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Subject: Whidbey Island Military Jet Noise Measurements

Ladies and Gentlemen:

This report presents the results of additional noise measurements of military jet operations on Whidbey Island near Coupeville, WA. The new noise measurements were conducted on February 2, 2016 during flight carrier landing practice (FCLP) at three locations near Outlying Field Coupeville (OLF Coupeville), approximately 3 miles southeast of Coupeville, WA. Figure 1 presents an aerial photograph showing the noise measurement locations. The additional noise measurements were conducted at Position 1, Position 4, and a new location (Position 6) at the residence located at 118 Keystone Avenue, which is marked by the red star in Figure 1. The aircraft used in these operations were three EA-18G aircraft, which are generally referred to as the "Growlers".

Acoustic Instrumentation

The noise measurements were taken with two data logging sound level meters with recent calibration certificates. The data from Positions 1 and 6 were collected using a Bruel & Kjaer model 2270, and the data from Position 4 was collected using a Bruel & Kjaer model 2238. Both instruments were calibrated with the same portable acoustic calibrator (Bruel & Kjaer model 4230, Serial No. 1025975) prior to the start of the measurements, and both meters were programmed to record the A-weighted sound pressure level and the un-weighted (linear) sound pressure level every second. At each location the sound level meter was positioned on a tripod with the measurement microphone and protective windscreen positioned 5 feet above existing grade and away from nearby reflecting objects. Figure 2 presents a photograph of the B&K 2270 at Position 1 and the B&K 2238 at Position 4. Measurement Position 6 included both an exterior measurement on the upper level north facing deck of the residence and an interior measurement with the sound level meter moved to the upstairs office.

Measurement Results

The noise measurements began a few minutes before noon and ended shortly after 2:15 PM. Unlike the previous measurements which were conducted during a warm spring day, these new measurements were conducted on a cool winter day with clear skies, little or no wind and the temperature at 50 degrees F. and a relative humidity of 45%. Two temporally discrete sessions were recorded, with three jets performing 14 FCLP flyovers in the first session and three jets performing 11 FCLP flyovers in the second session. Data from Position 1 was recorded from the first session of 42 flyovers, and the second session was recorded at Position 6 (half on the deck and half about 10 feet away but inside the house). The measurements at Position 4 (the baseball field at Rhododendron Park) included both the first and second sessions. In each session the number of jets operating increased quickly from the first jet's arrival circle, to all three and at the end of the session trailing off to the last single jet's circle of the racetrack and final departure. With three jets flying, the overheads were approximately 40 to 50 seconds apart, each jet taking about 2.25 minutes to complete one circle of the racetrack.

Figures 3 through 10 present the measured A-weighted and un-weighted peak (linear) sound pressure level as a function of time at each of the three measurement locations. The odd numbered figures present the 1-second average A-weighted sound pressure level (L_{eq}), and the even numbered figures present the un-weighted peak (linear) sound pressure level for each second of the measurement. It should be noted that the A-weighted sound pressure level is always significantly less than the un-weighted peak sound pressure level. There are two reasons for this difference. First and foremost, the A-weighting filters out much of the low frequency noise. Second, each of the A-weighted data points represents an average over a full second, while the un-weighted data points represent the highest sound level during each second. The un-weighted peak sound pressure level is typically about 18 dB higher than the 1-second average (L_{eq}) A-weighted sound pressure level during the aircraft flyover sessions. Most outdoor noise criteria are based on the A-weighted sound pressure level, but some hearing damage criteria are based on the un-weighted peak sound pressure level, and that is why the un-weighted peak data is included in this report.

Table 1 presents the summary noise level statistics for these measurements. The highest noise levels occurred at Position 1 and Position 6 (on the deck). Both of these positions are in a densely populated residential area (Admiral's Cove) 1 mile south of the south end of the OLF runway, with Position 6 being at about the start of the FCLP approach path. The similarity of noise levels was therefore presumably relatively consistent along the approach path crossing Admiral's Cove between Positions 1 and 6.

