Appendix E

Noise

Appendix E Noise

E.1 General Characteristics of Aircraft Noise

Sound, when transmitted through the air and upon reaching our ears, may be perceived as desirable or unwanted. People normally refer to noise as unwanted sound. Because sound can be subjective, individuals have different perceptions, sensitivities, and reactions to noise. Loud sounds may bother some people, while others may be bothered by certain rhythms or frequencies of sound. Sounds that occur during sleeping hours are usually considered to be more objectionable than those that occur during daytime hours.

Aircraft noise originates from both the engines and the airframe of an aircraft, but the engines are by far the more significant source of noise. Meteorological conditions affect the propagation (or transmission) of sound through the air. Wind speed and direction, and the temperature immediately above ground level cause diffraction and displacement of sound waves. Humidity and temperature materially affect propagation of air-to-ground sound through absorption associated with the instability and viscosity of the air.

E.2 Noise Analysis Methodology

The methodology used for this aircraft noise analysis involved: (1) the use of noise descriptors developed for airport noise analyses; (2) development of basic data and assumptions for use as input to a computer model; and (3) the application of the computer model, providing estimates of aircraft noise levels.

E.3 Noise Descriptors

Noise levels are measured using a variety of scientific metrics. As a result of extensive research into the characteristics of aircraft noise and human response to that noise, standard noise descriptors have been developed for aircraft noise exposure analyses. The descriptors used in this noise analysis are described below.

Decibel, dB – Sound is a complex physical phenomenon consisting of complex minute vibrations traveling through a medium, such as air. These vibrations are sensed by the human ear as sound pressure. Because of the vast range of sound pressure or intensity detectable by the human ear, sound pressure level (SPL) is represented on a logarithmic scale known as decibels (dB). A sound level of 0 dB is approximately the threshold of human hearing and is barely audible under extremely quiet (laboratory-type) listening conditions. An SPL of 120 dB begins to be felt inside the ear, and discomfort and pain at approximately 140 dB. Most environmental sounds have SPLs ranging from 30 to 100 dB.

Because decibels are logarithmic, they cannot be added or subtracted directly like other (linear) numbers. For example, if two sound sources each produce 100 dB, when they are operated together they will produce 103 dB, not 200 dB. Four 100 dB sources operating together again double the sound energy, resulting in a total SPL of 106 dB, and so on. In addition, if one source is much louder than another, the two sources operating together will produce the same SPL as if the louder source were operating alone. For example, a 100 dB source plus an 80 dB source produce 100 dB when operating together. Two useful rules to remember when comparing SPLs are: (1) most people perceive a 6 to 10 dB increase in SPL between two noise events to be about a doubling of loudness, and (2) changes in SPL of less than about 3 dB between two events are not easily detected outside of a laboratory.

A-Weighted Sound Pressure Level, dBA: The decibel (dB) is a unit for describing sound pressure level. When expressed in dBA, the sound has been filtered to reduce the effect of very low and very high frequency sounds, much like the human ear does. Frequency, or pitch, is a basic physical characteristic of sound and is expressed in units of cycles per second or hertz (Hz). The normal frequency range of hearing for most people extends from about 20 to 20,000 Hz. Because the human ear is more sensitive to middle and high frequencies (i.e., 1,000 to 4,000 Hz), as compared to low frequencies, a frequency weighting called "A" weighting is applied. With the A-weighting, calculations and sound monitoring equipment approximates the sensitivity of the human ear to sounds of different frequencies.

Some common sounds on the dBA scale are listed in **Table E-1**. As shown in the table, the relative perceived loudness of a sound doubles for each increase of 10 dBA, even though a 10 dBA change corresponds to a change of relative sound energy by a factor of 10. Generally, sounds with differences of 2 dBA or less are not perceived to be noticeably different by most listeners.

Maximum A-Weighted Noise Level, L_{max} – Sound levels vary with time. For example, the sound increases as an aircraft approaches, then falls and blends into the ambient or background as the aircraft recedes into the distance. Because of this variation, it is often convenient to describe a particular noise "event" by its highest or maximum sound level (L_{max}). Note that L_{max} describes only one dimension of an event; it provides no information on the cumulative noise exposure generated by a sound source. In fact, two events with identical L_{max} may produce very different total exposures as one may be of very short duration, while the other may be much longer.

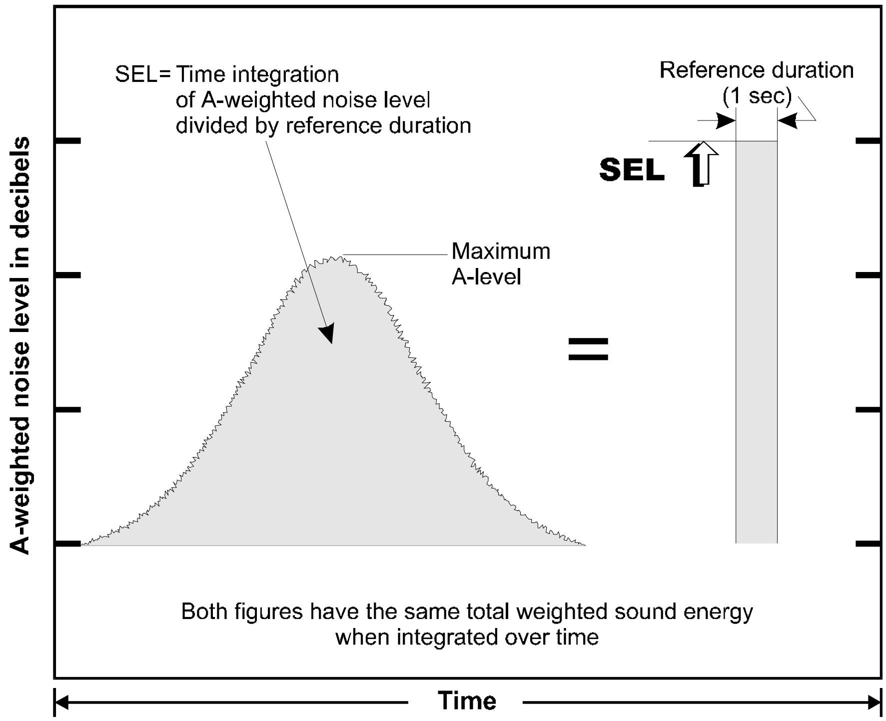
Table E-1: Common Sounds on the A-Weighted Decibel Scale

