NOTICE OF PROPOSED AMENDMENT (NPA) No 14/2004
DRAFT DECISION OF THE EXECUTIVE DIRECTOR OF THE AGENCY,
on certification specifications for large aeroplanes (CS-25)

Operation on Contaminated Runways

Contents

This Notice of Proposed Amendment is made up of four different parts:

A. Explanatory Note
Describing the development process and explaining the contents of the proposal.

B. Proposals
The actual proposed amendments.

C. Original JAA NPA 25G-334 proposals justification
The proposals were already circulated for comments as a JAA NPA. This part contains the justification for the JAA NPA.

D. JAA NPA 25G-334 Comment-Response Document
This part summarizes the comments made on the JAA NPA and the responses to those comments.

A. EXPLANATORY NOTE

I. General

1. The purpose of this Notice of Proposed Amendment (NPA) is to propose changes to the certifications specifications for large aeroplanes (CS-25). The reason for this proposal is outlined further below. This measure is included in the Agency's 2004 Rulemaking programme.

2. The text of this NPA was developed by the JAA Flight Study Group (FSG). It was adapted to the EASA regulatory context by the Agency. It is now submitted for consultation of all interested parties in accordance with Article 5(3) of the EASA rulemaking procedure[1].
The review of comments will be made by the Agency unless the comments are of such nature that they necessitate the establishment of a group.

II. Consultation

3. Because the content of this NPA was already the subject of a full worldwide consultation, the transitional arrangements of article 15 of the EASA rulemaking procedure apply. They allow for a shorter consultation period of six weeks instead of the standard three months and also exempt from the requirement to produce a full Regulatory Impact Assessment.

4. To achieve optimal consultation, the Agency is publishing the draft decision on its internet site in order to reach its widest audience and collect the related comments.

Comments on this proposal may be forwarded *(preferably by e-mail)*, using the attached comment form, to:

By e-mail: NPA@easa.eu.int

By correspondence: **Ms.** Inge van Opzeeland
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Comments should be received by the Agency before **03-01-2005** and if received after this deadline they might not be treated. Comments may not be considered if the form provided for this purpose is not used.

III. Comment response document

5. All comments received will be responded to and incorporated in a Comment Response Document (CRD). This will contain a list of all persons and/or organisations that have provided comments. The CRD will be widely available ultimately before the Agency adopts its final decision.

IV. Content of the draft Decision

[1] Decision of the Management Board concerning the procedure to be applied by the Agency for the issuing of opinions, certification specifications and guidance material ("rulemaking procedure"), EASA MB/7/03, 27.6.2003.

6. The initial issue of CS-25 was based upon JAR-25 at amendment 16. During the transposition of airworthiness JARs into certification specifications the rulemaking activities under the JAA system were not stopped. In order to assure a smooth transition from JAA to EASA the Agency has committed itself to continue as much as possible of the JAA rulemaking activities. Therefore it has included most of it in its own rulemaking programme for 2004 and planning for 2005-2007. This NPA is a result of this commitment and a transposed version of the JAA NPA 25G-334 which was circulated for comments from 1st september 2002 till 1st December 2002.

7. A requirement related to performance on contaminated runways was introduced through JAR 25X1591 and AMJ 25X1591 at JAR-25, Change 13, 18th October 1988. The rule and associated advisory material addressed the development of performance information on both wet and contaminated runways.

At that time, the methodology associated with the determination of aeroplane performance on a contaminated runway was reasonably well developed and since then it has been used on many JAA certifications. In the course of a few certifications some discrepancies were noted between the theoretical methods of the AMJ and measured results, with particular reference to smaller jet aeroplanes. As a result Temporary Guidance Material (TGM/25/04, Performance Information for Take-Off from Wet Runways; Information on Precipitation Drag, 1st October 1995), which calls for limited test substantiation, was published.

The final rules arising from NPA 25B,D,G-244 "Accelerate-Stop Distances and Related Performance Matters", published in JAR-25 at Change 15 on 1 October 2000, introduce specific requirements for the determination of performance on wet runways into the normal performance requirements of Subpart B. There is also an associated change removing the references to wet runways from JAR 25X1591 which means that, for the future, CS 25.1591 and the associated AMC will address only contaminated runways.

As a result of both of the above developments and better knowledge of aeroplane performance on contaminated runways, the Flight Study Group (FSG) considered that a general revision of the AMJ 25X1591 was necessary and, as an interim measure, the AMJ was marked Reserved at Change 15 and TGM 25/07 (Performance on Contaminated Runways) was published to give guidance for the application of JAR 25X1591 pending this revision. Now, following additional work on more accurate determination of performance on a contaminated runway by an ad-hoc Sub-Group, a revised CS 25.1591 and a new AMC 25.1591 are proposed by means of this NPA. Note that CS 25.1591 does not require the applicant to provide the data but, if he does not do so, operation on contaminated runways will be prohibited.

FAR 25 does not address performance on contaminated runways so harmonisation is not currently a consideration. The performance information required by CS 25.1591 and provided by AMC 25.1591 enables an operator to show compliance with JAR-OPS 1.490 and, where necessary, JAR-OPS 1.520. However, harmonisation of this issue will be addressed in the future.

B. PROPOSALS

The following amendments should be included in Decision No. 2003/2/RM of the Executive Director of the Agency of 17 October 2003:

1. Change two cross-references in AMC 25.1583(k) from "CS 25.1591(c)(2)" to "CS 25.1591."

2. Amend CS 25.1591 and introduce a new AMC 25.1591 as follows:

CS 25.1591: Performance Information for Operations with Contaminated Runway Surface Conditions
(See AMC 25.1591)

(a) Supplementary performance information applicable to aeroplanes operated on runways contaminated with standing water, slush, snow or ice may be furnished at the discretion of the applicant. If supplied, this information must include the expected performance of the aeroplane during take-off and landing on hard-surfaced runways covered by these contaminants. If information on any one or more of the above contaminated surfaces is not supplied, the AFM must contain a statement prohibiting operation(s) on the contaminated surface(s) for which information is not supplied. Additional information covering operation on contaminated surfaces other than the above may be provided at the discretion of the applicant.

(b) Performance information furnished by the applicant must be contained in an approved document, and may be used to assist operators in producing operational data and instructions for use by their flight crews when operating with contaminated runway surface conditions. The information may be established by calculation or by testing.

(c) The approved document must clearly indicate the conditions and the extent of applicability for each contaminant used in establishing the contaminated runway performance information. It must also state that actual conditions that are different from those used for establishing the contaminated runway performance information may lead to different performance.

AMC 25.1591
The derivation and methodology of performance information for use when taking-off and landing with contaminated runway surface conditions.

1.0 Purpose

This AMC provides information, guidelines, recommendations and acceptable means of compliance for use by applicants in the production of performance information for aeroplanes when operated on runways that are contaminated by standing water, slush, snow, ice or other contaminants.

2.0 Technical Limitations of Data

The methodology specified in this AMC provides one acceptable means of compliance with the provisions of CS 25.1591. In general it does not require aeroplane testing on contaminated runway surfaces, although such testing if carried out at the discretion of the applicant may significantly improve the quality of the result or reduce the quantity of analytical work required.

Due to the nature of naturally occurring runway contaminants and difficulties associated with measuring aeroplane performance on such surfaces, any data that is either calculated or measured is subject to limitations with regard to validity. Consequently the extent of applicability should be clearly stated.

The properties specified in this AMC for various contaminants are derived from a review of the available test and research data and are considered to be acceptable for use by applicants. This is not an implied prohibition of data for other conditions or that other conditions do not exist.

It has been recently determined that the assumption to use wet runway surface field length performance data for operations on runway surfaces contaminated with dry snow (depths below 20 mm) and wet snow (depths below 5 mm) may be inappropriate. Flight test evidence together with estimations have indicated some measure of relatively low gear displacement drag and a measurable reduction in surface friction in comparison to the assumptions associated with wet runway field performance data. As a consequence it has been agreed that additional work is required to further develop the associated methodology. As an interim measure it has been concluded that it is reasonable to consider these surfaces by recommending that they be addressed through retaining the assumptions relating to a compacted snow surface.

It is intended that the use of aeroplane performance data for contaminated runway conditions produced in accordance with CS 25.1591 should include recommendations associated with the operational use of the data. Where possible, this operational guidance should be provided by the applicant or its production co-ordinated with the applicant to ensure that its use remains valid.

3.0 Standard Assumptions

Due to the wide variation in possible conditions when operating on contaminated runways and the limitations inherent in representing the effects of these conditions analytically, it is not possible to produce performance data that will precisely correlate with each specific operation on a contaminated surface. Instead, the performance data should be determined for a standardised set of conditions that will generally and conservatively represent the variety of contaminated runway conditions occurring in service.

It should be assumed that:

- the contaminant is spread over the entire runway surface to an even depth (although rutting, for example, may have taken place).

- the contaminant is of a uniform specific gravity.

- where the contaminant has been sanded, graded (mechanically levelled) or otherwise treated before use, that it has been done in accordance with agreed national procedures.

4.0 Definitions

These definitions may be different to those used by other sources but are considered appropriate for producing acceptable performance data, suitable for use in aeroplane operations.

4.1 Standing Water

Water of a depth greater than 3mm. A surface condition where there is a layer of water of 3mm or less is considered wet for which AMC 25.1591 is not applicable.

4.2 Slush

Partly melted snow or ice with a high water content, from which water can readily flow, with an assumed specific gravity of 0.85. Slush is normally a transient condition found only at temperatures close to 0°C.

4.3 Wet Snow

Snow that will stick together when compressed, but will not readily allow water to flow from it when squeezed, with an assumed specific gravity of 0.5.

4.4 Dry Snow

Fresh snow that can be blown, or, if compacted by hand, will fall apart upon release (also commonly referred to as loose snow), with an assumed specific gravity of 0.2. The assumption with respect to specific gravity is not applicable to snow which has been subjected to the natural ageing process.

4.5 Compacted Snow

Snow which has been compressed into a solid mass such that the aeroplane wheels, at representative operating pressures and loadings, will run on the surface without causing significant rutting.

4.6 Ice

Water which has frozen on the runway surface, including the condition where compacted snow transitions to a polished ice surface.

4.7 Specially Prepared Winter Runway

A runway, with a dry frozen surface of compacted snow and/or ice which has been treated with sand or grit or has been mechanically or chemically treated to improve runway friction. The runway friction is measured and reported on a regular basis in accordance with national procedures.

4.8 Specific Gravity

The density of the contaminant divided by the density of water.

5.0 Contaminant Properties to be Considered

5.1 Range of Contaminants

The following general range of conditions or properties may by used. The list given in Table 1 is not necessarily comprehensive and other contaminants may be considered, provided account is taken of their specific properties.

Data should assume the contaminant to be uniform in properties and uniformly spread over the complete runway.

Contaminants can be classified as being:-

(i) Drag producing, for example by contaminant displacement or impingement,

(ii) Braking friction reducing, or

(iii) A combination of (i) and (ii).

Data to be produced should use the classification and assumptions of Table 1 and then the appropriate sections of the AMC as indicated.

Contaminant Type	***Range of Depths to be Considered - mm***	***Specific Gravity Assumed for Calculation***	***Is Drag Increased ?***	***Is Braking Friction Reduced Below Dry Runway Value?***	***Analysis Paragraphs Relevant***
Standing water, Flooded runway	3-15 (see Note 1)	1.0	Yes	Yes	7.1, 7.3, 7.4
Slush	3-15	0.85	Yes	Yes	7.1, 7.3, 7.4
Wet Snow (see Note 2)	Below 5		No	Yes	7.3, 7.4

Wet Snow (see Note 3)	5-30	0.5	Yes	Yes	7.1, 7.3, 7.4
Dry Snow (see Note 2)	Below 20		No	Yes	7.3, 7.4
Dry Snow	20-130	0.2	Yes	Yes	7.2, 7.3, 7.4
Compacted Snow	0 (see Note 4)		No	Yes	7.3, 7.4
Ice	0 (see Note 4)		No	Yes	7.3, 7.4
Specially Prepared Winter Runway	0 (see Note 4)		No	Yes	7.3, 7.4

Table 1

Note 1: Runways with water depths less than 3mm are considered wet, for which AMC 25.1591 is not applicable.

Note 2: Contaminant drag may be ignored.

Note 3: For conservatism the same landing gear displacement and impingement drag methodology is used for wet snow as for slush.

Note 4: Where depths are given as zero it is assumed that the aeroplane is rolling on the surface of the contaminant.

5.2 <u>Other Contaminants</u>

Table 1 lists the contaminants commonly found. It can be seen that the complete range of conditions or specific gravities has not been covered. Applicants may wish to consider other, less likely, contaminants in which case such contaminants should be defined in a manner suitable for using the resulting performance data in aeroplane operations.

6.0 Derivation of Performance Information

6.1 General Conditions

Take-off and landing performance information for contaminated runways should be determined in accordance with the assumptions given in paragraph 7.0.

Where performance information for different contaminants are similar, the most critical may be used to represent all conditions.

This AMC does not set out to provide a complete technical analytical process but rather to indicate the elements that should be addressed. Where doubt exists with regard to the accuracy of the methodology or the penalties derived, consideration should be given to validation by the use of actual aeroplane tests or other direct experimental measurements.