The first two rows in Table 1 show the maximum A-weighted and peak un-weighted (linear) sound pressure levels during the measured session at each measurement location. The third row presents the total sound exposure level (SEL) for the entire session of jet flyovers. The sound exposure level (SEL) represents the total acoustic energy in a noise event, and it depends not only on the level of the noise but also the duration of the noise. The duration of each session is presented in the 4th row.

Table 1A. 2016 noise level statistics at each measurement location.

Statistic based on 2016 measurements	Pos. 1	Pos. 4	Pos. 6 Deck	Pos.6 Inside
Maximum A-weighted Level (dBA)	118.0	113.1	117.9	94.0
Maximum Un-Weighted Peak Level (dB)	132.7	133.1	133.1	111.6
Session SEL (dBA)	127.3	130.8	127.6	115.7
Session Duration (minutes)	40	73	17	17
Total Jet Flyovers	42	75	17	16
Average SEL per Jet Flyover (dBA)	111.1	112.0	115.3	103.7

Table 1B. 2013 noise level statistics at each measurement location.

Statistic based on 2013 measurements	Pos. 1	Pos. 2	Pos. 3	Pos. 4	Pos. 5
Maximum A-weighted Level (dBA)	119.2	113.4	115.7	114.3	81.1
Maximum Un-Weighted Peak Level (dB)	134.2	126.7	130.6	131.4	101.8
Session SEL (dBA)	128.5	124.5	122.7	127.7	92.1
Session Duration (minutes)	39	58	45	36	25
Total Jet Flyovers	35	43	26	28	8
Average SEL per Jet Flyover (dBA)	113.1	108.2	108.5	113.2	83.1

Because the jets are so close together, there is not enough time for the noise level to return to the ambient noise level before the next jet arrives, so it is not possible to measure the SEL of each individual jet flyover. However, knowing the number of jets and the total SEL for the entire session, it is possible to calculate the average SEL for a single jet flyover at each location, and this is what is shown in the last row of Tables 1A and 1B.

Tables 2A and 2B present the total time (in seconds) that the A-weighted and un-weighted peak sound pressure levels were over the indicated sound level threshold at each measurement location for that measurement session. Note that the times for Position 4 in Table 2A are much greater than Position 1. This is because the data at Position 4 covers both sessions while the data for Position 1 covers only the first session. Likewise, the data for Position 6 (deck) represents only half of the actual session so the actual times for a full session would be approximately twice the values shown.

Table 2A. Time over threshold statistics at each measurement location (2016 data).

Statistic	Pos. 1	Pos. 4	Pos. 6 Deck	Pos. 6 Inside
Total Time over 80 dBA (sec)	649	1,899	384	75
Total Time over 85 dBA (sec)	529	1,360	313	32
Total Time over 90 dBA (sec)	409	896	237	5
Total Time over 95 dBA (sec)	264	491	163	0
Total Time over 100 dBA (sec)	124	254	100	0
Total Time over 105 dBA (sec)	37	85	48	0
Total Time over 110 dBA (sec)	5	16	12	0
Total Time over 100 dB peak linear (sec)	595	1,766	367	73
Total Time over 105 dB peak linear (sec)	464	1,182	288	25
Total Time over 110 dB peak linear (sec)	326	640	209	0
Total Time over 115 dB peak linear (sec)	181	317	122	0
Total Time over 120 dB peak linear (sec)	68	134	64	0
Total Time over 125 dB peak linear (sec)	18	37	23	0
Total Time over 130 dB peak linear (sec)	4	3	2	0

Table 2B. Time over threshold statistics at each measurement location (2013 data).

