Oceanic Tailored Arrival Trials
Fuel, Noise, and Emissions

SFO Noise Roundtable
Kevin Elmer
The Boeing Company

June 6, 2007
Fuel, Time, Noise, and Emissions

- **Method:**
  - Compare baseline and oceanic tailored arrival flights
    - Low-density and congested operations
  - Generate Boeing performance and FAA noise models
  - Compare fuel, time, noise, and emission differences
### Number of Flights Included in Analysis

<table>
<thead>
<tr>
<th>Operation</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phases 1 &amp; 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oceanic tailored arrivals</td>
<td>17</td>
<td>18</td>
<td>35</td>
</tr>
<tr>
<td>(participating UAL76 flights)</td>
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<tr>
<td>Low density baseline</td>
<td>6</td>
<td>13</td>
<td>19</td>
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<tr>
<td>(nonparticipating UAL76 flights)</td>
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<td></td>
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<tr>
<td>Congested baseline</td>
<td>75</td>
<td>84</td>
<td>159</td>
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<tr>
<td>(all other 777 flights)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Total 777 flights</td>
<td>98</td>
<td>115</td>
<td>213</td>
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</tbody>
</table>
All B-777 CEP Track C Lateral Tracks
Dec 9 – Jan 6, 2007

SFO

Early morning (4am - 5am)
Morning (7am - 11am)
Early Evening (5 pm)
Evening (7 pm - 10 pm)
All B-777 CEP Track C Vertical Profiles
Dec 9 – Jan 6, 2007
All B-777 CEP Track C Arrivals
Dec 9 – Jan 6, 2007

- Early morning (4am - 5am)
- Morning (7am - 11am)
- Early Evening (5 pm)
- Evening (7 pm - 10 pm)
Vectoring within the SFO TRACON for 777 Operations
Mean and Two Sigma

Track distance within ANOMS coverage, nm

- All operations
- Low density operations
- Congested operations
- OTA flights

- Round 1
- Round 2
- Rounds, 1 & 2
Lateral Path Comparison
Oceanic Tailored Arrival and Baseline Operations

- OTA Flights (UAL76) (4am - 5am)
- Max UAL892 12/27 (8 am)
- Avg ANZ8 1/3 (11 am)
- Min ANZ8 12/15 (11 am)
- Typical Baseline Operations
Vertical Profile Comparison
Oceanic Tailored Arrival and Baseline Operations

Distance, ft

-400000  -300000  -200000  -100000  0

Altitude, ft

12000  10000  8000  6000  4000  2000

OTA Flights (UAL76) (4am - 5am)
Max UAL892 12/27 (8 am)
Avg ANZ8 1/3 (11 am)
Min ANZ8 12/15 (11 am) Typical Baseline Operations

Distance, ft

-400000  -300000  -200000  -100000  0

SFO
Arrival Comparison
Oceanic Tailored Arrival and Baseline Operations

OTA Flights (UAL76) (4am - 5am)
Max UAL892 12/27 (9am)
Avg ANA8 1/3 (11 am)
Min ANA8 12/15 (11 am)
Typical Baseline Operations
### Benefits of OTA for Low, Average, and Maximum Congested Operations

#### Fuel, Time, and Distance

<table>
<thead>
<tr>
<th></th>
<th>WFCON (lbs)</th>
<th>Time (min)</th>
<th>Distance from CREAN to SFO (NM)</th>
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<tbody>
<tr>
<td>Basic OTA Profile</td>
<td>7192</td>
<td>39.2</td>
<td>232.5</td>
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<tr>
<td>OTA w/ EDA Profile (11k)</td>
<td>7477</td>
<td>40.2</td>
<td>232.5</td>
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<tr>
<td>Min Congestion</td>
<td>7230</td>
<td>40.1</td>
<td>238.7</td>
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<td>Avg Congestion</td>
<td>7416</td>
<td>41.6</td>
<td>244.0</td>
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<tr>
<td>Max Congestion</td>
<td>11543</td>
<td>51.2</td>
<td>273.0</td>
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<table>
<thead>
<tr>
<th></th>
<th>WFCON (lbs)</th>
<th>Time (min)</th>
<th>Distance from CREAN to SFO (NM)</th>
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</thead>
<tbody>
<tr>
<td>Min Congestion</td>
<td>38</td>
<td>0.9</td>
<td>6.2</td>
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<tr>
<td>Avg Congestion</td>
<td>225</td>
<td>2.4</td>
<td>11.5</td>
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<tr>
<td>Max Congestion</td>
<td>4351</td>
<td>12.0</td>
<td>40.4</td>
</tr>
</tbody>
</table>
FAA Integrated Noise Model Predictions

Sound Exposure Level Contours

- Round 2 EDA OTA
- Typical Congested Baseline
- Max Congested Baseline (incomplete terrain effects)
- Average Congested Baseline

SEL contours:
- 72
- 71
- 70
- 69
- 68
- 67
- 66
- 65
Noise Measurements Locations

Deployed portable noise monitors

Permanent noise monitor sites

Courtesy SFO Noise Abatement Office
Microphone Noise Measurements
Corrected for Path Offset

Finding from OTA test (rounds 1 and 2)—no significant change found in noise at measurement locations
Finding from OTA test (rounds 1 and 2)—no significant change found in noise at measurement locations
Emissions Analysis
Crean to the Runway

CO2 (3.149*fuel) LBS

CO(g)

HC(g)

NOX(g)
Emissions Analysis
Within the TRACON (from 10,000’ high to the Runway)
OTA trials during low-density operations resulted in no significant change in noise levels over communities where current noise abatement procedures exist:

- However, compared to congested times, the noise exposure contour area is significantly reduced.

- **Flight time was reduction potential varied from 1 to 12 minutes for low to high congestion operations**

- **Fuel savings potential of 250 lb per flight during minimum congestion**
  - However, this savings increases to 400 to 4,200 lb per flight for congested operations.
Summary, Continued

- **Total Emissions Reductions (Low to High Congestion):**
  - CO₂ (7 to 72%)
  - CO (5 to 12%)
  - HC (2 to 19%)
  - NOₓ (0 to 46%)

- **Emissions Reductions below 10,000’ (Low to High Congestion):**
  - CO₂ (41 to 113%)
  - CO (44 to 47%)
  - HC (37 to 54%)
  - NOₓ (15 to 59%)
Noise Measurements
Maximum A-Weighted Noise Level

OTA round 2 UAL76 compliant flights

Corrected maximum A-weighted noise level, dBA

Noise measurement site ID

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Noise Measurements
Sound Exposure Level

OTA round 2 UAL76 compliant flights

Corrected sound exposure level, dB

Noise measurement site ID

12/14/2006
12/17/2006
12/19/2006
12/21/2006
12/22/2006
01/02/2007
01/06/2007
01/07/2007
Modeled Noise Contours

Tailored Arrival

Heavy Congestion Baseline: Level @ 6000 ft for 30 nmi

Light Congestion Baseline Level @ 8,000 ft for 16 nmi

Moderate Congestion Baseline Level @ 8,000 ft for 23 nmi

SEL Contours

- 72
- 71
- 70
- 69
- 68
- 67
- 66
- 65
FAA Integrated Noise Model Predictions
Maximum A-Weighted Noise Level Contours

Round 2 EDA OTA

Typical Congested Baseline

Max Congested Baseline
(incomplete terrain effects)

Average Congested Baseline

Max A-Weighted Noise Level Contours
57 56 55 54 53 52 51 50