Key Points

• Two Noise Abatement Departure Profiles (NADPs) are followed domestically and internationally: the *Close-in* and *Distant* departure profiles

• A Close-in NADP is more beneficial in abating noise in areas *closer* to the runway end; while a Distant NADP is more beneficial in abating noise in areas *farther* down the departure corridor

• A Distant NADP appears to provide the most benefits to the developed areas in the SEA environs
Presentation Overview

• Introduction

• Background on Abatement Departure Profiles

• Review the SEA NADP Noise Analysis Results

• Recommendations

• Respond to Questions from StART Members
Introduction

• To determine the NADPs currently in use at Seattle-Tacoma International Airport (SEA), ESA surveyed five airlines operating Boeing 737-800s at SEA

• The existing NADPs were normalized to Stage Length 4 conditions and aircraft noise exposure was modeled using the Aviation Environmental Design Tool (AEDT)

• ESA compared the Sound Exposure Level (SEL) Contours and Grid Point values for the Close-In and Distant NADPs for four runway ends: 16L, 16C, 34R, and 34C

• The analysis identified a preferred NADP for use at SEA
Important Update

- After the technical work was completed and presented to the StART Working Group on October 14, 2019, Delta Air Lines conducted an internal review of its response to the NADP Survey.

- As a result of that review, Delta Air Lines determined that its survey response incorrectly reflects the NADP that it is using at SEA.

- Delta Air Lines has since indicated that it is using the Distant NADP (NADP 2) at SEA.

- Therefore, Delta’s SEL contours and grid point values would be similar to the Distant NADPs the other four surveyed airlines are flying at SEA.

- However, the NADP Noise Analysis still provides a valuable comparison between the Close-In and Distant NADPs.
Background on NADPs:

Purpose

- NADPs serve as standard departure profiles for the minimization of aircraft noise in communities beneath departure corridors
- NADPs supplement the use of preferential departure runways and flight paths
- NADPs specify acceptable parameters for:
  - Speed
  - Altitude
  - Thrust settings
  - Aircraft configuration (flaps/slats)
# Background on NADPs: Close-In vs. Distant

<table>
<thead>
<tr>
<th>Close-In (NADP1)</th>
<th>Distant (NADP2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intended to provide noise reduction for noise sensitive areas near the departure end of the runway.</td>
<td>Intended to provide noise reduction for all other noise sensitive areas.</td>
</tr>
<tr>
<td>Thrust cutback initiated <em>prior to</em> initiation of flaps/slats retraction.</td>
<td>Thrust cutback initiated <em>after</em> initiation of flaps/slats retraction.</td>
</tr>
<tr>
<td>Climb power typically maintained to 1,500 feet above field elevation, then reduced.</td>
<td>Climb power may be reduced at 800 feet above field elevation.</td>
</tr>
<tr>
<td>Speed and thrust criteria are maintained to 3,000 feet above field elevation or full transition to en route climb configuration.</td>
<td></td>
</tr>
<tr>
<td>Standard departure internationally.</td>
<td>Standard departure in the U.S.</td>
</tr>
</tbody>
</table>


*Reduction of noise in one area results in a noise increase in another area.*
Background on NADPs: Close-In vs. Distant

Not to Scale

- **Retract Flaps/Slats before 3,000’ AFE**
- **Cutback Thrust at 1,500’ AFE**
- **Retract Flaps/Slats, Cutback Thrust at 800’ AFE**
- **Transition to Normal Climb Procedures**

Source: Boeing, ESA Annotations, October 2019

AFE = Above Field Elevation
Background on NADPs: International Civil Aviation Organization (ICAO)

• In addition to the US NADPs recommended by the FAA, there are two NADPS that are used by international aircraft operators

• International Civil Aviation Organization (ICAO) Procedure A (Close-In)
  - The internationally accepted procedure
  - Consideration is given to areas closest to airports
  - If procedures are not followed, airlines can face penalties/fines (AOPA, 2018)

• ICAO Procedure B (Distant)
  - Can be used to meet single-engine performance requirements usually dictated by terrain
  - Also used for noise abatement when appropriate to specific communities
Background on NADPs

• Interpretation of NADPs may vary according to:
  
  – Airline
    • Based on standard operating procedures
    • Flight optimization practices/software utilized
  
  – Aircraft Type
    • Engine type
    • Noise footprint
SEA NADP Noise Analysis Results

• Noise Analysis Overview
  
  − Aviation Environmental Design Tool, Version 2d (AEDT)
    • FAA-approved software for modeling aircraft noise exposure
    • Allows for dynamic modeling of aircraft performance in space and time
    • Can calculate the noise exposure of single flights or multiple operations
  
  − Boeing 737-800 selected as representative aircraft
    • Prevalence throughout domestic fleets
    • Prevalence at SEA
    • Robust SEL footprint
SEA NADP Noise Analysis Results: Existing Conditions

- Five airlines operating the Boeing 737-800 at SEA were surveyed to determine the NADPs currently in use.