SOUND	SOUND LEVEL (DBA)	RELATIVE LOUDNESS (APPROXIMATE)	RELATIVE SOUND ENERGY
Rock music, with amplifier	120	64	1,000,000
Thunder, snowmobile (operator)	110	32	100,000
Boiler shop, power mower	100	16	10,000
Orchestral crescendo at 25 feet, noisy kitchen	90	8	1,000
Busy street	80	4	100
Interior of department store	70	2	10
Ordinary conversation, 3 feet away	60	1	1
Quiet automobiles at low speed	50	1/2	.1
Average office	40	1/4	.01
City residence	30	1/8	.001
Quiet country residence	20	1/16	.0001
Rustle of leaves	10	1/32	.00001
Threshold of hearing	0	1/64	.000001

SOURCE: U.S. Department of Housing and Urban Development, Aircraft Noise Impact—Planning Guidelines for Local Agencies, 1972.
PREPARED BY: Ricondo & Associates, Inc., August 2014.

Sound Exposure Level, SEL: Sound exposure level (SEL) is a time integrated measure, expressed in decibels, of the sound energy of a single noise event to a reference duration of one second. The sound level is integrated over the period that the level exceeds a threshold. Therefore, SEL accounts for both the maximum sound level and the duration of the sound. The standardization of discrete noise events into a one-second duration allows the calculation of the cumulative noise exposure of a series of noise events that occur over a period of time. Because of this compression of sound energy, the SEL of an aircraft noise event is typically 7 to 12 dBA greater than the L_{max} of the event. SEL values for aircraft noise events depend on the location of the aircraft relative to the noise receptor, the type of operation (landing, takeoff, or overflight), and the type of aircraft. The SEL concept is depicted on **Exhibit E-1**.

Exhibit E-1: Sound Exposure Level Concept



SOURCE: Brown-Buntin Associates, Inc.
PREPARED BY: Ricondo & Associates, Inc., August 2014.

A-weighted Day-Night Average Sound Level, DNL: DNL, also denoted as L_{dn} is expressed in dBA and represents the noise level over a 24-hour period. DNL includes the cumulative effects of a number of sound events rather than a single event. It also accounts for increased sensitivity to noise during nighttime hours. The DNL values are used to estimate the effects of specific noise levels on land uses. The U.S. Environmental Protection Agency (USEPA) introduced the metric in 1976 as a single number measurement of community noise exposure. The FAA adopted DNL as the noise metric for measuring cumulative aircraft noise under FAR Part 150, *Airport Noise Compatibility Planning*. The Department of Housing and Urban Development, the Veterans Administration, the Department of Defense, the United States Coast Guard, and the Federal Transit Administration have also adopted DNL for measuring cumulative noise exposure.

The calculation of DNL applies a 10-decibel-weighting penalty (equivalent to a ten-fold increase in aircraft operations) for each hour during the nighttime period (10:00 p.m. to 7:00 a.m.) before the 24-hour value is computed. The weighting penalty accounts for the more intrusive nature of noise during the nighttime hours.

DNL is expressed as an average noise level on the basis of annual aircraft operations for a calendar year, not on the average noise levels associated with different aircraft operations. To calculate the DNL at a specific location, SEL values at that location associated with each individual aircraft operation (landing or takeoff) are determined. Using the SEL for each noise event and applying the 10-decibel penalty for nighttime operations as appropriate, a partial DNL value is then calculated for each aircraft operation. The partial DNL values for each aircraft operation are added logarithmically to determine the total DNL.

The logarithmic addition process, whereby the partial DNL values are combined, can be approximated by the following guidelines:

When two DNLs differ by:	Add the following amount to the higher value:
0 or 1 dBA	3 dBA
2 or 3 dBA	2 dBA
4 to 9 dBA	1 dBA
10 dBA or more	10 dBA

For example:

70 dBA + 70 dBA (difference: 0 dBA) = 73 dBA
60 dBA + 70 dBA (difference: 10 dBA) = 70 dBA

Adding the noise from a relatively quiet event (60 dBA) to a relatively noisy event (70 dBA) results in a value of 70 dBA because the quieter event has only 1/10 of the sound energy of the noisier event. As a result, the quieter noise event is “drowned out” by the noisier one, and there is no increase in the overall noise level as perceived by the human ear.

DNL is used to describe existing and predicted noise exposure in communities in an airport environs based on the average daily operations over the year and the average annual operational conditions at the airport. Therefore, at a specific location near an airport, the noise exposure on a particular day is likely to be higher or lower than the annual average exposure, depending on the specific operations at the airport on that day. DNL has been widely accepted as the best available method to describe aircraft noise exposure and is the noise descriptor required by FAA for aircraft noise exposure analyses and land use compatibility planning under Federal Aviation Regulations Part 150, *Airport Noise Compatibility Planning*, and for environmental assessments for airport improvement projects.

E.3.1 DNL AND NOISE EXPOSURE RANGES

Noise exposure criterion levels of 65 dB, 70 dB, and 75 dB were used for the analysis, in accordance with FAA Order 1050.1E. The three noise exposure ranges used were 1) DNL 65 to 70 dB, 2) DNL 70 to 75 dB, and DNL 75+ dB. Noise exposure maps for 2013 existing conditions and for 2016 and 2021 future conditions for the No Action Alternative, Proposed Action Alternative (Refinement #8 Alternative), Refinement #1 Alternative, and Refinement #7 Alternative were prepared for this Environmental Assessment. The DNL 65 dB contour was examined for all of the action alternatives to identify noise sensitive areas where noise would increase by DNL 1.5 dB or greater, when compared to the DNL 65 dB contour for the No Action Alternative for the same timeframe. In addition, the DNL 65 dB contour was also examined for the shifting of aircraft operations during the construction phase of the Proposed Action Alternative, when compared to the DNL 65 dB contour for the normal operations in the same timeframe.

