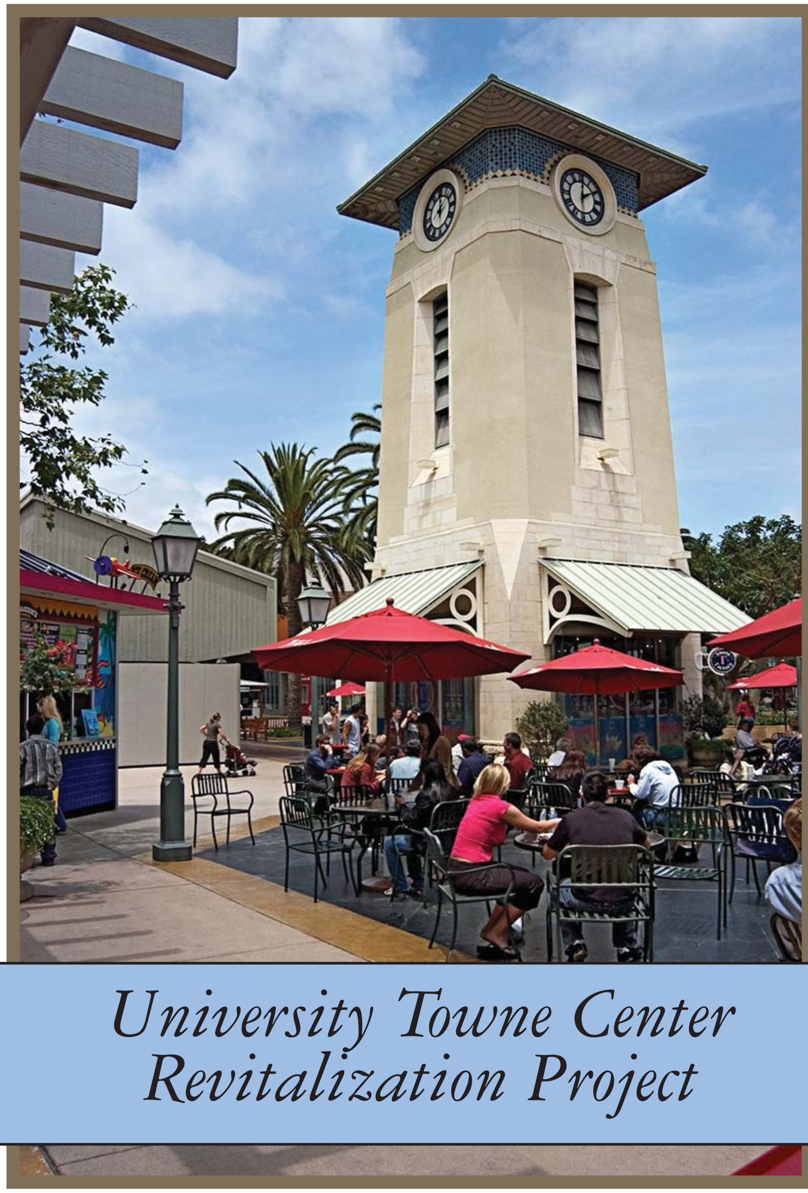
TECHNICAL APPENDIX L:
ACOUSTICAL SITE ASSESSMENT REPORT

to the

Final Environmental Impact Report



University Towne Center Revitalization Project

SCH No. 2002071071 LDR No. 41-0159/PTS No. 2214

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March 2008

UNIVERSITY TOWNE CENTER REVITALIZATION PROJECT

ACOUSTICAL SITE ASSESSMENT REPORT

January 30, 2008

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ACOUSTICAL IMPACT ANALYSIS FOR UNIVERSITY TOWNE CENTER MASTER PDP

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GLOSSARY OF TERMS AND ACRONYMS

