosswind value (if scheduled). The manufacturer's published Maximum Recommended crosswind values that are greater than the maximum demonstrated crosswind will not be considered in the determination of minimum runway widths.

11.9.2 The crosswind will affect the deviation from the centreline at engine failure. Determination of V_{MCG}, in most cases, has no accountability for crosswind.

11.9.3 Optimising runway width will require determining the crosswind limit that will provide adequate controllability to allow the aeroplane to remain within the runway width after an engine failure.

11.9.4 For the purposes of narrow runway approvals, the determination of V_{1MIN} and crosswind limitations will need to be considered. Crosswind limits can be determined and optimised such that the remaining deviation allowance, over and above the deviation at V_{1MIN} at zero crosswind, can be accounted for. The crosswind is gradually increased, maintaining the scheduled V_{1MIN}, until the minimum crosswind of 7kts is reached, or further increased to the desired crosswind limit.

11.9.5 The crosswind extrapolation, determined in accordance with subparagraph 10.1.3 *Note 1* of this CAAP, takes into consideration the maximum deviation achieved during flight test at the scheduled V_{1MIN}. The maximum allowable analytical extrapolation is 25% of the crosswind measured during flight test up to a maximum of 5kts. For example, if during an actual aircraft flight test, the maximum crosswind was 25kts and the measured deviation was 3m, then crosswind extrapolation to 30kts is acceptable; provided the maximum deviation remains within the allowable limit for the runway width and the maximum demonstrated crosswind and/or limit scheduled in the AFM is not exceeded.

11.9.6 The narrow runway maximum crosswind limit should not be greater than the maximum demonstrated crosswind determined by the aeroplane manufacturer during certification or the scheduled crosswind limitation in the AFM (whichever is less).

> *Note: Due to engine compressor stalls or other engine internal flow instability, engine manufacturers may limit the crosswind for setting take-off static power. In cases where the take-off crosswind is limited for this reason, and the manufacturer does not have a specific procedure to mitigate engine surge conditions, then the narrow runway crosswind limit should be limited by the engine surge crosswind limit, if it is less than the crosswind value determined in this CAAP.*

11.9.7 In the case of narrow runway operations, it is likely the take-off crosswind limit will be more restrictive than the OEI landing crosswind limit.

11.9.8 Credit for demonstrated crosswinds, greater than those found in the AFM, is acceptable if the demonstrated crosswind values are determined by the OEM conducted aeroplane flight test certified by CASA or the applicable NAA acceptable to CASA under regulation 21.010A, 21.012 or 21.470 of CASR 1998.

11.9.9 The narrow runway approach and landing crosswind limit will be referenced to the:

- maximum crosswind demonstrated during narrow runway flight testing

  or
- maximum demonstrated crosswind determined during certification flight testing

  or
- crosswind limit as published (OEI if scheduled) in the AFM, whichever is less.

11.9.10 The crosswind limit for operations on all runways considered to be narrow is the crosswind limit determined in accordance with this CAAP. A crosswind limit for intermediary runway widths cannot be determined by interpolation. For example, if a 20kt crosswind limit has been determined for an 18m wide runway for an aeroplane that normally operates from a 30m wide runway with a maximum certificated demonstrated crosswind limit of 40kts, then the crosswind limit that is to be applied for an intermediary 23m wide runway would be 20kts, unless specific testing/analysis had been carried out on 23m wide runways.

11.10 **Ground handling characteristics**

11.10.1 Flight testing will not guarantee an aeroplane will have acceptable handling characteristics to operate on narrow runways. In some cases, particularly turbo-prop aeroplanes, flight testing may indicate operations from runways 23m or less, with an operationally acceptable crosswind is not feasible. For this reason, it is necessary that a detailed assessment be made of a particular aeroplane type before committing to a specific aeroplane for narrow runway operations.

11.10.2 Operations from 18m runways will require successful detailed aeroplane or FFS flight testing and will require considerably more in-depth flight testing than required for the assessment on wider runways.

11.11 **Wet runway**

11.11.1 Minimum runway width may be determined for both dry and wet runway conditions. In the case of high take-off weights, on wet runways with a limiting runway length, it is particularly important to identify the scheduled V_{1MIN} limited by V_{MCG}. The capability of the aeroplane to operate from wet narrow runways maybe limiting.