E.3.2 GRAPHIC REPRESENTATION

To graphically represent DNL, contour lines that connect points of equal DNL values are drawn on a map. For example, a contour may be drawn to connect all points with a DNL of 70 dB; another may be drawn to connect all points with a DNL of 65 dB; and so forth. Aircraft noise exposure contours were drawn at 5-DNL intervals to reflect the ranges in DNL values from 65 to 75 dB.

E.3.3 THE DNL DESCRIPTOR

The validity and accuracy of DNL calculations depend on the basic information used in the calculations. For future airport activities, the reliability of DNL calculations is affected by a number of uncertainties:

- Future aviation activity levels—the forecast number of aircraft operations, the types of aircraft serving the airport, the times of operation (daytime, evening, and nighttime), and aircraft flight tracks—are estimates. Achievement of the estimated levels of activity cannot be assured.
- Acoustical and performance characteristics of future aircraft are also estimates. When new aircraft designs are involved, aircraft noise data and flight characteristics must be estimated.
- The noise descriptors used as the basis for calculating DNL represent typical human response (and reaction) to aircraft noise. Because people vary in their responses to noise and because the physical measure of noise accounts for only a portion of an individual's reaction to that noise, DNL can be used only to obtain an average response to aircraft noise that might be expected from a community.
- Single flight tracks used in computer modeling represent a wider band of actual flight tracks.

These uncertainties aside, DNL mapping was developed as a tool to assist in land use planning around airports. The mapping is best used for comparative purposes rather than for providing absolute values. That is, DNL calculations provide valid comparisons between different projected conditions, as long as consistent assumptions and basic data are used for all calculations.

Thus, sets of DNL calculations can show anticipated changes in aircraft noise exposure over time, or differences in noise exposure associated with different airport development alternatives or operational procedures. However, a line drawn on a map does not imply that a particular noise condition exists on one side of that line and not on the other. DNL calculations provide a means for comparing noise exposure under different scenarios.

Nevertheless, DNL contours can be used to (1) highlight an existing or potential aircraft noise problem that requires attention, (2) assist in the preparation of noise compatibility programs, and (3) provide guidance in the development of land use controls, such as zoning ordinances, subdivision regulations, and building codes. DNL is considered to be the best noise metric available for expressing aircraft noise exposure.

E.3.4 EVALUATION OF THE ADEQUACY OF THE DNL DESCRIPTOR

In order to address concerns related to methods of aircraft noise measurement, and to reach a national consensus, the Federal Interagency Committee on Noise (FICON) was created to assess the manner in which noise exposure and its effects are evaluated and the usefulness of DNL to describe the effects of aircraft noise on people. The committee included representatives of all of the federal agencies involved in environmental noise studies, including staff from the USEPA, the Council on Environmental Quality (CEQ), the Departments of Treasury, Defense (DOD), Housing and Urban Development (HUD), Veterans Affairs, and Transportation, as well as technical advisors from the Committee on Hearing and Biomechanics.

The FICON evaluated the threshold for acceptable noise levels (threshold of significance) and whether the DNL 65 was the proper threshold. The committee's findings were released in the *Federal Register* (FR 44223, September 24, 1992). Some of the committee's conclusions were:

- Continue using the DNL to measure airport noise;
- Complaints are an inadequate indicator of the full extent of noise effects on a population;
- Noise predictions and interpretations are frequently less reliable below DNL 65— predictions below this level should take into account the inaccuracy of prediction models at large distances from the airport;
- No definitive evidence of non-auditory health effects from aircraft noise exist, particularly below DNL 70;
- Every change in the noise environment does not necessarily affect public health and welfare.

FICON also recommended that a new federal interagency committee be formed with a mandate to provide a forum for debate of future aviation noise research needs.

In March 1993, the FAA requested public comments concerning the FICON report released in 1992.[1] The request for comment coincided with a study that was prepared by the FAA in accordance with the Safety, Capacity, Noise Improvement, and Intermodal Transportation Act of 1992.[2] Later in 1993 the Federal Interagency Committee on Aviation Noise (FICAN) was formed. FICAN has provided a forum for soliciting input from interested members of the aviation profession and communities. FICAN members have worked with researchers to develop individual agency priorities for research to address noise issues, and have published technical papers on aviation noise topics, including a 1997 study of the effects of aviation noise on sleep.[3] One of the findings of FICAN was that the use of supplemental metrics provides valuable information

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1 *Federal Register*, FR16569, March 29, 1993.

2 Section 123 of the Airport and Airway Safety, Capacity, Noise Improvement, and Intermodal Transportation Act of 1992 (49 U.S.C. app 2102, PL 102-581) required the FAA to conduct a noise study and report the results to Congress not later than October 31, 1993. The study analyzed the social, economic, and health effects of airport noise within the DNL 55, 60, and 65 dBA contours to determine the actual level at which noise adversely impacts populations. It also included an evaluation of single event analysis on populations.

3 *Effects of Aviation Noise on Awakenings from Sleep*, Federal Interagency Committee on Aviation Noise, June 1997.

that is not easily captured by DNL. However, both FICON and FICAN validated the use of the DNL metric as the acceptable metric to identify significant aircraft noise impacts.

E.4 Integrated Noise Model

In 1978, the FAA released the first version of a computer simulation model designed to assess aircraft noise exposure. Known as the Integrated Noise Model or INM, it has become the standard tool used for modeling airport noise. The INM generates noise exposure contours and noise levels at individual locations and provides a graphical image of aircraft noise levels for a selected geographic area.

The INM computes DNL using an internal database that includes performance characteristics and noise data for a wide variety of civilian and military aircraft. Noise exposure levels are calculated from airport-specific data that are input into the model. The input includes runway coordinates, flight tracks, fleet mix, activity levels, runway and flight track utilization, average local temperatures, time of day, and departure trip length data. The INM correlates these data with the internal aircraft database using a series of algorithms that calculate noise exposure. The INM database incorporates detailed information about each aircraft type, including departure profiles for different trip lengths, approach profiles, and SEL noise curves based on distances and various thrust settings. The outputs of these calculations include plots of points that connect to form noise contours. The INM is typically used to model average annual aircraft noise exposure, that is, the average sound level over an average 24-hour period of both busy and quiet times for the airport.