<table>
<thead>
<tr>
<th>Airline</th>
<th>Reported NADP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alaska Airlines</td>
<td>Distant</td>
</tr>
<tr>
<td>American Airlines</td>
<td>Distant</td>
</tr>
<tr>
<td>Delta Air Lines</td>
<td>Close-In*</td>
</tr>
<tr>
<td>Southwest Airlines</td>
<td>Distant (Equivalent)</td>
</tr>
<tr>
<td>United Airlines</td>
<td>Distant</td>
</tr>
</tbody>
</table>


*Delta Air Lines has indicated, post SEA NADP Noise Analysis, that it uses the Distant NADP at SEA
SEA NADP Noise Analysis Results: Existing Conditions

• The detailed survey responses were used to develop the AEDT inputs

• Modeling Assumptions
  - Annual average day temperature for SEA – 52 degrees F
  - Headwind – Turned on – 6.69 Knots
  - Terrain – Turned on

• The AEDT calculated the Sound Exposure Level (SEL) contours and SEL grid point values for existing NADP conditions
SEA NADP Noise Analysis Results: Existing Conditions

- There are no federal standards for aircraft SELs
- Different SEL contour values yield different results
- Which SEL contours are most useful for comparing NADPs?
SEA NADP Noise Analysis Results

- Which SEL contours are most useful for comparing NADPs?

SEL 90 dBA Contours


Note: SEL Contours represent the Stage Length 4 condition
SEA NADP Noise Analysis Results

• Which SEL contours are most useful for comparing NADPs?

SEL 90 dBA Contours and the SEL 80 dBA Contours


Note: SEL Contours represent the Stage Length 4 condition.
The AEDT noise model associates a typical aircraft departure weight with a “stage length”

<table>
<thead>
<tr>
<th>Stage Length</th>
<th>Distance to Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage Length 1</td>
<td>0 to 500 miles</td>
</tr>
<tr>
<td>Stage Length 2</td>
<td>500 to 1,000 miles</td>
</tr>
<tr>
<td>Stage Length 3</td>
<td>1,001 to 1,500 miles</td>
</tr>
<tr>
<td>Stage Length 4</td>
<td>1,501 to 2,500 miles</td>
</tr>
<tr>
<td>Stage Length 5</td>
<td>2,501 to 3,500 miles</td>
</tr>
<tr>
<td>Stage Length 6</td>
<td>3,501 to 4,500 miles</td>
</tr>
<tr>
<td>Stage Length 7</td>
<td>4,501 to 5,500 miles</td>
</tr>
<tr>
<td>Stage Length 8</td>
<td>5,501 to 6,500 miles</td>
</tr>
<tr>
<td>Stage Length 9</td>
<td>6,500+ miles</td>
</tr>
</tbody>
</table>

SEA NADP Noise Analysis Results: Close-In vs. Distant NADP Conditions

- Variations among operators’ reported typical departure weights resulted in the assignment of different stage lengths in the AEDT
  - Stage Length 3 – Southwest Airlines
  - Stage Length 4 – Alaska Airlines, American Airlines, and United Airlines
  - Stage Length 5 – Delta Air Lines

- In order to control for variations in typical aircraft departure weights, stage lengths assigned to the individual operators were normalized to Stage Length 4
SEA NADP Noise Analysis Results: Close-In vs. Distant NADP Conditions

- SEL contours for Runway 16C
SEA NADP Noise Analysis Results: Close-In vs. Distant NADP Conditions

- Plotted SEL grid point values for Runway 16C

SEA NADP Noise Analysis Results: Close-In vs. Distant NADP Conditions

- SEL contours for Runway 16L

SEA NADP Noise Analysis Results: Close-In vs. Distant NADP Conditions

- Plotted SEL grid point values for Runway 16L

SEA NADP Noise Analysis Results:
Close-In vs. Distant NADP Conditions

- SEL contours for **Runway 34C**

**SOURCE:** AEDT 2d, 2019; ESA, September 2019.
SEA NADP Noise Analysis Results: Close-In vs. Distant NADP Conditions

- Plotted SEL grid point values for **Runway 34C**

SEA NADP Noise Analysis Results: Close-In vs. Distant NADP Conditions

- SEL contours for **Runway 34R**

SEA NADP Noise Analysis Results: Close-In vs. Distant NADP Conditions

- Plotted SEL grid point values for **Runway 34R**

SEA NADP Noise Analysis Results: People Exposed to SEL 80 dBA and Higher

<table>
<thead>
<tr>
<th>NADP</th>
<th>16C</th>
<th>16L</th>
<th>34C</th>
<th>34R</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEL 80 dBA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Close-In</td>
<td>76,200</td>
<td>79,435</td>
<td>94,905</td>
<td>89,987</td>
</tr>
<tr>
<td>Distant</td>
<td>73,088</td>
<td>75,781</td>
<td>68,551</td>
<td>68,698</td>
</tr>
<tr>
<td>Difference</td>
<td>3,111</td>
<td>3,655</td>
<td>26,353</td>
<td>21,288</td>
</tr>
<tr>
<td>SEL 90 dBA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Close-In</td>
<td>4</td>
<td>1</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Distant</td>
<td>171</td>
<td>141</td>
<td>528</td>
<td>119</td>
</tr>
<tr>
<td>Difference</td>
<td>-167</td>
<td>-140</td>
<td>-521</td>
<td>-116</td>
</tr>
</tbody>
</table>


- For this analysis, the American Airlines NADP represented the Distant NADP and was compared to the Delta Air Lines Close-In NADP.

- The Distant NADP exposes fewer people within the SEL 80 dBA contour, while the Close-In NADP exposes fewer people within the SEL 90 dBA contour.

- These results are consistent with expectations regarding the benefits and drawbacks of the Close-In and Distant NADPs.
SEA NADP Noise Analysis Results: Conclusions and Recommendations

- Based on the B737-800 results, ESA recommends that the Port of Seattle request all aircraft operators implement the **Distant NADP (NADP 2)** or its ICAO equivalent (Procedure B) at SEA

- The Port’s implementation process may benefit from direct meetings with the airlines

- The Port should track and report on airline adoption and use of the Distant NADP

- The Port should evaluate and report on the change in aircraft noise exposure levels over time due to the Distant NADP
Questions from StART Members?