6.2 Take-off on a Contaminated Runway

6.2.1 Except as modified by the effects of contaminant as derived below, performance assumptions remain unchanged from those used for a wet runway, in accordance with the agreed certification standard. These include accelerate-stop distance definition, time delays, take-off distance definition, engine failure accountability and stopping means other than by wheel brakes (but see paragraph 7.4.3).

6.2.2 Where airworthiness or operational standards permit operations on contaminated runways without engine failure accountability, or using a V_{STOP} and a V_{GO} instead of a single V_1, these performance assumptions may be retained. In this case, a simple method to derive a single V_1 and associated data consistent with the performance assumptions of paragraph 6.2.1 must also be provided in the AFM.

NOTE: V_{STOP} is the highest decision speed from which the aeroplane can stop within the accelerate-stop distance available. V_{GO} is the lowest decision speed from which a continued take-off is possible within the take-off distance available.

6.3 Landing on a Contaminated Runway

6.3.1 Airborne distance

Assumptions regarding the airborne distance for landing on a contaminated runway are addressed in paragraph 7.4.2.

6.3.2 Ground Distance

Except as modified by the effects of contaminant as derived below, performance assumptions for ground distance determination remain unchanged from those used for a dry runway. These assumptions include:

- Touchdown time delays.
- Stopping means other than wheel brakes (but see paragraph 7.4.3).

7.0 Effects of Contaminant

7.1 Contaminant Drag - Standing Water, Slush, Wet Snow

General advice and acceptable calculation methods are given for estimating the drag force due to fluid contaminants on runways:

Total drag due to fluid contaminant	=	Drag due to fluid displacement by tyres	+	Drag due to airframe impingement of fluid spray from tyres

The essence of these simple calculation methods is the provision of appropriate values of drag coefficients below, at, and above tyre aquaplaning speed, V_P (see paragraph 7.1.1):

- Paragraphs 7.1.2.a and 7.1.2.b give tyre displacement drag coefficient values for speeds below V_P.
- Paragraph 7.1.3.b.2 gives tyre equivalent displacement drag coefficient values to represent the skin friction component of impingement drag for speeds below V_P.
- Paragraph 7.1.4 gives the variation with speed, at and above V_P, of drag coefficients representing both fluid displacement and impingement.

7.1.1 Aquaplaning Speed

An aeroplane will aquaplane at high speed on a surface contaminated by standing water, slush or wet snow. For the purposes of estimating the effect of aquaplaning on contaminant drag, the aquaplaning speed, V_P, is given by -

$$V_P = 9\sqrt{P}$$

where V_P is the ground speed in knots and P is the tyre pressure in lb/in^2.

Predictions (Reference 5) indicate that the effect of running a wheel over a low density liquid contaminant containing air, such as slush, is to compress it such that it essentially acts as high density contaminant. This means that there is essentially no increase in aquaplaning speed to be expected with such a lower density contaminant. For this reason, the aquaplaning speed given here is not a function of the density of the contaminant.

[See References 1 and 5]

7.1.2 Displacement Drag

This is drag due to the wheel(s) running through the contaminant and doing work by displacing the contaminant sideways and forwards.

a. Single wheel.

The drag on the tyre is given by —

$$D = C_D \tfrac{1}{2} \rho V^2 S$$

Where ρ is the density of the contamination, S is the frontal area of the tyre in the contaminant and V is the groundspeed, in consistent units.

S = b x d where d is the depth of contamination and b is the effective tyre width at the contaminant surface and may be found from —

$$b = 2W \left[\left(\frac{\delta + d}{W} \right) - \left(\frac{\delta + d}{W} \right)^2 \right]^{1/2}$$

Where W is the maximum width of the tyre and δ is the tyre deflection, which may be obtained from tyre manufacturers' load-deflection curves.

The value of C_D may be taken as 0.75 for an isolated tyre below the aquaplaning speed, V_P.

[See Reference 3]

b. Multiple wheels

A typical dual wheel undercarriage shows a drag 2.0 times the single wheel drag, including interference. For a typical four-wheel bogie layout the drag is 4 times the single wheel drag (again including interference). For a six-wheel bogie layout a reasonable conservative estimate suggests a figure of 4.2 times the single wheel drag. The drag of spray striking the landing gear structure above wheel height may also be important and should be included in the analysis for paragraph 7.1.3.b.1 but for multiple wheel bogies the factors above include centre spray impingement drag on gear structure below wheel height.

[See Reference 3]

7.1.3 Spray Impingement Drag

a. Determination of spray geometry

The sprays produced by aeroplane tyres running in a liquid contaminant such as slush or water are complex and depend on aeroplane speed, the shape and dimensions of the loaded tyre and the contaminant depth. The spray envelope should be defined, that is the height, width, shape and location of the sideways spray plumes and, in the case of a dual wheel undercarriage, the centre spray plumes. Additionally, a forward bow-wave spray will be present which may be significant in drag terms should it impinge on the aeroplane.

In order to assess the drag it is necessary to know the angles of the spray plumes so that they can be compared with the geometry of the aeroplane. The angle at which the plumes rise is generally between 10° and 20° but it varies considerably with speed and depth of precipitation and to a small extent with tyre geometry. A method for estimating the plume angles in the horizontal and vertical directions is given in References 1 and 7 and may be used in the absence of experimental evidence. This information may be used to indicate those parts of the airframe which will be struck by spray, in particular whether the nose-wheel plume will strike the main landing gear or open wheel-wells, the wing leading edges or the engine nacelles, and whether the main-wheel plumes will strike the rear fuselage or flaps.

b. Determination of the retarding forces

Following definition of the spray envelopes, the areas of contact between the spray and the airframe can be defined and hence the spray impingement drag determined. This will be in two parts, direct interaction of the spray with the aeroplane structure and skin friction.

For smaller jet aeroplanes, typically those where the wing-to-ground height is less than 2 metres (6 feet), the methods contained in this document may not be conservative. Drag estimates should be correlated with performance measurements taken, for example, during water trough tests for engine ingestion.

b.1. Drag caused by direct impact of the spray

For aeroplane designs where surface areas are exposed to direct spray impact, the resulting drag forces should be taken into account. These forces exist where a significant part of the spray flow is directed at part of the aeroplane structure at a normal or non-oblique angle. The drag, or momentum loss of the mass of fluid, so caused should be accounted for.

[See Reference 6]

b.2. Drag caused by skin friction

Reference 2 explains that the relative velocity between spray from the landing gear and wetted aeroplane components causes drag due to skin friction and provides a method for its calculation. Where more than one spray acts on the same wing or fuselage surface the skin friction forces are not cumulative and the single, higher calculated value should be used.

An alternative, simple, conservative empirical estimate of skin friction drag, which converts the skin friction drag into an equivalent displacement drag coefficient based on nose-wheel alone drag measurements, is given by

C_D spray = 8 x L x 0.0025

where C_D spray is to be applied to the total nose-wheel displacement area (b x d x number of wheels) and L is the wetted fuselage length in feet behind the point at which the top of the spray plume reaches the height of the bottom of the fuselage. This relation can also be used in the case of a main-wheel spray striking the rear fuselage. In the case of any one main wheel unit only the inner plume from the innermost leading wheel is involved so the relevant displacement area is half that of one main wheel.

7.1.4 Effect of Speed on Displacement and Impingement Drag Coefficients at and above Aquaplaning Speed

The drag above V_P reduces to zero at lift off and one acceptable method is to reduce C_D as shown in the curve in Figure 1. This relationship applies to both displacement and spray impingement drag coefficients.

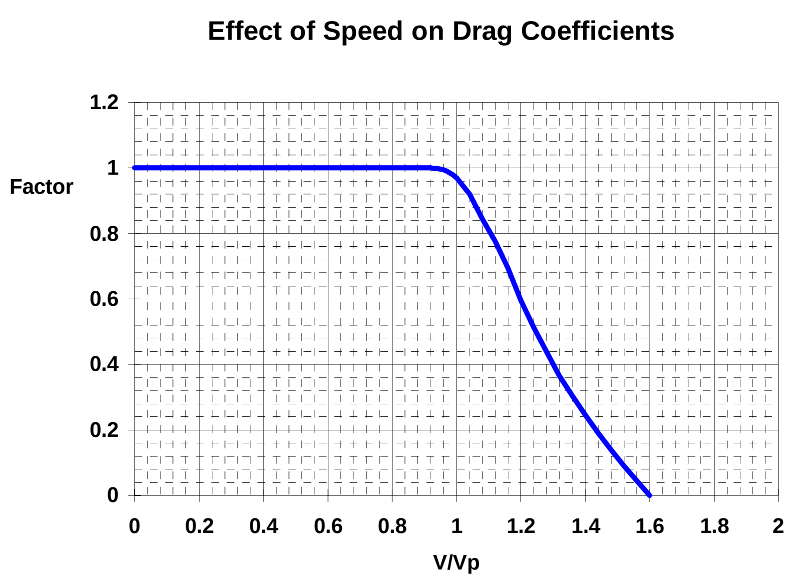

Figure 1

7.2 Contaminant Drag - Dry Snow

A basic method for calculating the drag of aeroplane tyres rolling in dry snow is given herein. The method is based on the theoretical model presented in References 8 and 9, using a specific gravity of 0.2 as provided in Table 1. Only snow of specific gravity of 0.2 is selected because it represents naturally occurring snow and results in the highest drag variation with ground speed for the range of snow specific gravities that are likely to be encountered. For other snow specific gravities, the more detailed methods of Reference 8 should be used.

7.2.1 Single Tyre Drag

The total displacement drag of a tyre rolling in dry snow is presented by the following equation:

$$D = D_C + D_D$$

The term D_C represents the drag due to the compression of the snow by the tyre. The term D_D represents the drag due to the displacement of the snow particles in a vertical direction.

The drag due to snow compression for a single tyre for snow with a specific gravity of 0.2 is given by:

Tyre pressure > 100 psi

$$D_C = 74000\ bd \quad \text{(Newtons)}$$

Tyre pressure $50 \le p \le 100$ psi

$$D_C = 56000\ bd \quad \text{(Newtons)}$$

In which:

d = snow depth in metres
b = is the tyre width at the surface in metres (see paragraph 7.1.2)

The drag due to the displacement of the snow particles in a vertical direction for a single tyre for snow with a specific gravity of 0.2 is given by:

Tyre pressure > 100 psi

$$D_D = \left(\frac{56}{R} + \frac{9}{d}\right) bd^2 V_g^2 \quad \text{(Newtons)}$$

Tyre pressure $50 \le p \le 100$ psi

$$D_D = \left(\frac{52}{R} + \frac{8}{d}\right) bd^2 V_g^2 \quad \text{(Newtons)}$$

In which:

d = snow depth in metres
b = is the tyre width at the surface in metres (see paragraph 7.1.2)
V_g = the ground speed in m/s
R = tyre radius in metres

For other snow densities D_C and D_D can be calculated using the method presented in Reference 8.

7.2.2 Multiple Wheels

The drag on dual tyre landing gears (found on both nose and main gears) is simply the drag of both single tyres added together. The interference effects between both tyres, found on dual tyre configurations running through slush or water, are not likely to be present when rolling over a snow covered surface. The drag originates from the vertical compaction of the snow layer. Although there is some deformation perpendicular to the tyre direction of motion, this deformation occurs mainly at or below the bottom of the rut and therefore does not affect the deformation in front of the adjacent tyre. Hence, interference effects can be ignored.

In the case of a bogie landing gear only the leading tyres have to be considered for the drag calculation, as explained in Reference 8. After the initial compression of the snow by the leading tyres, the snow in the rut becomes stronger and a higher pressure must be applied to compress the snow further. Therefore, the drag on the trailing tyres can be neglected and the drag on a bogie landing gear is assumed to be equal to that of a dual tyre configuration. All other multiple-tyre configurations can be treated in the same manner.

7.2.3 Spray Impingement Drag

Experiments have shown that the snow spray coming from the tyres is limited with only small amounts striking the airframe. The speed and the density of the snow spray are much lower than, for instance, that of water spray. Therefore, the drag due to snow impingement on the airframe can be neglected.

7.2.4 Total Landing Gear Drag

To obtain the total drag on the tyres due to snow, D_C and D_D for each single tyre (excluding the trailing tyres of a bogie gear) should be calculated and summed.

7.3 Braking Friction (All Contaminants)

On most contaminant surfaces the braking action of the aeroplane will be impaired. Performance data showing these effects can be based on either the minimum conservative 'default' values, given in Table 2 or test evidence and assumed values (see paragraph 7.3.2). In addition the applicant may optionally provide performance data as a function of aeroplane braking coefficient or wheel braking coefficient.

7.3.1 Default Values

To enable aeroplane performance to be calculated conservatively in the absence of any direct test evidence, default friction values as defined in Table 2 may be used. These friction values represent the effective braking coefficient of an anti-skid controlled braked wheel/tyre.