Note: Wet V_1 shall not be less than V_{MCG}.

11.11.2 In the majority of cases where V_{1MIN} has been scheduled for a dry runway, scheduling the same V_{1MIN} for wet runways will require a reduction in crosswind limit.

11.11.3 Alternatively V_{1MIN} can be increased, provided that the take-off field length considerations are not limiting and the take-off speeds are scheduled in the AFM accordingly.

11.11.4 Operations from contaminated narrow runways will not be approved, unless the aeroplane is specifically scheduled for contaminated narrow runway operations by the OEM and approved by CASA, or the NAA acceptable to CASA under regulation 21.010A, 21.012 or 21.470 of CASR 1998.

11.11.5 Take-off performance will take into account the rescheduling of V_{1MIN}.

12. Manual requirements

12.1 AFM

12.1.1 The AFM must contain limitations to ensure the safe operation of the aeroplane from and into narrow runways.

12.1.2 In addition, the AFM must contain the normal, emergency and abnormal procedures and performance information (as appropriate).

12.1.3 The contents of specific narrow runway AFM sections must be included in the operator's Operations Manual. This information must be available to the flight crew during operations into and out of aerodromes with narrow runways.

12.1.4 The AFM or Operations Manual, or combination of the two, must include, as a minimum, the following:

(a) the variant and type of aeroplane approved for narrow runway operations.

(b) limitations:

- (i) minimum runway width
- (ii) V_{MCG} either specifically or referenced
- (iii) V_{1MIN} specific to minimum runway width operations (if applicable)
- (iv) maximum take-off crosswind for dry and/or wet operations (as applicable)
- (v) maximum take-off crosswind for setting static engine take-off power (i.e. averting engine surge), if applicable
- (vi) maximum approach and landing crosswind limit, if different from paragraph 12.1.4 (b)(iv) and/or (v) above (refer to paragraph 10.3 of this CAAP)
- (vii) type of runway surface approved for narrow runway operations
- (viii) runway surface conditions applicable to the approval (i.e. dry and/or wet runway)

Notes:

1. *Operations from contaminated narrow runways will not be approved, unless specifically scheduled for contaminated narrow runway operations by the OEM and approved by the NAA.*

2. *Operations from wet unpaved narrow runways will not be approved.*

(ix) system serviceability requirements; including:

- o nose wheel steering
- o thrust reversers
- o directional control assistance systems (such as rudder boost)
- o thrust augmentation compensation systems
- o brakes
- o anti-skid
- o all flight control systems that must be fully serviceable

(x) MEL items that have a direct effect on the directional control of the aeroplane during take-off and landing that preclude operations on narrow runways.

(c) normal procedures:

(i) take-off configuration, as specified for operations on narrow runways

(ii) take-off thrust or power specified for operations on narrow runways

(d) emergency and abnormal procedures (if applicable)

(e) performance (if applicable), taking into account:

(i) take-off speed schedule applicable to operations on narrow runways, including re-scheduled V_{EF} and V_{1MIN} as established in accordance with subparagraph 10.1.3(a)(i) of this CAAP;

(ii) take-off configuration established by flight testing, in accordance with subparagraph 10.1.3(a)(v) of this CAAP

(iii) landing performance.

Notes:

1. *If narrow runway performance and take-off speeds are unchanged from that found in the manufacturer's approved AFM, then the performance must be in accordance with that published in the AFM. In this case the narrow runway AFMS is not required to have specific narrow runway performance accountability.*

2. *If there are specific procedures for narrow runway operations that affect the take-off performance then the effect on take-off performance must be taken into account.*

12.2 Operator's Operations Manual

12.2.1 In accordance with the operator's SMS (or equivalent) and risk management assessment, the operator's Operations Manual must contain the operating limitations and procedures found in the narrow runway AFMS, AFM, or operational document, and as required in subparagraph 12.1.4 (as applicable). In addition, it is recommended the following operational information is provided in the operator's Operations Manual:

(a) flight crew operations:

(i) specific procedures for operations on narrow runways as recommended by the aircraft manufacturer (e.g. the A380 outboard engine spool up requirement to mitigate foreign object damage.

