

# CRD - NPA 14/2004

Comment

Response

(B.) AMC 25.1591

Paragraph 2.

Cmt. 20 / Transport Canada

Suggest changing paragraph 2, fourth sub paragraph, first sentence to 'with dry snow (depths below 10 mm)'

The fourth sub paragraph in AMC 25.1591 paragraph 2.0 already refers to recent flight test evidence not taken into account in NPA 14/2004. The evidence provided by TC address the depth to be considered for no contaminant drag and the friction values for dry and wet snow covered runway surfaces. The data provided by TC show that the recommendations in NPA 14/2004 are non conservative. It is advised to revise NPA 14/2004 in line with these data. (see also cmtnr 13)

Comment accepted, text AMC 25.1591 2.0 fourth sub paragraph changed accordingly.

reason/justification

Suggest changing paragraph 2, fourth sub paragraph, last sentence to "...As an interim measure it has been concluded that it is reasonable to consider these surfaces by recommending that they be addressed by using the data for the lowest depth of the contaminant provided."  
See separate comment on paragraph 5.1 Table where it is recommended to set the threshold depth for consideration of contamination drag from dry snow to be 10 mm.  
See separate comment on paragraph 7.3.1 Table where it is recommended to use the same default friction value for wet and dry snow regardless of depth.

Comment	Response
<b>(B.) AMC 25.1591</b>	
<b>Paragraph 5.</b>	
<b>Cmt. 11 / Oslo Airport AS</b>	
Delete: 'Data should assume the contaminant to be uniform in properties and uniformly spread over the complete runway.'	<p>Comment indicate preference not to repeat the assumption in the paragraph 5.1 describing the range of contaminants.</p> <p>Comment not accepted.</p>
<b>reason/justification</b>	
This is described under paragraph 3.0 - Standard assumptions, and need not to be duplicated.	
<b>Cmt. 21 / Transport Canada</b>	
Suggest changing paragraph 5.1 Table for the Range of Depth to be considered for Dry Snow to 'Below 10' for No Drag Increase and '10 - 130' for Drag Increase.	<p>The fourth sub paragraph in AMC 25.1591 paragraph 2.0 already refers to recent flight test evidence not taken into account in NPA 14/2004. The evidence provided by TC address the depth to be considered for no contaminant drag and the friction values for dry and wet snow covered runway surfaces. The data provided by TC show that the recommendations in NPA 14/2004 are non conservative. It is advised to revise NPA 14/2004 in line with these data. See also related cmtnr 13 and 20.</p> <p>Comment accepted, text AMC 25.1591 paragraph 5.1 Table 1 changed accordingly.</p>
<b>reason/justification</b>	
<p>Based the Transport Canada/FAA/NASA/NRC Joint Winter Runway Friction Measurement Program (JWRFMP) Falcon 20 tests on a large number of snow covered surfaces of various depths, it was concluded that contamination drag was negligible below a equivalent depth of approximately 0.5 inch for snow of specific gravity of 0.2. This is equivalent to 13 mm.</p> <p>Using the model of drag for snow defined in the AMC, the effect of different snow depths has been examined for a representative 50-seat regional jet. Under typical conditions (MTOW, SL, -10 deg C), a change in Field Length of 4.2% was calculated with 20 mm dry snow. This figure reduced to 2.6% with 15mm dry snow and 1.4% dry snow.</p> <p>Based on the above arguments it is recommended that the threshold for drag should be at 10 mm instead of 20 mm.</p>	
<b>Cmt. 28 / Boeing</b>	
<p>Table 1 of AMC 25.1591</p> <p>In Table 1 of the AMC 25.1591, it should be made clear that runways with a slush depth less than 3mm can be considered as a wet runway. This can be accomplished by inserting the same note, i.e., (See Note 1), in the "Range of Depth to be Considered" column, similar to what is done for standing water. Also, the definition of Note 1 should be revised to state "Runways with water or slush depths less than 3 mm ... ."</p>	<p>Comment accepted, text changed AMC 25.1591 paragraph 5.1 Table 1 changed accordingly.</p>
<b>reason/justification</b>	
Applicants would benefit by clarification of Table 1 noted above.	

**Comment****Response**

(B.) AMC 25.1591

**Paragraph** 6.

**Cmt.** 15 / FAA, USA

AMC Paragraph 6.2.1

Delete '(but see paragraph 7.4.3)' from the end of this paragraph.

Comment refers to the fact that the reference to paragraph 7.4.3 made at the end of paragraph 6.2.1 in AMC 25.1591 is superfluous.

In the context of fixing attention on controllability during operation with contaminated runway surface conditions (see cmtnr 9) it is decided to leave AMC Paragraph 6.2.1 as is.

Comment not accepted.

**reason/justification**

This paragraph says that the performance assumptions remain unchanged from those used for a wet runway. CS 25.109 already allows credit for reverse thrust where available and controllable.

**Comment****Response****(B.) AMC 25.1591****Paragraph 7.****Cmt. 3 / Oslo Airport AS**

7.3.1 Default Values  
 The effective braking coefficient of an anti-skid controlled braked wheel/tyre for a standing water and slush covered runway should be expressed as functions of texture depth.

NPA 14/2004 is based on JAA NPA 25G-334 including the received comments. Explanatory notes to NPA 14/2004 are presented in Part A. Several comments to NPA 14/2004 identify that any reference to recommended future work as given in part D is not included in Part A. Additional clarification will be included in Part A will without changing the intention of the NPA.

CS 25.109 presents two sets of equations defining the maximum tyre-to-ground wet runway braking coefficient depending on the quality (texture) of the runway surface. Higher wet runway braking coefficients may be used for runway surfaces that have been grooved or treated with a porous friction material.

AMC 25.1519 paragraph 7.3.1 Table 2 presents a conservative worst case equation for the braking coefficient for the standing water and slush covered runway, without any credit for the benefits of better quality runways. This approach reflects the consensus view in the FTG. Through cmtnr 4 future work is recommended to define a set of equations reflecting the influence of texture on the braking coefficient for stansing water and slush covered runway.

Additional information is required to substantiate further refinement of the proposed data.

Further action is defined based on cmtnr 4. See also comment 12 with suggestion for future supporting data.

The comment is considered for future development outside of the present scope of the NPA.

**reason/justification**

In change 15 of JAR-25.109 a principle was introduced. Two sets of equations defining the maximum tyre-to-ground wet runway braking coefficient are described. The difference between them is the texture. The same principle is valid for the standing water and slush covered runway. The subject should be treated in line with current knowledge. Accordingly the relationship described in 7.3.1 for standing water and slush should be described as equations relating to different texture depth.

As written the equation schedule 'worst case' data for ALL runways and do not seek to take credit for the benefits of better quality runways.

For some states the ESDU data representative for ALL runways do reflect a very conservative distribution with respect to surface texture for runways (See attached SWIFT 2000 pdf.file) which shows the distribution representative for Norwegian runways compared with ESDU ALL runways. This fact highlights the issue even more.

