TECHNICAL MEMORANDUM

To:	Ms. Grace Leung City Manager City of Newport Beach, California 100 Civic Center Drive Newport Beach, CA 92660
From:	Justin W. Cook – INCE, LEED GA
Date:	December 7, 2019
Subject:	John Wayne Airport (SNA) - Aircraft Noise Abatement Departure Procedure (NADP) Analysis - Task 2
Reference:	HMMH Project Number 309680.000

1. BACKGROUND

This technical memorandum contains results from further analysis conducted since the publication of HMMH technical memorandum entitled, "John Wayne Airport (SNA) – Aircraft Noise Abatement Departure Procedure (NADP) Analysis – Task 1" that was dated September 26, 2018.

The results of Task 1, especially the modeled results of the supplemental analysis, provided a solid foundation for the analysis conducted as part of Task 2. The goal of Task 2 was to determine whether improvements are possible to NADP-1 or NADP-2 to reduce noise levels at NMS 5s, 6s, and 7s by comparing modeled to measured data at SNA Noise Monitoring Stations (NMS) 5s, 6s, and 7s.

1.1 Modeling Analysis

HMMH utilized the Federal Aviation Administration's (FAA) Aviation Environmental Design Tool 2d (AEDT) to model noise levels for various scenarios at NMS 5s, 6s, and 7s. NMS 5s is located at 324 ½ Vista Madera, NMS 6s is located at 1912 Santiago, and NMS 7s is located at 1311 Back Bay Drive in the City of Newport Beach, California, as depicted in Figure 1.

There were six (6) scenarios modeled: NADP-2 – 800-foot cutback, NADP-2 – 1,500-foot cutback, NADP-1 – 800-foot cutback, NADP-1 – 1,100-foot cutback, NADP-1 – 1,200-foot cutback, and NADP-1 – 1,500-foot cutback.

Flight track and aircraft identification data as well as correlated noise event data was obtained from SNA for four (4) months, October 2017 through January 2018. The analysis of Task 2 focused on the Boeing 737-700, Boeing 737-800, Airbus A319, and Airbus A320 aircraft for a single airline (Airline A). Data was analyzed from 7 a.m. to 9 a.m. each day for the complete four (4) months of data.

HMMH identified 2,257 aircraft operation in the NOMS system that occurred between the hours of 7:00 a.m. and 9:00 a.m. at SNA over the four (4) month period. The flight track geometry and actual takeoff weight data provided by SNA was imported into AEDT and the appropriate aircraft type was applied to the inputs. The AEDT model was then run for each of the 2,257 individual aircraft operations for each of the five (5) scenarios.

AEDT has several settings that affect aircraft performance profiles and sound propagation based on meteorological data. Meteorological settings include average annual temperature, barometric pressure, and relative humidity at the airport. AEDT holds the following values for annual average weather conditions at SNA:

- Temperature: 65° F
- Sea-level Pressure: 1015.38 Millibars
- Relative Humidity: 69.45%
- Dew Point: 52.96° F
- Wind Speed: 5.54 Knots