(ii) except for training or check flights, the PIC shall be the pilot flying into and out of 18m wide narrow runways.

(iii) when designating the co-pilot as the flying pilot into and out of narrow runways, due consideration shall be taken of the:
- runway width
- runway surface conditions
- co-pilot experience
- meteorological conditions (i.e. crosswind)

(iv) the narrow runway crosswind limit or the operator’s co-pilot crosswind limit (whichever is less) shall be the maximum crosswind limit when the co-pilot is the pilot flying into and out of a narrow runway.

Note: Specific consideration should also be given to the limitations placed on particular training flights from and into narrow runways.

(b) aerodrome facility requirements:

(i) accurate wind information at the intended aerodrome

(ii) runway centreline guidance is required (e.g. centreline marking or lighting)

(iii) turbo-jet aeroplanes landing on narrow runways require a Visual Approach Slope Indicator (VASI) / Precision Approach Path Indicator (PAPI) for both runway directions for the same narrow runway. It is recommended that a VASI/PAPI is available when turbo-prop aeroplanes are landing on narrow runways.

(c) operational considerations:

(i) if the forecast crosswind at the narrow runway destination is equal to, or greater than that limited by subparagraph 12.1.4 (b)(vi) of this CAAP, then pre-flight fuel planning calculations will include fuel for a diversion from the destination to a suitable alternate aerodrome

(ii) if the forecast weather at the narrow runway destination is such that the runway surface conditions will not be compliant with subparagraph 12.1.4 (b) (viii) of this CAAP, then pre-flight fuel planning calculations will include fuel for a diversion from the destination to a suitable alternate aerodrome

(iii) en-route diversion considerations after failure of critical narrow runway aircraft systems, refer to MEL for system functionality and operational acceptability

(iv) en-route diversion considerations when aerodrome critical facilities become unserviceable

(v) take-off alternate available (if applicable)

(vi) a statement that low visibility procedures are prohibited during narrow runway operations, unless specifically approved by CASA or the NAA acceptable to CASA under regulation 21.010A, 21.012 or 21.470 of CASR 1998 (e.g. A380 operations on 45m runways are specifically approved)

(vii) take-off and/or landing visibility limitations particular to each aerodrome (taking into consideration the surrounding terrain, obstacles and runway conditions etc.)

(viii) accurate line up with the runway centreline

(ix) recommendations should be provided for operations on narrow runways to prevent foreign object damage to the engines and other parts of the aeroplane, especially when they are physically beyond the runway surface

(x) stabilised approach criteria

(xi) accurate control of final approach and landing flight path following VASI/PAPI guidance (if available).

Note: There may be a requirement for special visibility considerations as a result of unique terrain and/or obstacles in close proximity to the aerodrome. Low visibility operations from and into aerodromes with narrow runways will require specific and separate approval.

(d) MEL:

(i) MEL items that are annotated with narrow runway operational requirements and/or limitations are referenced in the Operations Manual in addition to the MEL.

13. Flight crew training requirements

13.1 Flight crew training requirements must be detailed in the Training and Checking Manual. When simulators are required, in accordance with the operators training and checking requirements, narrow runway simulator training is required to be included in the recurrent simulator training syllabus. Flight crew must complete the required training prior to conducting operations into and out of narrow runways.

13.2 **Training and Checking Manual**

13.3 In accordance with the operator’s SMS (or equivalent) and risk management assessment, the operator must ensure all applicable crew complete narrow runway training and checking. Followed by appropriate line training and checking before commencing operations into and out of destination aerodromes with narrow runways.

13.4 The training and checking manual must include specific training and checking requirements for operations on narrow runways. The extent of the training and checking will be dependent on the:

- type of operation involved
- aerodromes with narrow runways in the operator’s route network
- operator’s particular operational environment.

13.5 The flight crew must complete the training and checking prior to operations from and into narrow runways.

13.6 Flight crew narrow runway ground training and briefings shall be carried out for operators that have alternate aerodromes with narrow runways.

