NEED FOR ENGINEERING BASED ASSESSMENT OF PREDICTED LANDING PERFORMANCE

RnwyCC = 3 = Medium – Airport/Pilot

$\mu_{\text{Brakes}} \ 0.199 - 0.16 - \text{Engineer}$

Were my assumptions correct?
BUT...CAN WE ALL SPEAK ENGINEER?

• WHAT ARE $\mu_{\text{brakes}}$?
• HOW DO I KNOW IF I HAVE A GOOD VALUE?
• HOW CAN I RELATE $\mu_{\text{brakes}}$ TO THE GLOBAL REPORTING FORMAT?
• IS $\mu$ FROM AIRCRAFT THE SAME AS $\mu$ FROM AIRPORTS?
• STARTED BY ORIGINAL MEMBERS OF THE “TALPA ARC” 2006-2009

• GLOBAL COMMUNITY OF ENGINEERS WHO ARE TASKED WITH ALL ASPECTS OF AIRCRAFT OPERATIONAL PERFORMANCE.

• ESTABLISHED A SPECIAL WORKGROUP IN 2017 FOR CREATING STANDARDS RELATED TO AIRCRAFT REPORTING SYSTEMS.

Lion Team working group formed “To develop standards (not algorithms) for aircraft friction recording and reporting technologies.”
AMERICAN SOCIETY FOR TESTING AND MATERIALS

- 140+ COUNTRIES
- 12,500 STANDARDS
- 30,000+ VOLUNTEERS AND MEMBERS
- COMMITTEE E17 – VEHICLE PAVEMENT SYSTEMS
- 2018 - E17.26 AIRCRAFT FRICTION
E17.26/SAPOE TASK GROUP
ENGINEERING SCALE FOR BRAKING PERFORMANCE
HIGHLIGHTS SEVERAL ISSUES

• Harmonization of new aircraft braking performance scale with investigations and research

• Harmonize engineering definitions with definitions of Pilot Reported Braking (AIREP/PIREP)

• Provide an objective guide for an engineering based Safety Assurance Process across national and international operators.

<table>
<thead>
<tr>
<th>Runway Condition Code</th>
<th>Braking Description</th>
<th>Wheel Braking Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Good</td>
<td>Ground Speed Dependent per §25.109(c)</td>
</tr>
<tr>
<td>4</td>
<td>Medium to Good</td>
<td>0.20</td>
</tr>
<tr>
<td>3</td>
<td>Medium</td>
<td>0.16</td>
</tr>
<tr>
<td>2</td>
<td>Medium to Poor</td>
<td>50% of §25.109(c) Max $m_B\text{=}0.16$, min $m_B\text{=}0.05$</td>
</tr>
<tr>
<td>1</td>
<td>Poor</td>
<td>0.08</td>
</tr>
</tbody>
</table>
REASONS FOR AN AIRCRAFT BRAKING STANDARD #1

RISK IS A FUNCTION OF AIRCRAFT PERFORMANCE

\[ F_{\text{Brakes}} = \frac{\text{Force of Braked Wheels Decelerating the Aircraft}}{\text{Normal Force on the braked wheels (W-L)}} \]

Must allow crew to make decisions based on proper guidance, policies, and checklists.
### Performance versus Contamination

<table>
<thead>
<tr>
<th>Braking</th>
<th>$\mu_{\text{Brakes}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>per §25.109(c)</td>
</tr>
<tr>
<td>Good to Medium</td>
<td>0.20</td>
</tr>
<tr>
<td>Medium</td>
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</tr>
<tr>
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<td>50% of §25.109(c) Max $m_B=0.16$, min $m_B=0.05$</td>
</tr>
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<td>Poor</td>
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</tr>
</tbody>
</table>

### Runway Condition

- **FROST**
- **WET** (The runway surface is covered by any visible dampness or water up to and including 3 mm depth)
- Up to and including 3 mm depth:
  - **SLUSH**
  - **DRY SNOW**
  - **WET SNOW**
- -15°C and lower outside air temperature:
  - **COMPACTED SNOW**
- **WET** ("slippery wet" runway)
  - **DRY SNOW** or **WET SNOW** (any depth) ON TOP OF COMPACTED SNOW
  - More than 3 mm depth:
    - **DRY SNOW**
    - **WET SNOW**
    - Higher than -15°C outside air temperature1:
      - **COMPACTED SNOW**
  - More than 3 mm depth of water or slush:
    - **STANDING WATER**
    - **SLUSH**
    - **ICE 2**
REASONS FOR AN AIRCRAFT BRAKING STANDARD #3

PILOTS BRAKING ACTION REPORTS – CAN WE COMPLETELY DEPEND ON THEM?
ASTM E3188-19
STANDARD TERMINOLOGY FOR AIRCRAFT BRAKING PERFORMANCE

YES, YOU CAN SPEAK ENGINEER!!

- Aircraft Braking Coefficient
- Aircraft Braking Simulation Equipment
- Airport Friction Measurements
- Anti-Skid Efficiency
- AutoBrakes
- Average Braking Coefficient
- Braking Action

**Aircraft Braking Action Report**

**PILOT BRAKING ACTION REPORT**

- Friction Limited Braking
- Friction Limited (Aircraft/Wheel) Braking Coefficient
- Maximum Aircraft Wheel Braking Performance
- Maximum Tire to Ground Braking Coefficient
- Mu Slip Curve
- SCAP
- Slip-Ratio
- Time Varying Braking Coefficient
- Tire to Ground Friction Coefficient
- Torque Limited Braking
- Wheel Braking Coefficient
What the Standard Will Address
Friction Limited Aircraft Braking Measurements and Reporting

Ensure good data from aircraft
Ensure accurate data analysis

Aircraft Braking Action Report
“Good” “Medium” Etc.

Map result to standardized scale (TALPA/APM)
STANDARD PRACTICES FOR FRICTION LIMITED AIRCRAFT BRAKING MEASUREMENTS AND REPORTING

- Must not limit participation to only Aircraft Manufacturers
- Must provide actionable information for decision making
- Not intended as operational policy but must support the creation of policies, procedures, checklists, automation, and briefings
STANDARD PRACTICES FOR FRICITION LIMITED AIRCRAFT BRAKING MEASUREMENTS AND REPORTING

Requirements, lists, acceptance methods. Intentionally broad in some areas due to aircraft variances.

Guidance material, examples, best practices, and recommendations.
QUESTIONS?

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WWW.SAPOE.ORG