.....SWIFT pdf.file attached in paper version!!

Comment	Response
<p><b>Cmt.</b> 7 / <i>Oslo Airport AS</i></p>	
<p>The limitations with regard to validity for groundspeed V, and contaminant depth for the equation for standing water and slush should be given. The extent of applicability for the equation should be clearly stated.</p>	<p>In considering the maximum depth of runway contaminants it may be necessary to take account of the maximum depth for which the engine air intakes have been shown to be free of ingesting hazardous quantities of water in accordance with CS 25.1091(d)(2). This is added to AMC 25.1591 paragraph 2.0.</p> <p>No further background information on the equation for the braking coefficient for the standing water and slush covered runway given in AMC 25.1591 paragraph 7.3.1 Table 2 is found.</p> <p>Comment accepted, additional text added in AMC 25.1591 paragraph 2.0.</p>
<p><b>reason/justification</b></p>	
<p>What is written in paragraph 2.0, Technical Limitations Data, of this NPA should also be valid for the document itself. If the extent of applicability is not clearly stated, the operators will not be able do so in their own documentation.</p> <p>'Due to nature of naturally occurring 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.'</p>	
<p><b>Cmt.</b> 17 / <i>Airbus, France</i></p>	
<p>AMC 25.1591 § 7.4.1 'minimum V1'</p> <p>Airbus supports FSG response to UK CAA dissenting opinion, which is mentioned in the original JAA NPA 25G-334 justification. Airbus considers that the possible introduction of VMCG determined on contaminated runways is premature, and should be preceded by appropriate research studies.</p>	<p>Airbus supports the FSG response to the UK CAA dissenting opinion copied below.</p> <p>FSG Response to UK CAA Dissenting Opinion</p> <p>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 VMCG 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.</p> <p>Comment noted.</p>
<p><b>reason/justification</b></p>	

Comment	Response
<p><b>Cmt. 22 / Transport Canada</b></p>	
<p>Suggest changing paragraph 7.3.1 Table: Contaminant Wet Snow below 5 mm depth, Default Friction Value from 0.20 to 0.17.</p> <p>Suggest changing paragraph 7.3.1 Table: Contaminant Dry Snow below 10 mm depth, Default Friction Value from 0.20 to 0.17.</p>	<p>Comment provide data collected during the TC/FAA/NASA Joint Winter Runway Friction Measurement Program not supporting using different friction values depending on the depth of the contaminant proposed in NPA 14/2004. The proposed revision to use a default friction value of 0.17 for wet and dry snow independent of depth is considered conservative.</p> <p>Comment accepted, text AMC 25.1591 paragraph 7.3.1 Table 2 changed accordingly.</p>
<p><b>reason/justification</b></p>	
<p>Existing data collected during the Transport Canada/FAA/NASA Joint Winter Runway Friction Measurement Program (JWRFMP) does not support using different braking coefficients for dry snow or wet snow, nor does the data support using a different coefficient depending on the depth. For a representative 50 seat regional jet under typical conditions (MTOW, SL, -10 degC), the change in field length on dry snow is 3.8% using a friction value of 0.20 instead of 0.17. Hence it is not reasonable to provide recommendations which are not conservative, when available suggests otherwise.</p>	
<p><b>Cmt. 23 / Transport Canada</b></p>	
<p>Suggest changing fourth sentence to: 'Not withstanding 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 groundspeed for runways contaminated with wet snow, dry snow, compacted snow or ice'</p>	<p>Comment provides clarification and brings AMC 25.1591 paragraph 7.3.3 in line with the information provided Table 2.</p> <p>Comment accepted, text AMC 25.1591 paragraph 7.3.3 changed accordingly.</p>
<p><b>reason/justification</b></p>	
<p>The assumption of a constant coefficient with groundspeed has only been shown to be valid for runways contaminated with snow or ice. For standing water or slush the braking coefficient is dependent on groundspeed as noted in the default value provided in paragraph 7.3.1.</p>	
<p><b>Cmt. 24 / Transport Canada</b></p>	
<p>Suggest adding the following to 7.4.3 'Unless the applicant can substantiate controllability on a contaminated runway with one engine inoperative and in crosswind conditions, the accelerate stop distance with one engine inoperative should not take credit for reverse thrust.'</p>	<p>Comment address again the importance of controllability aspects associated with operation with contaminated runway surface conditions, which is considered to be outside the scope of the current NPA 14/2004 but cannot be ignored totally for obvious reasons.</p> <p>This controllability aspect is implicitly covered (and so not neglected) through AMC 25.1591 paragraph 7.4.3. If the applicant decides to take credit for the use of reverse thrust as additional means of deceleration on contaminated runways demonstration of controllability will be subject for discussion with the Authority.</p> <p>Comment not accepted.</p>
<p><b>reason/justification</b></p>	
<p>Since takeoff performance on contaminated runways may well be predicated on accelerate stop distance, the assumption of using reverse thrust following an engine failure neglects the controllability aspects on contaminated runways, particularly in crosswind conditions. Hence it is not a conservative assumption to always permit credit for reverse thrust during an accelerate stop on a contaminated runway following an engine failure.</p>	

Comment	Response
<p><b>Cmt.</b> 29 / Boeing</p>	
<p>AMC 25.1591, Paragraphs 7.3 and 7.3.3</p> <p>In AMC 25.1591, paragraphs 7.3 and 7.3.3 use the terms "aeroplane braking coefficient" and "wheel braking coefficient." We consider that the "aeroplane braking coefficient" is consistent with the Boeing definition of "airplane braking coefficient," where braking force is equal to the "aeroplane/airplane braking coefficient" times (Weight - Lift); whereas, the "wheel braking coefficient" must be multiplied by the weight on the braked wheels to determine braking force. It is not obvious that everyone who reads this AMC will appreciate this subtlety, and therefore a definition should be provided. Also, to avoid confusion, the header in Table 2 should be "Default Wheel Friction Value."</p>	<p>Comment requests clarification to the terms used in AMC 25.1591 paragraph 7.3. The explanatory note to Table 2 is considered sufficient to understand that the default fraction values in Table 2 are tyre-to-ground braking coefficients.</p> <p>Comment not accepted.</p>
<p><b>reason/justification</b></p>	
<p>Applicants would benefit by the clarification noted above.</p>	

**Comment****Response****(B.) AMC 25.1591****Paragraph 8.****Cmt. 14 / FAA, USA**

More guidance should be provided relative to CS 25.1591(c) regarding the extent of applicability of the performance data for each contaminant and for when the actual conditions are different from those used to develop the performance information. At least the following four concerns should be addressed:

