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Braking Action Measurement

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BAE SYSTEMS - Regional Aircraft

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Introduction

- My Background
- Discussion Items
  - ✈ Contaminated Runway Operation
  - ✈ Runway Condition and Braking Definitions
  - ✈ Aircraft Certification for contaminated runway operation
  - ✈ Operational Requirements
  - ✈ Further Work
  - ✈ Questions and Discussion

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Contaminated Runway Operation

- A variety of information available (conflicting?)
- Operators need to consider aircraft handling, performance and the effect on aircraft systems (frozen slush and snow in u/c bays & lower wing)
  - ✈ There may be reduced directional control resulting in reduced crosswind and reverse thrust capability.
  - ✈ The effect of frozen slush on the wing l/e may result in reduced lift at rotation
- Manufacturers may offer data derived from actual testing however it is more likely to be advisory material without test experience.
- Information required for the Crews to make a considered decision based on actual arrival or take-off conditions.
- Let's consider the different runway performance data and friction terminology

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Runway Condition and Braking Definitions

- ICAO
  - ✈ Damp, Wet, Water Patches, Flooded
- JAR Ops 1.480
  - ✈ Dry, Damp, Wet, Contaminated
- JAA Certification
  - ✈ Water, Slush, Wet Snow, Dry Snow, Compacted Snow, Specially prepared Winter Runway, Ice
- Manufacturer
  - ✈ Slippery? contaminant depth?
- ATC
  - ✈ Good, Medium, Poor, nil

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JAR Ops Contaminant Definitions

- ***Dry Runway -*** A dry runway is one which is neither wet or contaminated, and includes those paved runways which have been specially prepared with grooves or porous pavement and maintained to retain “effectively dry” braking action even when moisture is present. !!!!!!

- ***Runway contaminated by standing water,slush or loose snow -*** A runway is considered to be contaminated when more than 25% of the runway surface area (whether isolated or not) within the required length and width being used, is covered by surface water, more than 3mm deep, or by slush, or loose snow, equivalent to more than 3mm of water

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Aircraft Certification for Contaminated runway Operation

- No testing required
- Compliance material is still being developed
- JAA are in the process of approving new rule NPA 25B,G-334 for compliance with 25X1591. Sent to JAA HQ 1st Sept 2002.
- Replaces NPA25B,D,G- 244 as published in JAR25 change 15
- No corresponding FAR requirement so there has been no rule harmonisation.
- Any AFM or MOM information may be advisory material dependant on the relevant certification basis.

Certification Friction Levels

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- Performance data on contaminated runways can be based on either test evidence or the minimum conservative default values given below.

Contaminant	***Default Friction Value*** μ
Standing Water, Slush and Wet Snow	$= -0.0632\left(\frac{V}{100}\right)^3 + 0.2683\left(\frac{V}{100}\right)^2 - 0.4321\left(\frac{V}{100}\right) + 0.3485$ where V is groundspeed in knots Note 1 Braking Force = load on braked wheel x μ Note 2 For V greater than the aquaplaning speed, use μ = 0.05 constant
Compacted Snow	0.2*
Sanded Snow	No default value can be given as the friction level to be assumed is based on actual measurement
Dry Snow	0.17*
Ice	0.05*

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Operational requirements

- JAR Ops 1.490 & 1.520
  - ✈ A limitation prohibiting take-off is also compliant
  - ✈ Requires consideration of appropriate approved data
- ATC rely on runway friction devices and reports from other crews
  - ✈ Both can provide incorrect or confusing information
- Runway Friction Measurement Devices
  - ✈ No International standard for Friction devices
  - ✈ Accuracy of friction devices depends on contaminant type and design of device
  - ✈ No correlation to Certification friction levels or IATA terminology
- Crew Reports
  - ✈ Level of “friction” is based on retardation and is therefore aircraft type specific
- Advisory Information in MOM (FCOM)

Operational Requirements cont'd

- Information available to the crew
  - ✈ Data from airlines Flt Ops (from Manufacturers MOM/FCOM?)
  - ✈ This data should provide information to allow the crew to make real time decisions based on:
    - current runway condition
    - effect of tailwind if permitted
    - effect of incremental speeds on Vref and Vr
    - margin to limiting weights.
  - ✈ How does this compare against ATC braking action or friction information
    - What does good mean >0.5? Good contaminated or dry runway
    - How do you correlate this subjective term to actual predicted performance
    - YOUR PERFORMANCE DATA REQUIRES YOU TO KNOW.

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Contaminated Runway - Further Work

- Joint Winter Runway Programme - Canada
  - ✈ Objective: Develop an international standard of reporting runway friction (IRFI)
- Performance Harmonisation Working Group - Contaminated Runway Sub Group - JAA
  - ✈ CAA have tasked ESDU with Analysis of runway data
- The Future ?
  - ✈ An overview is required in order to provide consistent data
  - ✈ Must consider :
    - Aircraft and Airline Certification
    - Manufacturer Data & Testing,
    - Airline Operation and
    - ATC Airfield measurement and reporting

Conclusions

- There is no overall accepted “certification to operational correlation” between mu meters and airplanes.
- Contaminated runway operation continues and overruns will happen.

Related Papers

- NPA 25G-334 At JAA for final approval
- Thomas Yager; Aircraft and Ground Vehicle Winter Runway Friction Assessment: NASA /TM-1999-209142
- Jim Martin;Transport Canada presentation to IATA:Aircraft Takeoff Performance on Contaminated runways;
- ASFT - History of Runway Friction Measurement. http://www.asft.se/history.html
- John Croll; IATA APWG Briefing September 2002 : Joint Winter Runway Friction Program Aircraft Test Results
- ICAO Annex 14, Operational Friction measurements

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Questions and Discussion ?