Statistic	Pos. 1	Pos. 2	Pos. 3	Pos. 4	Pos. 5
Total Time over 80 dBA (sec)	581	1,298	593	919	1
Total Time over 85 dBA (sec)	448	855	365	600	0
Total Time over 90 dBA (sec)	335	371	195	408	0
Total Time over 95 dBA (sec)	235	121	87	248	0
Total Time over 100 dBA (sec)	128	50	39	135	0
Total Time over 105 dBA (sec)	48	18	10	45	0
Total Time over 110 dBA (sec)	11	3	2	8	0
Total Time over 100 dB peak linear (sec)	501	1,299	464	861	6
Total Time over 105 dB peak linear (sec)	385	696	261	550	0
Total Time over 110 dB peak linear (sec)	279	227	125	332	0
Total Time over 115 dB peak linear (sec)	175	83	61	186	0
Total Time over 120 dB peak linear (sec)	87	31	29	83	0
Total Time over 125 dB peak linear (sec)	28	5	5	23	0
Total Time over 130 dB peak linear (sec)	8	0	2	3	0

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Summary and Conclusions

The primary purpose for this study was to determine if there is any significant difference in the measured noise levels when compared with the data collected in 2013. The measurements in 2013 included testing during three sessions, whereas the present data included only two sessions. As a result, the total number of jets is significantly lower during the most recent measurements. However, when you look at the maximum noise levels and the average SEL per jet for both Positions 1 and 4 you will see very little change. In every case the change is less than 2 dB, which is a change in level that is too small to be detected by the human ear, except under laboratory conditions. If you consider the variability in maximum sound level from jet to jet within the same session, the agreement shown in Table 3 is nothing short of amazing. For example, at Position 1 there were 42 over-flights during the first session, and the maximum level for each of the 42 events ranged from 91 dBA to 115 dBA, with an average of 104.6 dBA with a standard deviation of 4.3 dBA. At Position 4 the average maximum level was 100.8 dBA with a standard deviation of 7.4 dBA. There was more scatter in the data at Position 4 because the aircraft were spread out over a wider path compared to Position 1 where there was much less deviation in the flight path from plane to plane. The fact that the measured change from 2013 to 2016 is less than half of the standard deviation of the maximum noise level within a single session suggests that the difference is insignificant.

Table 3. Comparison of 2013 and 2016 noise level statistics (dB).

Noise Level Statistic	2013	2016	Change
Position 1 Maximum A-weighted Level (dBA)	119.2	118.0	-1.2
Position 4 Maximum A-weighted Level (dBA)	114.3	113.1	-1.2
Position 1 Maximum Un-Weighted Peak Level (dB)	134.2	132.7	-1.5
Position 4 Maximum Un-Weighted Peak Level (dB)	131.4	133.1	+1.7
Position 1 SEL per jet	113.1	111.1	-2.0
Position 4 SEL per jet	113.2	112.0	-1.2

Based on these most recent data, I see no reason to change the conclusions presented in my 2013 report. If you have any questions regarding these findings, do not hesitate to give me a call.