1. The guidance should clearly state that the definitions of the contaminants used by the applicant should be provided with the performance data. These definitions should be expressed in an operationally useable sense, that is, in terms of easily observable descriptions, not solely in engineering terms. An example would be the definitions provided in the AMC material, but without the references to specific gravity. This information is necessary because there may be other definitions of the contaminants used elsewhere.
2. Although CS 25.1591(c) requires a statement that 'actual conditions that are different from those used in establishing the contaminated runway performance information may lead to different performance', this AMC paragraph (covering what should be stated with the performance data) does not include this statement.
3. Operators should be made aware of the different effects of aquaplaning speed, contaminant type, and contaminant depth on the acceleration and braking ability (i.e., continued takeoff vs. accelerate-stop) used in the performance data. For example, for a given contaminant, additional depth will result in higher drag, but will not affect the braking friction. Therefore, for increasing contaminant depth, the performance data will reflect a reduced acceleration capability, but improved stopping performance.
4. More guidance should be provided for conditions that are different than those used for developing the data. It will be rare that a uniform contaminant covers the entire runway surface to an even depth. Rather than simply acknowledging that performance may be different, more guidance should be provided for selecting the appropriate performance data level to use. An example would be: 'Operators are expected to make careful and conservative judgments in selecting the appropriate performance data to use for operations on contaminated runways. Particular attention should be paid to the presence of any contaminant in the critical high speed portion of the runway. For takeoff, it may be appropriate to use different contaminant types or depths for the takeoff and the accelerate-stop portions. For example, it may be appropriate to use a greater contaminant depth or a contaminant type that has a more detrimental effect on acceleration for the takeoff portion than for the accelerate-stop portion of the takeoff analysis.'

**reason/justification**

Completeness

Comment propose to improve the AMC 25.1591 on the subject of completeness. A number of concerns are raised.

Nr 1 address the issue of how to correlate factual information received by the crew with the applicable performance information presented in the AFM. It is noted that e.g. in JAR-OPS the term loose snow is used. Harmonization on this issue is recommended but considered outside the scope of NPA 14/2004.

Nr 2 refer to CS 25.1591© and requires a statement to be included in the approved document presenting the performance information for operation with contaminated runway surface conditions. The requirement is clear without need for repeat in the AMC.

Nr 3 address the importance of awareness creation at the operator. Other comments also state the importance of this (see cmtnr 8 and 9). This is considered outside scope of NPA 14/2004

Nr 4 requests additional guidance to be provided for conditions different than those for developing the performance data. With the current information available this cannot be achieved in reasonable time. To emphasise this issue a general warning is added to AMC 25.1591, paragraph 2.0.

In summary:

These comments are considered for future development and discussion outside of the present scope of the NPA.

Comment	Response
<p><b>Cmt.</b> 25 / <i>Transport Canada</i></p>	
<p>Suggest changing paragraph 8.3, first sub paragraph, last sentence to: 'Operational factors should not be included. However the AFM should contain a clear statement that the data has been prepared with the assumption that appropriate operational factors will be used.'</p>	<p>Justification is presented in Discussion Paper no 35, EASA NPA 14/2004 landing distance on contaminated runways. The proposed revision provides clarification to application of operational factors as required by JAR-OPS or other operating regulations.</p> <p>Comment accepted, text AMC 25.1591 paragraph 8.3 changed accordingly.</p>
<p><b>reason/justification</b></p>	
<p>A recent study (attached) has shown that landing data prepared in accordance with the AMC guidance will not be representative of what would be expected in operational service. The data requires to be factored. However although the current JAR-OPS factor of 1.15 appears to be the minimum acceptable, it may not be conservative. In addition other operating authorities may have different factors. Hence it is recommended that the landing data are provided with no factors but with the proviso that the AFM states that the data are derived with the assumption that appropriate operational factors will be used.</p>	
<p><b>Cmt.</b> 30 / <i>Boeing</i></p>	
<p>AMC 25.1591, Paragraph 8.3, Takeoff and Landing Data</p> <p>We suggest deleting or revising the sentence that states:</p> <p>"Where data is provided for a range of contaminant depths, for example 3, 6, 9, 12, 15 mm, then the AFM should include a statement that interpolation is not permitted"</p>	<p>If interpolation is not permitted, the contaminant depth selected should be conservative.</p> <p>The text is revised in such way that the AFM should indicate how to select contaminant depth, and reads:</p> <p>"Where data is provided for a range of contaminant depths, for example 3, 6, 9, 12, 15mm, then the AFM should clearly indicate how to define data for contaminant depths within the range of contaminant depths provided".</p> <p>Comment accepted.</p>
<p><b>reason/justification</b></p>	
<p>The instruction in paragraph 8.3 should not be mandatory. Whether interpolation is or is not permitted should be determined by the manufacturer's comfort with the interpolation of the data, not a blanket statement.</p>	

**Comment****Response**

(B.) AMC 25.1591

Paragraph 9.

Cmt. 12 / Oslo Airport AS

ESDU Data Item 72008, May 1972. 'Frictional and retarding forces on aircraft tyres. Part III: planning.'

Comment propose to expand AMC 25.1591 paragraph 9 with the document indicated. The comment also suggests that the document referenced would provide additional information to support the recommended future work proposed in cmtnr 3.

Comment accepted, text AMC 25.1591 paragraph 9 changed accordingly.

**reason/justification**

In paragraph 7.1.1 and 7.3.1 there is reference to the aquaplaning speed.

ESDU Data Item 72008 describes the mechanisms of aquaplaning. Paragraph 7.1.1 and 7.3.1 should therefore have a reference to this document.

In figure 7, Conditions in which sustained planing has been observed with rib-tread tyres, the influence of water depth and surface texture depth are shown. By including the ESDU document in the reference list the influence of texture is addressed. ESDU Data Item 72008 should be updated with current knowledge.

**Comment****Response****A. Explanatory Note****Paragraph**

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**Cmt. 4 / Oslo Airport AS**

A 7

As a result of current knowledge the influence of surface texture on contaminants such as standing water and slush are recognized. In the case of wet runways, JAR-25, at change 15 on 1 October 2000, it was expressed as two sets of equations. However, in the case of standing water and slush the consensus view was to prefer to schedule 'worst case' data for ALL runways rather than to seek to take credit for the benefit of better quality runways. It is recommended that future work address the development of a set of equations reflecting the influence of texture.

NPA 14/2004 is based on JAA NPA 25G-334 including the received comments. Explanatory notes to NPA 14/2004 are presented in Part A. Several comments to NPA 14/2004 identify that any reference to recommended future work as given in part D is not included in Part A. Additional clarification will be included in Part A will without changing the intention of the NPA.

Comment accepted, text Part A paragraph IV 8 added accordingly. Part A paragraph IV 8 identifies the issues for future work and ongoing discussion outside of the present scope of the NPA.

**reason/justification**

The text should reflect the current knowledge. Please see attached e-mail and statement from Ken Balkwill dated December 2004.

As written the NPA does not mention the influence of surface texture.

**Cmt. 8 / Oslo Airport AS**

D 4 (page 25)

V (New paragraph at page 4) (Alternatively)

5. Braking friction related to surface texture, standing water and slush. Addressing the influence of surface texture and bringing the subject more in line with current knowledge.