A-Weighted Sound Levels	Decibels (referenced to 20 micro-Pascals) as measured with an A-weighting network of standard sound level meter, abbreviated dB(A)
ANSI	American National Standards Institute
Background Noise	The measured ambient noise level associated with all existing environmental, transportation, and community noise sources, in the absence of any audible construction activity
Caltrans	California Department of Transportation
CEQA	California Environmental Quality Act
CNEL	Community Noise Equivalent Level: A 24-hour average, where sound levels during the evening hours of 7:00 p.m. to 10:00 p.m. have an added 5 dB weighting, and sound levels during the nighttime hours of 10:00 p.m. to 7 a.m. have an added 10 dB weighting; this is similar to and often used interchangeably with L_{DN}
Construction Site	For purposes of noise and vibration control requirements, the contract limits of construction; this includes right-of-way lines, property lines, construction easement boundary or property lines, and contractor staging areas outside the defined boundary lines, used expressly for construction
DNL or L_{DN}	Day-Night Sound Level - A 24-hour average, where sound levels during the nighttime hours of 10:00 p.m. to 7:00 a.m. have an added 10 dB weighting, but no added weighting on the evening hours, abbreviated as DNL or L_{DN}
dB	Decibel
dB re	dB reference to
dBA	A-weighted sound pressure level
Daytime	The period from 7:00 a.m. to 10 p.m.
Evening	The period from 7:00 p.m. to 10:00 p.m.

HVAC	Heating, ventilating, and air conditioning
L_{EQ}	The equivalent sound level, or the continuous sound level, that represents the same sound energy as the varying sound levels, over a specified monitoring period
L_{EQ}(h)	One-Hour Equivalent Noise Level
L_{MAX}	The root-mean-square (rms) value of the period measurement peak noise level
mph	Miles per hour
Nighttime	Periods other than daytime (as defined above), including legal holidays
Noise	Any audible sound that has the potential to annoy or disturb humans, or to cause an adverse psychological or physiological effect in humans
Noise Emission	The industry standard format of sound power level, which is the total acoustic power radiated from a given sound source as relates to a reference power level of 10 picowatts. Sound power level differs from sound pressure level, which quantifies the fluctuations in air pressure caused by acoustic energy.
Noise Level Measurements	Unless otherwise indicated, the use of A-weighted and "slow" response of instrument complying with at least Type 2 requirements of latest revision of American National Standard Institute (ANSI) S1.4. Specification for Sound Level Meters
Noise-sensitive Location	A location where particular sensitivities to noise exist, such as residential areas, institutions, hospitals, parks, or other environmentally sensitive areas
NSLU	Noise Sensitive Land Use
Octave-Filtered and Octave-Filtered Data	A contiguous series of continuous sound spectra centered about the stated frequency with half of the bandwidth above and half below the stated frequency; this data is used for machinery noise analysis and barrier effectiveness calculations
rms	Root mean square
sec	Second

EXECUTIVE SUMMARY

This acoustical analysis report was prepared to satisfy the request for an analysis of the Single-Event Noise Exposure Level (SNEL) for aircraft noise. Its purpose is to provide potential future residents and businesses proposed by the Westfield Corporation at the University Town Center (UTC) Shopping Center with information to assess noise effects from aircraft activities associated with Marine Corps Air Station (MCAS) Miramar.

The sound exposure level of a single noise event (such as an aircraft flyover or a truck pass-by) measured over the time interval between the initial and final times for which the sound level of the single event exceeds the background noise level, is expressed as the equivalent energy for a 1-second time period.

The proposed project includes the redevelopment and renovation of the UTC regional shopping center. The Master PDP proposes eight different land use scenarios that could result in the construction of a combination of uses, including up to 750,000 square feet (sf) of new retail, 725 multi-family residential dwelling units, 250 hotel rooms and/or 35,000 sf of office space on site. These residences could occur at up to three locations on the UTC. The Towne Center Garden land use district would be the closest residences to the MCAS Miramar flight operations.

The terms SNEL and Single-Event Level (SEL) are synonymous. No published standards are available for allowable impacts based solely on the SNEL or SEL descriptors. For simplicity sake the term SEL is used throughout this report. The analysis is based on the Federal Interagency Committee on Aviation Noise (FICAN) paper entitled *Effects Of Aviation Noise On Awakening From Sleep*, dated June 1997. The Threshold of Significance developed in the Los Angeles Master Plan Supplement to the Draft EIS/EIR, Supplemental Aircraft Noise Technical Report, June 2003 of 10% awakenings is used.

A total of 102 events were measured over 16 hours of field measurements taken in November 2007 with an SEL which could be reasonably calculated above ambient.

The residential units proposed on site will require a California Title 24 Acoustic Study upon the final building plan(s) submittal due to the combined noise impacts from MCAS Miramar and the nearby roadways. With enhanced quality dual pained windows and forced air ventilation a 30 dBA exterior to interior noise level reduction can be achieved with reasonable quality construction.