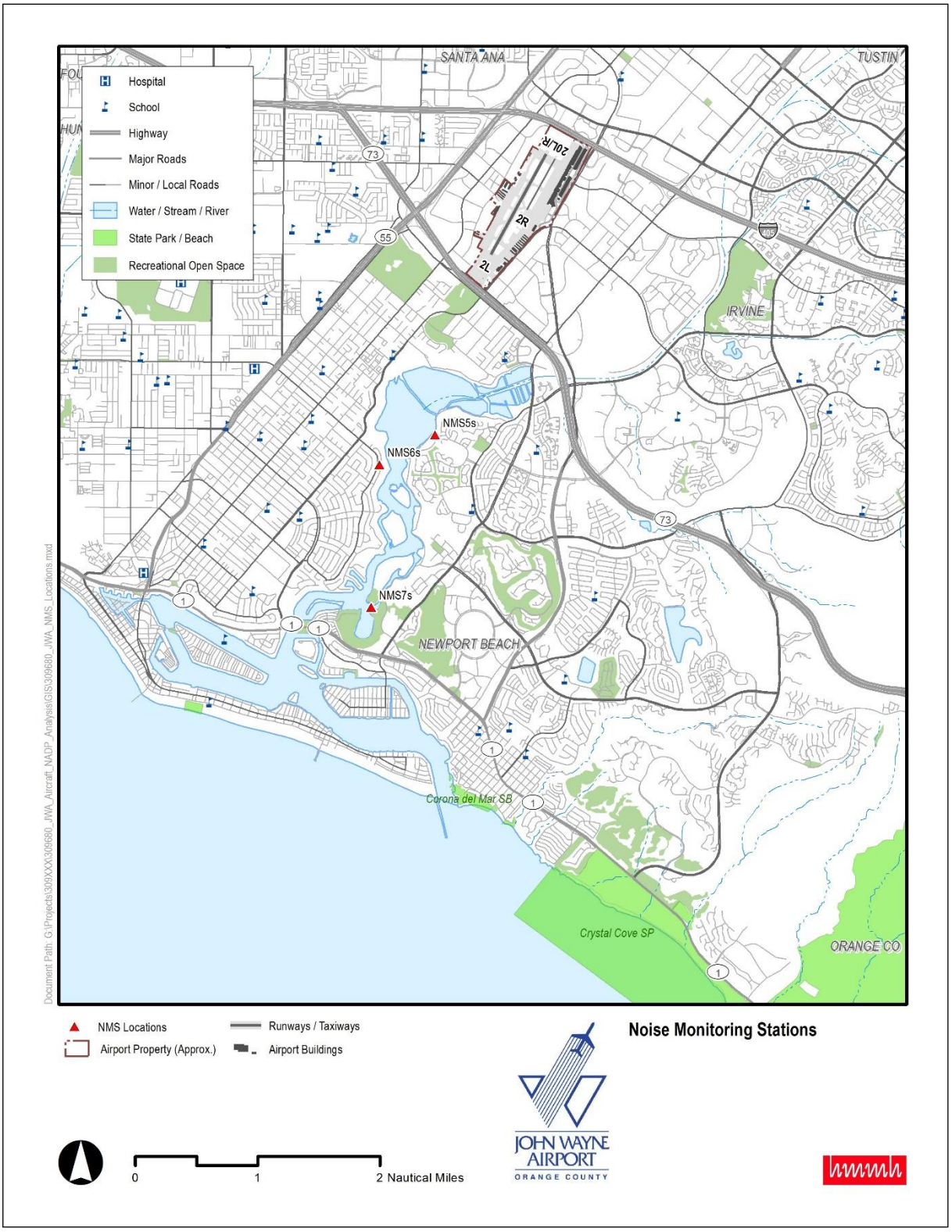


Figure 1. Noise Monitoring Stations (NMS

AEDT uses terrain data to adjust the ground level under the flight paths. The terrain data does not affect the aircraft's performance or noise levels but does affect the vertical distance between the aircraft and a "receiver" on the ground. This in turn affects noise propagation assumptions about how noise propagates over ground. The terrain data was obtained from the United States Geological survey (USGS) National Map Viewer and was used with the terrain features of AEDT on in this analysis.

Within the AEDT database, aircraft takeoff or departure profiles are usually defined by a range of trip distances identified as "stage length." A longer trip distance or higher stagelength is associated with a heavier aircraft due to the increase in fuel requirements for the flight. Stagelength in this analysis was determined by the GTOW as provided by SNA.

Specific noise and performance data must be entered into AEDT for each aircraft type. Noise data is included in the form of Sound Exposure Level (SEL) at a range of distances (from 200 feet to 25,000 feet) from a particular aircraft with engines at a specific thrust level. Performance data includes thrust, speed, and altitude profiles for takeoff and landing operations. The AEDT database contains standard noise and performance data for over 300 different fixed-wing aircraft types, most of which are civilian aircraft. AEDT automatically accesses the noise and performance data for takeoff and landing operations by those aircraft. For the analysis as part of Task 2, HMMH created custom profiles for each aircraft type by utilizing Assumed Temperature (AT) data provided by Airline A.

The only current thrust modes in the AEDT model are the maximum takeoff and maximum climb modes. Airlines typically use less than the maximum thrust available, primarily to reduce the maintenance costs associated with running the engines at full thrust. The most common method for determining a lower-than-maximum thrust is through the use of AT. AT methods use the fact that turbine engines are flat-rated up to a given temperature, above which the engines' thrust falls off with increasing temperature. By inputting a higher-than-actual temperature (the AT) into the engine management system (EMS), the engines will operate as if the AT were setting the limits on the thrust the engine could produce.

Note that because the actual temperature is lower than the AT, the density of the air going through the engine is higher than what the EMS is using, so the engines actually generate more thrust with an AT than they would if the AT were the actual temperature.

Rather than attempting to model each individual flight using its unique AT, we elected to use the up-coming AEDT 3 method of a fixed percentage thrust reduction as a representation of the in-practice use of reduced thrust. Based on our analysis of the data, we used the AEDT 3 maximum thrust reduction of 15% for the takeoff thrust, followed by a climb thrust reduction of 10%. The thrusts were modeled by modifying the ANP takeoff and climb thrust coefficients.