Other output from the INM include the area within each contour, noise measurements at locations (referred to as grid points), and SEL curves or values for specific aircraft types. The SEL curves can be used to estimate SEL for a specific aircraft type depending on how far the aircraft is from a listening point or observer and the estimated thrust setting. Since the introduction of the INM, newer versions have been released by the FAA with an updated aircraft database to reflect changes in the existing and projected aircraft fleet mixes of airports throughout the National Airspace System and to incorporate enhanced algorithms for calculating aircraft noise at specific locations and propagation of noise.

Version 7.0d of INM was used for the noise analysis documented in this EA, which was the latest approved version of the model at the time the analysis was done. Version 7.0d is an accepted, state-of-the-art tool for determining the total effect of aircraft noise at and around airports. The aircraft database contains a representation of commercial, general aviation, and military aircraft powered by turbojet, turbofan, turboprop, or piston-driven engines. The noise exposure maps derived from the INM for the alternatives in this study are based on the DNL noise metric.

Noise exposure maps were generated using INM for existing and future conditions using a slightly different aircraft fleet mix and runway usage for the years included in the study (2013, 2016 and 2021). All action alternatives would slightly change the long-term operational conditions at LAX for future scenarios. The Proposed Action Alternative would shift Runway 24L approximately 800 feet to the east; the Refinement #1 Alternative would shift Runway 24L 835 feet to the east; the Refinement #7 Alternative would shift Runway 24L 480 feet to the east. For each action alternative, the shift in the Runway 24L departure point would shift the departure point for certain aircraft departures, mainly "heavy" aircraft, on Runway 6R-24L to the east by the respective shift distance.[4] The existing Runway 24L threshold would remain in its current location for all action alternatives. Therefore, declared distances would also be implemented. None of the action alternatives would change the number or type of aircraft operations at LAX. Contours were developed in INM for all alternatives for both 2016 and 2021.

Construction of the Proposed Action Alternative (Refinement #8 Alternative) would require construction activities within the Runway 6R-24L RSA on both ends of the runway, which would be conducted in two distinct phases, estimated at 6 months each, covering the entire 2016 calendar year. The first phase of construction would focus on the RSA improvements to the Runway 24L end; once those improvements are completed, construction of the RSA improvements to the Runway 6R end would be conducted. While an extended closure of the runway is not expected, the Proposed Action Alternative would require connecting taxiways to be intermittently closed during construction. As Runway 6R-24L is the primary departures runway on the north airfield, a runway length analysis was performed to determine the number of aircraft to be shifted to other runways. More information can be found in Section 4.2.2.1. The temporary construction contour was developed in INM.

E.5 Basic Data and Assumptions

To determine aircraft noise exposure levels under existing and forecasted conditions, aircraft operations attributed to an average annual day are used in INM. For this EA, noise exposure was analyzed for operational years 2013 (existing conditions), 2016, and 2021. Additionally, noise exposure during the construction phase of the RSA improvements on Runway 6R-24L was analyzed.

The primary data required to develop noise exposure maps using INM Version 7.0d includes:

- The existing and forecasted number of aircraft operations accounted for by time of day, type of aircraft, and stage length (nonstop departure trip length from LAX).
- Operational information including runway use, location and use of flight tracks (the paths that pilots fly to arrive at and depart from an airport), departure profiles, existing noise abatement procedures, etc.

E.5.1 AIRCRAFT OPERATIONS

Individual daily aircraft operations at LAX for 2013 were obtained from LAWA. The future noise environment for 2016 and 2021 was analyzed based on FAA TAF forecasted operational conditions for each respective year. Annual operations are the same for the No Action Alternative, Proposed Action Alternative, Refinement #1

4 The weight category "heavy" is defined as any aircraft weighing more than 255,000 pounds, including the Boeing 747 and Airbus 340.

Alternative, and Refinement #7 Alternative. Annual flight operations data for 2013, 2016 and 2021 are shown in **Table E-2**.

Table E-2: Existing and Forecast LAX Aircraft Flight Operations

AIRCRAFT CATEGORY	ANNUAL FLIGHT OPERATIONS		
	EXISTING 2013 1/	TAF 2016 2/	TAF 2021 3/
Air Carrier (AC)	501,598	526,526	595,235
Air Taxi (AT)	92,624	97,541	100,922
General Aviation (GA)	18,226	18,755	19,591
Military (MIL)	2,469	2,525	2,474
Total Operations	**614,917**	**645,346**	**718,222**

NOTES:

1/ 2013 Annual operations obtained from Federal Aviation Administration OPSNET for 2013 calendar year.

2/ 2014 Federal Aviation Administration Terminal Area Forecast for 2016 fiscal year.

3/ 2014 Federal Aviation Administration Terminal Area Forecast for 2021 fiscal year.

SOURCES: Federal Aviation Administration, 2014 Terminal Area Forecast, http://aspm.faa.gov/main/taf.asp, accessed August 4, 2014; Federal Aviation Administration, OPSNET for 2013 calendar year, https://aspm.faa.gov/opsnet/, accessed August 4, 2014.

PREPARED BY: Ricondo & Associates, Inc., March 2015.

E.5.2 AIRCRAFT FLEET MIX

Aircraft noise levels can vary greatly based on the aircraft type. This is due to differences in the noise emissions of the various airframe/engine combinations and aircraft performance characteristics. For this reason, it is very important to determine the precise mix of aircraft operating from the airport. LAWA's Aircraft Noise and Operations Monitoring System (ANOMS) data were used to determine the existing 2013 INM fleet mix at LAX. The Design Day Flight Schedule was used to determine the 2016 and 2021 fleet mix.