Based on the site field measurements the percentage of flight operations, which may cause sleep disturbances when compared to Recommended Sleep Disturbance Dose-Response Relationship FICAN, is:

- 30% of the measured flight operations would exceed a predicted interior SEL of 55 this would cause sleep disturbance in approximately 3 percent of the population.
- 15% of the measured flight operations would exceed a predicted interior SEL of 60 this would cause sleep disturbance in approximately 4 percent of the population.
- 9% of the measured flight operations would exceed a predicted interior SEL of 65 this would cause sleep disturbance in approximately 7 percent of the population.

These measurements were made on top of the existing southern 2 level parking structure, which is the closest residential location to the MCAS Miramar flight path which does not have traffic noise impacts which would reduce the accuracy and numerical value of the aircraft SEL. The flight noise across the rest of the site would have only a minor variation; most of the site would have slightly lesser impacts.

No predicted interior impacts would exceed an SEL of 70 with closed windows.

Under worst case conditions with all windows operating and flight operations were the same at night as during the day, significantly less than 10 percent of the total number of the residents of the building would have a sleep disturbance impact by flight operations.

The SEL levels from MCAS Miramar have a wide band of variability because of the variability of the aircraft activity whereas; the operations at a normal commercial aviation facility are far more consistent. This severely limits the use of the SEL level as an interior noise control analysis tool for MCAS Miramar. It can provide only limited statistical information. Planning for this project should be based on the MCAS Miramar noise contours and standard Title 24 California Building Code requirements.

1.0 INTRODUCTION

This acoustical analysis report was prepared to satisfy the request for an analysis of the Single-Event Noise Exposure Level (SNEL) for aircraft noise. Its purpose is to provide potential future residents and businesses proposed by the Westfield Corporation at the University Town Center (UTC) Shopping Center with information to assess noise effects from aircraft activities associated with Marine Corps Air Station (MCAS) Miramar.

The analysis is based on the Federal Interagency Committee on Aviation Noise (FICAN) paper entitled *Effects Of Aviation Noise On Awakening From Sleep*, dated June 1997. The Threshold of Significance developed in the Los Angeles Master Plan Supplement to the Draft EIS/EIR, Supplemental Aircraft Noise Technical Report, June 2003 of 10% awakenings is used.

The Federal Aviation Administration's Integrated Noise Model (INM) is normally used to predict aircraft SEL levels for analysis. However, because MCAS Miramar aircraft pass-by's do not have a regular altitude, flight path, power setting, or loading the model will not provide accurate predictions of SEL levels. Therefore, all information presented in this report is based on on-site measurements and observation of flight activities during the measurements.

1.1 NOISE TERMINOLOGY

All noise level or sound level values presented herein are expressed in terms of decibels (dB), with A-weighting, abbreviated "dBA," to approximate the hearing sensitivity of humans. Time-averaged noise levels are expressed by the symbol "L_{EQ}" unless a different time period is specified, "L_{EQ}" is implied to mean a period of one hour. Some of the data may also be presented as octave-band-filtered and/or A-octave-band-filtered data, which are a series of sound spectra centered about each stated frequency, with half of the bandwidth above and half of the bandwidth below each stated frequency. This data is typically used for machinery noise analysis and barrier-effectiveness calculations.

The CNEL is a 24-hour average, where sound levels during evening hours of 7:00 p.m. to 10:00 p.m. have an added 5 dB weighting, and sound levels during nighttime hours of 10:00 p.m. to 7:00 a.m. have an added 10 dB weighting. This is similar to the Day-Night sound level, L_{DN}, which is a 24-hour average with an added 10 dB weighting on the same nighttime hours but no added weighting on the evening hours. Sound levels expressed in CNEL are always based on the A-weighted decibel. These metrics are used to express noise levels for both measurement and municipal regulations, for land use guidelines, and for enforcement of noise ordinances.

Noise emission data is often supplied per the industry standard format of Sound Power, which is the total acoustic power radiated from a given sound source as related to a reference power level. Sound Power differs from Sound Pressure, which is the fluctuations in air pressure caused by the presence of sound waves, and is generally the format that describes noise levels as heard by the receiver.

Sound Pressure is the actual noise experienced by a human or registered by a sound level instrument. When Sound Pressure is used to describe a noise source it must specify the distance from the noise source to provide complete information. Sound Power is a specialized analytical method to provide information without the distance requirement, but it may be used to calculate the sound pressure at any desired distance.