1.2 Measurement Analysis

In addition to providing AT data, Airline A also conducted periods of test flights for the following scenarios: NADP-2 – 800-foot cutback, NADP-1 – 800-foot cutback, and NADP-1 – 1,500-foot cutback. Noise monitoring data for NMS 5s, 6s, and 7s was provided by SNA. Refer to Figure 2 for a general depiction of the difference between NADP-1 800-foot and 1,500-foot cutbacks for Airline A. Refer to Figure 3 for a general depiction of the difference between NADP-2 800-foot and 1,500-foot cutbacks for Airline A.

2. RESULTS

Tables 1-3 below detail the average measured and modeled SEL noise levels for Airline A and four (4) aircraft types for NMS 5s, 6s, and 7s respectively. Each table has six (6) rows of data that correspond to five (5) scenarios: NADP-2 – 800-foot cutback, NADP-2 – 1,500-foot cutback, NADP-1 – 800-foot cutback, NADP-1 – 1,100-foot cutback, NADP-1 – 1,200-foot cutback, and NADP-1 – 1,500-foot cutback. The last two (2) rows of data are the same scenario, but for two different measurement periods. The figures below Tables 1-3 contain a graphical representation of the data within each of the respective tables.

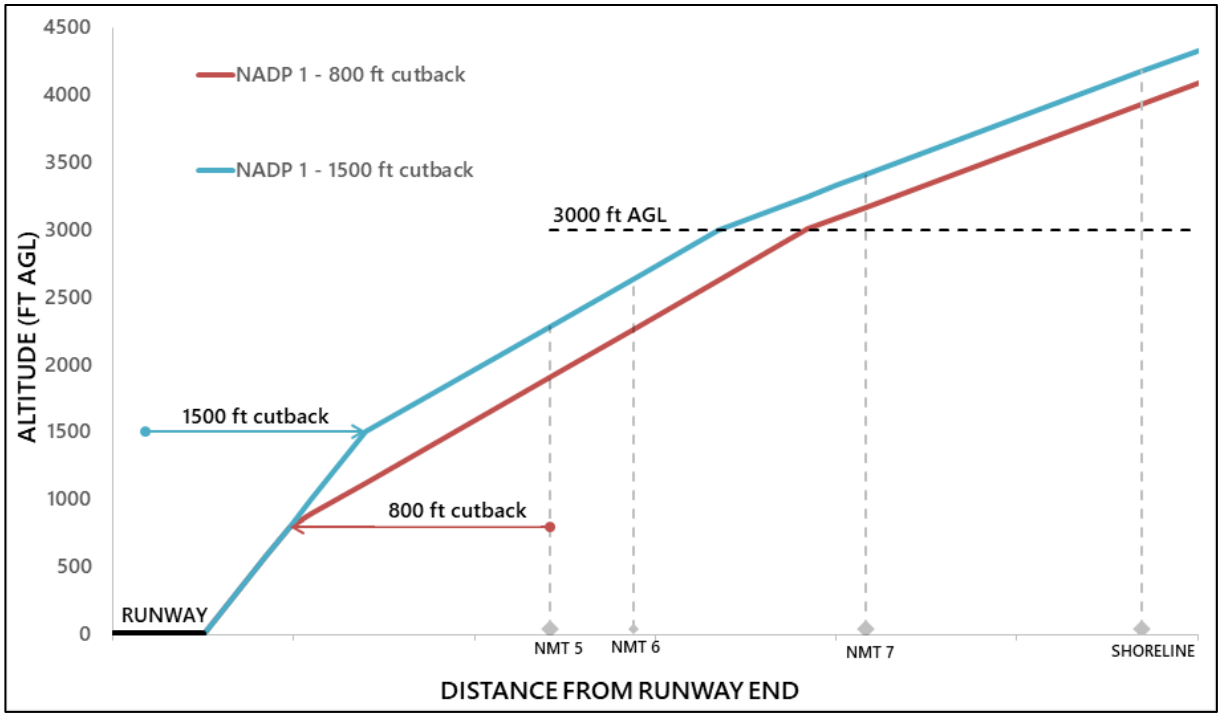


Figure 2. Airline A – NADP-1 800-Foot and 1,500-Foot Cutbacks

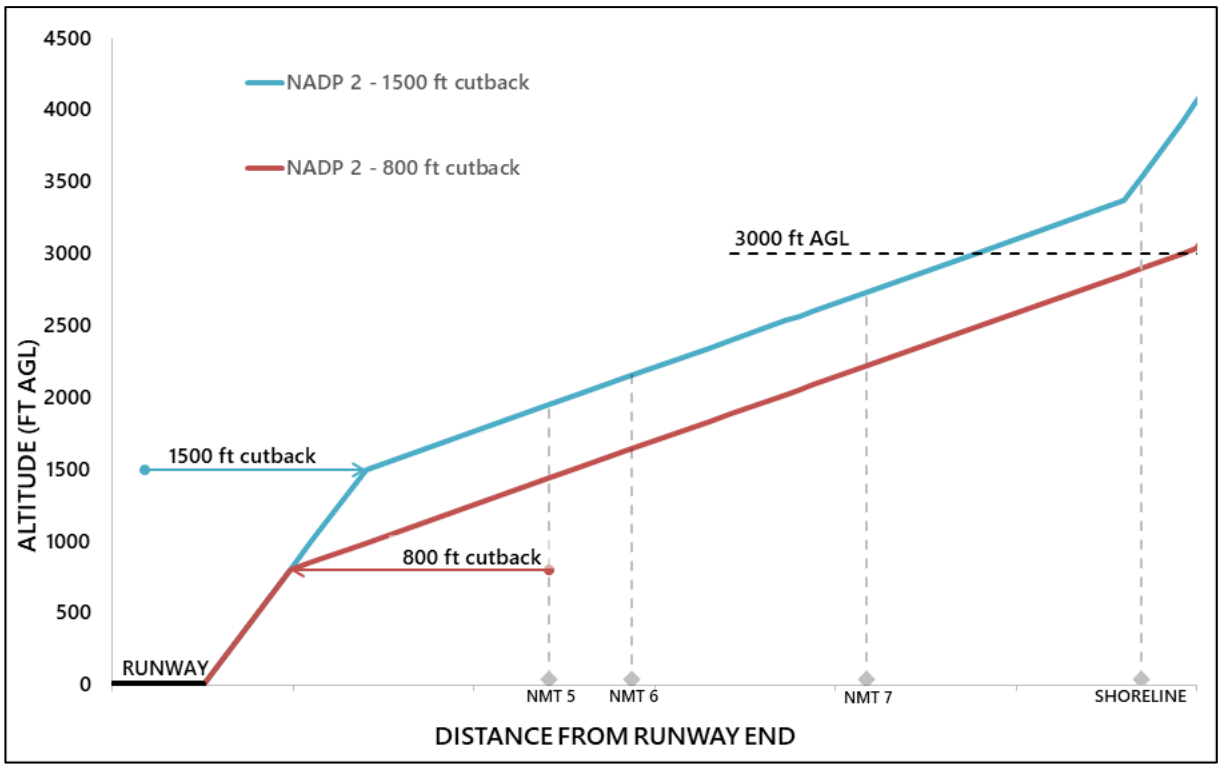


Figure 3. Airline A – NAPD-2 800-Foot and 1,500-Foot Cutbacks

Table 1. NMS 5s Average Measured and Modeled SEL Values for Airline A

Scenario	Average Measured SEL Noise Levels (dB)				Average Modeled SEL Noise Levels (dB) [1]			
	B737	B738	A319	A320	B737	B738	A319	A320
NADP-2[2] – 800 Foot Cutback (Measured 10/2017 – 1/2018)	89.5	89.1	85.1	85.7	88.0	87.6	82.7	85.8
NADP-2[2] – 1,500 Foot Cutback	N/A	N/A	N/A	N/A	88.3	88.9	83.6	87.3
NADP-1 – 800 Foot Cutback (Measured 3/2019)	90.2	90.0	84.4	85.0	89.6	89.1	83.0	83.2
NADP-1 – 1,100 Foot Cutback	N/A	N/A	N/A	N/A	89.5	89.0	82.8	83.0
NADP-1 – 1,200 Foot Cutback	N/A	N/A	N/A	N/A	89.5	89.0	82.7	82.9
NADP-1 – 1,500 Foot Cutback (Measured 3/2019)	91.5	91.4	86.3	86.6	89.7	89.2	82.7	83.1
NADP-1 – 1,500 Foot Cutback (Measured 7-9/2019)	90.3	90.1	84.9	85.4				

Notes: [1] Numerical calculation is airline and aircraft specific
[2] Primary procedure used by airline

Figure 4. NMS 5s Average Measured (10/2017-1/2018) (Blue) and Modeled (Orange) SEL Values for Airline A for Scenario NADP-2 – 800 Foot Cutback