Table E-3 through **Table E-5** presents the different INM aircraft types modeled for LAX for 2013, 2016 and 2021, respectively. For noise modeling purposes, aircraft are assigned an aircraft type from the INM database. While INM aircraft types provide representative noise characteristics for a large variety of aircraft, the database is not exhaustive. When selecting INM aircraft type, it is often appropriate to combine aircraft with similar characteristics (e.g., engine types, number of engines, weight, performance characteristics, and noise exposure characteristics) under the same INM aircraft type.

Table E-3 (1 of 3): 2013 LAX Fleet Mix

	2013 ANNUAL OPERATIONS			
INM DESIGNATION	DAY	EVENING	NIGHT	TOTAL
1900D	5906	86	300	6292
727EM2	124	9	25	158
737300	14136	2913	1447	18496
737400	4134	826	234	5193
737500	41	7	1	49
737700	44694	10124	7041	61859
737800	59739	13754	15931	89424
747200	27	61	472	559
74720B	508	145	73	726
747400	6969	2135	5135	14238
7478	1062	444	1068	2574
757300	6737	1577	2106	10420
757PW	23629	4856	9599	38084
757RR	9239	2725	4198	16162
767300	9381	3372	4083	16836
767400	112	22	27	161
767CF6	4732	1022	1680	7434
777200	6927	742	1462	9131
777300	10	1	0	11
7773ER	10508	1841	4629	16979
7878R	983	77	115	1175
A300-622R	435	79	1286	1801
A300B4-203	23	137	977	1137
A310-304	24	13	8	45
A319-131	17727	3972	4773	26472
A320-211	20904	5045	4709	30658
A320-232	14302	3368	5399	23069
A321-232	6558	1591	2887	11036
A330-301	878	58	45	982
A330-343	1900	76	609	2584
A340-211	1980	453	245	2678

[Draft]

Table E-3 (2 of 3): 2013 LAX Fleet Mix

INM DESIGNATION	2013 ANNUAL OPERATIONS			
	DAY	EVENING	NIGHT	TOTAL
A340-642	1498	839	252	2589
A380-841	1347	294	1400	3041
A380-861	1579	5	88	1672
BEC58P	135	35	25	195
C130E	466	0	42	508
CIT3	73	11	11	94
CL600	2210	311	266	2787
CL601	36009	8357	4430	48797
CNA172	26	3	1	30
CNA182	7	0	0	7
CNA206	22	1	0	24
CNA208	183	45	159	387
CNA20T	5	1	0	6
CNA441	539	93	86	718
CNA500	209	22	30	261
CNA510	416	74	54	544
CNA525C	398	61	61	520
CNA55B	326	24	31	381
CNA560E	145	21	6	172
CNA560XL	744	85	67	895
CNA680	364	54	43	460
CNA750	1141	153	144	1438
CRJ9-ER	41083	11895	4995	57973
CVR580	0	93	355	448
DC1010	714	407	1539	2660
DC870	944	0	0	944
DC93LW	10	3	7	20
DHC6	92	14	12	119
DHC830	4640	1552	172	6364
DO328	19	1	2	22
ECLIPSE500	17	4	9	30

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Table E-3 (3 of 3): 2013 LAX Fleet Mix

INM DESIGNATION	2013 ANNUAL OPERATIONS			
	DAY	EVENING	NIGHT	TOTAL
EMB14L	4	66	75	145
EMB170	2913	518	100	3531
EMB190	3051	771	293	4115
F10062	688	72	61	821
FAL20	38	10	15	63
GASEPV	62	9	7	78
GII	58	18	12	87
GIIB	275	50	63	388
GIV	1910	375	258	2543
GV	1881	309	295	2485
IA1125	169	16	18	204
LEAR25	178	6	5	188
LEAR35	1813	279	296	2388
MD11GE	1335	461	1499	3295
MD11PW	459	195	579	1233
MD81	17	1	7	24
MD82	1429	350	183	1962
MD83	2884	547	271	3702
MD9025	5	2	5	12
MU3001	693	85	76	854
PA28	9	3	6	18
PA31	9	1	1	11
PA42	6	2	5	13
SD330	140	26	25	191

SOURCE: Federal Aviation Administration, OPSNET; LAWA ANOMS Data 2013; Environmental Science Associates, 2014.
PREPARED BY: Ricondo & Associates, Inc., August 2014.

[Draft]

Table E-4 (1 of 3): 2016 LAX Fleet Mix

INM DESIGNATION	2016 ANNUAL OPERATIONS			
	DAY	EVENING	NIGHT	TOTAL
1900D	4096	0	0	4096
737300	12894	3340	2801	19036
737400	3620	938	787	5345
737500	34	9	7	51
737700	43123	11171	9369	63663
737800	62339	16149	13544	92033
74720B	555	0	185	740
747400	5599	2502	4435	12536
7478	1232	551	976	2758
757300	7134	1905	2790	11829
757PW	26075	6963	10196	43234
757RR	11065	2955	4327	18347
767300	9837	2342	5153	17332
767400	94	22	49	166
767CF6	4343	1034	2275	7652
777200	6274	1171	1703	9148
777300	8	1	2	11
7773ER	11666	2178	3166	17010
7878R	1699	0	0	1699
A300-622R	417	208	1042	1667
A300B4-203	263	132	658	1052
A310-304	340	0	340	680
A319-131	19372	3399	6457	29228
A320-211	23665	5231	7370	36266
A320-232	17807	3936	5545	27289
A321-232	4758	2039	3399	10196
A330-301	561	0	374	936
A330-343	1478	0	985	2463
A340-211	2419	691	0	3110
A340-642	2339	668	0	3007
A380-841	2412	0	658	3070

[Draft]