The terms SNEL and Single-Event Level (SEL) are synonymous. For simplicity sake the term SEL is used throughout this report. SEL is defined as the sound exposure level of a single noise event (such as an aircraft flyover or a truck pass-by) measured over the time interval between the initial and final times for which the sound level of the single event exceeds the background noise level. By definition SEL values are referenced to a duration of one second. It is expressed as the equivalent energy for a one-second time period. Unit of measurement: Decibel. Unit symbol: dB. Abbreviation: SNEL. Letter Symbol: L_{AX}.

1.2 PROJECT LOCATION

The project site is located in the northwestern portion of the City of San Diego within the north University Community Plan area, less than five miles from the Pacific Ocean but outside of the coastal zone, as designated by the California Coastal Commission.

The site is one-mile north of an extended direct line with the MCAS Miramar runway, the normal flight path from MCAS aircraft, which are leaving MCAS Miramar, is to takeoff towards the site but curve to the northeast after takeoff while still east of the site. The site has a partial view of an area of Miramar where the aircraft do other on-base training exercises. Please see the attached San Diego County Airport Land Use Compatibility Plan provided as Figure 1 for the Fixed Wing Aircraft Flight Path and Helicopter Flight Path for more flight path information.

For a graphic representation of the site and plans, please refer to the ~~Vicinity~~ Project Location Map and Conceptual Site Plan/Land Use Districts (UTC Revitalization Project) provided as Figures 2 and 3, respectively.

1.3 PROJECT DESCRIPTION

The proposed project includes the redevelopment and renovation of a regional shopping center. The Master PDP proposes eight different land use scenarios that could result in the construction of a combination of uses, including up to 750,000 square feet (sf) of new retail, 725 multi-family residential dwelling units, 250 hotel rooms and/or 35,000 sf of office space on site. The proposed project would allow for the phased development of up to 750,000 sf of new retail and entertainment space and 250 residential dwelling units, with the option to build less retail for more residential, hotel and/or office uses instead under the various land use scenarios in the Master PDP.

1.4 SENSITIVE RECEPTORS

Sensitive receptors for the project are defined as the future residents and businesses that would live and work at the completed project site.

1.5 APPLICABLE NOISE STANDARDS

No published standards are available for allowable impacts based solely on the SNEL or SEL descriptors. However, the Federal Interagency Committee on Aviation Noise (FICAN) has published a paper entitled: *Effects Of Aviation Noise On Awakening From Sleep*, dated June 1997. A copy of that paper is attached to this report as Appendix A.

The Los Angeles International Airport (LAX) Master Plan Supplement to the Final EIR (LAXos Angeles World Airports ,20043) identifies 10 percent awakenings as the threshold for significance for an SEL analysis. The report section is included as Appendix B.

The FICAN study provides an interior SEL of 81 as the 10 percent threshold of significance for sleep disturbance.

2.0 ENVIRONMENTAL SETTING

2.1 EXISTING NOISE ENVIRONMENT

The project site is subject to noise from on-site driveways, on-site Heating, Ventilating and Air Conditioning (HVAC) equipment, delivery trucks, pedestrian noise, public roadway traffic, and aircraft operations associated with MCAS Miramar.

For a complete description of the MCAS Miramar operations, airport details, and flight information available to the public please see the publication Air Installation Compatible Use Zones (AICUZ) available on the MCAS Miramar website: www.miramar.usmc.mil.

On-site noise measurements were conducted on Wednesday, November 21, 2007 and Thursday, November 29, 2007. Measurements were made on the top level of the parking structure adjacent to the Sears auto repair center. These measurements were made on top of the existing southern 2 level parking structure, which is the closest available clear view of the MCAS Miramar flight path which does not have traffic noise impacts which would reduce the accuracy and numerical value of the aircraft SEL. The flight noise across the rest of the site would have only a minor variation; most of the site would have slightly lesser impacts.

2.2 MCAS MIRAMAR OPERATIONS INFORMATION

To obtain information on normal flight schedules Tony Guinn, Assistant Aircraft Operations Officer for MCAS Miramar was contacted at (858) 577-4419, Mr. Guinn provided the following information:

Normal Base Operating Hours
0730 to 2400 Hours, Monday thru Thursday
0730 to 1800 Hours, Friday
Closed Saturday
1400 to 1800 Hours, Sunday

These are the MCAS Miramar normal airfield operating hours. MCAS Miramar is a military base and may be scheduled for flight operations at any time on an intermittent or continuous basis without public notification with the appropriate internal review approval used.