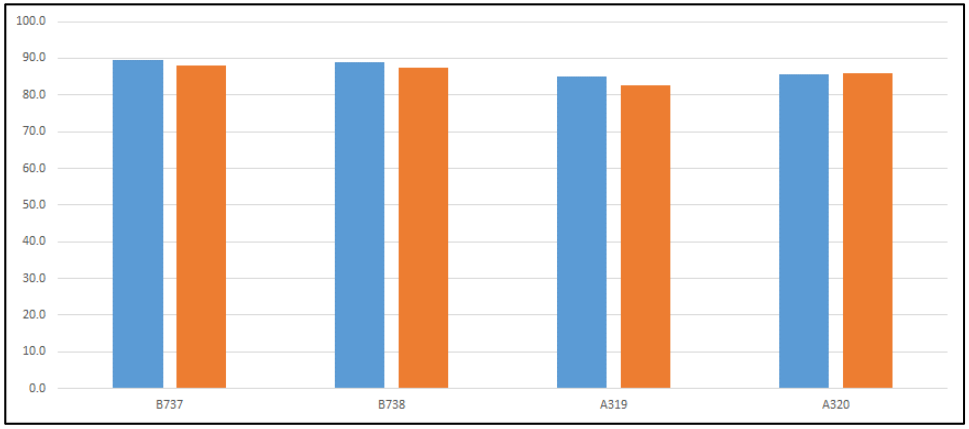


Figure 5. NMS 5s Average Measured (3/2019) (Blue) and Modeled (Orange) SEL Values for Airline A for Scenario NADP-1 – 800 Foot Cutback

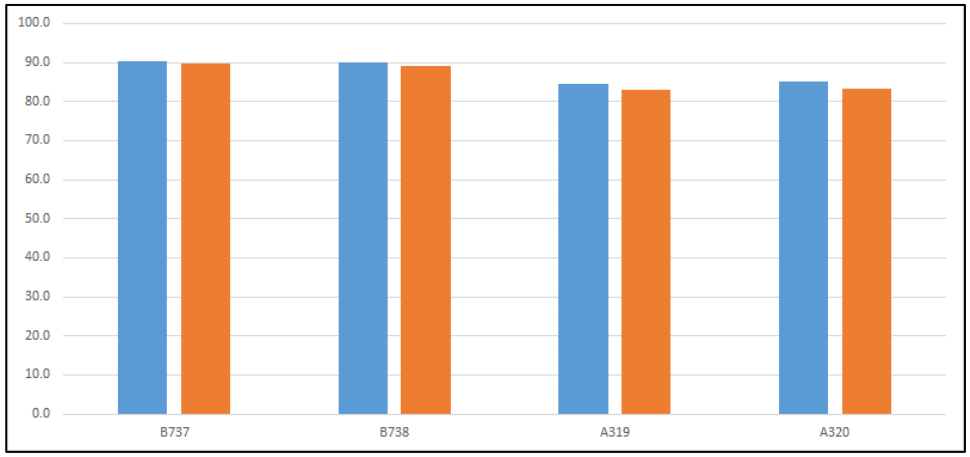


Figure 6. NMS 5s Average Measured (3/2019) (Blue), Measured (7-9/2019) (Grey) and Modeled (Orange) SEL Values for Airline A for Scenario NADP-1 – 1,500 Foot Cutback

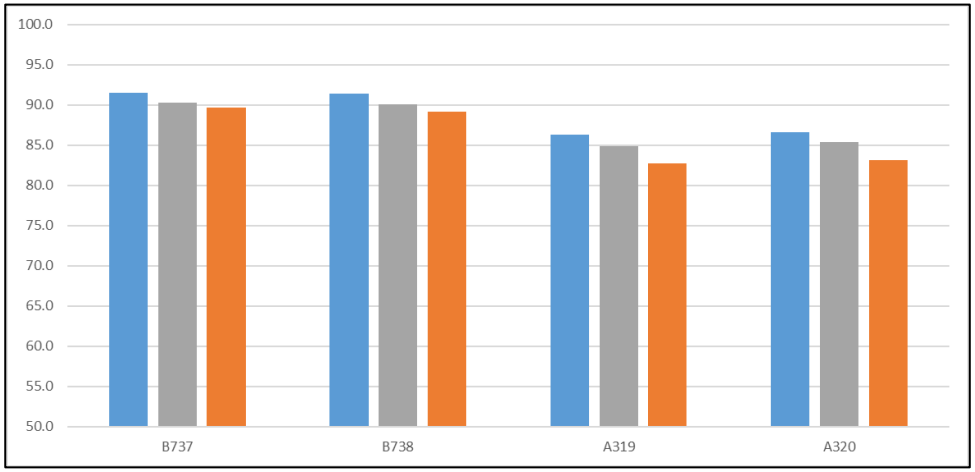


Table 2. NMS 6s Average Measured and Modeled SEL Values for Airline A

Scenario	Average Measured SEL Noise Levels (dB)				Average Modeled SEL Noise Levels (dB) [1]			
	B737	B738	A319	A320	B737	B738	A319	A320
NADP-2[2] – 800 Foot Cutback (Measured 10/2017 – 1/2018)	90.4	90.0	86.7	88.0	90.0	89.2	86.1	88.7
NADP-2[2] – 1,500 Foot Cutback	N/A	N/A	N/A	N/A	89.8	89.1	84.6	87.5
NADP-1 – 800 Foot Cutback (Measured 3/2019)	90.8	90.6	85.6	86.6	89.9	89.0	84.5	87.4
NADP-1 – 1,100 Foot Cutback	N/A	N/A	N/A	N/A	89.9	88.8	84.3	87.1
NADP-1 – 1,200 Foot Cutback	N/A	N/A	N/A	N/A	89.8	88.8	84.3	87.1
NADP-1 – 1,500 Foot Cutback (Measured 3/2019)	91.2	90.5	86.6	86.5	89.8	89.1	84.2	87.2
NADP-1 – 1,500 Foot Cutback (Measured 7-9/2019)	90.2	89.7	85.4	85.8				