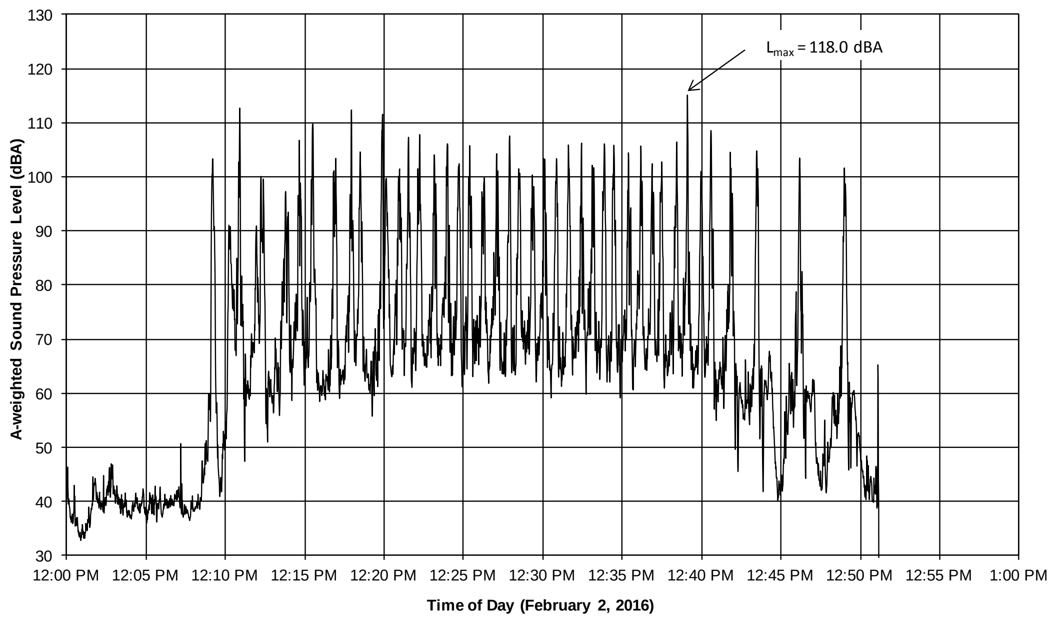
Very truly yours,
JGL Acoustics, Inc,

Jerry G. Lilly, P.E., President, FASA
Member INCE (*Bd. Cert.*), ASTM, NCAC

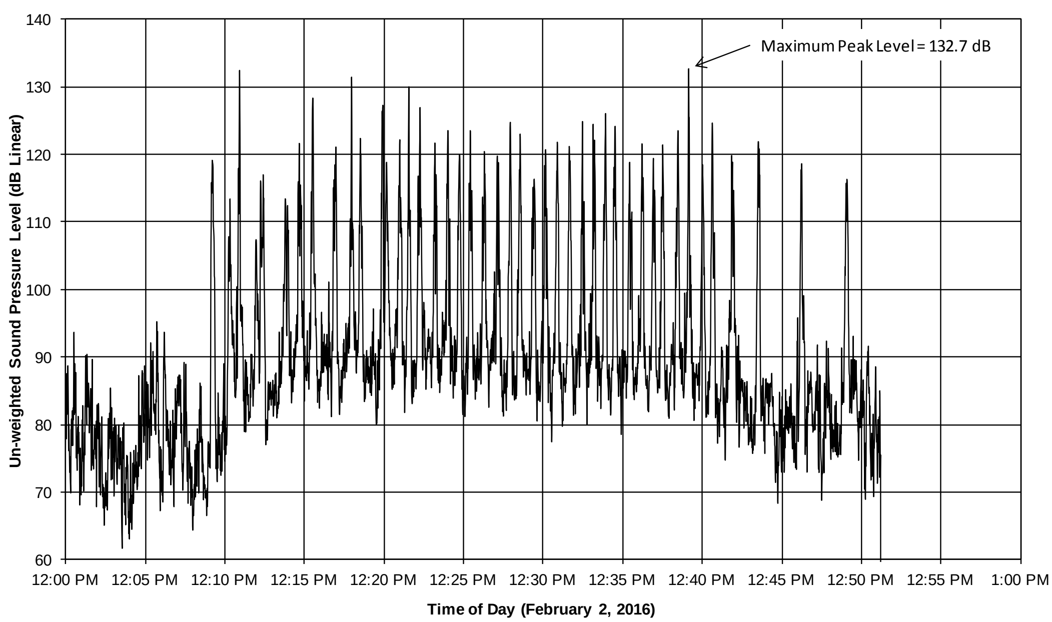
Figure 1. Aerial photograph showing the noise measurement locations.

Figure 2. Photographs of sound level meter at Position 1 (above) and Position 4 (below).