Reference to future work is already addressed in cmtnr 4.

**reason/justification**

If part D of the NPA is not part of what are defined under Explanatory Note with respect to comments, a new section V - Recommended future work should be established in the Explanatory Note.

Comment	Response
<p><b>Cmt. 9 / Oslo Airport AS</b></p>	
<p>A 8 (New paragraph) Operations on contaminated runways are challenging. Operators and operating authorities should consider a classification of skill levels of pilots operating under harsh winter conditions. The FSG acknowledge this as an important issue and address it as a topic under recommended future work</p>	<p>The comment propose to consider a classification of the skill level of pilots operating in winter conditions. NPA 14/2004 primarily presents performance information for operations with contaminated runway surface conditions. Specific handling (controllability) issues are considered outside the scope of this NPA, although the link with controllability is indicated e.g. in AMC 25.1591 7.4.3 and 8.1.3.</p> <p>The issue of skill level is important but considered outside the scope of the NPA 14/2004. The comment is considered for future development outside the scope of the NPA.</p> <p>Comment not accepted.</p>

**reason/justification**

Operating under harsh winter conditions is a challenging task. Historically operators in northern countries allowed only the most experienced pilots to operate under these conditions. The new concept of operation, open sky, gives another dimension to this type of operations. Guidance material should be developed to help those operators and operating authorities that do not have the experience but now are faced with occasional operations under such harsh winter conditions. (Charterflights).

At the IMAPCR 04 (International Meeting on Aircraft Performance on Contaminated Runways) in Montreal November 2004 there was a presentation from Finnair describing their winter operations. An immediate response from Boeing very strongly addressed that this was an example in accordance with their view, as the aircraft performance allowed was in accordance with the skill level of the pilots.

The issue is an important one and should be reflected in a document describing operations on contaminated runways. To level the 'playground' there should be an agreed classification of demonstrated skill levels. (Example: Experienced, Regular, Occasional).

**Cmt. 10 / Oslo Airport AS**

6. Classification of skill levels for operations under harsh winter conditions.  
D 4 (page 25)  
V (New paragraph at page 4) (Alternatively)

Reference to skill levels of pilots operating in winter conditions is already addressed in cmtnr 9.

**reason/justification**

Level the 'playground' and give guidance to operators and operating authorities not used to operations under harsh winter conditions.

If part D of the NPA is not part of what are defined under Explanatory Note with respect to comments, a new section V - Recommended future work should be established in the Explanatory Note.

Comment	Response
<p><b>Cmt.</b> 16 / Airbus, France</p> <p>Paragraph IV.7 (bottom of page 4)</p> <p>Quote :  FAR 25 does not address performance on contaminated runways so harmonization is not currently a consideration... However, harmonization of this issue will be addressed in the future.  Unquote</p>	<p>The comment is clear and self explanatory.</p> <p>The comment is considered for discussion outside of the present scope of the NPA.</p>
<p><b>reason/justification</b></p> <p>Airbus is concerned about unilateral introduction of recurring NPAs upgrading certification standards on contaminated runway performance, whereas there is no equivalent FAR standard.</p> <p>It appears that the FAA has no near term activity planned to harmonize with EASA on this subject.  Equal treatment between European and US manufacturers/airlines is therefore questioned.</p> <p>Airbus would like to have some information on:</p> <ul style="list-style-type: none"> <li>- EASA position regarding the harmonization with FAA</li> <li>- Schedule of harmonization activity with FAA: date of start and end</li> <li>- Expected date regarding the embodiment of equivalent FAR standard.</li> </ul>	

Comment	Response
<b>B. Proposals</b>	
<b>Paragraph</b> -	
<b>Cmt.</b> 13 / FAA, USA	
<p>AMC Paragraphs 2.0, 4.2, Table 1</p> <p>Runways contaminated by standing water of a depth less than 3mm are to be considered wet. Dry or wet snow contamination less than 20mm deep or 5mm deep, respectively, is to be considered as compacted snow. However, no guidance is provided for slush depths less than 3mm deep. It would appear that applicants could use the friction value for slush with no contaminant drag, but this is not specifically stated.</p>	<p>CS 25.1583(k) requires a limitation on the maximum depth of runway contaminants for take-off operation to be furnished. If information on the effect of runway contaminants on the expected take-off performance is not provided take-off operation should be limited to runways where the degree of contamination does not exceed the equivalent of 3 mm of water. High density slush is considered to be equivalent to water ref e.g. AMC 25.1091(d)(2) precipitation covered runways. However, no clear definition of a wet runway is found in CS 25.</p> <p>Considering the above slush depths less than 3 mm can be considered also as wet, for which AMC 25.1591 is not applicable. Note 1 in AMC Paragraphs 5.1 Table 1 are also applicable in the relevant field in the slush row. See also cmtnr 20, 21 and 28)</p> <p>Comment accepted, text AMC Paragraphs 5.1 Table 1 changed accordingly.</p>
<b>reason/justification</b>	
Consistency and completeness.	

Comment	Response
(B.) CS 25.1591	
Paragraph -	
Cmt. 19 / Transport Canada	
Suggest changing paragraph (a), second sentence to 'If supplied, this AFM information must include the expected performance'	<p>In compliance with CS 25.1581(1), the aeroplane flight manual must contain the information required by CS 25.1583 to 25.1587. CS 25.1581(2) refers to other information necessary for safe operation because of design, operating, or handling characteristics. CS 25.1591 is not included but could be considered as information described in CS 25.1581(2). The existing CS 25.1591 also refers to an approved document.</p> <p>This comment assumes that performance information for operation with contaminated runway surface conditions must be provided in the AFM, where the proposed CS 25.1591(b) leaves the option to provide information in an approved document.</p> <p>Reading AMC 25.1591 paragraph 8.2 may lead to the conclusion that the AFM is the assumed document for presentation of the supplementary performance information.</p> <p>Cmntnr 27 also indicates that NPA 14/2004 is not clear on this issue.</p> <p>The comment is considered for ongoing discussion outside of the present scope of the NPA.</p>
reason/justification	
Although it is implicit in the CS proposal and the AMC, it should be clearly specified that the performance information is to be included in the AFM. This is a change from the existing JAR 25X1591, which did not specify the AFM.	