3.0 METHODOLOGY AND EQUIPMENT

3.1 METHODOLOGY

3.1.1 Noise Work Analysis Software

Noise Work is a general-purpose graphics based noise and vibration analysis software package. Noise Work calculates functions including all mathematical operations from data blocks, spectra, multi-spectra, levels versus time, engine revolution or speed, and more. Levels of selected spectral bands can be modified or cancelled, both in frequency and in time domain, for data matrix or multi-spectra including SEL for the selected time period.

3.1.2 Aircraft Noise Measurement Methodology

The measurement microphone was positioned atop an approximate 25-foot high pole and aimed upwards to the northeast and connected to the meter with an extension cable. The meter was set to measure and record an overall A-weighted value and 1/3-octave noise levels at 1/10 of a second intervals. The measurement location is shown on ~~the attached~~ Figure 4, Existing Site Plan.

A log was kept of visual flight operations and times. The measured noise data is downloaded to a laptop computer for post measurement analysis.

3.2 MEASUREMENT EQUIPMENT

Some or all of the following equipment was used at the site to measure existing noise levels:

- Larson Davis Model 831, Type 1 Sound Level Meter
- Larson Davis Model CA250, Type 1 Calibrator

The sound level meter was field-calibrated immediately prior to the noise measurement and checked afterwards, to ensure accuracy. All sound level measurements conducted and presented in this report, in accordance with the regulations, were made with sound level meters that conform to the American National Standards Institute specifications for sound level meters (ANSI SI.4-1983, R2001). All instruments are maintained with National Bureau of Standards traceable calibration, per the manufacturers' standards.

4.0 IMPACTS

4.1 ANALYSIS METHODS

The measured data was analyzed as a series of graphic charts in the Noise Work analysis software. The on-site log was consulted and the appropriate noise event analyzed to determine the event SEL. The SEL event level was noted above and/or to the right of the peak of the event noise level. ~~These charts are noted with the date of the measurement and the time of the measurement on the X-Axis and attached to this report.~~

The SEL level, event noise source, and the event start and end times were recorded into a spreadsheet for final analysis. This information was used to generate graphs of all event SEL levels and durations and hourly average event occurrences.

4.2 MEASURED SEL LEVELS

A total of 102 events were measured during the two-day measurement period. The data and observation notes were compared and events were analyzed which had an SEL which could be reasonably calculated above ambient noise levels. These events are shown in the following tables that are organized by observed aircraft type. Measurements were made between the hours of 8 a.m. and 4 p.m. when flight activities stopped. The event duration is noted in hours: minutes: seconds.

Table 1
Measurements Made Wednesday, November 21, 2007

Number	SEL	Observed Aircraft Type	Duration
1	83.7	Not Visible From Measurement Location	0:01:05
2	83.9	Not Visible From Measurement Location	0:01:23
3	84.1	Not Visible From Measurement Location	0:00:07
4	85.6	Not Visible From Measurement Location	0:00:40
5	81.5	Not Visible From Measurement Location	0:00:40
6	82.2	Not Visible From Measurement Location	0:00:55
7	78.5	Not Visible From Measurement Location	0:00:20
8	77.6	Not Visible From Measurement Location	0:00:23
9	83.2	Not Visible From Measurement Location	0:00:20
10	75.3	Not Visible From Measurement Location	0:00:25
11	78.0	Not Visible From Measurement Location	0:00:26
12	77.9	Not Visible From Measurement Location	0:00:31
13	74.6	Not Visible From Measurement Location	0:00:31
14	81.0	Not Visible From Measurement Location	0:01:10
15	81.3	Not Visible From Measurement Location	0:00:16

Table 2
Measurements Made Thursday, November 29, 2007

Number	SEL	Observed Aircraft Type	Duration
1	79.4	Not Visible From Measurement Location	0:00:45
2	77.3	Not Visible From Measurement Location	0:00:50
3	77.6	Not Visible From Measurement Location	0:01:00
4	82.0	Not Visible From Measurement Location	0:01:15
5	83.3	Not Visible From Measurement Location	0:01:45