Contaminant	***Default Friction Value*** μ
Standing Water and Slush	$= -0.0632\left(\frac{V}{100}\right)^3 + 0.2683\left(\frac{V}{100}\right)^2 - 0.4321\left(\frac{V}{100}\right) + 0.3485$ where V is groundspeed in knots Note: For V greater than the aquaplaning speed, use $\mu = 0.05$ constant
Wet Snow below 5mm depth	0.20
Wet Snow	0.17
Dry Snow below 20mm depth	0.20
Dry Snow	0.17
Compacted Snow	0.20
Ice	0.05

Note: Braking Force = load on braked wheel x Default Friction Value μ

Table 2

Note: For a specially prepared winter runway surface no default friction value can be given due to the diversity of conditions that will apply.

7.3.2 Other Than Default Values

In developing aeroplane braking performance using either test evidence or assumed friction values other than the default values provided in Table 2, a number of other brake related aspects should be considered. Brake efficiency should be assumed to be appropriate to the brake and anti-skid system behaviour on the contaminant under consideration or a conservative assumption can be used. It can be assumed that wheel brake torque capability and brake energy characteristics are unaffected. Where the tyre wear state significantly affects the braking performance on the contaminated surface, it should be assumed that there is 20% of the permitted wear range remaining.

Where limited test evidence is available for a model predecessor or derivative this may be used given appropriate conservative assumptions.

7.3.3 Use of Ground Friction Measurement Devices

Ideally it would be preferable to relate aeroplane braking performance to a friction index measured by a ground friction device that would be reported as part of a Surface Condition Report. However, there is not, at present, a common friction index for all ground friction measuring devices. Hence it is not practicable at the present time to determine aeroplane performance on the basis of an internationally accepted friction index measured by ground friction devices. Notwithstanding this lack of a common index, the applicant may optionally choose to present take-off and landing performance data as a function of an aeroplane braking coefficient or wheel braking coefficient constant with ground speed. The responsibility for relating this data to a friction index measured by a ground friction device will fall on the operator and the operating authority.

7.4 Additional Considerations

7.4.1 Minimum V_1

For the purpose of take-off distance determination, it has been accepted that the minimum V_1 speed may be established using the V_{MCG} value established in accordance with CS 25.149(g). As implied in paragraph 8.1.3, this may not ensure that the lateral deviation after engine failure will not exceed 30 ft on a contaminated runway.

7.4.2 Landing Air Distance

For contaminated surfaces, the airborne distance should be calculated by assuming that 7 seconds elapse between passing through the 50 ft screen height and touching down on the runway. In the absence of flight test data to substantiate a lower value, the touchdown speed should be assumed to be 93% of the threshold speed.

7.4.3 Reverse Thrust

Performance information may include credit for reverse thrust where available and controllable.

8.0 Presentation of Supplementary Performance Information

8.1 General

Performance information for contaminated runways, derived in accordance with the provisions of paragraphs 5.0 to 7.0, should be accompanied by appropriate statements such as:

8.1.1 Operation on runways contaminated with water, slush, snow, ice or other contaminants implies uncertainties with regard to runway friction and contaminant drag and therefore to the achievable performance and control of the aeroplane during take-off, since the actual conditions may not completely match the assumptions on which the performance information is based. Where possible, every effort should be made to ensure that the runway surface is cleared of any significant contamination.

8.1.2 The performance information assumes any runway contaminant to be of uniform depth and density.

8.1.3 The provision of performance information for contaminated runways should not be taken as implying that ground handling characteristics on these surfaces will be as good as can be achieved on dry or wet runways, in particular following engine failure, in crosswinds or when using reverse thrust.

8.1.4 The contaminated runway performance information does not in any way replace or amend the Operating Limitations and Performance Information listed in the AFM, unless otherwise stated.

8.2 Procedures

In addition to performance information appropriate to operating on a contaminated runway, the AFM should also include recommended procedures associated with this performance information. Differences in other procedures for operation of the aeroplane on a contaminated surface should also be presented, e.g., reference to crosswinds or the use of high engine powers or derates.

8.3 Take-off and Landing Data

This should be presented either as separate data appropriate to a defined runway contaminant or as incremental data based on the AFM normal dry or wet runway information. Information relating to the use of speeds higher than V_{REF} on landing, that is speeds up to the maximum recommended approach speed additive to V_{REF}, and the associated distances should also be included. Operational factors, as required by JAR-OPS or other operating regulations, should be stated as being included or not included.

Where data is provided for a range of contaminant depths, for example 3, 6, 9, 12, 15mm, then the AFM should include a statement that interpolation is not permitted.

Where the AFM presents data using V_{STOP} and V_{GO}, it must be stated in the AFM that use of this concept is acceptable only where operation under this standard is permitted.

9 References

Reference sources containing worked methods for the processes outlined in 7.1 to 7.3.3 are identified below:

1. ESDU Data Item 83042, December 1983, with Amendment A, May 1998. "Estimation of Spray Patterns Generated from the Side of Aircraft Tyres Running in Water or Slush".

2. ESDU Data Item 98001, May 1998. "Estimation of Airframe Skin-Friction Drag due to Impingement of Tyre Spray".

3. ESDU Data Item 90035, November 1990, with Amendment A, October 1992. "Frictional and Retarding Forces on Aircraft Tyres. Part V: Estimation of Fluid Drag Forces".

4. ESDU Memorandum No.97, July 1998. "The Order of Magnitude of Drag due to Forward Spray from Aircraft Tyres"**.**

5. ESDU Memorandum No. 96, February 1998. "Operations on Surfaces Covered with Slush".

6. ESDU Memorandum No. 95, March 1997, "Impact Forces Resulting From Wheel Generated Spray: Re-Assessment Of Existing Data".

7. NASA Report TP-2718 "Measurement of Flow Rate and Trajectory of Aircraft Tire-Generated Water Spray".

8. Van Es, G.W.H., "Method for Predicting the Rolling Resistance of Aircraft Tires in Dry Snow". AIAA Journal of Aircraft, Volume 36, No.5, September-October 1999.

9. Van Es, G.W.H., "Rolling Resistance of Aircraft Tires in Dry Snow", National Aerospace Laboratory NLR, Technical Report TR-98165, Amsterdam, 1998.

C. ORIGINAL JAA NPA 25G-334 PROPOSALS JUSTIFICATION

Explanation and Justification

Since 1988, general refinements of the methodologies associated with determining aeroplane performance on a contaminated runway have taken place. These have been the result of test work in both Europe and North America and of significant analytical work by the Engineering Sciences Data Unit (ESDU) in London and NLR in The Netherlands.

There is no underlying safety rationale for this revision to JAR 25X1591 and the AMJ, other than the improvements in performance accuracy resulting from a better understanding of the subject. The compliance methods remain broadly unchanged, the improvements being in detail rather than in major principle. Consequently, it can be concluded that the revision can be considered to be of equivalent safety.

Dissenting Opinion on Proposed Paragraph 7.4.1 – UK CAA

The UK CAA recognises that the stated intent of the NPA is to effect relatively minor improvements to the AMJ 25X1591, as current at Change 14, to take account of the removal of the wet runway performance information and some recognised non-conservatisms. However, the discussions in the Flight Study Group and its Contaminated Runway Subgroup have made clear the lack of advice in the old AMJ regarding any adjustment to V_{MCG} when operating on contaminated surfaces. This silence can be construed in two ways, either that use of the non-contaminated V_{MCG} is acceptable without further showing, or that it should be considered but that no advice on adjustment can be given.

The text proposed in paragraph 7.4.1 of the NPA endorses this first interpretation but CAA does not accept this position. There is a very high probability of an effect on aeroplane controllability following engine failure on a contaminated surface that should be considered and it is the applicant's responsibility to provide the best information possible on any resulting adjustment to minimum V_1 necessary when operating on contaminated runways. The proposed text removes this responsibility from the applicant. CAA recognises the difficulty in providing precise information, with the current level of knowledge, on the effect on V_{MCG} when operating on a contaminated surface but this does not allow that the issue be ignored.

CAA proposes that paragraph 7.4.1 be re-written as follows:

"7.4.1 Minimum V_1

> Minimum V_1 may need to be adjusted in consideration of the reduced controllability following engine failure on a contaminated runway."

CAA further proposes that the Flight Test Harmonisation Working Group be tasked with the harmonisation of Contaminated Runway Performance Information as a matter of urgency. This was part of the Better Plan tasking and was put on hold awaiting proposals for the harmonisation of the operating rules by the Airplane Performance Harmonisation Working Group. With that task completed, there is no technical bar to harmonisation of the certification material.

FSG Response to UK CAA Dissenting Opinion

The FSG studied this issue in detail and the relevant proposed NPA paragraphs (7.4.1 and 8) are considered to be consistent with accepted practice and the current state of knowledge. There is no agreed method for modifying V_{MCG} values for contaminated runways. The FSG considered a broad range of issues that include those raised by the UK CAA. Accordingly, the above referenced NPA paragraphs include appropriate provisos and cautions that are reflective of the current state of knowledge and that recognise the potential hazards of contaminated runway operations.

Economic Impact

Economically, no penalty to an applicant should result from adoption of the revised AMJ 25X1591, as the combination of JAR 25X1591 and the changed advisory material is, in principle, neither more nor less difficult to show compliance with. It is also likely that operational data produced using the revised AMJ will permit more accurate scheduling of AFM data, which should produce a commercial benefit. It can be concluded that this revision to JAR-25 causes no economic penalty.

D. JAA NPA 25G-334 COMMENT-RESPONSE DOCUMENT

1. Introduction

Notice of Proposed Amendment 25G-334, sponsored by the Flight Steering Group (FStG), was published for comment on 1 September 2002. The comments received on the NPA have been considered by the FStG and its ad hoc Contaminated Runway Subgroup, and some changes have been accepted for the Final Rule. This Comment and Response Document reviews the comments received and proposes that a final rule be adopted based on the NPA 25G-334 but with amendments agreed by the FStG.

2. Background

NPA 25G-334 proposes to amend the JAR-25 requirements and advisory material addressing the provision of contaminated runway performance information. Amendments to JAR 25X1591 and ACJ 25.1583(k) are proposed, together with the re-introduction of an amended AMJ 25X1591 (reserved at Change 15 following the adoption of NPA 25B,D,G-244.) The NPA was prepared following discussions in the Flight Study/Steering Group and its ad hoc Contaminated Runway Subgroup.

3. Discussion of Comments

Responses to NPA 25G-334 were received from the following organisations:

No Comments and/or Accept:
CAA NL
Czech CAA
DGAC
LFV
Skyways Express
SLV
Swiss International Airlines

Comments:
AECMA
AIA
Austrocontrol
ESDU
ERAA
Jetflite Oy
LBA
NATAM
Saab
Scandinavian Airlines
Tomistopalvelu Puronto Oy
Transport Canada
UK CAA

Detailed responses to these latter comments are given in the following pages.

4. NPA 25G-334 Draft Final Rule and Recommendations

Following a review of the public comments by the JAA Flight Steering Group Contaminated Runway Sub-Group, the NPA has been proposed for a Final Rule with revision in the following main areas:-

a) Editorial reformatting to improve presentation.
b) The contaminant properties of wet snow are now different to those of slush.
c) Greater emphasis has been placed with respect to correlating drag estimates with performance measurements for the smaller aeroplane designs.
d) Acknowledgement made with respect to the use of operational field performance data linked to reported surface friction.
e) Treating dry snow less than 20mm depth and wet snow less than 5mm depth as compacted snow.
f) New wet snow braking coefficient default value being the same as that for dry snow.

Whilst this NPA reflects notable progress with respect to the development of methodologies relating to contaminated runway field performance, it is clear that further progress is desirable. The Flight Steering Group has recommended that the requirements and guidance relating to the provision of contaminated runway performance scheduling be a high priority item for future harmonisation. In addition the Aeroplane Performance Harmonisation Group has recommended in their ARAC report that a Group be tasked with identifying and addressing any airworthiness type certification criteria associated with determining contaminated runway performance.

It has been acknowledged that the methodologies contained in this NPA link performance scheduling to a description of the contaminant, rather than to a reported runway friction. Certain operational performance data software does schedule field performance against aeroplane braking coefficient that then is linked to reported runway friction index or aeroplane braking action. Transport Canada Airworthiness has developed a Canadian Runway Friction Index that is linked to aeroplane performance for slippery surfaces i.e. ice and compacted snow. In addition ESDU has developed methodologies to relate the braking performances of aeroplane and ground test machines in wet conditions and which it is expanding to include all contaminants. This work is not sufficiently mature to provide an internationally agreed standard but does provide fertile ground to develop the associated methodologies further.

Aeroplane test data has also shown that the methodologies proposed in the NPA are still exposed to providing optimistic performance levels as a result of under prediction of spray impingement drag for the smaller aeroplane designs.

Until such time that our technical understanding relating to the effects of a contaminated runway surface on V_{MCG} is increased and that these effects can be reasonably predicted, the UK CAA dissenting opinion expressed in the NPA is not supported. However the group strongly recommends seeking an improvement in the knowledge necessary to account for V_{MCG} and cross-wind effects on controllability when operating on contaminated surfaces. During development of the Final Rule, the FSG and the Contaminated Runway Sub-Group discussed concerns with the technical validity of treating a runway contaminated with <20mm dry snow and <5mm wet snow as a wet surface. No comment was raised on this issue during the public consultation on the NPA and, as an interim solution, it was considered reasonable to use performance data associated with compacted snow.