Comment	Response
<p><b>Cmt.</b> 27 / Boeing</p> <p>CS 25.1591 (b) and (c)</p> <p>CS 25.1591 (b) and (c) state that the performance data must be in an "approved document", whereas AMC 25.1591 paragraph 8.2, implies that the performance data is in the AFM. In light of this, is the "approved document" only the AFM? A clarification of what constitutes an "approved document" is desirable.</p>	<p>The present CS 25.1591(a) states that the supplementary information must be in an approved document, which serves as guidance material to assist the operator in developing guidance, recommendations or instructions for use by their flight crews. Furthermore, CS 25.1591(c) states that <u>if</u> the supplementary information appears in the Aeroplane Flight Manual, it must be segregated and clearly distinguished from the normal Flight Manual material.</p> <p>This clearly means that the term 'approved document' is not restricted to the AFM, but can be any document approved by EASA.</p> <p>The revised text for CS 25.1591 as proposed by NPA 14/2004 seems to express the same intent. In CS 25.1591(a) a new sentence has been added which states that if the supplementary information is not supplied, the AFM must contain a statement prohibiting operation on contaminated runways. This reference to the AFM in itself does not contradict the fact that the supplementary information may be supplied in another 'approved document'.</p> <p>However, the proposed AMC 25.1591 contains many references to the AFM. Although none of these references specifically states that the supplementary information must be in the AFM, many references make hardly any sense if that is not the case. The proposed text of AMC 25.1591 clearly seems to have been written on the assumption that the supplementary performance information is in the AFM.</p> <p>Comment is accepted. It needs to be made clear whether the supplementary information must be in the AFM or may be supplied in another approved document.</p> <p>NPA 14/2004 is revised. The proposed text of CS 25.1591 is amended to change all references to 'approved document' to 'AFM'. This makes the text of CS 25.1591 consistent with that of AMC 25.1591 and removes any ambiguities.</p>

**reason/justification**

Applicants would benefit by clarification of what constitutes an "approved document."

**Comment****Response****C. Original JAA NPA 25G-334 Proposal Justification****Paragraph**

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**Cmt.** 2 / CAA, UK

The dissenting opinion regarding this paragraph, described on page 21 of the NPA, is still fully supported.

In this comment UK CAA presented the dissenting opinion on Paragraph 7.4.1 of the NPA.

This issue has been studied in detail by the FSG and the relevant proposed paragraphs 7.4.1 and 8 are considered to be consistent with accepted practice and the current state of knowledge. The outcome of the discussion in the FSG is supported by Airbus as indicated in cmtnr 17.

Comment is not accepted.

**reason/justification**

Paragraph 7.4.1 as presented does not resolve CAA's concerns.

Comment	Response
<b>GENERAL COMMENT(S)</b>	
<b>Paragraph</b> -	
<b>Cmt.</b> 1 / <i>LFV Sweden</i>	
LFV Supports NPA.	Noted.
<b>reason/justification</b>	
<b>Cmt.</b> 1 / <i>SLV, Sweden</i>	
SLV supports NPA.	Noted
<b>reason/justification</b>	
<b>Cmt.</b> 5 / <i>Oslo Airport AS</i>	
<p>I want to comment on the equation for standing water and slush at page 17 in the draft document. (In previous draft document wet snow was also included). This equation does not reflect the influence of surface texture. I believe that surface texture has a significant influence.</p> <p>I believe that the same relationship, following the JAR 25.109 regulation for wet runway, should apply to standing water and slush to. Here there are two sets of equations relating to tyre pressure and surface texture.</p>	Information referenced in cmtnr 3 and 4. Noted.
<b>reason/justification</b>	

Comment	Response
<p><b>Cmt.</b> 6 / <i>Oslo Airport AS</i></p> <p>The 'AMJ' section of EASA CS 25 is a set of advisory material that constitutes a minimum standard of data and/or methods that aircraft manufacturers may use if they wish to certificate an aircraft for operations on contaminated runways. However, there is nothing to stop the use of superior and more precise data and methods - as is evi-dent from the ESDU References included at the end of the AMJ.</p> <p>Many of the larger companies have their own databases that often link current aircraft to their remote ancestors as designs have evolved within the culture of the specific company. When the opportunity arises, you can be assured that ESDU will seek to include a version of the material that I presented in Canada as Reference material in the AMJ. This version will be in the form of a series of Data Items, which will include both a statement of the methods and ways in which the methods can be used.</p> <p>Regarding the braking curve for contaminated runways; I understand that this is one such 'default' option chosen from among a collection of curves that are used in vari-ous countries. You are, of course, correct that such relationships should be expressed as functions of texture depth. However, in this case the consensus view was to prefer to schedule 'worst case' data for ALL runways rather than seek to take credit for the benefits of better quality runways. Here, better quality refers to improvements in the depth of the macro-texture</p> <p><b>reason/justification</b></p>	<p>Supplement to cmtnr 3. Noted.</p>

Comment	Response
<p><b>Cmt.</b> 25 / Transport Canada</p>	
<p>Attachment 1 to comments 019 - 025</p> <p>Issue 1 11 January 2005</p> <p>TRANSPORT CANADA AIRCRAFT CERTIFICATION FLIGHT TEST DIVISION</p> <p>DISCUSSION PAPER NO. 35</p> <p>EASA NPA 14/2004 LANDING DISTANCE ON CONTAMINATED RUNWAYS</p> <p>(The Initial Issue of this Discussion Paper, dated 11 January 2005, contains a comparison of landing distances on contaminated runways determined using the method proposed by EASA NPA 14/2004 with the results from a Monte Carlo Statistical Analysis, and an adaptation (for contaminated runways) of the method contained in FAA AC 121.195(d)-1A.)</p> <p>1 INTRODUCTION</p> <p>1.1 General</p> <p>EASA NPA 14/2004 introduces changes to CS 25.1591 'Performance Information for Operations with Contaminated Runway Surface Conditions', and associated material in AMC 25.1591 'The Derivation and methodology of performance information for use when taking-off and landing with contaminated runway surface conditions'. It is intended that the performance data should be determined for a standardized set of conditions that will generally and conservatively represent the variety of contaminated runway conditions occurring in service.</p> <p>Paragraph 7 of the AMC describes the effects of contamination on takeoff and landing performance. These effects include contamination displacement and impingement drag, and reduced braking action compared to a bare and dry runway.</p> <p>For landing, paragraph 7.4.2 of the AMC states that the airborne portion of the landing 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.</p> <p>Paragraph 8.3 of the AMC states that for speeds higher than VREF, that is speeds up to the recommended approach speed additive to VREF, 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.</p> <p>This paper compares representative results for landing distances obtained using the methodology of EASA NPA 14/2004 with the results from a Monte Carlo Statistical Analysis. In the Monte Carlo method, a landing distance model is established which includes most of the variables that could affect the landing distance on a contaminated runway. Independent random values of each significant operational variable are selected from estimates of the statistical distribution of the variable, and the resulting landing distance is determined. By repeating this calculation a large number of times, the distribution of expected operational landing distances in service may be estimated. From this distribution, the value corresponding to a specified probability of not being exceeded can be determined.</p>	<p>TC discussion paper no. 35 presents representative results for landing distances obtained using the methodology of EASA NPA 14/2004 with results from a Monte Carlo Statistical Analysis. The paper also compares representative results for landing distance obtained using the methodology of FAA AC 121.195(d)-1A.</p> <p>It is concluded that a factor of 1.15 is required to obtain equivalent results between landing distances calculated according to EASA NPA 14/2004 and the Landing distances obtained from the 95% probability results from the Monte Carlo Statistical Analysis.</p> <p>Even with a 1.15 factor applied to the NPA distances, these distances are still not conservative when compared with the results calculated according to the methodology of FAA AC 121.195(d)-1A. This is because the FAA AC method specifies an increase in VREF and an increase in the touchdown speed ratio, in addition to the 1.15 factor.</p> <p>In order to ensure an acceptable level of safety, data produced in accordance with the NPA must be used with appropriate operational factors.</p> <p>In common with other codes of airworthiness regulations, the landing distances defined by CS 25 are 'nominal distances' without any operational safety factors. This is independent of the condition of the runway (see CS 25.125 for dry runways, or CS 25.1591 for contaminated runways). The definitions and calculation methods contained in the proposed AMC 25.1591 are consistent with this practice.</p> <p>Any operational safety factors are prescribed by the operating regulations in force in the country of origin of the operator. The prevailing regulations governing European operators are JAR-OPS 1.</p> <p>In JAR-OPS 1.515 it is stated that when landing on a dry runway, the aircraft must be able to come to a complete stop within 60% of the landing distance available for turbo-jet powered aircraft or 70% of the landing distance available for turbo-propeller powered aircraft. In other words, the operational factors on dry runways are 1.67 for jet aircraft or 1.43 for turboprop aircraft. JAR-OPS 1.520(a) prescribes a further factor of 1.15 when the runway is wet, so that the total operational factor becomes 1.92 for jet aircraft or 1.64 for turboprop aircraft (applied to the landing distance determined on a _dry_ runway!).</p> <p>For landing on a contaminated runway, which is the subject of the proposed AMC 25.1591, JAR-OPS 1.520(b) specifies a factor of 1.15 to be applied to the landing distance data on a contaminated runway. The same paragraph further states that the required landing distance must not be less than that required on a wet runway. So JAR-OPS 1 ensures that the operational safety factor on a contaminated runway is never less than 1.15.</p> <p>As far as the presentation of landing distance information in the AFM is concerned, AMC 25.1581.6d(18) states that the landing distance must be presented either directly (i.e. 'nominal distances') or with the factors required by the operating regulations. CS 25.1587(b)(7)</p>

