High-Fidelity Simulations of Landing Gear Noise

Airframe Noise Group
Computational Aerosciences Branch
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NASA’s Noise Reduction Goals

Change in noise “footprint” area for a single event landing and takeoff

- Environmentally Responsible Aviation Project
- Subsonic Fixed Wing Project

- Relative ground contour areas for notional Stage 4 (current) and future generations of aircraft

Current Rule: Stage 4 Baseline Area

<table>
<thead>
<tr>
<th>Stage</th>
<th>CUM Noise Level</th>
<th>Area of Baseline</th>
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</thead>
<tbody>
<tr>
<td>N</td>
<td>10 dB</td>
<td>55%</td>
</tr>
<tr>
<td>N+1</td>
<td>32 dB</td>
<td>15%</td>
</tr>
<tr>
<td>N+2</td>
<td>42 dB</td>
<td>8.3%</td>
</tr>
<tr>
<td>N+3</td>
<td>71 dB</td>
<td>1.5%</td>
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NASA-Gulfstream Partnership

Objectives

• Mitigate radiated airframe noise during aircraft landing
• Develop effective noise reduction (NR) concepts applicable to current and future generation of civil transport

Execution Plan

• Utilize flight tests, wind-tunnel experiments, and computational simulations to generate a comprehensive aerodynamic and acoustic database to:
  » Identify and quantify the prominent airframe noise sources
  » Better understand the principles of airframe noise generation
  » Improve airframe noise prediction tools
  » Develop efficient noise reduction concepts
• Evaluate the most promising noise reduction concepts in a realistic environment (on Gulfstream aircraft)
NASA-Gulfstream Airframe Noise Flight Test

F = 1400 Hz

F = 1335 Hz

F = 1400 Hz
Nose Gear Tests & Corresponding Simulations

1/4th Scale Nose Landing Gear Model

Simulated Configuration

University of Florida

NASA Langley
(Flow vorticity field behind door)

- NASA Langley FUN3D Code
- Executed on 1200 CPUs
- 1.7 million CPU hours used (two months)
- Animations by NAS Visualization Group
Simulated Flow Field
Surface Pressure Fluctuations (Noise Sources)
Radiated Acoustic Field
Back Up Charts
NASA’s Noise Reduction Goals – Idealized Impact

Change in noise “footprint” area for a single event landing and takeoff

- Relative ground contour areas for notional Stage 4 and N+1, N+2, and N+3 aircraft
  - Independent of aircraft type/weight
  - Independent of baseline noise level

- Noise reduction assumed to be evenly distributed between the three certification points

- Simplified model: Effects of source directivity, wind, etc. not included
Volumetric Grid

1/4th Scale Nose Landing Gear Model

Simulated Configuration