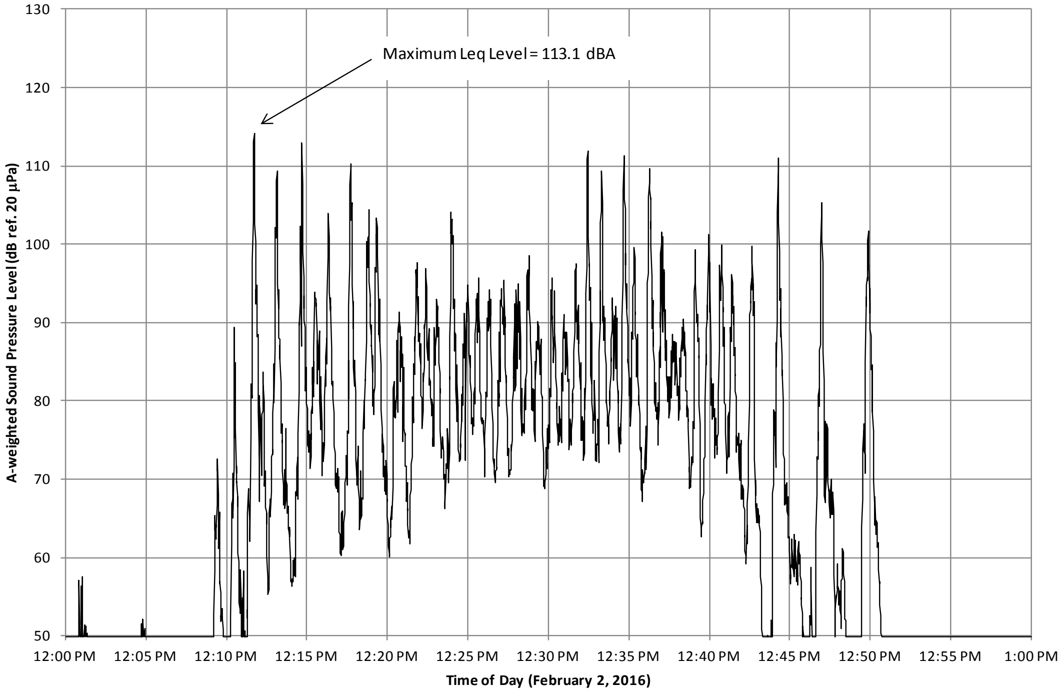
Whidbey Island Military Jet Noise, dBA
Figure 3. Position 1 (empty lot at the corner of Lockwood & Stark)



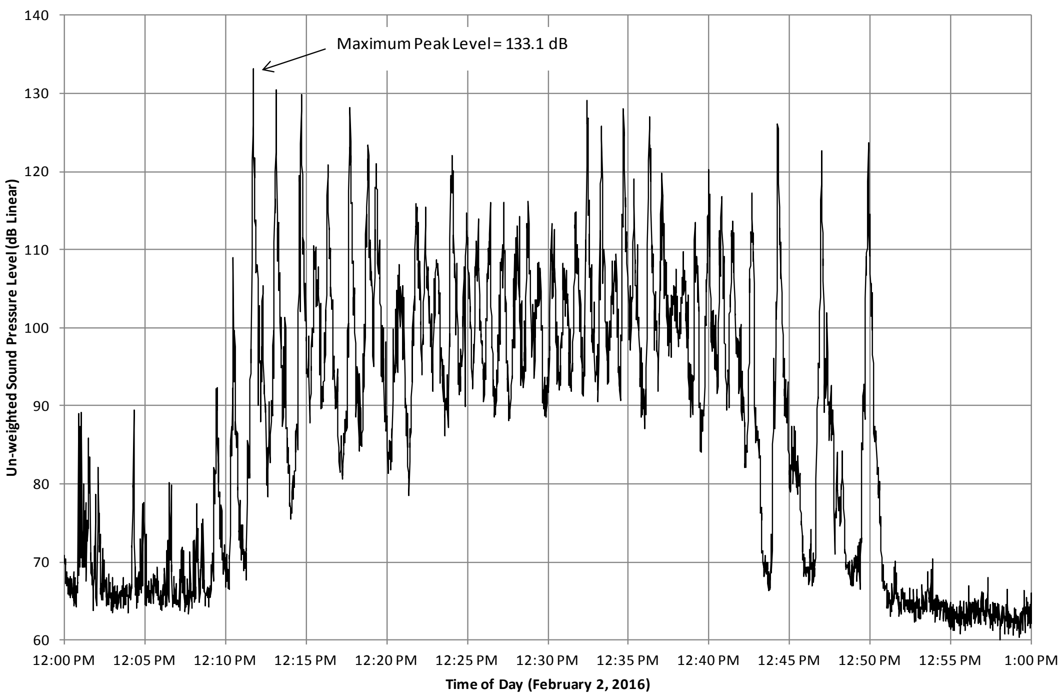
Whidbey Island Military Jet Noise, dB (Linear)
Figure 4. Position 1 (empty lot at the corner of Lockwood & Stark)