Table 3 Measurements Made Wednesday, November 21, 2007			
Number	SEL	Observed Aircraft Type	Duration
1	80.6	F-18 Over MCAS Miramar Only	0:00:31
2	85.9	F-18 Over MCAS Miramar Only	0:00:32
3	89.9	F-18 Over MCAS Miramar Only	0:00:20
4	77.5	F-18 Over MCAS Miramar Only	0:00:32
5	78.0	F-18 Over MCAS Miramar Only	0:00:09
6	75.7	F-18 Over MCAS Miramar Only	0:00:15
7	82.2	F-18 Over MCAS Miramar Only	0:00:53
8	77.9	F-18 Over MCAS Miramar Only	0:00:44
9	76.3	F-18 Over MCAS Miramar Only	0:00:30

Table 4 Measurements Made Thursday, November 29, 2007			
Number	SEL	Notes	Duration
1	80.7	F-18 Over MCAS Miramar Only	0:00:35
2	84.3	F-18 Over MCAS Miramar Only	0:01:20
3	76.6	F-18 Over MCAS Miramar Only	0:00:38
4	78.5	F-18 Over MCAS Miramar Only	0:00:35
5	75.7	F-18 Over MCAS Miramar Only	0:00:20
6	78.8	F-18 Over MCAS Miramar Only	0:00:40
7	79.1	F-18 Over MCAS Miramar Only	0:00:45
8	76.0	F-18 Over MCAS Miramar Only	0:00:30
9	76.0	F-18 Over MCAS Miramar Only	0:00:30

Table 5 Measurements Made Wednesday, November 21, 2007			
Number	SEL	Observed Aircraft Type	Duration
1	89.0	F-18 Pass-by to the north	0:00:38
2	79.0	F-18 Pass-by to the north	0:00:36
3	101.4	F-18 Pass-by to the north	0:01:03
4	94.6	F-18 Pass-by to the north	0:01:49
5	94.3	F-18 Pass-by to the north	0:01:00
6	87.7	F-18 Pass-by to the north	0:01:25

Table 6 Measurements Made Thursday, November 29, 2007			
Number	SEL	Observed Aircraft Type	Duration
1	87.0	(2) F-18 Pass-by to the north	0:01:10
2	92.6	F-18 Pass-by to the north	0:02:30
3	79.1	F-18 Pass-by to the north	0:01:30
4	83.9	F-18 Pass-by to the north	0:00:55
5	89.1	F-18 Pass-by to the north	0:01:05
6	81.1	F-18 Pass-by to the north	0:01:20
7	99.0	(2) F-18 Pass-by to the north almost overhead	0:01:38
8	87.2	F-18 Pass-by to the north	0:01:10
9	87.1	F-18 Pass-by to the north	0:00:55
10	98.1	(2) F-18 Pass-by to the north almost overhead	0:01:25
11	75.4	F-18 Pass-by to the north	0:00:35
12	76.3	F-18 Pass-by to the north	0:01:10
13	76.1	F-18 Pass-by to the north	0:00:55
14	75.1	F-18 Pass-by to the north	0:00:50
15	83.2	(2) F-18 Pass-by to the north	0:01:15
16	90.6	F-18 Pass-by to the north	0:01:10
17	78.4	F-18 Pass-by to the north	0:00:50
18	88.1	F-18 Pass-by to the north	0:01:40
19	78.2	F-18 Pass-by to the north	0:01:10
20	83.8	F-18 Pass-by to the north	0:01:25
21	92.5	F-18 Pass-by to the north	0:01:53
22	76.3	F-18 Pass-by to the north	0:00:45
23	83.5	(2) F-18 Pass-by to the north	0:01:00
24	82.2	F-18 Pass-by to the north	0:00:40
25	85.9	(2) F-18 Pass-by to the north	0:01:05
26	75.0	F-18 Pass-by to the north	0:00:52
27	85.7	F-18 Pass-by to the north	0:01:25
28	88.0	F-18 Pass-by to the north	0:00:50
29	76.6	F-18 Pass-by to the north	0:01:05
30	91.9	(3) F-18 Pass-by to the north	0:01:55
31	95.2	(3) F-18 Pass-by to the north	0:01:35
32	98.3	(2) F-18 Pass-by to the north	0:01:15
33	78.6	F-18 Pass-by to the north	0:01:02
34	76.8	F-18 Pass-by to the north	0:00:40
35	73.9	F-18 Pass-by to the north	0:00:25
36	74.5	F-18 Pass-by to the north	0:00:40
37	78.1	F-18 Pass-by to the north	0:00:35