As a consequence of the above, further work is recommended addressing:

1. Relating aeroplane performance to reported runway friction,

2. Under-prediction of spray impingement drag for smaller aeroplanes,

3. V_{MCG} and crosswind effects on contaminated surfaces, and

4. Braking friction and contaminant drag on "Dry Snow < 20mm" and "Wet Snow <5mm".

The Flight Steering Group recommends continued development of these methodologies with the intent of harmonising the rules and guidance. It is envisaged that this activity should involve a broad spectrum of specialists to include aerodrome, surface friction measurement, operational, certification, ICAO and research disciplines.

COMMENT NR	NPA 25G-334 (28/05/02) requirement or AMJ	COMMENTS PROPOSED TEXT/ GENERAL COMMENT REASON(S) FOR PROPOSED TEXT / COMMENT	*JAA Flight Steering Group Contaminated Runway Sub-Group Responses*	Revised NPA 25G-334 (12/05/03) requirement or AMJ
004	**25X1591**	COMMENT: The subject of computing airplane takeoff and landing performance on contaminated runway surfaces is complex, and there is little test data with which to validate performance estimation methods. Although draft AMJ 25X1591 provides a reasonable reference for contaminated runway performance, there remains the major issue of harmonization with the FAA (starting with JAR 25X1591), and the difficult subject of correlating airport friction test device values with airplane performance. It is recommended that the Flight Steering Group and its Contaminated Runway Subgroup continue their efforts to understand these issues in preparation for future regulatory harmonization and the development of improved contaminated runway performance estimation guidance material. **Reason(s) for proposed text/comment:**	***The Flight Steering Group have recommended that the requirements and guidance relating to the provision of contaminated runway performance scheduling be a high priority item for future harmonisation. In addition the Aeroplane Performance Harmonisation Group have recommended in their ARAC report that a Group be tasked with identifying and addressing any airworthiness type certification criteria associated with determining contaminated runway performance. It was acknowledged that the methodologies contained in this NPA link performance scheduling to a description of the contaminant, rather than to a reported runway friction. Certain operational performance data software does schedule field performance against aircraft braking coefficient which then is linked by some means to reported runway friction index or aircraft braking action. DOTC have developed a Canadian Runway friction index which is linked to aircraft performance for slippery surfaces ie ice and compacted snow. In addition ESDU have developed methodologies intended to relate the braking performances of aircraft and ground test machines in wet conditions which they currently are expanding to include all contaminants. The work today has not sufficiently matured to provide an internationally agreed standard and consequently it was not possible for their associated methodologies to be included in this NPA. Nevertheless the Sub-Group have acknowledged the use of such data with the introduction of new paragraph 7.3.3. The recommendation was supported by the Sub-group. It was envisaged that this activity should involve a broad spectrum of specialists to include aerodrome, cart vehicle, operational, certification, ICAO and research.***	**25X1591** **Para. 7.7.3**
014	**25X1591**	PROPOSED TEXT/COMMENT : This revised AMJ gives guidelines for establishment of performance information for use when taking off and	***The Flight Steering Group have recommended that the requirements and guidance relating to the provision of***	**25X1591**

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		landing with contaminated surface conditions required by JAR 25X1591. However all terminology, friction coefficient values ... used in this AMJ are relative to A/C performance and not runway qualification as defined in Annex 14. It appears for AECMA that this document should be part of a general process reviewing all the issues such as: - harmonisation of friction values and terminology between A/C, friction measuring device and airport terminology ; - progress should be made to harmonise data delivered by friction cart and those used for A/C performance establishment (friction measuring devices should work on all surfaces even with contaminated depth). **<u>Reason(s) for proposed text/comment</u>:**	***contaminated runway performance scheduling be a high priority item for future harmonisation. In addition the Aeroplane Performance Harmonisation Group have recommended in their ARAC report that a Group be tasked with identifying and addressing any airworthiness type certification criteria associated with determining contaminated runway performance. It was acknowledged that the methodologies contained in this NPA link performance scheduling to a description of the contaminant, rather than to a reported runway friction. Certain operational performance data software does schedule field performance against aircraft braking coefficient which then is linked by some means to reported runway friction index or aircraft braking action. DOTC have developed a Canadian Runway friction index which is linked to aircraft performance for slippery surfaces ie ice and compacted snow. In addition ESDU have developed methodologies intended to relate the braking performances of aircraft and ground test machines in wet conditions which they currently are expanding to include all contaminants. The work today has not sufficiently matured to provide an internationally agreed standard and consequently it was not possible for their associated methodologies to be included in this NPA. Nevertheless the Sub-Group have acknowledged the use of such data with the introduction of new paragraph 7.3.3. The recommendation was supported by the Sub-group. It was envisaged that this activity should involve a broad spectrum of specialists to include aerodrome, cart vehicle, operational, certification, ICAO and research.***	**Para. 7.3.3**
017	**25X1591 (a)**	**<u>PROPOSED TEXT/COMMENT</u>:** First sentence. Delete “or as required by Operational Regulations” Suggested editorial change. This should not be part of the JAR 25 requirement. **<u>Reason(s) for proposed text/comment</u>:**	***The rule states that contaminated runway surface supplementary performance information may be furnished at the discretion of the applicant or as required by Operational Regulations. It was agreed that the reference to operational regulations within a certification rule was best avoided and it’s***	**25X1591 (a)**

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		Suggested editorial change. This should not be part of the JAR 25 requirement.	***deletion was agreed. However it was noted that the intent of the NPA remains the same in regard to the consideration of the impact from operational rules on data scheduling requirements as reflected in AMJ 25X1591 sub-paragraph 6.2 relating to the V_{STOP} and V_{GO} concept.***	**Para. 6.2**
018	**25X1591 (c)**	**<u>PROPOSED TEXT/COMMENT</u>:** Last sentence. Change to new sub-paragraph "(d) Where information covering operation on a contaminated runway surface is not supplied, the AFM must contain a statement which prohibits operation on that contaminated surface." **<u>Reason(s) for proposed text/comment</u>:** Suggested editorial change to emphasize the prohibition and to reflect that the prohibition is only for those contaminated surfaces for which data is not provided.	***It was agreed that the prohibition was emphasized sufficiently by embodying it in the first sub-paragraph (a) of JAR 25X1591 as proposed in comment 057.***	**25X1591 (a)**
057	**25X1591**	**<u>Reason(s) for proposed text/comment</u>:** LBA agree to the proposals. With respect to the dissenting opinion, LBA support the majority position of the FSG, reflecting accepted practice. However, LBA agree to the proposal to resolve this issue in course of the Harmonisation work. <u>JAR 25X1591:</u> The last sentence of proposed subparagraph (c) should be moved to the end of (a). The last sentence in (a) covers the case when performance information on contaminated runways is supplied, whilst the last sentence of (c) would cover the case when that information is not supplied. These two sentences logically complement each other well and should be grouped together. Also changing, "When" to "If" in both sentences, subparagraph (a) would then read: <u>(a) Supplementary performance information applicable to aeroplanes operated on runways contaminated with standing water, slush, snow, ice or other contaminant may be furnished at the discretion of the applicant or as required by Operational Regulations. **If** supplied, this information should include the expected performance of the aeroplane during take-off and landing on hard-surfaced runways covered by selected contaminants. **If information covering operations on a contaminated runway is not supplied, the AFM must contain statements prohibiting operations on contaminated surfaces.**</u>	***These comments were note.*** ***This proposal was accepted.***	**25X1591 (a)**
065	**25X1591**	**<u>PROPOSED TEXT/COMMENT & REASON FOR PROPOSED TEXT/COMMENT</u>:** Issue # 3. It is unfortunate that the NPA does not address wet runway calculations for purposes of establishing standard for wet runway LAHSO. It does, however, indicate that a runway is considered contaminated by "standing water" only if there is more than 3mm of water. One can assume that 3mm or less is simply "wet". A water depth of 3mm or less is unlikely to cause hydroplaning.	***This NPA addresses contaminated runway and not wet runway field operations. The definition relating to standing water has been amended to remove any ambiguity which may cause confusion relating to a non-contaminated wet runway surface.***	**Para. 4.1**
007	**Explanation and Justification Page 2**	**<u>PROPOSED TEXT/COMMENT</u>:** The last paragraph states: *The compliance methods remain broadly unchanged, the improvements being in detail rather than in major principle. Consequently, it can be concluded that the revision can be considered to be of equivalent safety.* It should be stated whether operators having shown compliance with the <u>previous</u> performance information in JAR 25X1591 and by AMJ 25X1591 are required to revise their performance documentation to show continued compliance with JAR-OPS 1.490 and, where necessary, JAR-OPS 1.520. Based on the above statement we believe that such revision should not be required.	***The embodiment of these rules within JAR 26 for retroactive certification application has not been decided. Consequently this comment is relevant to compliance with operational rather than certification rules. JAR-OPS 1.485(b) leaves it open to the***	

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		Reason(s) for proposed text/comment: The impact of the proposal in this document, regarding definitions of Wet Snow and Dry Snow, may require rather large and expensive changes to the existing performance data published in our aircraft operating manuals and reprogramming of Takeoff Data Computers, which will be an economical burden on the operators. Regarding Wet Snow, additional performance penalties have to be introduced. The Dry Snow definition will require less performance penalties. The old definitions are preferred by Scandinavian Airlines. This is based on experience and previous calculated performance data.	***NAA to decide on retroactive application of revised AMJ data standards. Consequently it would not be appropriate to make the requested statement within the NPA.*** ***It was agreed to provide separate definitions for dry and for wet snow.***	**Paras. 4.3 & 4.4.**
019	**Paragraph 2.0**	**PROPOSED TEXT/COMMENT:** First sub-paragraph, second sentence. "It does not require aeroplane testing on contaminated runway surfaces, …" **Reason(s) for proposed text/comment:** Suggested editorial change – there are at least four different types of contaminated surfaces with differing effects on aeroplane performance	***This comment was agreed.***	**Para. 2.0**
020	**Para. 2.0**	**PROPOSED TEXT/COMMENT:** Second sub-paragraph, last sentence. Change to "Consequently the extent of applicability must be clearly stated." **Reason(s) for proposed text/comment:** It is not practical to ensure that data is presented for the most adverse condition due to the reasons noted.	***The comment was agreed since it was accepted that one could not always determine the most critical contaminant.***	**Para. 2.0**
056	**Para. 2.2**	**PROPOSED TEXT/COMMENT:** **Where in JAR25 is the definition of a wet runway after this revision of AMJ 25X1591?** In AMJ 25X1591 there was a definition of wet runway in paragraph 2.2 which stated: *A runway is considered as wet when it is well soaked but without significant areas of standing water.* *A runway is considered well soaked when there is sufficient moisture on the runway surface to cause it to appear reflective.* In JAR 25 Change 15 the specific rules for wet runway earlier included in AMJ 25X1591 was introduced into the normal performance requirements of Subpart B but where is the definition of a wet runway? **Reason(s) for proposed text/comment:**	***This comment was accepted and it was agreed to provide a definition of a wet runway. Consequently the definition relating to standing water is amended as follows :-*** ***Water of a depth greater than 3mm. A surface condition where there is a layer of water of 3mm or less is considered wet for which AMJ 25X1591 is not applicable.***	**Para. 4.1**
021	**Para. 3.0**	**PROPOSED TEXT/COMMENT:** First sub-paragraph, first sentence. Change to "… and the limitations inherent in representing the effects of these conditions analytically…" **Reason(s) for proposed text/comment:** Suggested editorial change – to indicate that it is the adverse effects of the contaminant(s)	***This comment was accepted.***	**Para. 3.0**
022	**Para. 3.0**	**PROPOSED TEXT/COMMENT:** Second sub-paragraph, first dash. Change to "- the contaminant is spread over the entire runway surface and although rutting may take place, an even depth is assumed"	***This comment was accepted but it was recognised that rutting was not the sole reason for uneven contaminant depths eg loose snow / water drainage / effects of wind. It was agreed to generalise the linkage between use of data and non-uniform***	**Para. 3.0**