Comment	Response
<p>This paper also compares representative results for landing distance obtained using the methodology of FAA AC 121.195(d)-1A. FAA AC 121.195(d)-1A contains a method of establishing operational landing distances on wet runways. This method has been adapted for contaminated runways based on a braking coefficient appropriate to the contaminated surface.</p> <p>1.2 Table of Contents</p> <p>1 INTRODUCTION</p> <p>1.1 General</p> <p>1.2 Table of Contents</p> <p>2 METHODOLOGY</p> <p>2.1 Landing Performance Program Description</p> <p>2.2 Landing Distance Calculation</p> <p>2.3 AFM Landing Distance</p> <p>2.4 Monte Carlo Statistical Analysis</p> <p>2.5 EASA NPA 14/2004 Method</p> <p>2.6 FAA 121.195(d)-1A Method</p> <p>3 RESULTS</p> <p>3.1 Sample Aircraft</p> <p>3.2 Sample Flight Conditions</p> <p>3.3 Sample Contaminated Runway Condition</p> <p>3.4 Results Presentation</p> <p>3.5 Comparison of Results</p> <p>3.6 Discussion</p> <p>4 CONCLUSIONS</p> <p>Figures 1 to 4</p> <p>2 METHODOLOGY</p> <p>2.1 Landing Performance Program Description</p> <p>As part of an overall program to improve takeoff and landing safety on wet and contaminated runways, Transport Canada Aircraft Certification has developed a Landing Performance Program. This program has been developed using industry standard performance methods. The program contains a Monte Carlo Statistical Analysis option.</p> <p>The program has been modified to calculate the landing distance on a contaminated runway using the methods of EASA NPA 14/2004 and FAA AC 121.195(d)-1A.</p> <p>2.2 Landing Distance Calculation</p> <p>The landing distance is calculated in 4 distinct segments comprised of the threshold offset distance (dzero), the air distance (d1), the transition distance (d2) and the braking distance (d3). These distances are described below.</p> <p>2.2.1 Threshold Offset Distance (dzero)</p> <p>This distance is the horizontal distance that the aircraft is assumed to be from the threshold</p>	<p>requires an explanation of the operational landing runway length factors included in the presentation, if appropriate.</p> <p>Comment is accepted. Commentor is correct in stating that the landing distances on contaminated runways as defined by the proposed AMC 25.1591 in themselves do not ensure a sufficient level of safety and that operational factors have to be applied. Commentor proposes a factor of at least 1.15, which happens to coincide with the requirements of JAR-OPS 1.520. The responsible authorities in other countries should ensure that a similar level of safety is achieved by their own operating regulations.</p> <p>It is recommended to treat the landing distances on contaminated runways as far as possible in a similar way as the landing distances on dry runways. This means that the landing distances in AMC 25.1591 are defined without factors and that operational factors are prescribed in the applicable operational regulations, and allow the AFM to present the landing distance data either without or with factors included, with proper explanation. NPA 14/2004 paragraph 8.3 is revised accordingly.</p>

Comment	Response
<p>of the runway when the aircraft main wheels are at a height of 50 ft above the runway.</p> <p>The Threshold Offset Distance is only used in the Monte Carlo Statistical Analysis. It is set to zero for the AFM Landing Distance and the landing distances determined using the NPA and AC.</p> <p>2.2.2 Air Distance (d1)</p> <p>This distance is the horizontal distance from the point at which the main wheels are at a height of 50 ft above the runway to the point of main wheel touchdown.</p> <p>2.2.3 Transition Distance (d2)</p> <p>The transition distance is defined as the distance between the point of touchdown to a point where the aircraft is in the full braking configuration (i.e. ground attitude, lift dump spoilers extended and full anti-skid braking pressure).</p> <p>2.2.4 Braking Distance (d3)</p> <p>The braking distance is defined as the distance between the point at which the aircraft is in the full braking configuration to the point of stop.</p> <p>This segment can be calculated with no credit for reverse thrust or taking credit for reverse thrust. When credit for reverse thrust is taken, the calculation is based on use of reverse thrust in accordance with operational procedures for the particular aircraft.</p> <p>2.2.5 Total Distance (landdist)</p> <p>The total distance is the sum of the segments dzero, d1, d2 and d3. As noted above, the Threshold Offset Distance (dzero) is only used in the Monte Carlo Statistical Analysis.</p> <p>2.3 AFM Landing Distance</p> <p>The AFM Landing Distance is the total distance (d1 + d2 + d3), calculated on a dry runway for the given input conditions of weight, altitude and wind.</p> <p>The input wind is factored by 0.5 for a positive input value (headwind) and by 1.5 for a negative input value (tailwind). The temperature is ISA for the specified altitude, and the runway slope is zero.</p> <p>The program uses certification test data for each applicable aircraft for all variable parameters needed to determine the air distance, transition distance and the braking distance.</p> <p>The AFM Landing Distance corresponds to the requirements of FAR 25.125.</p> <p>2.3.1 Air Distance Calculation</p> <p>For the AFM Landing Distance, d1 is calculated according to a modified version of the parametric air distance method described in AC 25-7A. The ground speed at 50 ft is calculated from the equivalent airspeed at 50 ft, altitude, temperature and head wind component. The rate of descent at 50 ft is calculated from the ground speed and the glide path. The time from 50 ft to touchdown and the ground speed at touchdown are determined from established relationships with the rate of descent at 50 ft and the rate of descent at touchdown. The distance is then determined by multiplying the average speed</p>	