Table 7
Measurements Made Wednesday, November 21, 2007

Number	SEL	Observed Aircraft Type	Duration
1	83.2	Helicopter Pass-by	0:03:50

Table 8
Measurements Made Thursday, November 29, 2007

Number	SEL	Observed Aircraft Type	Duration
1	74.3	Helicopter	0:01:00
2	85.3	4 Engine Turboprop Pass-BY	0:01:10
3	80.1	2 Rotor Transport Helicopter	0:00:50
4	78.3	2 Rotor Transport Helicopter	0:01:10
5	75.7	2 Rotor Transport Helicopter	0:01:00
6	72.9	(2) Big Single Rotor Helicopters	0:00:35
7	83.2	(2) F-18 Pass-by to the north	0:01:15
8	72.0	2 Rotor Transport Helicopter	0:01:00
9	76.5	Cargo Jet	0:00:33
10	82.5	Small Helicopter	0:01:50
11	77.5	Small Helicopter	0:01:50
12	74.0	2 Rotor Transport Helicopter	0:00:45
13	82.2	F-18 Pass-by to the north	0:00:40
14	85.9	(2) F-18 Pass-by to the north	0:01:05
15	95.8	2 Rotor Transport Helicopter	0:01:30
16	75.5	2 Rotor Transport Helicopter	0:00:40
17	75.8	2 Rotor Transport Helicopter	0:01:05
18	77.3	2 Rotor Transport Helicopter	0:01:00
19	75.6	4 Engine Transport	0:00:50
20	80.8	4 Engine Transport	0:01:05

4.3 SLEEP IMPACTS

The project site is located in an area shown as greater than 60 CNEL of the currently adopted Airport Land Use Commission Plan for MCAS Miramar. Therefore, a California Title 24A Acoustic Study will be required with the Building Plan submittal. With enhanced quality dual-paned windows and forced air ventilation, a 30 dBA exterior to interior noise level reduction can be achieved with reasonable quality construction. This 30-dBA reduction is also discussed in the FICAN study. ~~T~~In contrast, the LAX study identifies an exterior to interior reduction of 13-dBA with the windows open.

Based on the site field measurements the percentage of flight operations, which may cause sleep disturbances when compared to Recommended Sleep Disturbance Dose-Response Relationship by the FICAN study with closed windows, is:

- 30% of the measured flight operations would exceed a predicted interior SEL of 55 this would cause sleep disturbance in approximately 3 percent of the population.
- 15% of the measured flight operations would exceed a predicted interior SEL of 60 this would cause sleep disturbance in approximately 4 percent of the population.
- 9% of the measured flight operations would exceed a predicted interior SEL of 65 this would cause sleep disturbance in approximately 7 percent of the population.

No predicted interior impacts exceed an SEL of 70 with the windows closed.

If a worst case consideration is made, whereby residents were assumed to keep there windows open during the nighttime hours, and if the flight operations were the same at night as during the day. Six events occurred during the two days of measurements which would create an interior noise level in excess of SEL 81 with open windows. The loudest of these, an exterior SEL 101.4, would have an interior SEL of 87.6 for the residents with open windows facing the flight path. In this worst case, hypothetical scenario, significantly less than 10 percent of the total number of the residents of the building would have a sleep disturbance impact by flight operations.

These predictions are only valid for units with a clear window view of MCAS Miramar or the flight path. Any units, which do not have a clear view, will have ~~significantly~~ lower impacts if the units are built to the same standards. This reduction will depend on location relative to the flight path, but will be a minimum of 5 dBA and may be significantly greater.

5.0 CONCLUSION

Miramar flight operations are predominantly daytime, measurement of actual impacts during the nighttime hours of 10 p.m. and 7 a.m. are not feasible due to their infrequency.

The SEL levels from MCAS Miramar have a wide band of variability because of the variability of the aircraft activity whereas; the operations at a normal commercial aviation facility are far more consistent. This severely limits the use of the SEL level as an interior noise control analysis tool for MCAS Miramar. It can provide only limited statistical information.