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		Reason(s) for proposed text/comment: Slush and snow are subject to rutting. The revised definition reflects the assumption.	***surfaces with the following revision :-*** ***"……and although, for example, rutting may have taken place, an even depth is assumed"***	
023	**Para. 3.0**	**PROPOSED TEXT/COMMENT:** Second sub-paragraph, third dash. Delete. **Reason(s) for proposed text/comment:** Ice covered runways and compacted snow covered runways generally arise because of natural aging as well as other factors. While it is true that loose snow may "age" and its characteristics change after 24 hours, the more realistic operational condition is that loose snow will have been removed from the runway. Overall it is considered better to delete the assumption, however if it is kept, it should be clarified that it applies only to loose snow.	***It was agreed to delete this text on the basis that the definition relating to dry snow would make it clear that the assumptions did not include the ageing process.***	**Para. 4.3**
008	**p 4.0**	**COMMENT:** There should be a difference in specific gravity regarding Slush versus Wet Snow. Wet Snow should be defined with a Specific gravity less than Slush. **Reason(s) for proposed text/comment:** The impact of the proposal in this document, regarding definitions of Wet Snow and Dry Snow, may require rather large and expensive changes to the existing performance data published in our aircraft operating manuals which will be an economical burden on the operators. Regarding Wet Snow, additional performance penalties will be introduced. The Dry Snow definition will require less performance penalties. The old definitions are preferred by Scandinavian Airlines. This is based on experience and previous calculated performance data.	***The reason for assuming an equal density for wet snow and slush was based on a practical problem when trying to identify if the runway is covered by wet snow or slush. The difference between both contaminants isn't always easy to determine. In certain cases you would need a microscope to actually see any differences. To solve this problem it was decided to treat both contaminants as the same. From a flight operational point of view this seemed the most logical thing to do. Nevertheless it was acknowledged that specific gravities for wet snow have historically been accepted as different to those of slush and that the NPA should not deny the continued use of this approach. Consequently the applicant may optionally produce performance data specific to wet snow thus avoiding any unnecessary penalties.*** ***It was agreed to adopt the wet snow definition proposed in comment 024 which included reference to a specific gravity of 0.5 and to distinguish between slush and wet snow in Tables 1 and 2. (however see response to comment 028).*** ***It is acknowledged that the commentator prefers the old definitions relating to contaminants however the guidance makes clear that the contaminant definitions may be different to those used by other sources. No retroactive certification application is intended and consequently we do not see that currently scheduled performance data would need to be changed unless required through application of operational rules.***	**Para. 4.3** **Tables 1 & 2**
063	**Para. 4.0**	**PROPOSED TEXT/COMMENT:** The definitions differ within the document and from those definitions used for reporting purposes in the ICAO	***The majority of SNOWTAM contaminants are addressed in the NPA apart from rime or frost covered surfaces, frozen ruts or***	

COMMENT NR	NPA 25G-334 (28/05/02) requirement or AMJ	COMMENTS PROPOSED TEXT/ GENERAL COMMENT REASON(S) FOR PROPOSED TEXT / COMMENT	*JAA Flight Steering Group Contaminated Runway Sub-Group Responses*	Revised NPA 25G-334 (12/05/03) requirement or AMJ
		SNOWTAM-format. These definitions should be harmonised throughout the document and with those used for reporting purposes. The definitions do not reflect use of liquid or solid chemicals. **Reason(s) for proposed text/comment:** Table 2, page 16, should use the same definitions as those defined at page 6 and 7. (Specially Prepared Winter Runway – Sanded Snow). From a safety point of view one should use the same definitions for the contaminants for reporting and performance purposes. The intent of the specifications in ICAO Annex 14 is to satisfy the SNOWTAM and NOTAM promulgation requirements contained in ICAO Annex 15. This information, which is the reported information of the contaminated movement area, is the information the pilot has to rely upon when taking his decisions. Different definitions is not the consistent level of safety we all desire, and puts extreme pressure on operators and pilots and airport operators as they do not "speak the same language" while communicating.	***ridges. However it was accepted that there is no current linkage with reported braking fiction and aircraft performance as previous comments have specified and further work is recommended to develop such guidance.*** ***It was agreed to acknowledge the use of chemical treatments such as non-bonding and de-icing fluids which are intended to brake down contaminants and improve surface friction. Consequently reference to such has been introduced in the definition relating to a specially prepared winter runway.***	**Para. 4.7**
024	**Para. 4.2**	**PROPOSED TEXT/COMMENT:** Change to "Wet snow – Snow that will stick together when compressed, but will not readily allow water to flow from it when squeezed, with an assumed specific gravity of 0.5. **Reason(s) for proposed text/comment:** If water can be squeezed and it has a specific gravity of 0.85 then it is slush. An alternative definition is proposed, which more clearly describes the wet snow condition. The specific gravity comes from the upper value noted in ICAO Annex 14.	***The proposed definition was accepted.***	**Para. 4.3**
070	**Para. 4.2**	**PROPOSED TEXT/COMMENT:** 4.2 Snow Snow which is solid, can resist compression by hand and does not create a spray effect with a specific gravity of 0.40. **Reason(s) for proposed text/comment:** Case: normal snow covered runway - the NPA definition for wet snow is same as slush and can lead to a situation where the crew defines the contaminant with real specific gravity of 03-0.4 to dry snow (specific gravity 0.20). This is potential danger factor. On the other hand the conservative interpretation with specific gravity 0.85 leads to high payload loss. Contaminant definitions should be as informative and clear as possible for the pilot. The pilot should be able to use these definitions to identify the contaminant type. In this respect one must not confuse a snowflake falling from the sky and its water content to the contaminant on the runway after the snow hits the runway surface. In respect to contaminant identification the main issue is the behavior of the contaminant: - is it contaminant with water viscosity, or - is it slush which creates spray effect when hit by the foot, or - is it solid snow with no spray effect of which one can make a snow ball, or - is loose snow which can be blown off Referring to U.S. Department of the Interior and its study "Snow Accumulation Algorithm for the WSR-88D Radar: Second Annual Report 1997" and our own in house studies, logical and conservative specific gravity values to differentiate above mentioned contaminant types would be: - water 1.00 - slush 0.80 - snow 0.40 (not wet nor dry, but plain snow) - loose snow 0.20	***The reason for assuming an equal density for wet snow and slush was based on a practical problem when trying to identify if the runway is covered by wet snow or slush. The difference between both contaminants isn't always easy to determine. In certain cases you would need a microscope to actually see any differences. To solve this problem it was decided to treat both contaminants as the same. From a flight operational point of view this seemed the most logical thing to do. Nevertheless it was acknowledged that specific gravities for wet snow have historically been accepted as different to those of slush and that the NPA should not deny the continued use of this approach. Consequently the applicant may optionally produce performance data specific to wet snow thus avoiding any unnecessary penalties.*** ***It was agreed to adopt the wet snow definition proposed in comment 024 which included reference to a specific gravity of 0.5 and to distinguish between slush and wet snow in Tables 1 and 2. Furthermore it was decided that the use of the methodologies in Table 1 and the default friction value in Table 2 associated with slush and wet snow could be retained for wet***	

COMMENT NR	NPA 25G-334 (28/05/02) requirement or AMJ	COMMENTS PROPOSED TEXT/ GENERAL COMMENT REASON(S) FOR PROPOSED TEXT / COMMENT	*JAA Flight Steering Group Contaminated Runway Sub-Group Responses*	Revised NPA 25G-334 (12/05/03) requirement or AMJ
		These gravity values seem to represent conservative limit values to above described behavior patterns of snow. Enclosed one can find a "combination diagram" of the mentioned report and in house study results.	***snow to provide a conservative approach (however see response to comment 028). It is acknowledged that the commentator prefers the old definitions relating to contaminants however the guidance makes clear that the contaminant definitions may be different to those used by other sources and that applicants may wish to consider other less likely contaminants. Consequently these guidelines contain the flexibility for consideration of different contaminant definitions. No retroactive certification application is intended and consequently we do not see how these proposals are likely to affect scheduled performance data which currently exists unless required through application of operational rules.***	Para. 5.2
025	**Para. 4.3**	**PROPOSED TEXT/COMMENT:** Change to "Dry snow – Snow that can be blown, or, if compacted by hand, will fall apart upon release (also commonly referred to as loose snow), with an assumed specific gravity of 0.2 **Reason(s) for proposed text/comment:** This is an alternative and clearer operational definition of dry snow, which includes the assumption, for aeroplane performance purposes, that the specific gravity is 0.2. Note that ICAO Annex 14 assumes a specific gravity for dry snow of up to but not including 0.35.	***This definition has been agreed and coordinated within DOTC. The Sub-Group preferred this definition but would wish to add reference to "Fresh snow" and in addition state "… of 0.2. The assumption with respect to specific gravity is not applicable to snow which has been subjected to the natural ageing process"***	Para. 4.4
071	**Para. 4.3**	**PROPOSED TEXT/COMMENT:** 4.3 Loose Snow Fresh snow with relatively little water content, such that water cannot be squeezed out when compressed by hand. It is possible to remove this type of snow by blowing it off. It has a specific gravity not greater than .02. **Reason(s) for proposed text/comment:** Referring to same reason as in comment on paragraph 4.2	***It was decided that the reference to a specific gravity of 0.2 was a typographical error and that the definition proposed in comment 025 was preferred.***	Para. 4.4
026	**Para. 4.4**	**PROPOSED TEXT/COMMENT:** First sentence. Change to "… dry frozen surface of compacted snow or ice, which has been treated with sand or grit, or has been mechanically treated, to improve runway friction" **Reason(s) for proposed text/comment:** The proposed text clarifies the common means of increasing runway friction on runways covered with ice or compacted snow.	***These comments were accepted with the additional reference to chemical treatments (see response to comment 063).***	Para. 4.7
072	**Para. 4.6**	**PROPOSED TEXT/COMMENT:** 4.6 Slush Partly melted snow with a high water content. Slush cannot significantly resist compression by hand and does create spray effect when hit by foot. It has specific gravity of 0.80. **Reason(s) for proposed text/comment:** Referring to same reason as in comment on paragraph 4.2	***We have now split wet snow from slush and it was agreed to redefine slush as "Partially melted snow or ice with a high water***	Para. 4.2

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			content, from which water can readily flow, with an assumed specific gravity of 0.85.” The value of 0.85 was considered acceptable for drag calculations but is a nominal value only. ***The guidance makes clear that the contaminant definitions may be different to those used by other sources and that applicants may wish to consider other less likely contaminants. Consequently these guidelines contain the flexibility for consideration of different contaminant definitions. The value of 0.85 has been used for many years in the calculation of airplane performance on slush covered runways and it’s retention was preferred.***	Para. 5.2
027	**Para. 4.7**	**PROPOSED TEXT/COMMENT:** Change to “Ice – Water which has frozen on the runway surface and includes the condition commonly referred to as “black ice” and the condition where compacted snow transitions to a polished ice surface” **Reason(s) for proposed text/comment:** This is an alternative and clearer operational definition of ice. There is no need to discuss “dry” and “wet” ice.	***The proposal was agreed except that reference to “black ice” was thought immaterial and warranted deletion.***	Para. 4.6
028	**Para. 5.1**	**PROPOSED TEXT/COMMENT:** Table 1. A separate row should be added for wet snow. Depth of 5-30 mm and specific gravity of 0.5 are suggested. The same aircraft braking coefficient as for dry snow should be assumed. **Reason(s) for proposed text/comment:** It should be an option to consider wet snow as a separate surface.	***It was agreed to change Table 1 with respect to depth and specific gravity (see responses to comment 008). The actual depths 5-30 mm were based on water equivalent depth. It was agreed to amend NPA Table 2 to reposition wet snow as a separate row, with a default friction value the same as for dry snow. This was agreed on the basis that the aircraft test***	Table 1

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			results database justifying the braking coefficient for dry snow, included contaminants with higher specific gravities appropriate to wet snow.	
029	**Para. 5.1**	**<u>PROPOSED TEXT/COMMENT</u>:** Table 1. Rows should be in same general order of guidance or definitions (Section 4.0) e.g. standing water, slush, wet snow (if required), dry snow, compacted snow, ice and specially prepared winter runway. **<u>Reason(s) for proposed text/comment</u>:** Suggested editorial change.	***It was agreed to revise the NPA such that the order of presentation of section 4, Table 1 and Table 2 would be consistent. (eg standing water/slush/wet snow/dry snow/compacted snow/ice/specially prepared).***	**Section 4 Tables 1 & 2**
073	**Para. 5.1**	**<u>PROPOSED TEXT/COMMENT</u>:** <u>5.1 Table 1</u> Contaminant Type: Loose Snow (instead of Dry Snow), Specific Gravity: 0.20 Contaminant Type: Snow (new type between Loose Snow and Sslush) Specific Gravity: 0.40 Contaminant Type: Slush (instead of Slush and Wet Snow) Specific Gravity: 0.80 **<u>Reason(s) for proposed text/comment</u>:** Referring to same reason as in comment on paragraph 4.2	***The guidance makes clear that the contaminant definitions may be different to those used by other sources and that applicants may wish to consider other less likely contaminants. Consequently these guidelines contain the flexibility for consideration of different contaminant definitions.***	**Para. 5.2**
030	**Para. 5.2**	**<u>PROPOSED TEXT/COMMENT</u>:** Second subparagraph. Change to "A specific gravity of 0.2 is considered reasonable for freshly fallen snow although values higher than this can occur. With snow that has been aged by, for example, lying for more than 24 hours, specific gravities higher than 0.2 will occur. However this condition is considered to be operationally unlikely" **<u>Reason(s) for proposed text/comment</u>:** This is a more factually correct statement explaining the assumption of a specific gravity equal to 0.2 for dry snow. Note that ICAO Annex 14 assumes a specific gravity of up to but not including 0.35.	***It was agreed to delete the last two paragraphs in NPA paragraph 5.2. The assumptions relating to specific gravity are included in the definitions of NPA paragraph 4, which are deemed appropriate for producing acceptable performance data. References to ageing have been included in the definition of dry snow.***	**Para. 5.2**
031	**Para. 5.2**	**<u>PROPOSED TEXT/COMMENT</u>:** Second and third sub-paragraphs. Move to paragraph 5.1 as Notes to the table. **<u>Reason(s) for proposed text/comment</u>:** Suggested editorial change. Paragraph 5.2 is a discussion of other contaminants. The information in the second and third sub-paragraphs is an explanation of the assumptions for specific gravity of contaminants to be considered in paragraph 5.1.	***It was agreed to delete the last two paragraphs in NPA paragraph 5.2. The assumptions relating to specific gravity are included in the definitions of NPA paragraph 4, which are deemed appropriate for producing acceptable performance data. References to ageing have been included in the definition of dry snow.***	**Para. 5.2**
074	**Para. 5.2**	**<u>PROPOSED TEXT/COMMENT</u>:** <u>5.2 Other Contaminants (last paragraph)</u> Slush can exist with natural specific gravities of 0.40 to 0.80, with values above 0.80 it's viscosity is near water viscosity and therefore very difficult to indentify as slush instead of water. Based on this 0.80 is considered to be acceptable for drag calculations with slush contaminant. **<u>Reason(s) for proposed text/comment</u>:** Referring to same reason as in comment on paragraph 4.2	***A specific gravity of 0.85 has been taken as a conservative nominal accepted value. The guidance makes clear that the contaminant definitions may be different to those used by other sources and that applicants may wish to consider other less likely contaminants. Consequently these guidelines contain the flexibility for consideration of different contaminant definitions.***	**Para. 5.2**