13.7 The narrow runway training and checking can be amalgamated with the normal cycle of training and checking. The training and checking manual must include the following narrow runway knowledge:

(a) reference to the specific narrow runway AFM limitations and the relevant narrow runway sections of the Operations Manual

(b) acknowledgement of the hazards associated with narrow runway operations (i.e. consideration of foreign object damage)

(c) aeroplane system knowledge applicable for narrow runway operations. Some turbo-prop aeroplanes have limitations on the use of reverse when one-engine is inoperative, this will have significant effect during rejected take-off and OEI landing

(d) actions to be taken following malfunctions

(e) V_{MCG} general knowledge, including:

  (i) effect of directional control

  (ii) effect of crosswind.

(f) V_{1MIN} general knowledge, including:

  (i) effect on take-off speed schedules (refer to paragraph 11.8.4 of this CAAP); and

  (ii) effect on wet runway capability and performance (if operations from wet narrow runways are scheduled).

(g) in accordance with the AFM, the requirement for smooth symmetric take-off power application prior to, and throughout, the thrust setting portion of the take-off roll.

(h) engine failure on take-off:

  (i) accurate line up with runway centreline without excessive use of runway length

  (ii) awareness of accurate centre line tracking in reduced visibility, with reference to available guidance such as Head Up Display (if fitted), runway centreline marking and/or lighting

  (iii) control requirements at engine failure speeds approaching V_{MCG}

  (iv) considerations at or below V_{1MIN}

  (v) awareness of rapid response required in the case of engine failure during the take-off roll

  (vi) awareness and increased vigilance of braking requirements and directional control required during rejected take-off, taking into consideration crosswind and runway surface conditions (i.e. wet and type of surface)

  (vii) effects of different combinations of aeroplane weight and centre of gravity on aeroplane handling characteristics and performance

  (viii) effects of crosswind and differential cornering friction during the application of retardation devices such as thrust reversers, propeller feathering and braking

  (ix) continued take-off considerations, including directional control, taking into account crosswind and runway surface conditions.

(i) increased awareness of stabilised approach criteria

(j) increased vigilance to accurately control final approach and landing flight path following the VASI/PAPI guidance (if available)

(k) awareness of the possible requirement to conduct 180^{o} turns on the runway depending on runway width and taxiway locations.

(l) tailwind considerations for narrow runway operations, effect on V1/VR ratio and directional control.

(m) limitations in conditions of adverse weather during:

  (i) take-off

  (ii) approach/landing.

(n) MEL applicability

(o) Human factor aspects associated with narrow runway operations (i.e. visual illusions that occur during approach and landings, particularly at night with the tendency for late landing flare which can result in hard landings).

13.8 Narrow runway simulator training

13.8.1 When simulators are required in accordance with the operators training and checking requirements flight crew will carry out simulator training on a representative narrow runway. The required training can be integrated into the normal simulator training and checking cycle.

13.8.2 Successful completion of the narrow runway training will be required prior to flight crew operating from and into destination aerodromes with narrow runways.

13.9 Narrow runway simulator training syllabus will include, as a minimum, the following:

(a) engine failure immediately prior to V_{EF} on a dry runway

(b) engine failure at or after V_1 on a wet runway with the maximum split between V_1 and V_R

(c) OEI landing.

13.9.1 The take-off exercises should be carried out with maximum available take-off power/thrust at the maximum narrow runway crosswind limit. The take-off configuration must be as stated in the AFM.

13.9.2 The OEI landing exercise is to be carried out at the maximum narrow runway landing crosswind limit.

13.9.3 If the operator permits circling approaches then a landing from a circling approach will be carried out.

> *Note: The circling approach exercise is not for the purposes of an instrument rating renewal. The circling manoeuvre in this case is to demonstrate the pilot's ability to handle the aeroplane in maximum crosswind conditions onto a narrow runway. For the purposes of the circling manoeuvre required by this CAAP, it is not a requirement for the simulator visual system and/or fidelity to meet the circling approach requirements found in Part 60 MOS.*

13.9.4 As part of the normal scheduled simulator training and checking cycle the flight crew should carry out a check, including narrow runway operations as part of the check scenario.

13.10 Line training

13.10.1 Flight crew operating as PIC must carry out a line training flight into a narrow runway that is a company destination prior to operations from and into narrow runways as PIC.

13.10.2 Specific narrow runway line training is not required into or out of aerodromes that are only designated as the operator's alternate aerodrome(s).

