Brantare

Flight Operational Impact of Steeper Approaches
Presentation content

- Project overview
- Work performed & results so far
- Ongoing
- Future
- Questions
Project overview

- Steeper approaches – noise reducing potential by moving the noise source further away from the ground

- The operational behavior of the pilots changes when flying steeper approaches
  - Timing of flap/slat/landing gear extension,
  - Use of speed brake,
  - Speed selection,
  - Engine thrust

→ Affects the aircraft as a noise source
Project overview

Overall purpose:
Study the operational behavior of the pilots when they are flying steeper approaches

Issues:
• Availability of steeper approaches  
  • Access to flight recorder data
Focus on the operational behavior of the pilots under *varying wind conditions* during the final approach phase – approximately between (or just prior to) glide slope intercept and landing
How to use wind data

Project assumption: An approach conducted in tailwind conditions “equals” a steeper approach angle under 0-wind conditions

\[
\sin \alpha_{GS} = \frac{y}{z_1}, \quad \sin \alpha_2 = \frac{y}{z_2} \quad \text{and} \quad \frac{z_2}{z_1} = \frac{v_{App}}{v_{App} + v_{TW}}
\]

hence...
How to use wind data

\[ \alpha_2 = \sin^{-1} \left( \frac{(v_{\text{App}} + v_{\text{TW}}) \sin \alpha_{\text{GS}}}{v_{\text{App}}} \right) \]

<table>
<thead>
<tr>
<th>Nominal glide slope angle, ( \alpha_{\text{GS}} ) [°]</th>
<th>Approach speed, ( v_{\text{App}} ) [kt]</th>
<th>Tail wind, ( v_{\text{TW}} ) [kt]</th>
<th>Equivalent zero wind glide slope angle, ( \alpha_2 ) [°]</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0</td>
<td>160</td>
<td>-20</td>
<td>2.62</td>
</tr>
<tr>
<td>3.0</td>
<td>160</td>
<td>-10</td>
<td>2.81</td>
</tr>
<tr>
<td>3.0</td>
<td>160</td>
<td>0</td>
<td>3.00</td>
</tr>
<tr>
<td>3.0</td>
<td>160</td>
<td>10</td>
<td>3.19</td>
</tr>
<tr>
<td>3.0</td>
<td>160</td>
<td>20</td>
<td>3.38</td>
</tr>
</tbody>
</table>
Key calculation problem

Example of tail- and headwind during one approach
Key calculation problem

How to use real fluctuating wind data to be able to make a meaningful calculation of an *equivalent zero wind glide slope angle*?
Key calculation problem

Relevant questions:

• What triggers/queues the pilots’ operational behavior during an approach?
• What are the main differences between using the calculated method proposed in this paper and analyzing data from actual steeper approaches?
Selection of calculation method

Workshop *(to generate potential calculation methods)*
- 8 pilots, all Captains representing two airlines
- Combined flying experience > 100 000 h
- Discussions & questionnaire

Follow up interviews with pilots
- 10 (other) pilots
- Validation of workshop results
Workshop scenarios - Results

Extension behavior, flaps and gear for different wind situations
Results after workshop & interviews

Preferred calculation methods
(out of adapted workshop result):

1. Average wind between G/S intercept and gear down
2. Spot wind at gear down
3. Average wind between G/S intercept and 1000 ft.
4. Spot wind at glide slope intercept
Conclusions for calculation method

Average wind between G/S intercept and gear down selection will be the primary tool in the continuation of this study to get an:

• Increased understanding of the expected pilot behavior during approaches with various glide slope angles
• Increased understanding about flight operational possibilities/limitations related to steeper glide slope angles
Flight Recorder Data

Flight Recorder Data from actual flights

- Data from Novair Airbus A321
- 107 different parameters from each flight
- Update rate; 1Hz
Flight Recorder Data

In order to get it…

- Agreement between Swedish ALPA and Novair, and
- Agreement between the project and Novair, approved by the Swedish ALPA
- Data is sensitive
  - Pilot integrity
  - Commercial
Ongoing - Flight Recorder Data

First test batch of 150 flights analyzed

- Cleaning up data performed
- Calculation method(s) tested and verified
- Approx 2-3% of the flights fulfill tailwind requirement
- Correlation between wind and operational behavior indicated
- Waiting for next batch of 1,500 flights
- Sample flight delivered to SAFT
Ongoing - Dissemination

Pilot impact on the noise abatement effect of steeper approaches – Initial analysis of wind and flight data

Johan Sigfrid, Mahner AB
Bengt Hoberg, Vernamack AB
Perilla Ulfvergren, KTH

INTER-NOISE 2017
46th International Congress and Exposition on Noise Control Engineering
Montreal, Canada
27 - 30 August, 2017

Acknowledgements

Research is supported by the Centre for Sustainable Aviation (CSA), at the Royal Institute of Technology (KTH), Stockholm, Sweden.
1. Review available parameters.

2. Wish list regarding parameters from flights

3. Deliver approved parameters from (at least) one flight.
Future

1. Deliver noise data from selected flights

Brantare

Assist with flight operational expertise

INFRA

ULLA

2. Deliver noise data synchronized with flight data

SAFT
Thank You!

Questions?