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032	**Para. 6.1**	**PROPOSED TEXT/COMMENT:** First sub-paragraph. Delete "below" at the end of the sentence. New text: "…with the assumptions given in paragraph 7.0." **Reason(s) for proposed text/comment:** Suggested editorial change. Depending on the document formatting, paragraph 7.0 might be on another page.	***The comment was accepted.***	**Para. 6.1**
033	**Para. 6.1**	**PROPOSED TEXT/COMMENT:** Third sub-paragraph, first sentence. Change to "…to indicate the elements that should be addressed." **Reason(s) for proposed text/comment:** Suggested editorial change. The latter part of the sentence does not add to, or clarify, the general conditions.	***The comment was accepted.***	**Para.6.1**
034	**Para. 6.2**	**PROPOSED TEXT/COMMENT:** First sub-paragraph, first sentence. Change to "…for a wet runway, in accordance with the agreed certification standard." **Reason(s) for proposed text/comment:** Suggested editorial change.	***The comment was agreed.***	**Para. 6.2**
035	**Para. 6.2**	**PROPOSED TEXT/COMMENT:** First sub-paragraph, last sentence. Replace with new paragraph. "Since it is possible for some aeroplane types to be operated in accordance with operational standards that do not require a single V_1, the applicant may optionally produce additional data for other than a single V_1 (that is, using a V_{STOP} and a V_{GO}). Note: V_{STOP} is…" **Reason(s) for proposed text/comment:** Aeroplane types such as business class aeroplanes may be operated in accordance with different operating rules. Since it is not possible for the applicant to determine what operating rules are going to be applied, the basic performance assumptions should be those of the agreed certification basis for wet runways. However recognizing that it is possible that a less strenuous operational standard could be applied, it is appropriate to mention that, at the option of the applicant, additional data can be provided.	***The comments were accepted however it was recognised that we can not have an operational standard applicable to an aircraft type. The intent of the NPA is to recognise that when defining performance data, such as the definition of take-off run or distance, that the original certification standard can be retained. However this should not deny the applicant the option to produce additional data. Consequently the intent of the NPA is to require the provision of take-off decision speeds V_1 but in addition Vstop & Vgo may be furnished and used if permitted operationally by the NAA.***	**Para. 6.2**
067	**Para. 6.2**	**PROPOSED TEXT/COMMENT & REASON FOR PROPOSED TEXT/COMMENT:** The concept of using Vstop and Vgo was never accepted by ACG as a part of the type certification process. This is an operational issue and should be covered in JAR-OPS. The text should be changed in the first bullet last sentence as follows: "Where existing **national** airworthiness ~~or operational~~ standards applicable to a specific aeroplane type permit operation without engine failure accountability, or using …" Add to the Note: **"In the FM has to be a note that this concept is only accepted by the NAA where operation under this standard is permitted."** Justification: The concept Vstop, Vgo is not in line with the intend of JAR 25 that if the engine failure occur at a certain speed, the	***The previous AMJ permitted the scheduling of Vstop & Vgo speeds to accommodate specific operational rules. As this situation has not changed it was decided that the NPA continue to provide this flexibility and leave to the NAA the decision to impose the V_1 concept outside of compliance with JAR-OPS 1. The intent of this NPA is that V_1 is scheduled with additional optional data such as Vstop & Vgo made available for use if permitted operationally. It was agreed to require an AFM reference to highlight this approach. eg "Use of Vstop & Vgo data is only accepted where operation under this standard is permitted."***	**Para. 6.2**

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		aeroplane can either safe stop within the available field length or can safe continue the start and take off. This condition is only granted if Vstop is selected to be as least equal or greater then Vgo. If Vstop is selected at a lower value than Vgo than if an engine failure occurs at a speed between Vstop and Vgo, the available take off distance might be not sufficient and or the aeroplanes does not have reached the screen height at the runway end. The use of this procedure under the airworthiness code cannot be supported and should be covered under operating rules.		
036	**Para. 6.3.1**	**PROPOSED TEXT/COMMENT:** Delete "below" at the end of the sentence. New text: "…distance for landing on a contaminated runway are addressed in 7.7.2." **Reason(s) for proposed text/comment:** Suggested editorial change. Depending on the document formatting, paragraph 7.7.2 might be on another page.	***The comment was accepted.***	**Para. 6.3.1**
037	**Para. 6.3.2**	**PROPOSED TEXT/COMMENT:** Change to "6.3.2 Ground Distance The touchdown time delays on a contaminated runway should be the same as those used on a dry runway multiplied by a factor of 1.92. Except as modified by the effects of contaminant as derived in paragraph 7.0, performance assumptions for ground distance determination remain unchanged from those used for a dry runway except that stopping means other than wheel brakes may be used (see 7.7.3)" **Reason(s) for proposed text/comment:** Time delays derived from selected landing tests on a dry runway in good atmospheric conditions do not represent the average performance that could be expected on a contaminated runway. Furthermore there is a lack of test data of the delays with achieving full anti-skid braking on a contaminated surface. For normal operations the AFM landing distance on a wet runway is increased by a factor of 1.92. Assuming that this factor is appropriate to the transition distance for contaminated runways (i.e. there are no further operational factors added), then the time delay should be multiplied by 1.92. The revision reflects the reality that it is not appropriate to use the dry runway time delays and proposes to multiply the dry time delay by a factor of 1.92	***For the transition distance on a contaminated runway the demonstrated time delays (main gear touchdown to brake initiation) are the same as those used for compliance with JAR 25.125. However the JAR 25.125 distance is a minimum distance which is then factored by operational rules ie for turbo-jets : 1.67 (dry) & 1.92 (wet). The effects on distance due to time delays will be magnified through the application of these operational factors. Consequently for contaminated runways which have a different operational field length factor, should we be using the same transitional time delays? This concern is compounded by the fact that currently DOTC do not prescribe contaminated runway distance factors. Furthermore DOTC test experience has shown that the minimum delay of 1 second given in the Flight Test Guide appears insufficient.*** ***It was accepted that there did appear to be a technical inconsistency with respect to the treatment of transition time delays however :-*** ***i) The proposed methodology relating to the derivation of contaminated runway landing distances has not been amended now for some time leading to a certain amount of operational experience.*** ***ii) The airborne distances are defined with more of a consideration to operational landing techniques resulting in a minimum airborne time of 7 seconds and V_{50} / V_{TD} speed ratio of 0.93.***	**Para. 6.3.2**

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			iii) JAR-OPS 1 does require a contaminated runway field length factor of 115% and this factored distance needs to be compared to the factored wet distance (1.92) and the longer of the two applied. ***iv) Any resulting factoring of delay times as proposed will have relatively small effects on total distance as compared to airborne and ground borne phases.*** ***v) Any changes to the methodology may have ramifications on the JAR-OPS 1 operational rule which would need to be considered.*** ***vi) The minimum delay time of 1 second in the Flight Test Guide was guidance related to all operations and not specific to contaminated runway operations.*** ***The overall opinion was to recognise that there did appear to be an apparent technical inconsistency with respect to the treatment of the effects on distance due to delay times. However it was felt that there was insufficient justification in adopting this proposal at this stage in the NPA's development and that it was preferable to retain the previously agreed standard.***	
065	**Para. 7.0 b**	**PROPOSED TEXT/COMMENT & REASON FOR PROPOSED TEXT/COMMENT:** There is conflict within this paper with respect to the calculation of the drag caused by a dual or four-wheel bogie configuration. Paragraph 7.0 b indicates that the drag for a double wheel is twice and a double bogie is four times that of a single wheel configuration. However, the second paragraph of 7.5.2 indicates that the drag on the trailing tires of a bogie configuration may be ignored and the drag on a bogie configuration is assumed to be same as a dual tire configuration.	***There is no conflict in the calculation of dual or four-wheel bogie configurations. Paragraph 7.0.b is applicable to standing water , slush and wet snow conditions, while paragraph 7.5.2 is applicable to dry snow conditions. However the structure of Section 7 of the AMJ could be improved to avoid the apparent conflict noted in the comment. At present paragraphs 7.1, 7.2, 7.3 and 7.4 deal with various aspects of the contaminant drag in standing water, slush, wet snow, while paragraph 7.5 deals with all aspects of drag in dry snow conditions. It was agreed to rearrange the paragraphs to improve clarity of presentation.***	**Para. 7**

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038	**Para. 7.1 a.**	**PROPOSED TEXT/COMMENT:** Change to "The drag on the tyre is given by - … … Where …and V is the groundspeed, in consistent units" **Reason(s) for proposed text/comment:** Suggested editorial change.	***The comment was accepted.***	**Para. 7.1.1 a**
039	**Para. 7.1 b.**	**PROPOSED TEXT/COMMENT:** Second sentence. It is not intuitively obvious why the displacement drag of a four-wheel bogie is 4 times the drag of a single wheel. It could be expected that the forward two tires would clear some of the water from the path of the rear two wheels. **Reason(s) for proposed text/comment:** See above.	***The direct measurements factor of 3.33 was derived from NASA data (ESDU Memo No 99 Jan 2000 DJ Mitchell). There was no displacement drag but impingement drag of rear wheels contributed to the overall effect. All the results for dual tandem bogies were considered and contribution from impingement drag removed to result in a predicted displacement drag weighted average of 4.003. Some of water is cleared by the forward tyres but impingement spray from other tyres was hitting the aircraft structure. The factor of 4 is supported via justification based on ESDU Memo No 99. It was agreed to delete the reference to "Reference 4" since it was not applicable to this sub-paragraph.***	**Para. 7.1.1 b**
040	**Para. 7.1 b.**	**PROPOSED TEXT/COMMENT:** Fourth sentence. Delete the word "below". New text: "The drag of spray striking the landing gear structure above wheel height may also be important and should be included in 7.4, but for multiple bogies the factors above include centre spray impingement drag on gear structure below wheel height." **Reason(s) for proposed text/comment:** Suggested editorial change. Depending on the document formatting, paragraph 7.4 might be on another page.	***This comment was accepted.***	**Para. 7.1.1 b**
041	**Para. 7.2**	**PROPOSED TEXT/COMMENT:** Second sentence. Change to "For the purposes of estimating the effect of aquaplaning on landing gear drag, the aquaplaning speed, VP, is given by …" **Reason(s) for proposed text/comment:** Despite what is stated in the next paragraph, the calculation of drag at a groundspeed does depend on the aquaplaning speed since the datum C_D is a function of V/V_P.	***The comment was agreed.***	**Para. 7.1.2**
042	**Para. 7.2**	**PROPOSED TEXT/COMMENT:** Delete the paragraph "Precise determination of…at all speeds." **Reason(s) for proposed text/comment:** It is necessary to calculate the aquaplaning speed to determine the displacement drag. It is suggested that Reference 3 could be noted in paragraph 7.1 and Reference 2 could be noted in paragraph 7.4.	***It was agreed to delete this sub-paragraph. During the discussion it was agreed to improve clarity, to amend figure 1 by replacing "Datum" with "Factor" and delete "Slush" from the chart's title.***	**Para. 7.1.2 Figure 1**