14. Aerodrome operator liaison

14.1.1 It is the responsibility of the operator and/or pilot to liaise with the aerodrome operator to ensure that the criteria prescribed in applicable sections of the Part 139 MOS are assessed for the intended operation. The following are examples of applicable aerodrome facilities which should be considered as part of the aerodrome assessment:

(a) runway turning area

(b) runway bearing strength

(c) runway shoulders

(d) objects on runway strips

(e) taxiways

(f) holding bays

(g) aprons

(h) jet blast

(i) taxiway markings

(j) apron markings

(k) movement area guidance signs

(l) apron floodlighting

(m) appropriate consideration of the Aerodrome Emergency Plan, taking into consideration the higher capacity aeroplane

(n) appropriate rescue and firefighting facilities for the intended operation.

14.1.2 The Obstacle Limitation Surface (OLS) requirements are based on runway Code Number which is a function of runway length requirements, not runway width. The OLS is an aerodrome operator responsibility dependent on the runway length equivalent Code number. Aeroplane operators and pilots may need to take into account specific obstacles, as published, in accordance with specific take-off and landing performance requirements. Aeroplane operating limitations for instrument approach obstacle clearance is based on Aircraft Approach Category which is a function of approach speeds.

14.1.3 Strip width requirements in Part 139 MOS are not applied as aeroplane operational limitations. It is expected that the aerodrome design meets the requirements of the particular ARC. The runway to which an aeroplane is permitted to operate is expected to have the strip width applicable to the ARC permitted in accordance with Part 139 MOS. The aerodrome operator may limit certain aeroplanes if it is necessary to do so.

Executive Manager
Standards Division

October 2014

Appendix A – Sample aeroplane characteristics – ICAO ARC

Data is provided for convenience, are subject to change and should be used only as a guide. Accurate data should be obtained from the aircraft manufacturer's documentation. Many aeroplane types have optional weights and also engine thrusts; therefore, pavement aspects and reference field lengths will vary, in some cases enough to change the aeroplane category. Reference field length should not be used for the design of aerodrome runway length, as the required length will vary depending on aerodrome elevation and reference temperature.

Aircraft model	Take-off weight (kg)	Take-off weight (lb)	Code	Reference field length (m)	Wingspan (m)	Outer main gear wheel span (m)	Nose gear to main gear distance (wheel base) (m)	Nose gear to main gear distance (wheel base) (ft)	Cockpit to main gear distance (m)	Fuselage length (m)	Overall (maximum) length (m)	Maximum tail height (m)	Maximum tail height (ft)	Approach speed (1.3 × Vs) (kt)
A319-100	75 500	166 449	4C	1 800	34.1	8.9	11.4	37.4	16.5	33.5	33.5	12.2	39.9	128
A320-200	77 000	169 756	4C	2 025	34.1	8.9	12.6	41.5	17.7	37.6	37.6	12.2	39.9	136
A321-200	93 500	206 132	4C	2 533	34.1	8.9	16.9	55.4	22.0	44.5	44.5	12.1	39.7	142
A330-300	233 000	513 677	4E	2 490	60.3	12.6	25.4	83.2	32.0	62.6	63.7	17.2	56.4	137
A340-300	276 500	609 578	4E	2 993	60.3	12.6	25.4	83.2	32.0	62.6	63.7	17.0	55.8	139
A380-800	560 000	1 234 589	4F	2 779	79.8	14.3	29.7	97.4	36.4	70.4	72.7	24.4	80.1	138
An-124-100	392 000	864 198	4F	3 000	73.3	9.0	22.8	74.9	25.6	69.1	69.1	21.1	69.16	154
An-124-100M-150	402 000	886 243	4F	3 200	73.3	9.0	22.8	74.9	25.6	69.1	69.1	21.1	69.16	160
An-225	640 000	1 410 935	4F	3 430	88.40	9.01	29.30	96.13	16.27	76.62	84.00	18.10	59.38	167
717-200	54 885	121 000	3C	1 670	28.4	5.9	17.6	57.8	17.0	34.3	37.8	9.1	29.8	139
737-300	62 823	138 500	4C	2 170	28.9	6.4	12.4	40.8	14.0	32.2	33.4	11.2	36.6	133
737-400	68 039	150 000	4C	2 550	28.9	6.4	12.4	40.8	15.9	35.2	36.4	11.2	36.6	139
737-600	65 091	143 500	3C	1 690	34.3	7.0	11.2	36.8	12.8	29.8	31.2	12.7	41.7	125
737-600/W	65 544	144 500	3C	1 640	35.8	7.0	11.2	36.8	12.9	29.8	31.2	12.7	41.7	125
737-700	70 080	154 500	3C	1 600	34.3	7.0	12.6	41.3	14.2	32.2	33.6	12.7	41.7	130
737-700/W	70 080	154 500	3C	1 610	35.8	7.0	12.6	41.3	14.2	32.2	33.6	12.7	41.7	130
737-800	79 016	174 200	4C	2 090	34.3	7.0	15.6	51.2	17.2	38.0	39.5	12.6	41.2	142
737-800/W	79 016	174 200	4C	2 010	35.8	7.0	15.6	51.2	17.2	38.0	39.5	12.6	41.2	142
737-900	79 016	174 200	4C	2 240	34.3	7.0	17.2	56.3	18.8	40.7	42.1	12.6	41.2	141
737-900ER/W	84 912	187 200	4C	2 470	35.8	7.0	17.2	56.3	18.8	40.7	42.1	12.6	41.2	141
747-400	396 893	875 000	4E	3 048	64.9	12.6	25.6	84.0	27.9	68.6	70.7	19.5	64.0	157