Table E-4 (2 of 3): 2016 LAX Fleet Mix

	2016 ANNUAL OPERATIONS			
INM DESIGNATION	DAY	EVENING	NIGHT	TOTAL
A380-861	1326	0	362	1688
BEC58P	130	25	45	200
C130E	389	0	130	518
CIT3	63	12	22	96
CL600	1855	360	645	2860
CL601	35656	6930	5540	48125
CNA172	21	4	7	32
CNA182	5	1	2	7
CNA206	16	3	5	24
CNA208	258	50	89	397
CNA20T	4	1	1	6
CNA441	738	0	19	757
CNA500	173	34	60	267
CNA510	362	70	126	558
CNA525C	346	67	120	534
CNA55B	254	49	88	391
CNA560E	115	22	40	177
CNA560XL	596	116	207	919
CNA680	307	59	106	472
CNA750	957	186	333	1476
CRJ9-ER	51279	9496	3798	64574
DC1010	1090	0	1289	2379
DC870	1061	0	580	1642
DHC6	56	0	19	74
DHC830	5120	1707	0	6826
ECLIPSE500	20	4	7	31
EMB120	26879	4704	4704	36287
EMB145	1107	0	0	1107
EMB14L	151	0	0	151
EMB170	1237	317	173	1726
EMB190	1442	369	201	2012

[Draft]

Table E-4 (3 of 3): 2016 LAX Fleet Mix

INM DESIGNATION	2016 ANNUAL OPERATIONS			
	DAY	EVENING	NIGHT	TOTAL
F10062	546	106	190	842
FAL20	42	8	15	64
GASEPV	52	10	18	80
GII	58	11	20	89
GIIB	258	50	90	398
GIV	1693	328	588	2609
GV	1654	321	575	2550
IA1125	136	26	47	209
LEAR25	140	6	47	192
LEAR35	1590	308	552	2451
MD11GE	1002	445	779	2226
MD11PW	375	167	291	833
MD81	22	3	10	35
MD82	1758	234	821	2813
MD83	3318	442	1548	5309
MU3001	569	110	198	877
PA28	12	2	4	18
PA31	7	1	2	11
PA42	8	2	3	13

SOURCE: Federal Aviation Administration, Terminal Area Forecast, http://aspm.faa.gov/main/taf.asp; Ricondo & Associates, Inc., August 2014.
PREPARED BY: Ricondo & Associates, Inc., August 2014.

[Draft]

Table E-5 (1 of 3): 2021 LAX Fleet Mix

INM DESIGNATION	2021 ANNUAL OPERATIONS DAY	EVENING	NIGHT	TOTAL
1900D	4249	0	0	4249
737300	14616	3786	3176	21579
737400	4104	1063	892	6059
737500	39	10	8	58
737700	48884	12663	10621	72168
737800	70667	18307	15354	104328
74720B	546	0	182	728
747400	6347	2836	5027	14210
7478	1397	624	1106	3127
757300	8087	2160	3162	13409
757PW	29558	7894	11558	49010
757RR	12544	3350	4905	20799
767300	11151	2655	5841	19647
767400	107	25	56	188
767CF6	4924	1172	2579	8675
777200	7112	1328	1930	10370
777300	9	2	2	13
7773ER	13224	2469	3589	19283
7878R	1926	0	0	1926
A300-622R	472	236	1181	1889
A300B4-203	298	149	746	1193
A310-304	385	0	385	771
A319-131	21960	3853	7320	33133
A320-211	26826	5930	8354	41111
A320-232	20186	4462	6286	30934
A321-232	5394	2312	3853	11558
A330-301	636	0	424	1061
A330-343	1675	0	1117	2792
A340-211	2742	783	0	3526
A340-642	2651	758	0	3409

[Draft]

Table E-5 (2 of 3): 2021 LAX Fleet Mix

	2021 ANNUAL OPERATIONS			
INM DESIGNATION	DAY	EVENING	NIGHT	TOTAL
A380-841	2735	0	746	3481
A380-861	1503	0	410	1913
BEC58P	136	26	47	210
C130E	382	0	127	509
CIT3	66	13	23	101
CL600	1943	377	675	2995
CL601	36993	7190	5748	49930
CNA172	22	4	8	34
CNA182	5	1	2	7
CNA206	16	3	6	25
CNA208	270	52	94	416
CNA20T	4	1	1	6
CNA441	762	0	19	781
CNA500	182	35	63	280
CNA510	379	74	132	584
CNA525C	363	70	126	559
CNA55B	266	52	92	410
CNA560E	120	23	42	185
CNA560XL	624	121	217	962
CNA680	321	62	112	495
CNA750	1003	194	348	1546
CRJ9-ER	58130	10765	4306	73200
DC1010	1236	0	1461	2697
DC870	1109	0	606	1716
DHC6	55	0	18	73
DHC830	5312	1771	0	7082
ECLIPSE500	21	4	7	33
EMB120	27887	4880	4880	37648
EMB145	1148	0	0	1148
EMB14L	156	0	0	156

Table E-5 (3 of 3): 2021 LAX Fleet Mix

	2021 ANNUAL OPERATIONS			
INM DESIGNATION	**DAY**	**EVENING**	**NIGHT**	**TOTAL**
EMB170	1403	359	196	1957
EMB190	1635	418	228	2281
F10062	572	111	199	882
FAL20	44	8	15	67
GASEPV	54	11	19	84
GII	61	12	21	94
GIIB	270	52	94	417
GIV	1773	344	616	2733
GV	1733	336	602	2671
IA1125	142	28	49	219
LEAR25	139	6	47	192
LEAR35	1665	323	579	2567
MD11GE	1136	505	883	2523
MD11PW	425	189	330	944
MD81	25	3	11	39
MD82	1993	266	930	3189
MD83	3761	501	1755	6018
MU3001	596	115	207	918
PA28	12	2	4	19
PA31	8	1	3	12
PA42	9	2	3	14

SOURCE: Ricondo & Associates, Inc., February 2015.
PREPARED BY: Ricondo & Associates, Inc., March 2015.