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043	**Para. 7.4.1**	**PROPOSED TEXT/COMMENT:** First sub-paragraph, second sentence. Change to "The spray envelope should be defined, that is the height, width, shape and location of the sideways spray plumes and in the case of a dual wheel undercarriage or a multiple bogie, the centre spray plumes." **Reason(s) for proposed text/comment:** Suggested editorial change and clarification that the centre plume has to be considered for multiple bogies.	***The dual tandem wheel factor of 4 has embodied the effect of centre spray but this is not the case for twin wheels. The proposal was accepted but without reference to multiple bogie designs.***	**Para. 7.1.4 a**
044	**Para. 7.4.1**	**PROPOSED TEXT/COMMENT:** Second sub-paragraph, last sentence. Change to "…nose-wheel plume will strike the main landing gear or open wheel wells, the wing leading edges or the engine nacelles, and whether the main-wheel plumes …" **Reason(s) for proposed text/comment:** Depending on the size and configuration, on smaller aircraft the nose-wheel plume can hit the wing leading edges and/or the engine nacelles.	***The proposal was accepted on the grounds of providing more detail.***	**Para. 7.1.4 a**
045	**Para. 7.4.1**	**PROPOSED TEXT/COMMENT:** Second sub-paragraph, Second sentence. Change to "...but it varies considerably with speed…" **Reason(s) for proposed text/comment:** Suggested editorial change.	***The comment was accepted.***	**Para. 7.1.4 a**
013	**Para. 7.4.3**	**PROPOSED TEXT/COMMENT :** This new paragraph concerns the drag caused by direct impact of the spray. As for several other paragraphs, a reference to a document (ESDU one ?) containing worked methods for evaluation of this drag level should be given. **Reason(s) for proposed text/comment:**	***It was agreed to provide the requested working methods by adding a reference against this paragraph and number 6 was chosen as this number was missing from the reference listing :- Reference 6 : "ESDU Memo No 95 Impact Forces Resulting From Wheel Generated Spray : Re-Assessment Of Existing Data March 1997."***	**Para. 7.1.4 c Para. 9**
046	**Para. 7.4.3**	**PROPOSED TEXT/COMMENT:** Last sentence. The following sentence should be added: "Due to the difficulty of estimating the momentum loss analytically, conservative assumptions should be used or the drag estimates should be correlated with performance measurements taken during water trough tests for engine induction." **Reason(s) for proposed text/comment:** In order to determine the momentum loss, the mass of fluid directly impacting the surface(s) and velocity loss needs to be determined. Together with the difficulties of determining which surfaces are going to be impacted and at what angle, the estimation of drag due to direct impact may be difficult to do analytically. Hence correlation with test results is suggested.	***Results were aired for certain regional/corporate jet aircraft designs relating to measurement of contaminant drag in comparison to predictions from water trough testing. Predicted drag was based on the methodologies using the old and revised AMJ standards except that for the former, the dual wheel factor of 2 was used as reflected in the revised NPA. The results indicated that for the smaller aircraft over certain ground speeds the measured drag exceeded the predicted drag by up to 80%. ESDU believe that the under-estimation of predicted drag could be principally due to spray which is deflected forward. At modest aircraft speeds the spray can be around 30 to 40% of it's initial speed when being overtaken and impacted by the wing. In consequence it constitutes an additional drag force. However this problem could in part, also***	**Para. 7.1.4**

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			be related to a skin friction issue. The current methodologies do not cover these effects. Little information is available to generate forward plume sprays. Concern was expressed that the revised methodologies appeared to still produce over-optimistic performance levels for smaller aircraft designs and this remained a safety concern. The onus should be placed on testing the appropriate aircraft designs and it was agreed to revise text under current NPA paragraph 7.4.2 relating to smaller jet aeroplanes as follows :- ***"… the methods contained in this document may not be conservative. Drag estimates should be correlated with performance measurements taken, for example, during water trough tests for engine induction."*** ***Manufactures are obliged to test in water troughs for engine induction tests. For safety and liability concerns some manufacturers of smaller aircraft designs normally measure drag during such tests and therefore this proposal is not considered as an increased burden beyond current general practice.***	**Para. 7.1.4 b**
065	**Para. 7.5.2** **(Already seen in 7.0 b)**	**PROPOSED TEXT/COMMENT & REASON FOR PROPOSED TEXT/COMMENT:** There is conflict within this paper with respect to the calculation of the drag caused by a dual or four-wheel bogie configuration. Paragraph 7.0 b indicates that the drag for a double wheel is twice and a double bogie is four times that of a single wheel configuration. However, the second paragraph of 7.5.2 indicates that the drag on the trailing tires of a bogie configuration may be ignored and the drag on a bogie configuration is assumed to be same as a dual tire configuration.	***There is no conflict in the calculation of dual or four-wheel bogie configurations. Paragraph 7.0.b is applicable to standing water , slush and wet snow conditions, while paragraph 7.5.2 is applicable to dry snow conditions. However the structure of Section 7 of the AMJ could be improved to avoid the apparent conflict noted in the comment. At present paragraphs 7.1, 7.2, 7.3 and 7.4 deal with various aspects of the contaminant drag in standing water, slush, wet snow, while paragraph 7.5 deals with all aspects of drag in dry snow conditions. It was agreed to rearrange the paragraphs to improve clarity of presentation.***	**Para. 7.2.2**
005	**Para. 7.6**	**PROPOSED TEXT:** We believe that the default friction values provided in Paragraph 7.6 ("Braking Friction), Table 2, were meant to be representative of an anti-skid controlled tire-to-runway friction. Therefore, the following sentence (in italics) should be inserted into the text preceding the table: "To enable aeroplane performance to be calculated conservatively in the absence of any direct test evidence, default friction values as defined in Table 2 below may be used. ***These friction values represent the effective braking coefficient of an antiskid controlled braked wheel/tire.*** Alternatively, where limited test evidence … " Additionally, the text following Table 2 should be revised to read as follows.	***Table 2 provides values which apply to anti-skid controlled wheel braking coefficients so it was agreed to clarify this aspect. The dry snow wheel braking coefficient value of 0.17 was chosen as a conservative value based on an average result of 0.19 taking due account of the data scatter. The provision of average values to determine critical performance levels was questioned. It was agreed to introduce the following text :-***	

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		"In developing aeroplane braking performance using test evidence or assumed friction values, ***other than the default values provided in Table 2,*** a number of other brake related aspects should be considered." Also, note that the default friction value of 0.17 provided for dry snow is the average aircraft braking coefficient demonstrated with a Falcon 20 during the 1999/2000 Transport Canada Winter Runway Programme. This value should be converted to tire-to-runway braking coefficient for consistency with the other default friction values. **Reason(s) for proposed text/comment:** (As stated above).	***"These friction values represents the effective braking coefficient of an anti-skid controlled braked wheel- tyre." Alternatively where….*** ***In addition it was agreed to add text after Table 2 as proposed "In developing aeroplane.."***	**Para. 7.3.1** **Para. 7.3.2**
047	**Para. 7.6**	**PROPOSED TEXT/COMMENT:** First sub-paragraph. Replace "below" by "in Table 2" at the end of the sentence. New text: "…effects can be based on either test evidence or the minimum conservative 'default' values, given in Table 2." **Reason(s) for proposed text/comment:** Suggested editorial change. Depending on the document formatting, Table 2 might be on another page.	***The comment was accepted.***	**Para. 7.3**
048	**Para. 7.6**	**PROPOSED TEXT/COMMENT:** Second and fourth sub-paragraphs. For the past number of years a flight test research program has been conducted by Transport Canada, Canadian NRC, NASA and the FAA to determine amongst other things an International Runway Friction Index and associated aircraft braking performance. The International Runway Friction Index is intended to be determined by use of ground devices that would be correlated to a common (International) standard. Due to the diversity of current devices and operational variability of typical contaminated runways, it has not yet proven possible to establish an International Runway Friction Index, which would be reliably and consistently reported by all current ground friction measurement devices. Notwithstanding the lack of correlation between ground friction measurement devices, it has been conclusively proven that aircraft braking performance can be correlated with at least one of the devices. Data from 8 different aircraft (6 different types) on over 250 separate aircraft braking runs on over 70 contaminated surfaces, has produced an excellent correlation between the aircraft braking coefficient (Braking Force/(Weight – Lift)) and the Canadian Runway Friction Index measured by an electronic recording decelerometer. These test results are fully reported in Canadian NRC Report No. LTR-FR-183 Evaluation of Aircraft Braking Performance on Winter Contaminated Runways and Prediction of Aircraft Landing Distance Using the Canadian Runway Friction Index (copy included with these comments). With the above background, it is proposed that the text for the second, third and fourth paragraphs be replaced with the following: "Ideally it would be preferable to relate aircraft braking performance to a friction index measured by a ground friction device which would be reported as part of a Surface Condition Report. However, although it has been proven that aircraft braking performance is well correlated with at least one friction index, there is not, at present, a common friction index for all ground friction measuring devices. Hence it is not practical at the present time to determine aircraft performance on the basis of an internationally accepted friction index measured by ground friction devices. Notwithstanding this lack of a common index, the applicant may optionally choose to present takeoff and landing performance data in the form of an aircraft braking coefficient. The responsibility for relating this data to a friction index	***The commentator was not disputing consideration of the default friction values but believes that the scheduling of aircraft performance versus different constant aircraft braking coefficient values, when made available will be of use (Canadian Runway Friction Index method). How this information is used and related to ground cart vehicle measured surface friction is up to the NAA's and the NPA is too negative in this regard.*** ***There was concern expressed that this proposal was a big change with respect to current certification practice and that embodiment of associated methodologies could not be accomplished at this late stage of this NPA's development. The application of this information had not yet been harmonised.*** ***The proposal does not dispute that performance levels should be derived using the specified braking default values but enables the optional provision of such data applicable to shallow contaminants. It was highlighted that aircraft wheel braking coefficient needs to be constant with speed. Concerns were raised with respect to how this information will be used or misused. However it was noted that JAR-OPS IEM 1.485(b) recognises use of such data and major manufacturers provide it in SCAP (operational performance) software. Consequently it was agreed to introduce additional text to acknowledge this***	

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		measured by a ground friction device will fall on the operator and the National Operating Authority. Since this may not be acceptable to all National Authorities, default values of maximum tire to ground friction values may be assumed for various contaminated surfaces as defined in Table 2. Alternatively, where limited test evidence is available for a model predecessor or derivative, this may be used given appropriate conservative assumptions." **Reason(s) for proposed text/comment:** See General Comment above.	***process but without providing associated methodologies.*** ***Proposed NPA changes :-***	
			Take existing paragraph 7.6 (1st three lines) second sentence " Performance data showing these effects can be based on either minimum conservative default values or test evidence. In addition the applicant may optionally provide performance data as a function of aircraft braking coefficient"	**Para. 7.3**
			Introduce New paragraph " Default Values". ***"To enable aeroplane performance…" (note comment 005 agreement)***	**Para. 7.3.1**
			Introduce New Paragraph " Braking Performance For Test Evidence". ***Whole paragraph under Table 2 modified (as agreed with comment 005).***	**Para. 7.3.2**
			Introduce New Paragraph "Use Of Ground Friction Measurement Devices".	**Para. 7.3.3**
			"Ideally it would be preferable to relate aircraft braking performance to a friction index measured by a ground friction device which would be reported as part of a Surface Condition Report. However, there is not, at present, a common friction index for all ground friction measuring devices. Hence it is not practical at the present time to determine aircraft performance on the basis of an internationally accepted friction index measured by ground friction devices. Notwithstanding this lack of a common index, the applicant may optionally choose to present takeoff and landing performance data as a function of a wheel braking coefficient constant with ground speed.	

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			The responsibility for relating this data to a friction index measured by a ground friction device will fall on the operator and the Operating Authority."	
049	**Para. 7.6**	**PROPOSED TEXT/COMMENT:** Table 2. Although it is not completely clear, it is understood that the Default Friction Value for the various surfaces is a maximum tire to ground friction value. To determine the total braking force, the default friction value should be factored by the weight on each braked wheel and the anti-skid efficiency assumed for the contaminated runway condition. However, to our knowledge, there is no database on values of anti-skid efficiency that could be expected on the various contaminated surfaces. Neither would it be practical to determine values by test for the various surfaces. Hence it is recommended that the default friction value be replaced by a default aircraft braking coefficient (defined as the total braking force/(weight – lift)). This would require modification to the values currently shown. **Reason(s) for proposed text/comment:** The current guidance is not readily usable.	***It was agreed that to improve clarity this comment should be addressed (see response to comment 005).***	**Para. 7.3.1**
050	**Para. 7.6**	**PROPOSED TEXT/COMMENT:** Table 2. Sanded snow is an example of a specially prepared winter runway surface. This row should be deleted, as it is not possible to provide a default friction value. **Reason(s) for proposed text/comment:** See comment above.	***It was agreed to delete the row corresponding to "Sanded Snow " and add a note against NPA Table 2 "For a specially prepared winter runway surfaces no default value can be given due to the diversity of conditions which will apply."***	**Table 2**
006	**Para. 7.7.1**	**COMMENT:** Paragraph 7.7.1 continues the current practice of accepting the use of VMCG, determined on a dry runway with the nose gear raised or castored, for take-off distance determination. The Introduction to the NPA provides a UKCAA dissenting opinion. We disagree with the UKCAA dissenting opinion and we strongly agree with the Flight Study Group's disposition of the dissenting position. **Reason(s) for proposed text/comment:** In light of the extensive discussion and presentation of data for a number of JAR 25 aircraft configurations within the Flight Study Group we believe that the primary factor for VMCG determination is aerodynamic control rather than the ground reaction, thus justifying continued use of the dry runway VMCG. NPA paragraphs 7.7.1 and 8.0 contain appropriate provisos and cautions that are reflective of the current state of knowledge, while still recognising the potential hazards of operating on contaminated surfaces.	***For V_{MCG} the Group accepted the majority Flight Steering Group position but supported further work to enhance and develop the understanding of the treatment of V_{MCG} on low friction surfaces. It was noted that ESDU have plenty of data with respect to tyre side force with yaw on wet and flooded but not on ice covered surfaces.***	**Para. 7.4.1**
012	**Para. 7.7.1**	**PROPOSED TEXT/COMMENT :** This proposed paragraph allows the use of the non-contaminated VMCG for take off distance determination. Studies carried on by several manufacturers have been made available to Flight Study Group members, and have confirmed that the driving factor for VMCG determination is the aerodynamic control and not the ground reaction. These studies which confirm that the use of non-contaminated VMCG is acceptable for contaminated runways are in accordance with present and accepted practices for A/C dispatch on contaminated runways, and this in agreement with AFM.	***For V_{MCG} the Group accepted the majority Flight Steering Group position but supported further work to enhance and develop the understanding of the treatment of V_{MCG} on low friction surfaces. It was noted that ESDU have plenty of data with respect to tyre side force with yaw on wet and flooded but not on ice covered surfaces.***	**Para. 7.4.1**