Aircraft model	Take-off weight (kg)	Take-off weight (lb)	Code	Reference field length (m)	Wingspan (m)	Outer main gear wheel span (m)	Nose gear to main gear distance (wheel base) (m)	Nose gear to main gear distance (wheel base) (ft)	Cockpit to main gear distance (m)	Fuselage length (m)	Overall (maximum) length (m)	Maximum tail height (m)	Maximum tail height (ft)	Approach speed (1.3 × Vs) (kt)
747-8	442 253	975 000	4F	3 070	68.4	12.7	29.7	97.3	32.0	74.2	78.0	19.2	62.8	150
747-8F	442 253	975 000	4F	3 070	68.4	12.7	29.7	97.3	32.0	74.2	78.0	19.2	62.7	159
757-200	115 666	255 000	4D	1 980	38.1	8.6	18.3	60.0	22.0	47.0	47.3	13.7	45.1	137
757-200/W	115 666	255 000	4D	1 980	41.1	8.6	18.3	60.0	22.0	47.0	47.3	13.7	45.1	137
757-300	122 470	270 000	4D	2 400	38.1	8.6	22.3	73.3	26.0	54.4	54.4	13.7	44.9	143
767-200	163 747	361 000	4D	1 981	47.6	10.8	19.7	64.6	24.3	47.2	48.5	16.1	52.9	135
767-200ER	179 623	396 000	4D	2 743	47.6	10.8	19.7	64.6	24.3	47.2	48.5	16.1	52.9	142
767-300	163 747	361 000	4D	1 981	47.6	10.9	22.8	74.8	27.4	53.7	54.9	16.0	52.6	140
767-300ER	186 880	412 000	4D	2 540	47.6	10.9	22.8	74.8	27.4	53.7	54.9	16.0	52.6	145
777-200	247 208	545 000	4E	2 380	60.9	12.9	25.9	84.9	28.9	62.9	63.7	18.7	61.5	136
777-200ER	297 557	656 000	4E	2 890	60.9	12.9	25.9	84.9	28.9	62.9	63.7	18.7	61.5	139
777-200LR	347 815	766 800	4E	3 390	64.8	12.9	25.9	84.9	28.9	62.9	63.7	18.7	61.5	140
777-300	299 371	660 000	4E	3 140	60.9	12.9	31.2	102.4	32.3	73.1	73.9	18.7	61.5	149
777-300ER	351 534	775 000	4E	3 060	64.8	12.9	31.2	102.4	32.3	73.1	73.9	18.8	61.8	149
B787-8	219 539	484 000	4E	2 660	60.1	11.6	22.8	74.8	25.5	55.9	56.7	16.9	55.5	140
MD-81	64 410	142 000	4C	2 290	32.9	6.2	22.1	72.4	21.5	41.6	45.0	9.2	30.2	134
MD-82	67 812	149 500	4C	2 280	32.9	6.2	22.1	72.4	21.5	41.6	45.0	9.2	30.2	134
MD-83	72 575	160 000	4C	2 470	32.9	6.2	22.1	72.4	21.5	41.6	45.0	9.2	30.2	144
MD-87	67 812	149 500	4C	2 260	32.9	6.2	19.2	62.9	21.5	36.3	39.8	9.5	31.2	134
MD-88	72 575	160 000	4C	2 470	32.9	6.2	22.1	72.4	21.5	41.6	45.0	9.2	30.2	144
MD-90	70 760	156 000	3C	1 800	32.9	6.2	23.5	77.2	22.9	43.0	46.5	9.5	31.2	138
MD-11	285 990	630 500	4D	3 130	51.97	12.6	24.6	80.8	31.0	58.6	61.6	17.9	58.8	153
CRJ200ER	23 133	51 000	3B	1 680	21.2	4.0	11.4	37.4	10.8	24.4	26.8	6.3	20.7	140
CRJ200R	24 040	53 000	4B	1 835	21.2	4.0	11.4	37.4	10.8	24.4	26.8	6.3	20.7	140
CRJ700	32 999	72 750	3B	1 606	23.3	5.0	15.0	49.2	14.4	29.7	32.3	7.6	24.9	135
CRJ700ER	34 019	75 000	3B	1 724	23.3	5.0	15.0	49.2	14.4	29.7	32.3	7.6	24.9	135
CRJ900	36 514	80 500	3B	1 778	23.3	5.0	17.3	56.8	16.8	33.5	36.2	7.4	24.1	136
CRJ900ER	37 421	82 500	4C	1 862	24.9	5.0	17.3	56.8	16.8	33.5	36.2	7.4	24.1	136
CRJ900R	38 329	84 500	4C	1 954	24.9	5.0	17.3	56.8	16.8	33.5	36.2	7.4	24.1	137
DHC-8-100	15 650	34 500	2C	890	25.9	7.9	8.0	26.2	6.1	20.8	22.3	7.5	24.6	101
DHC-8-200	16 465	36 300	2C	1 020	25.9	8.5	8.0	26.1	6.1	20.8	22.3	7.5	24.6	102
DHC-8-300	18 643	41 100	2C	1 063	27.4	8.5	10.0	32.8	8.2	24.2	25.7	7.5	24.6	107
DHC-8-400	27 987	61 700	3C	1 288	28.4	8.8	14.0	45.9	12.2	31.0	32.8	8.3	27.4	125