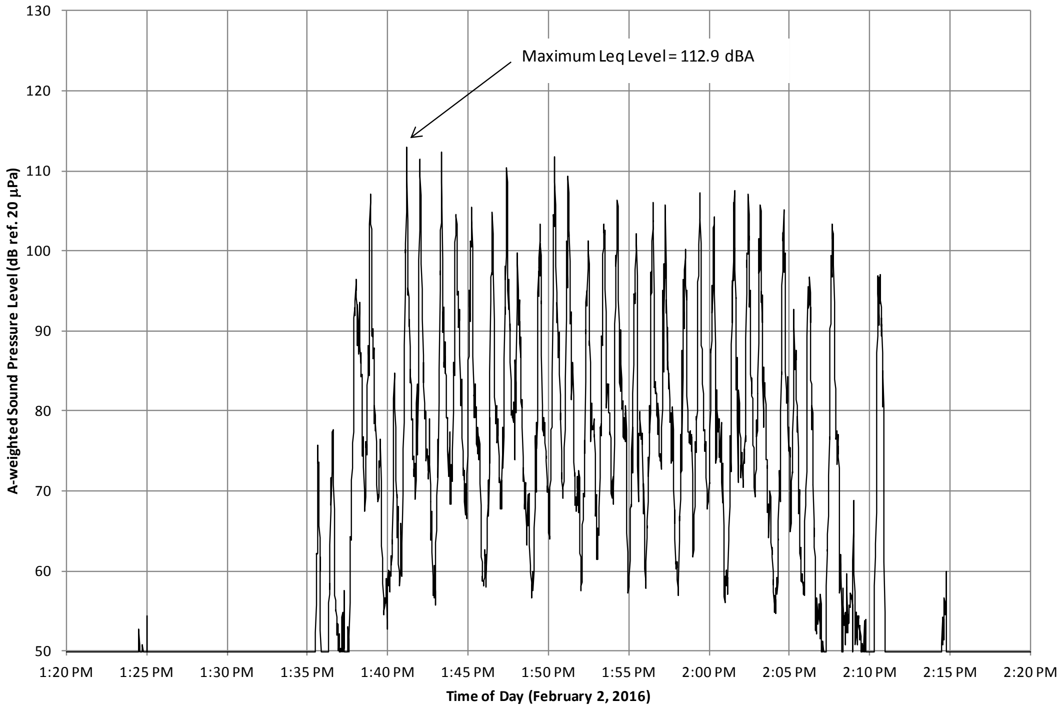
Whidbey Island Military Jet Noise, dBA
Figure 5. Position 4 (Rhodadendron Park Baseball Field)