Notes: [1] Numerical calculation is airline and aircraft specific
[2] Primary procedure used by airline

Figure 7. NMS 6s Average Measured (10/2017-1/2018) (Blue) and Modeled (Orange) SEL Values for Airline A for Scenario NADP-2 – 800 Foot Cutback

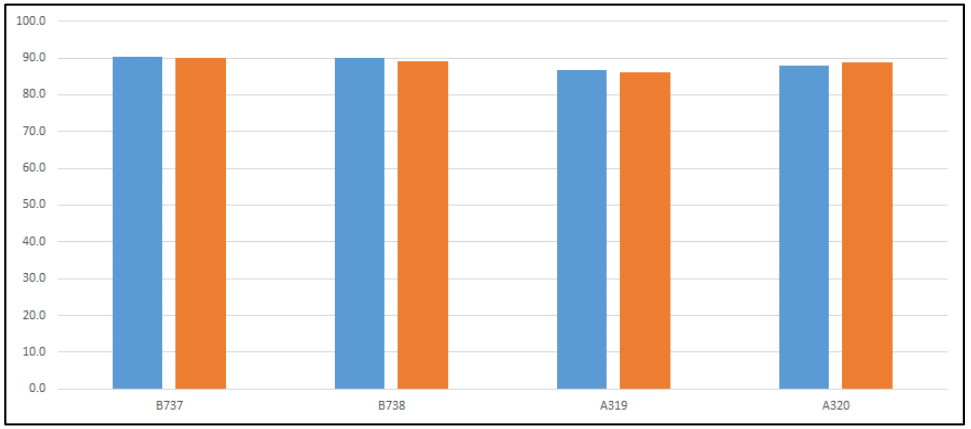


Figure 8. NMS 6s Average Measured (3/2019) (Blue) and Modeled (Orange) SEL Values for Airline A for Scenario NADP-1 – 800 Foot Cutback

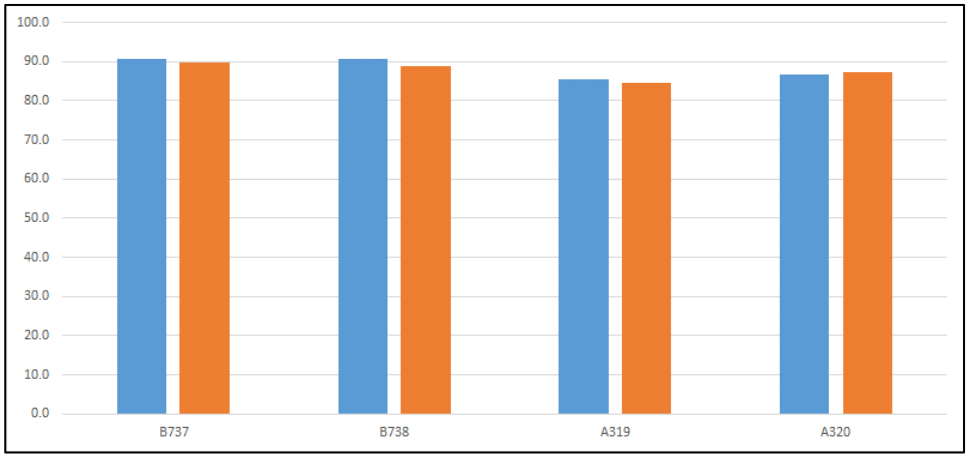


Figure 9. NMS 6s Average Measured (3/2019) (Blue), Measured (7-9/2019) (Grey) and Modeled (Orange) SEL Values for Airline A for Scenario NADP-1 – 1,500 Foot Cutback