Aircraft model	Take-off weight (kg)	Take-off weight (lb)	Code	Reference field length (m)	Wingspan (m)	Outer main gear wheel span (m)	Nose gear to main gear distance (wheel base) (m)	Nose gear to main gear distance (wheel base) (ft)	Cockpit to main gear distance (m)	Fuselage length (m)	Overall (maximum) length (m)	Maximum tail height (m)	Maximum tail height (ft)	Approach speed (1.3 × Vs) (kt)
EMBRAER ERJ 170-100 STD	35 990	79 344	3C	1 439	26.0	6.2	10.6	34.7	11.5	29.9	29.9	9.7	31.8	124
ERJ 170-100 LR, SU and SE	37 200	82 012	3C	1 532	26.0	6.2	10.6	34.7	11.5	29.9	29.9	9.7	31.8	124
ERJ 170-100 + SB 170-00-0016	38 600	85 098	3C	1 644	26.0	6.2	10.6	34.7	11.5	29.9	29.9	9.7	31.8	125
ERJ 170-200 STD	37 500	82 673	3C	1 562	26.0	6.2	11.4	37.5	12.3	31.7	31.7	9.7	31.8	126
ER 170-200 LR and SU	38 790	85 517	3C	1 667	26.0	6.2	11.4	37.5	12.3	31.7	31.7	9.7	31.8	126
ERJ 170-200 + SB 170-00-0016	40 370	89 000	4C	2 244	26.0	6.2	11.4	37.5	12.3	31.7	31.7	9.7	31.8	126
ERJ 190-100 STD	47 790	105 359	3C	1 476	28.7	7.1	13.8	45.3	14.8	36.3	36.3	10.6	34.8	124
ERJ 190-100 LR	50 300	110 892	3C	1 616	28.7	7.1	13.8	45.3	14.8	36.3	36.3	10.6	34.8	124
ERJ 190-100 IGW	51 800	114 199	3C	1 704	28.7	7.1	13.8	45.3	14.8	36.3	36.3	10.6	34.8	125
ERJ 190-200 STD	48 790	107 563	3C	1 597	28.7	7.1	14.6	48.0	15.6	38.7	38.7	10.5	34.4	126
ERJ 190-200 LR	50 790	111 972	3C	1 721	28.7	7.1	14.6	48.0	15.6	38.7	38.7	10.5	34.4	126
ERJ 190-200 IGW	52 290	115 279	4C	1 818	28.7	7.1	14.6	48.0	15.6	38.7	38.7	10.5	34.4	128