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		AECMA does not agree with the dissenting CAA opinion on this subject and recall that all request for VMCG or cross wind evaluation on contaminated runways must be preceded by an improvement of the knowledge of relevant data for such evaluation. **Reason(s) for proposed text/comment:**		
015	**Para. 7.7.1**	**PROPOSED TEXT/COMMENT:** It is proposed that paragraph 7.7.1 be re-written as follows: ***"7.7.1 Minimum V_1*** *Minimum V_1 may need to be adjusted in consideration of the reduced controllability following engine failure on a contaminated runway."* It is further proposed that the Flight Test Harmonisation Working Group be tasked with the harmonisation of Contaminated Runway Performance Information as a matter of urgency. **Reason(s) for proposed text/comment:** Support for the published Dissenting Position. There is a very high probability of an effect on aeroplane controllability following engine failure on a contaminated surface that should be considered and it is the applicant's responsibility to provide the best information possible on any resulting adjustment to minimum V_1 necessary when operating on contaminated runways. The proposed text removes this responsibility from the applicant. With the current level of knowledge, the difficulty in providing precise information on the effect on V_{MCG} when operating on a contaminated surface is recognised but this does not allow that the issue be ignored.	***Until such time that our technical understanding relating to the effects of a contaminated runway surface on V_{MCG} is increased and that these effects can be reasonably predicted, the UK CAA dissenting opinion was not supported. However the Group strongly recommends to seek an improvement in the knowledge necessary to account for V_{MCG} and cross-wind effects on controllability when operating on contaminated surfaces.***	**Para. 7.4.1**
016	**Para. 7.7.1**	**PROPOSED TEXT/COMMENT:** **Although it is intuitive to consider that VMCG will be adversely affected (increased) when operating on a contaminated runway, there is no test evidence available to quantify this effect. Some analytical/simulation studies have shown that there is only a small effect, but these studies have been based on largely unverified assumptions with respect to expected side force that can be generated by a rolling tire.** However it is known, from direct test evidence and accidents/incidents, that the level of directional controllability in a crosswind significantly decreases on slippery surfaces. Hence although VMCG may only be slightly increased in zero crosswind, it is likely to be significantly increased when there is an adverse crosswind. It is agreed that there is an inconsistent gap in the guidance provided in the AMJ that permits the use of a minimum V1 value based on a VMCG value determined in accordance with 25.149. However until such time that our technical understanding of the effects of a contaminated runway on VMCG is increased and that these effects (including an adverse crosswind) can be reasonably predicted, Transport Canada concurs with the FSG Response to the UK CAA Dissenting Opinion. **Reason(s) for proposed text/comment:** See above.	***For V_{MCG} the Group accepted the majority Flight Steering Group position but supported further work to enhance and develop the understanding of the treatment of V_{MCG} on low friction surfaces. It was noted that ESDU have plenty of data with respect to tyre side force with yaw on wet and flooded but not on ice covered surfaces.***	**Para. 7.4.1**
055	**Para.**	**PROPOSED TEXT/COMMENT:** ERA fully support the UKCAA proposal.	***This comment was not supported. Until such time that our technical understanding relating to the effects of a***	**Para.7.4.1**

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	7.7.1	**Reason(s) for proposed text/comment**:	***contaminated runway surface on V_{MCG} is increased and that these effects can be reasonably predicted, the UK CAA dissenting opinion was not supported. However the Group strongly recommends to seek an improvement in the knowledge necessary to account for V_{MCG} and cross-wind effects on controllability when operating on contaminated surfaces.***	
062	**Para. 7.7.1**	**PROPOSED TEXT/COMMENT**: ERA fully support the UKCAA proposal. **Reason(s) for proposed text/comment**:	***This comment was not supported. Until such time that our technical understanding relating to the effects of a contaminated runway surface on V_{MCG} is increased and that these effects can be reasonably predicted, the UK CAA dissenting opinion was not supported. However the Group strongly recommends to seek an improvement in the knowledge necessary to account for V_{MCG} and cross-wind effects on controllability when operating on contaminated surfaces.***	**Para. 7.4.1**
065	**Para. 7.7.1**	**PROPOSED TEXT/COMMENT & REASON FOR PROPOSED TEXT/COMMENT**: Issue # 1. The above reference concerns a dissention by the CAA over the proposed text contained in the document namely, Para. **7.7.1 Minimum V1**. The issue concerns certification, which requires an applicant to provide contaminated runway data for its operations and the CAA proposes an inclusion in the **Minimum V1** definition. V1 is a certification speed and can be reduced theoretically all the way down to, but not less than, Vmcg if required. The point being raised by the CAA is a V1 reduction issue for accelerate stop calculations however; this is a controllability issue that really does not concern V1 reduction. Issue # 2. In further discussions with colleagues, another issue has surfaced. A major manufacturer (Airbus) is seeking certification of an aircraft using reduced Vmcg on contaminated runway data with "Pilot controlled" de-rated engine performance criteria for balanced field measurements. Apparently this can improve take-off weights however, the margins for error are unknown (i.e. Accelerated Stop/Go) and all take-off runs would involve longer distances, which means a greater accumulation of contaminants freezing to the aircraft on take-off. At this point, too many unknown variables have not been made available to accurately address the issue further and in reality, if the runway/taxiways are so slippery that Vmcg becomes a GO/NO GO factor, then perhaps operations should cease.	***This comment was not supported. Until such time that our technical understanding relating to the effects of a contaminated runway surface on V_{MCG} is increased and that these effects can be reasonably predicted, the UK CAA dissenting opinion was not supported. However the Group strongly recommends to seek an improvement in the knowledge necessary to account for V_{MCG} and cross-wind effects on controllability when operating on contaminated surfaces.*** ***AMJ 25-13 entitled "Reduced And Derated Take-Off Thrust (power) Procedures" permits use of derated take-off procedures on contaminated surfaces.***	**Para. 7.4.1**
066	**Para. 7.7.1**	**PROPOSED TEXT/COMMENT & REASON FOR PROPOSED TEXT/COMMENT**: CAA position with regard to Minimum V1 a safety concern that following an engine failure on a contaminated runway under an adjusted V1, controllability will be reduced, is noted. Since there is no agreed method for modifying Vmcg value for contaminated runways is available, FSG stated that the relevant proposed NPA paragraphs are considered to be consistent with accepted practice and the current state of knowledge.	***Although the suggestion may have merit the technical understanding of cross-wind effects is currently inadequate (see recommendation under response to comment 015)***.	**Para. 7.4.1**

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		I would be in favour if the FSG would have analysed and addressed the possible impact of a reduced allowable crosswind during take off. This might ensure that lateral deviation after engine failure will not exceed 30ft on a contaminated runway. Taken this aspect into consideration, a restriction on the crosswind demonstrated under this condition added to the AFM (restricted introduced to take off under light crosswinds – up to 10kts) would reduce the risk that the lateral deviation after engine failure will exceed 30ft on a contaminated runway. § 7.7.1 and 8.18(c) could address this issue.		
051	**Para. 7.7.2**	**PROPOSED TEXT/COMMENT:** Change to: "For contaminated surfaces, the airborne distance should be calculated by assuming that 9 seconds elapse between passing through the 50 ft screen height and touching down on the runway. In the absence of flight test data to substantiate a lower value, the touchdown speed should be assumed to be 94% of the speed at screen height." **Reason(s) for proposed text/comment:** The assumptions for the airborne distance calculation are not representative of average performance. The air time from 50 ft to touchdown will normally be greater than 7 s and/or the ratio of the touchdown speed to the threshold (50 ft) speed will normally be greater than 93%. For example, data collected from operational landings on a jet transport aircraft show an average air time of 8.7 s and a touchdown speed factor of 0.95. The same data showed an average speed at 50 ft which is 10 KCAS higher than VREF. Another study has been made of 3 jet turbine powered aeroplanes and 3 turbojet powered aeroplanes using the parametric landing distance method. An air time of approximately 7 s was obtained with a touchdown speed factor of 0.94. The air distance was approximately 1.45 times the AFM certification value. For normal operations the AFM landing distance on a wet runway is increased by a factor of 1.92. Assuming that this factor is appropriate to the air distance for contaminated runways (i.e. there are no further operational factors added), then the air time should be increased to 7*(1.92/1.45)= 9.3 s. Based on these data, the guidance is changed to provide a more realistic air time of 9s and a touchdown speed factor of 0.94.	***The commentator had conducted an analysis based on 3 turbo-jet and 3 turbo-propeller aircraft. Using the parametric method for a 3 degree glide slope, an average sink rate of 2 ft/sec gave an airborne time of 7 seconds. This was then compared with the airborne distance associated with JAR 25.125 compliance and found to be longer by a factor of 1.45 and reflected a 94% V_{50} / V_{TD} speed ratio. Recorded operational data supplied by CAA had implied an airborne time of 8.7 seconds and 95% V_{50} / V_{TD} ratio but the sample could have been a mix of manual and automatic landings. The proposal factors 7 seconds by 1.92/1.45 which was disputed. The 1.45 factor related to a non-conservative braking phase and the 1.67 factor was thought more appropriate. It was agreed to revisit the landing distance concept in the future but was beyond the current scope of this NPA. ESDU have conducted work on this and have data for future consideration. See responses to comment 037 for similar arguments.***	**Para 7.4.2**
052	**Para. 7.8**	**PROPOSED TEXT/COMMENT:** Move this paragraph which contains the references to end of document. **Reason(s) for proposed text/comment:** Suggested editorial change to improve readability.	***The comment was agreed.***	**Para. 9**
058	**Para. 7.8**	**PROPOSED TEXT/COMMENT:** ESDU Data Item 90035, November 1990, with Amendment A, October 1992: "Frictional and retarding forces on aircraft tyres. Part V: estimation of fluid drag forces." **Reason(s) for proposed text/comment:** Full title has not been quoted.	***The comment was agreed.***	**Para. 9**
059	**Para. 7.8**	**PROPOSED TEXT/COMMENT:**	***It was agreed to delete this reference as it is applicable to a wet non-contaminated surface.***	**Para. 9**

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		10. ESDU Data Item 99015, November 1999, with Amendment A, October 2000: "Statistical Analysis of Wet Runway Friction for aircraft and ground-test machines." **Reason(s) for proposed text/comment:** Amendment A is the current release.		
060	**Para. 7.8**	**PROPOSED TEXT/COMMENT:** 11. ESDU Data Item 99016, June 1999, with Amendment A, November 2000: "Example of statistical analysis of wet runway friction: Aircraft with extensive set of test data." **Reason(s) for proposed text/comment:** Amendment A is the current release.	***It was agreed to delete this reference as it is applicable to a wet non-contaminated surface.***	**Para. 9**
061	**Para. 7.8**	**PROPOSED TEXT/COMMENT:** 12. ESDU Data Item 99017, October 1999, with Amendment A, November 2000: "Example of statistical analysis of wet runway friction: Aircraft with limited set of test data." **Reason(s) for proposed text/comment:** Title not quoted correctly. Amendment A is the current release.	***It was agreed to delete this reference as it is applicable to a wet non-contaminated surface.***	**Para. 9**
068	**Para. 7.8**	**PROPOSED TEXT/COMMENT:** Reference 6 is not listed. **Reason(s) for proposed text/comment:**	***A reference 6 will be added (see response to comment 013).***	**Para. 9**
053	**Para. 8.2**	**PROPOSED TEXT/COMMENT:** Second sentence. Change to "Differences in other procedures for operation of the aeroplane…" **Reason(s) for proposed text/comment:** Suggested editorial change.	***This comment was accepted.***	**Para. 8.2**
054	**Para. 8.3**	**PROPOSED TEXT/COMMENT:** Second sentence. Change to "Information relating to the use of speeds higher than V_{REF} on landing, that is speeds up to the maximum recommended approach speed additive to V_{REF}, and the associated landing distances…" **Reason(s) for proposed text/comment:** As presently written, the guidance is unclear with respect to speeds higher than $V_{REF.}$ The proposed text specifies that speeds up to the maximum recommended should be considered.	***This comment was agreed.***	**Para. 8.3**
	Para. 7	**PROPOSED TEXT/COMMENT:**	**It was agreed to change the order of presentation of chapters in this section accompanied with additional explanatory text.**	**Para.7.0**

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		Re-ordering of Sections 7.1.1 to 7.1.4: I am not convinced this is an improvement. The basic problem is that the currently-numbered Sections 7.1.2 and 7.1.4 only address one aspect of the effects of density and speed. The primary treatments, below Vp, are given in Sections 7.1.1 (displacement drag) and 7.1.3 (skin friction). Sections 7.1.2 and 7.1.4 consider when and how to change to the methodology that applies at speeds above Vp.		