E.5.3 TIME OF DAY

The Time of Day aircraft operations occur is important for determining cumulative noise exposure. In the CNEL metric, aircraft noise levels are weighted based on the time of day they occur. In determining CNEL, each aircraft operation occurring during the nighttime, between the hours of 10:00 p.m. and 7:00 a.m., is treated as if it were 10 operations in terms of noise exposure. Similarly, operations taking place during the evening period, between the hours of 7:00 p.m. and 10:00 p.m., are treated as if they were three operations. Logarithmically, these multipliers are the equivalent of adding 10 dB to the noise level of each nighttime operation and 4.77 dB to the noise level of each evening operation. These noise level penalties are intended to correspond to the drop in background noise level which studies have found takes place naturally from daytime to evening and nighttime in a typical community. The evening and nighttime decrease in ambient

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sound levels—from both outdoor and indoor sources—is commonly considered to be the principal explanation for people's heightened sensitivity to noises during these periods. CNEL is designed to account for this increased sensitivity. **Table E-6** through **Table E-8** summarizes operations by time of day for 2013 (existing), 2016, and 2021. Time of day operations by aircraft category do not differ between the No Action Alternative, Proposed Action Alternative, Refinement #1 Alternative, or Refinement #7 Alternative.

Table E-6: Summary of Operations by Time of Day (2013)

	ANNUAL FLIGHT OPERATIONS		
AIRCRAFT CATEGORY	**DAY (7 A.M. – 7 P.M.)**	**EVENING (7 P.M. – 10 P.M.)**	**NIGHT (10 P.M. – 7 A.M.)**
Large Narrow-Body	12.1%	12.0%	18.4%
Large Wide-Body and New Large Aircraft	8.8%	1.9%	4.5%
Non-Jet	8.8%	8.0%	5.4%
Small Jet	22.1%	23.4%	11.0%
Small Narrow-Body	44.0%	43.2%	38.8%
Small Wide-Body	4.2%	5.0%	8.4%

SOURCES: Existing (2013) data is based on data provided by Los Angeles World Airports (2014).
PREPARED BY: Ricondo & Associates, Inc., August 2014.

Table E-7: Summary of Operations by Time of Day (2016)

	ANNUAL FLIGHT OPERATIONS		
AIRCRAFT CATEGORY	**DAY (7 A.M. – 7 P.M.)**	**EVENING (7 P.M. – 10 P.M.)**	**NIGHT (10 P.M. – 7 A.M.)**
Large Narrow-Body	11.9%	14.7%	19.0%
Large Wide-Body and New Large Aircraft	8.8%	8.7%	12.4%
Non-Jet	8.6%	6.7%	4.3%
Small Jet	23.0%	19.3%	11.9%
Small Narrow-Body	43.6%	46.7%	42.8%
Small Wide-Body	4.0%	3.9%	9.6%

SOURCES: Ricondo & Associates, Inc., August 2014.
PREPARED BY: Ricondo & Associates, Inc., August 2014.

Table E-8: Summary of Operations by Time of Day (2021)

AIRCRAFT CATEGORY	ANNUAL FLIGHT OPERATIONS DAY (7 A.M. – 7 P.M.)	EVENING (7 P.M. – 10 P.M.)	NIGHT (10 P.M. – 7 A.M.)
Large Narrow-Body	12.1%	14.9%	19.2%
Large Wide-Body and New Large Aircraft	9.0%	8.8%	12.5%
Non-Jet	8.0%	6.2%	4.0%
Small Jet	22.5%	18.8%	11.3%
Small Narrow-Body	44.4%	47.4%	43.3%
Small Wide-Body	4.1%	3.9%	9.7%

SOURCES: Ricondo & Associates, Inc., February 2015.
PREPARED BY: Ricondo & Associates, Inc., March 2015.

E.5.4 RUNWAY USE

Runway utilization refers to the percentage of operations that utilize a given runway. Aircraft generally take off and land into the wind. As a result, runway utilization is largely determined by prevailing wind conditions. At LAX, prevailing winds are westerly. For operational efficiency, aircraft departures generally occur from the inboard runways, Runway 24L and Runway 25R, and arrivals are to the outboard runways, Runway 24R and Runway 25L. Radar data via the ANOMS were used to determine the existing runway utilization at LAX. Existing (2013) runway utilization is shown in **Table E-9**. Runway utilization will not change as a result of the Proposed Action Alternative, Refinement #1 Alternative, or Refinement #7 Alternative. **Table E-10** depicts the runway utilization for all alternatives in 2016; **Table E-11** shows the runway use for all alternatives in 2021.

Table E-9: LAX 2013 Operational Runway Utilization

	ARRIVALS				DEPARTURES			
RUNWAY	DAY	EVENING	NIGHT	TOTAL	DAY	EVENING	NIGHT	TOTAL
06L	0.5%	0.2%	3.6%	0.9%	0.0%	0.0%	0.0%	0.0%
06R	0.0%	0.0%	15.8%	2.3%	0.5%	0.2%	0.2%	0.4%
07L	0.0%	0.0%	6.6%	1.0%	0.5%	0.3%	0.7%	0.6%
07R	0.5%	0.3%	4.3%	1.0%	0.0%	0.0%	0.2%	0.0%
24L	1.6%	2.4%	1.3%	1.7%	43.2%	40.1%	25.9%	39.5%
24R	45.9%	46.6%	30.9%	43.9%	1.5%	0.5%	1.3%	1.3%
25L	49.4%	47.1%	35.6%	47.0%	3.2%	5.0%	10.7%	4.9%
25R	2.0%	3.3%	2.0%	2.3%	51.1%	53.9%	60.9%	53.3%

SOURCE: Los Angeles International Airport, 2013; Ricondo and Associates INM Input File, August 2014.
PREPARED BY: Ricondo & Associates, Inc., August 2014.

[Draft]

Table E-10: LAX 2016 Operational Runway Utilization

	ARRIVALS				DEPARTURES			
RUNWAY	DAY	EVENING	NIGHT	TOTAL	DAY	EVENING	NIGHT	TOTAL
06L	0.5%	0.2%	3.5%	0.9%	0.0%	0.0%	0.0%	0.0%
06R	0.0%	0.0%	15.1%	2.5%	0.5%	0.2%	0.2%	0.4%
07L	0.0%	0.0%	6.3%	1.1%	0.5%	0.3%	0.7%	0.5%
07R	0.5%	0.3%	3.8%	1.1%	0.0%	0.0%	0.2%	0.0%
24L	1.6%	2.4%	1.3%	1.7%	43.2%	43.3%	25.9%	40.0%
24R	45.7%	46.4%	32.0%	43.5%	1.5%	0.4%	1.4%	1.3%
25L	49.6%	47.4%	36.0%	47.0%	3.1%	4.7%	10.3%	4.6%
25R	2.0%	3.3%	2.0%	2.2%	51.2%	51.1%	61.4%	53.0%

SOURCE: Ricondo and Associates INM Input File, August 2014.
PREPARED BY: Ricondo & Associates, Inc., August 2014.