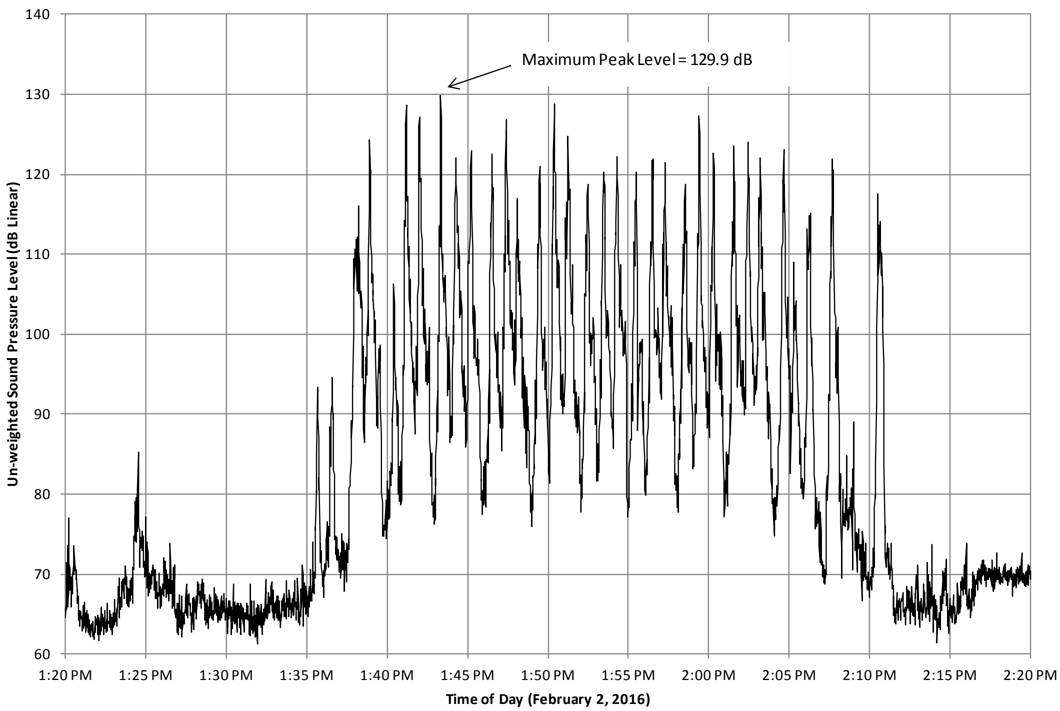
Whidbey Island Military Jet Noise, dB (peak linear)
Figure 6. Position 4 (Rhodadendron Park Baseball Field)



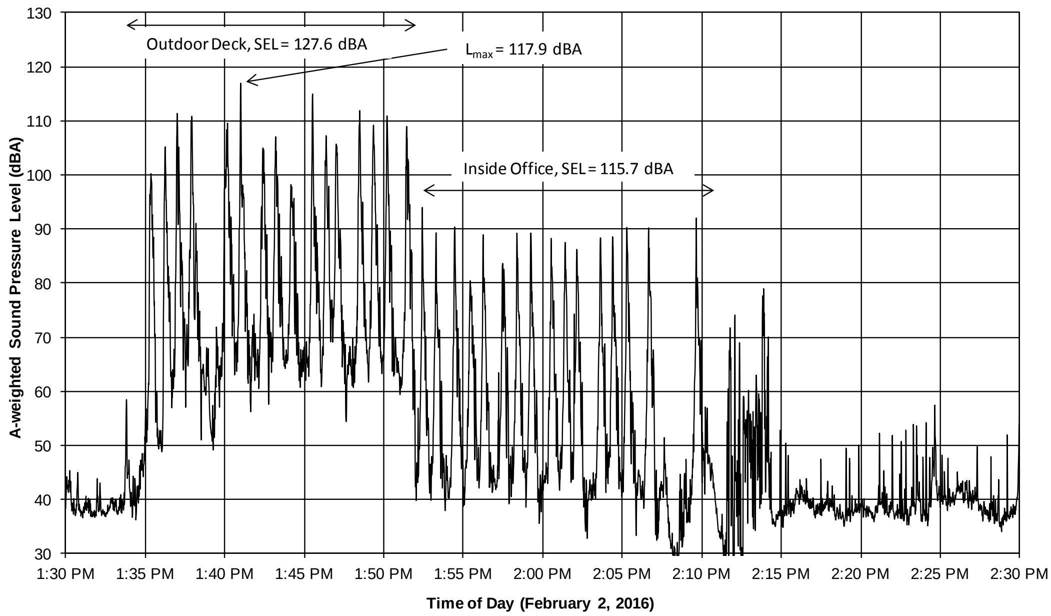
Whidbey Island Military Jet Noise, dBA
Figure 7. Position 4 (Rhodadendron Park Baseball Field)



Whidbey Island Military Jet Noise, dB (peak linear)
Figure 8. Position 4 (Rhodadendron Park Baseball Field)



Whidbey Island Military Jet Noise, dBA
Figure 9. Position 6 (outdoor deck and interior office at 118 Keystone Avenue)



Whidbey Island Military Jet Noise, dB (Linear)
Figure 10. Position 6 (outdoor deck and interior office at 118 Keystone Avenue)