Comment	Response
<p>by the time. The difference from the method described in AC 25-7A is that the parametric relationship is established for ground speed and not true airspeed.</p> <p>For the AFM Landing Distance, the rate of descent at 50 ft is that appropriate to a 3.5 degree glide path and the rate of descent at touchdown is 8 ft/s.</p> <p>2.3.2 Transition Distance Calculation</p> <p>This segment is modeled as a deceleration for a fixed time interval. The distance is calculated from the average groundspeed multiplied by delta time. The deceleration and the time interval are configuration dependent data established from flight tests for each of the specified configurations.</p> <p>2.3.3 Braking Distance Calculation</p> <p>Using the braking coefficient for a dry runway, the deceleration is calculated from the net force acting on the aircraft and the distance is calculated by double integration of the deceleration.</p> <p>There is no credit for reverse thrust in the AFM Landing Distance.</p> <p>2.4 Monte Carlo Statistical Analysis</p> <p>The Monte Carlo Statistical Analysis is based on the same landing distance model as the AFM Landing Distance. However each parameter in the landing distance model can be independently randomly varied in accordance with specified statistical distributions and the resulting landing distance determined. By running the model a large number of times, the distribution of landing distances can be determined.</p> <p>The landing distance, which will not be exceeded with a specified probability, can be calculated from the landing distance distribution. The results in this paper are presented in terms of the 95% probability value.</p> <p>2.4.1 Distribution of Landing Distance Parameters</p> <p>The distributions of the significant variable parameters affecting the landing distance used in the Monte Carlo Statistical Analysis are listed below:</p> <p>(a) Weight. To account for variability in weight, the input value is multiplied by a weight factor. Since aircraft weight is directly accounted for in the input, the expected variability is limited to errors in the estimation of weight at landing. The mean value is unity, the standard deviation is 0.5% of the estimated landing weight and the minimum and maximum values are <math>\pm 3</math> standard deviations.</p> <p>(b) Pressure Altitude. To account for variability in pressure altitude, an increment is added to the input value. Since altitude is directly accounted for in the input, the expected variability is limited to errors in the estimation of pressure altitude at the landing airport. The mean value is zero, the standard deviation is 300 ft and the minimum and maximum values are <math>-1000/+ 1000</math> ft.</p> <p>(c) Temperature. To account for variability in temperature, an increment is added to the ISA value for the input pressure altitude. The expected variability covers the operational temperature range for winter-contaminated runways. This requires that the increment be a</p>	

Comment	Response
<p>function of the pressure altitude. The mean value of the increment is chosen to give a temperature of -10 oC (e.g. the increment from ISA is -25 oC at Sea Level). The standard deviation is 10 oC. The minimum value is -3 standard deviations (i.e. -40 oC) and the maximum value is + 2 standard deviations (i.e. +10 oC).</p> <p>(d) Runway slope. The expected variability covers the operational runway slope range approved for the aircraft. The mean value is zero, the standard deviation is a gradient of 0.5% and the minimum and maximum values are -2 %/+2 %.</p> <p>(e) Headwind at 10 m. To account for variability in the reported headwind, an increment is added to the input value (without factoring). The mean value is zero and the standard deviation is 0.25 multiplied by the input headwind value, but not less than 1.25 knots. The minimum and maximum values are -/+ 3 standard deviations.</p> <p>(f) Threshold offset distance. Due to variability in the distance from the runway threshold to the point at which the aircraft is 50 ft above the runway, a threshold offset distance is added to the landing distance from 50 ft. The mean value is zero, the standard deviation is 100 ft and the minimum and maximum values are -300 ft/+300 ft.</p> <p>(g) Equivalent airspeed at 50 ft (V50). An increment is added to VREF to account for standard operating procedures and atmospheric conditions. The mean value of this increment is 50% of the reported headwind but not less than 5 knots. The standard deviation is 50% of the mean value and the minimum and maximum are 0/+20 knots.</p> <p>(h) Glide path at 50 ft. The mean value is 3 deg. The standard deviation is 0.2 deg and the minimum and maximum values are +2.5/+3.5 deg.</p> <p>(i) Touchdown rate of descent. The mean value is 3 ft/s. The standard deviation is 2 ft/s and the minimum and maximum values are +1/+6 ft/s.</p> <p>(j) Transition segment delta time. To account for variability in the time delay from main wheel touchdown to full braking configuration, an increment is added to the certification value. This increment is more typical of normal pilot response in de-rotating the aircraft and applying maximum braking. The mean value of the increment is 1 s, the standard deviation is 1 s and the minimum and maximum values are 0/+4 s.</p> <p>(k) Transition segment deceleration. To account for variability in deceleration during the transition time delay, the certification value is multiplied by a factor. This factor would be expected to be slightly lower in operational service than that obtained during certification tests. The mean value is 0.9, the standard deviation is 0.1 and the minimum and maximum values are -/+ 3 standard deviations.</p> <p>(l) Idle thrust. To account for variability in idle thrust during the braking segment, the certification value is multiplied by a factor. In operational service, the idle thrust could be expected to be either higher or lower than the value used in certification. The mean value is unity, the standard deviation is 0.1 and the minimum and maximum values are -/+ 3 standard deviations.</p> <p>(m) Contaminated runway braking coefficient. To account for variability in the contaminated runway braking coefficient, the mean value is multiplied by a factor. The reference value of the factor is unity, the standard deviation is 0.15 and the minimum and maximum values are -/+ 3 standard deviations.</p> <p>(n) Reverse thrust selection delta time. To account for variability in the time delay from full braking to reverse thrust selection, an increment is added to the certification value. This increment is more typical of normal pilot response than that used in certification testing.</p>	