Table E-11: LAX 2021 Operational Runway Utilization

	ARRIVALS				DEPARTURES			
RUNWAY	DAY	EVENING	NIGHT	TOTAL	DAY	EVENING	NIGHT	TOTAL
06L	0.5%	0.2%	3.5%	0.9%	0.0%	0.0%	0.0%	0.0%
06R	0.0%	0.0%	15.1%	2.6%	0.5%	0.2%	0.2%	0.4%
07L	0.0%	0.0%	6.3%	1.1%	0.5%	0.3%	0.7%	0.5%
07R	0.5%	0.3%	3.9%	1.1%	0.0%	0.0%	0.2%	0.0%
24L	1.6%	2.4%	1.4%	1.7%	43.4%	43.5%	26.0%	40.2%
24R	45.8%	46.4%	32.0%	43.6%	1.4%	0.4%	1.4%	1.3%
25L	49.6%	47.4%	35.9%	46.9%	3.1%	4.7%	10.3%	4.6%
25R	2.0%	3.3%	2.0%	2.2%	51.1%	50.8%	61.3%	52.9%

SOURCE: Ricondo and Associates INM Input File, February 2015.
PREPARED BY: Ricondo & Associates, Inc., March 2015.

Construction of the Proposed Action Alternative (Refinement #8 Alternative) would require construction activities within the Runway 6R-24L RSA on both ends of the runway, and a temporary reduction in runway length during each phase of construction. Construction would be conducted in two distinct phases, estimated at 6 months each, covering the entire 2016 calendar year. The first phase of construction would focus on the RSA improvements to the Runway 24L end; once those improvements are completed, construction of the RSA improvements to the Runway 6R end would commence. While closure of the runway is not anticipated during construction, the Proposed Action Alternative would require connecting taxiways to be intermittently closed. As Runway 6R-24L is the primary departures runway on the north airfield, normal aircraft operations on this runway would need to be adjusted during construction based on the available runway length for departures. Annualized runway use for the construction period of the Proposed Action Alternative is shown in **Table E-12**.

Table E-12: Proposed Action Construction Period Runway Utilization

	ARRIVALS				DEPARTURES			
RUNWAY	DAY	EVENING	NIGHT	TOTAL	DAY	EVENING	NIGHT	TOTAL
06L	0.5%	0.2%	11.0%	2.2%	0.0%	0.0%	0.0%	0.0%
06R	0.0%	0.0%	7.5%	1.3%	0.5%	0.2%	0.3%	0.4%
07L	0.0%	0.0%	6.3%	1.1%	0.5%	0.3%	0.9%	0.6%
07R	0.5%	0.3%	3.8%	1.1%	0.0%	0.0%	0.2%	0.0%
24L	1.6%	2.4%	1.3%	1.7%	35.7%	35.9%	19.9%	32.8%
24R	45.7%	46.4%	32.0%	43.5%	0.8%	0.3%	0.8%	0.7%
25L	49.6%	47.4%	36.0%	47.0%	6.5%	7.9%	13.1%	7.9%
25R	2.0%	3.3%	2.0%	2.2%	56.0%	55.3%	64.8%	57.5%

SOURCE: Ricondo and Associates INM Input File, February 2015.
PREPARED BY: Ricondo & Associates, Inc., March 2015.

E.5.5 AIRCRAFT FLIGHT TRACKS

The existing and assumed future uses of the runways and flight tracks to and from the Airport are important in determining where aircraft are flying and, consequently, where noise is generated in the Airport environs. Generalized flight tracks (the geographical spread of aircraft operations in terms of overflight density) for LAX for arrivals and departures are available in the Final Environmental Assessment for Los Angeles International Airport (LAX) Runway 7L-25R Runway Safety Area (RSA) and Associated Improvements Project.[5]

E.5.6 DEPARTURE TRIP LENGTH (STAGE LENGTH)

Departure trip length, commonly referred to as stage length (unrelated to "Stage" classifications of aircraft for FAR Part 36 noise certification), refers to the non-stop distance an aircraft travels after departure. This information is needed to determine average gross takeoff weights for different aircraft types. The noise generated by departures of a specific aircraft type will vary depending on the takeoff weights of the particular operations. For example, a fully loaded aircraft departing on a long flight will weigh more on departure than the same fully loaded aircraft departing on a shorter flight because the longer flight requires more fuel on board. It usually takes the heavier aircraft longer to reach its takeoff velocity, thereby using more runway length and climbing at a slower rate than a lighter aircraft, particularly on hot days. Therefore, more land area

5 City of Los Angeles, Los Angeles World Airports, *Final Environmental Assessment for Los Angeles International Airport (LAX) Runway 7L/25R Runway Safety Area (RSA) and Associated Improvements Project*, August 2013.

will be exposed to higher levels of aircraft noise by departures of heavier aircraft than departures of the same aircraft with lighter loads.

Table E-13 shows the nine different stage length categories included in INM that have been established to represent different departure trip length distances. The INM uses the stage length category for each operation to determine which profile to use for a specific aircraft departure. In most cases, using the published departure distances to determine the stage length and therefore the departure profile to be used provides good correlation between noise levels estimated by the INM and measured noise levels.

Table E-13: INM Departure Stage Length Categories

STAGE LENGTH CATEGORY	RANGE OF DEPARTURE TRIP LENGTH (NAUTICAL MILES)
1	0 – 500
2	500 – 1,000
3	1,000 – 1,500
4	1,500 – 2,500
5	2,500 – 3,500
6	3,500 – 4,500
7	4,500 – 5,500
8	5,500 – 6,500
9	6,500+

SOURCE: Federal Aviation Administration, *INM User's Guide*.
PREPARED BY: Ricondo & Associates, Inc., August 2014.