Appendix B

FAA AC 25-7C
Flight Test Guide for Certification of Transport Category Airplanes

Section 3. CONTROLLABILITY AND MANOEUVRABILITY

23. MINIMUM CONTROL SPEED - § 25.149.

(3) Minimum Control Speed - Ground (V_{MCG}) - § 25.149(e).

(a) It must be demonstrated that, when the critical engine is suddenly made inoperative at V_{MCG} during the takeoff ground roll, the airplane is safely controllable if the takeoff is continued. During the demonstration, the airplane must not deviate more than 30 ft. (25 ft. prior to Amendment 25-42) from the pre-engine-cut projected ground track. The critical engine) for ground minimum control speed testing should be determined during the takeoff ground run using techniques similar to these described in paragraph 23b(1). If there is a significant difference in left and right rudder deflection, the loss of asymmetric propeller disc loading, due to near zero angle-of-attack during the takeoff roll, could result in the critical engine being on the opposite side of the airplane relative to the airborne minimum control speed tests.

(b) Work up tests may be conducted by abruptly retarding the critical engine to idle to determine the airplane asymmetric control characteristics and provide data from which an estimate of V_{MCG} can be made. Due to the engine spindown characteristics with the critical engine retarded to idle, the speed will not, in general, be representative of the V_{MCG} speed that would be obtained with a fuel cut. Therefore, the certification tests for V_{MCG} should be conducted using fuel cuts. Starting from a speed comfortably above the estimated V_{MCG} and with the maximum takeoff power or thrust level to be certified, several fuel cuts should be made at decreasing calibrated airspeeds to establish the minimum airspeed at which the lateral deviation is less than or equal to 30 ft. V_{MCG} is determined for zero crosswind conditions. However, in light crosswind test conditions the V_{MCG} value determined should be that which is appropriate to the adverse crosswind or, at the applicant’s option, may be corrected to a zero crosswind value using runs made on reciprocal headings.

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

1 The pilot feeling a distinct change in the directional tracking characteristics of the airplane; or

2 The pilot seeing a directional divergence of the airplane with respect to the view outside the airplane.

(d) Directional control of the airplane should be accomplished by use of the rudder only. All other controls, such as ailerons and spoilers, should only be used to correct any alterations in the airplane attitude and to maintain a wings level condition. Pilot input to controls to supplement the rudder effectiveness should not be used. Care should also be taken not to inadvertently apply brake pressure during large rudder deflections, as this will invalidate the test data.

(e) V_{MCG} testing should be conducted at the most critical weight in the range where V_{MCG} may impact AFM V_1 speeds.

(f) V_{MCG} testing should be conducted at aft c.g. and with the nose wheel free to caster, to minimize the stabilizing effect of the nose gear. If the nose wheel does not caster freely, the test may be conducted with enough nose up elevator applied to lift the nose wheel off the runway.

(g) V_{MCG} testing should not be conducted on runways with excessive crowning (i.e., cross-runway slope) unless the effects of such crowning are determined to be conservative.

(h) For airplanes with certification bases prior to Amendment 25-42, V_{MCG} values may be demonstrated with nose wheel rudder pedal steering operative for dispatch on wet runways. The test should be conducted on an actual wet, smooth (i.e., not grooved or PFC) runway. The test(s) should include engine failure at or near a minimum V_{EF} associated with minimum V_R to demonstrate adequate controllability during rotation, liftoff, and the initial climbout. The V_{MCG} values obtained by this method are applicable for wet or dry runways only, not for icy runways.