Comment	Response
<p>The mean value is 1 s, the standard deviation is 1 sec and the minimum and maximum values are 0/+4 s.</p> <p>(o) Reverse thrust. The Monte Carlo calculation is done without credit for reverse thrust and with credit for reverse thrust. To account for variability in reverse thrust, the certification value is multiplied by a factor. In operational service, the reverse thrust could be expected to be either higher or lower than the value used in certification. The mean value is unity, the standard deviation is 0.1 and the minimum and maximum values are -/+ 3 standard deviations.</p> <p>2.5 EASA NPA 14/2004 Method</p> <p>The NPA distance is the total distance (d1 + d2 + d3), calculated on a contaminated runway for the given input conditions of weight, altitude and wind.</p> <p>The input wind is factored by 0.5 for a positive input value (headwind) and by 1.5 for a negative input value (tailwind). The temperature is ISA for the specified altitude, and the runway slope is zero.</p> <p>2.5.1 Air Distance</p> <p>The air distance (d1) is calculated assuming an air time between 50 ft and touchdown of 7 seconds. The touchdown speed is 0.93 of the true groundspeed at 50 ft (i.e. it is assumed that the speed loss in the landing flare is an inertial speed loss).</p> <p>2.5.2 Transition Distance</p> <p>For the transition distance, the AFM Landing Distance model is used with the touchdown speed derived as above.</p> <p>2.5.3 Braking Distance</p> <p>For the braking distance, the AFM Landing Distance model is used with the speed at the start of the braking segment derived as above. The braking segment is calculated using the specified effective braking coefficient. There is no credit taken for any drag due to the contaminant.</p> <p>The braking distance is calculated without credit for reverse thrust and with credit for reverse thrust.</p> <p>2.6 FAA 121.195(d)-1A Method</p> <p>The FAA AC distance is the total distance (d1 + d2 + d3), calculated on a contaminated runway for the given input conditions of weight, altitude and wind, multiplied by a factor of 1.15.</p> <p>The input wind is factored by 0.5 for a positive input value (headwind) and by 1.5 for a negative input value (tailwind). The temperature is ISA for the specified altitude, and the runway slope is zero.</p> <p>2.6.1 Air Distance</p> <p>The air distance (d1) is calculated assuming an air time between 50 ft and touchdown of the longer of 7 seconds or the AFM Landing Distance air time + 2 seconds.</p>	

**Comment****Response**

The FAA AC specifies the airspeed at 50 ft to be 1.4VSO. The minimum value of the landing reference speed for the determination of the AFM Landing Distance, VREF, is 1.3VSO. The choice of 1.4VSO is considered to more accurately represent operational landing speeds.

However not all aircraft utilize the minimum value for VREF. In addition, most recently certified aircraft have a minimum value based on 1.23 VS1g instead of 1.3VSO. Hence in this study, the airspeed at 50 ft has been calculated from  $VREF * (1.4/1.3)$ .

The touchdown speed specified by the FAA AC is 0.96 of the true groundspeed at 50 ft (i.e. it is assumed that the speed loss in the landing flare is an inertial speed loss).

#### 2.6.2 Transition Distance

For the transition distance, the AFM Landing Distance model is used with the touchdown speed derived as above.

#### 2.6.3 Braking Distance

For the braking distance, the AFM Landing Distance model is used with the speed at the start of the braking segment derived as above. The braking segment is calculated using the specified effective braking coefficient. There is no credit taken for any drag due to the contaminant.

The braking distance is calculated without credit for reverse thrust and with credit for reverse thrust.

### 3 RESULTS

#### 3.1 Sample Aircraft

In order to compare the methodology, four sample aircraft have been used in this study. The main characteristics are described below.

Table 1

Main Characteristics of Turbojets Used in Study

Turbojet Identifier (KEAS)	Type	Max Landing Weight (MLW) (lbf)	VREF at MLW
A	50 seat regional jet	47000	142
B	70 seat regional jet	67000	136
C	Large business jet	78600	132
D	Small business jet	33750	126

#### 3.2 Sample Flight Conditions

Twelve sample flight conditions have been chosen as follows:

- (a) 2 weights (Maximum Landing Weight (MLW) and  $0.75 * MLW$ )
- (b) 2 altitudes (Sea Level (SL) and 5000 ft)
- (c) 3 headwind components (Calm, 20 knots headwind and 5 knots tailwind).

#### 3.3 Sample Contaminated Runway Condition

Comment	Response
<p>For this study, the contaminated runway was covered by dry snow. No credit was taken for any contamination drag. As specified in the NPA, the mean wheel braking coefficient was 0.17 (without any further factoring due to anti-skid operation).</p> <p>3.4 Results Presentation</p> <p>The results are presented in terms of landing distance factors. The Monte Carlo Statistical Analysis results are presented in terms of the distance which will not be exceeded with a 95% probability, divided by the AFM Landing Distance. The NPA and AC factors are the calculated distance divided by the AFM Landing Distance.</p> <p>The factors are plotted against the AFM Landing Distance for each aircraft/flight condition combination (48 points).</p> <p>3.5 Comparison of Results</p> <p>Figure 1 shows the Monte Carlo 95% factors together with the factors calculated by NPA and the AC, without credit for reverse thrust. Figure 2 shows the Monte Carlo 95% factors together with the factors calculated by NPA and the AC, with credit for reverse thrust.</p> <p>In general, it can be seen that the factors predicted by the NPA are considerably lower than the Monte Carlo 95% factors whereas the factors calculated by the AC are higher.</p> <p>There are several reasons why the factors calculated by the AC are considerably higher than those calculated by the NPA: the increased speed assumed at 50 ft, the increase in touchdown speed ratio and the 1.15 factor.</p> <p>Figures 3 (no reverse) and 4 (with reverse) show the same Monte Carlo and FAA AC results but with the NPA factors multiplied by 1.15. In general, the NPA results, with the 1.15 factor, are very similar to the Monte Carlo results.</p> <p>3.6 Discussion</p> <p>It is clear from above that the landing distance calculated in accordance with the NPA guidance will not be representative of that which would be expected in operational service. Although the NPA guidance states that information on the effects of higher speeds than VREF should be included, it is unclear how it is intended to use this information.</p> <p>The NPA guidance states that operational factors, as required by JAR-OPS or other regulating regulations, should be stated as being included or not included. As indicated by the results in this paper, the current JAR-OPS factor of 1.15 should be considered a minimum acceptable value and a greater factor may be justified.</p> <p>The data produced in accordance with the NPA guidance will likely be used in other jurisdictions, including Canada, where similar operational factors are not in place. Hence it is recommended that the data be provided without operational factors and that the AFM contains a proviso that the data are derived on the assumption that appropriate operational factors will be used.</p> <p>5 CONCLUSIONS</p> <p>The landing distances calculated according to EASA NPA 14/2004 and speed of VREF are not conservative compared to the 95% probability results from the Monte Carlo Statistical</p>	

Comment	Response
<p>Analysis. A factor of 1.15 is required to obtain equivalent results.</p> <p>Even with a 1.15 factor applied to the NPA distances, these distances are still not conservative when compared with the results calculated according to the methodology of FAA AC 121.195(d)-1A. This is because the FAA AC method specifies an increase in VREF and an increase in the touchdown speed ratio, in addition to the 1.15 factor.</p> <p>In order to ensure an acceptable level of safety, data produced in accordance with the NPA must be used with appropriate operational factors.</p>	
<p><b>reason/justification</b></p>	
<p><b>Cmt.</b> 26 / ACG, Austria</p>	
<p>ACG Supports NPA.</p>	<p>Noted.</p>
<p><b>reason/justification</b></p>	