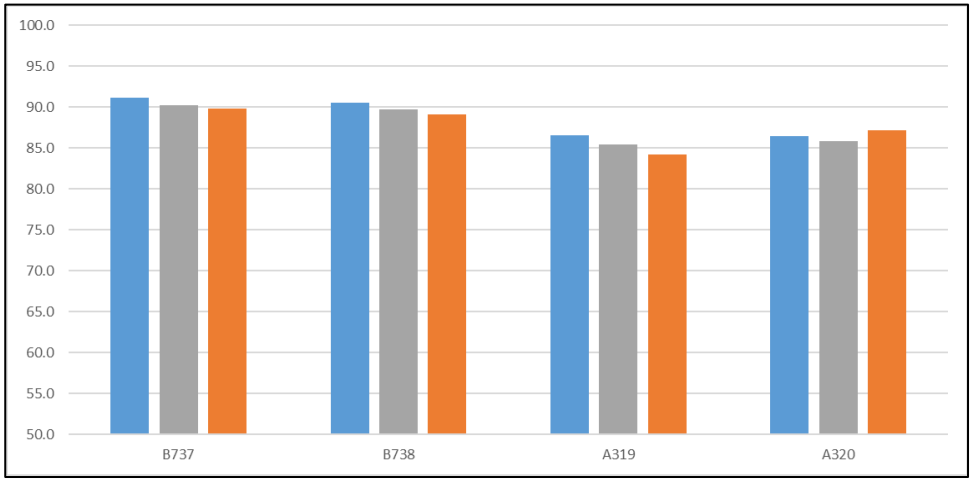


Table 3. NMS 7s Average Measured and Modeled SEL Values for Airline A

Scenario	Average Measured SEL Noise Levels (dB)				Average Modeled SEL Noise Levels (dB) [1]			
	B737	B738	A319	A320	B737	B738	A319	A320
NADP-2[2] – 800 Foot Cutback (Measured 10/2017 – 1/2018)	85.7	86.1	84.7	86.1	87.1	86.7	83.3	87.3
NADP-2[2] – 1,500 Foot Cutback	N/A	N/A	N/A	N/A	87.2	86.2	82.9	85.5
NADP-1 – 800 Foot Cutback (Measured 3/2019)	87.2	88.3	81.7	83.1	87.2	86.5	81.5	84.8
NADP-1 – 1,100 Foot Cutback	N/A	N/A	N/A	N/A	87.2	86.4	81.4	84.5
NADP-1 – 1,200 Foot Cutback	N/A	N/A	N/A	N/A	87.2	86.3	81.3	84.4
NADP-1 – 1,500 Foot Cutback (Measured 3/2019)	87.2	86.6	82.2	83.0	87.2	86.2	81.2	84.2
NADP-1 – 1,500 Foot Cutback (Measured 7-9/2019)	85.8	86.2	80.2	81.2				

Notes: [1] Numerical calculation is airline and aircraft specific
[2] Primary procedure used by airline

Figure 10. NMS 7s Average Measured (10/2017-1/2018) (Blue) and Modeled (Orange) SEL Values for Airline A for Scenario NADP-2 – 800 Foot Cutback

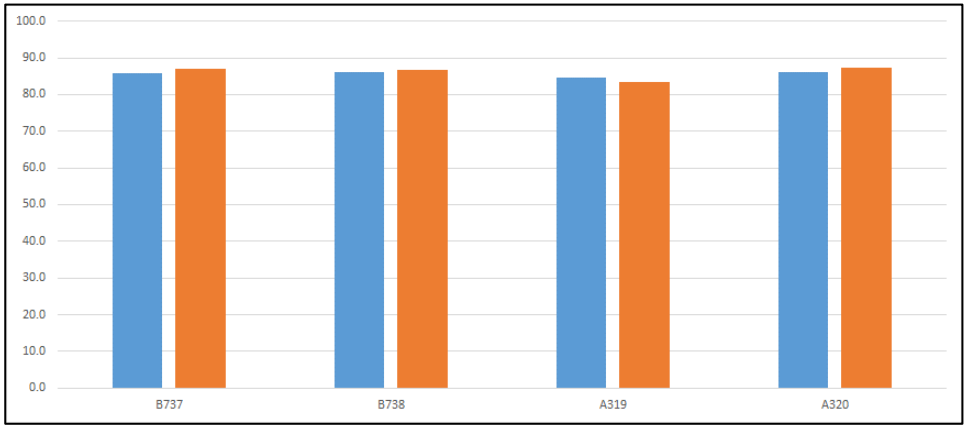


Figure 11. NMS 7s Average Measured (3/2019) (Blue) and Modeled (Orange) SEL Values for Airline A for Scenario NADP-1 – 800 Foot Cutback

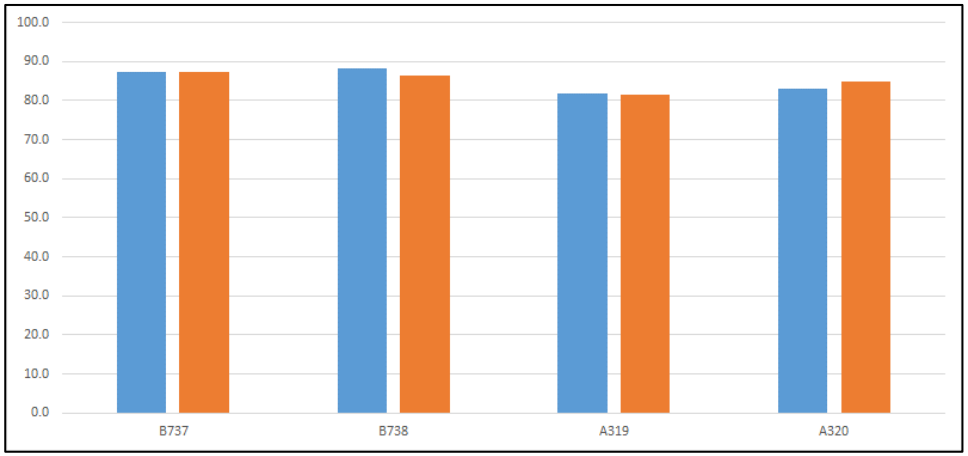
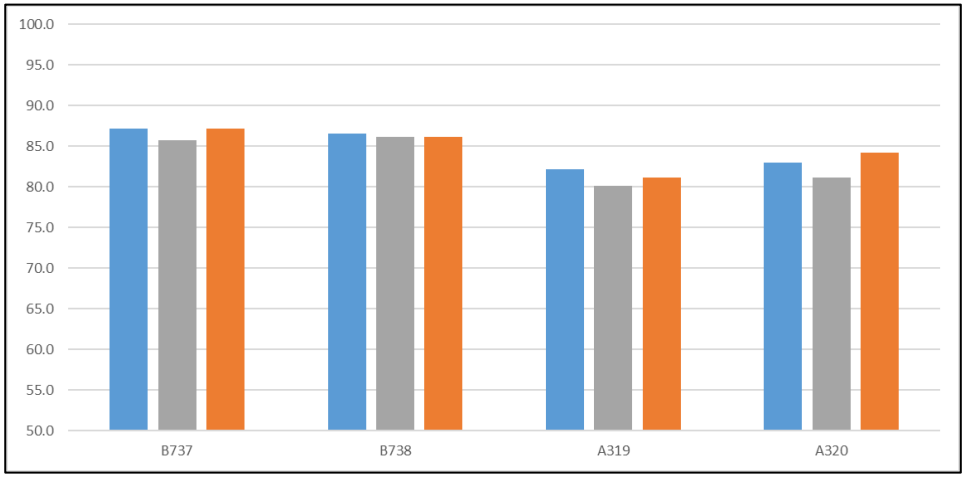


Figure 12. NMS 7s Average Measured (3/2019) (Blue), Measured (7-9/2019) (Grey) and Modeled (Orange) SEL Values for Airline A for Scenario NADP-1 – 1,500 Foot Cutback



3. SUMMARY OF RESULTS

Below is a bullet point summary of the results presented in the tables and figures above.

- There is little to no noise level differences between the modeled NADP-1 scenarios with varying cutbacks of 1,100, 1,200 and 1,500 feet at RMT's 5, 6 and 7.
- The noise measurement data from the test flights using NADP-1 with a 1,500-foot cutback, which occurred between July and September 2019, correlate very well to the modeled data using NADP-1 with a 1,500-foot cutback.
- Comparing the modeled data of NADP-2 with a 800-foot cutback to NADP-2 with a 1,500-foot cutback, NADP-2 with a 1,500-foot cutback had a lower noise level at RMTs 6 and 7 (average across all aircraft types of 0.7 dB), but a higher noise level at RMT 5 (average across all aircraft types of 1.0 dB).
- Comparing the modeled data of NADP-1 with an 800-foot cutback to NADP-1 with a 1,500-foot cutback, NADP-1 with a 1,500-foot cutback had a lower noise level at RMTs 5, 6 and 7 (average across all aircraft types of 0.1 dB).
- Comparing the modeled data of NADP-2 and NADP-1 with a 1,500-foot cutback, NADP-1 with a 1,500-foot cutback had a lower noise level at RMTs 5, 6 and 7 (average across all aircraft types of 0.5 dB).
- Comparing the measured data of NADP-1 with a 1,500-foot cutback to NADP-2 with an 800-foot cutback, NADP-1 with a 1,500-foot cutback had a lower level at RMT's 6 and 7 (average across all aircraft types of 1.7 dB). At RMT 5, NADP-1 with a 1,500-foot cutback had an average decrease in noise level for the A319 and A320 aircraft types of 0.3 dB. However, for the B737 and B738 aircraft types, there was an average increase in noise level of 0.9 dB.

The primary procedure utilized by Airline A is NADP-2 with a 1,500-foot cutback. If Airline A was to switch to a NADP-1 with a 1,500-foot cutback, on average, it should result in a slight decrease in noise levels at RMTs 5, 6 and. However, based upon the data above, this switch could also result in a slight increase in noise level at and before RMT 5.