Impacts from sleep disturbance due to flight activity near the UTC project site would be ~~are L~~less ~~T~~than ~~S~~significant.
~~The SEL levels from MCAS Miramar have a wide band of variability because of the variability of the aircraft activity whereas; the operations at a normal commercial aviation facility are far more consistent. This severely limits the use of the SEL level as an interior noise control analysis tool for MCAS Miramar. It can provide only limited statistical information. Planning for this project should be based on the then current MCAS Miramar noise contours and standard Title 24 California Building Code requirements.~~

6.0 CERTIFICATION

This report is based on the related project information received and measured noise levels, and represents a true and factual analysis of the acoustical impact issues associated with the proposed project.

This report was prepared by Charles Terry, Senior Acoustical Analyst.

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FICON, How do we Describe Aircraft Noise? (Current, Undated)
FICON, Federal Interagency Committee On Aviation Noise, The Use of Supplemental Noise Metrics in Aircraft Noise Analysis, February, 2002
FICON, Effects of Aviation Noise on Awakenings from Sleep, June 1997

<u>Los Angeles World Airports, LAX Master Plan Supplemental Aircraft Noise Technical Report 2003.</u>

Wyle, April 2005, Guidelines for Sound Insulation of Residences Exposed to Aircraft Operations Prepared For: Department of the Navy. Naval Facilities Engineering Command, Washington Navy Yard

Federal Aviation Administration (FAA)
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Appendix A

EFFECTS OF AVIATION NOISE ON AWAKENING FROM SLEEP

Effects of Aviation Noise on Awakenings from Sleep

Federal Interagency Committee on Aviation Noise (FICAN)

June 1997

The effect of aviation noise on sleep is a long-recognized concern of those interested in addressing the impacts of noise on people. In 1992, the Federal Interagency Committee on Noise (FICON) recommended an interim dose-response curve to predict the percent of the exposed population expected to be awakened as a function of the exposure to single event noise levels expressed in terms of SEL.

Since the adoption of FICON's interim curve in 1992, substantial field research in the area of sleep disturbance has been completed. The data from these studies show a consistent pattern, with considerably less percent of the exposed population expected to be behaviorally awakened than had been shown with laboratory studies.

FICAN recommends the adoption of a new dose-response curve for predicting awakening, based on the field data described in this paper and supporting references. The Committee takes the conservative position that, because the adopted curve represents the upper limit of the data presented, it should be interpreted as predicting the "maximum percent of the exposed population expected to be behaviorally awakened", or the "maximum % awakened".

1. SUMMARY

The effect of aviation noise on sleep is a long-recognized concern of those interested in addressing the impacts of noise on people. Historical studies of sleep disturbance were conducted mainly in laboratories, using various indicators of response (electroencephalographic recordings, verbal response, button push, etc). Field studies also were conducted, in which subjects were exposed to noise in their own homes, using real or simulated noise. However, in a 1989 assessment of existing research, Pearsons indicated the need for substantially more work in this area, citing the large discrepancy between laboratory and field studies as a major concern.

In 1992, the Federal Interagency Committee on Noise (FICON) recommended an interim dose-response curve to predict the percent of the exposed population expected to be awakened (% awakening) as a function of the exposure to single event noise levels expressed in terms of sound exposure level (SEL). This interim curve was based on the data presented in the 1989 study. The FICON report also recommended continued research into community reactions to aircraft noise, including sleep disturbance.

Since the adoption of FICON's interim curve in 1992, substantial field research in the area of sleep disturbance has been completed, using a variety of test methods, and in a number of locations. The data from these studies show a consistent pattern, with considerably less percent of the exposed population expected to be behaviorally awakened than had been shown with laboratory studies.

In light of this new information, FICAN recommends the adoption of a new dose-response curve for predicting awakening, based on the field data described in this paper and supporting references. The Committee takes the conservative position that, because the adopted curve represents the upper limit of the data presented, it should be interpreted as predicting the "maximum percent of the exposed population expected to be behaviorally awakened", or the "maximum % awakened". FICAN cautions that the dose-response relationship presented here relies on behavioral awakening as the indicator of sleep disturbance; relationships between aircraft noise and other potential sleep disturbance or related health effects responses have not been established by any of these newer studies. FICAN further notes that this curve should be applied only to long-term residential settings and should not be generalized to include children.

The new finding on the relationship between aircraft noise and sleep disturbance does not call into question the nighttime penalty applied to Day Night Sound Level (DNL). The 10 dB penalty added to noise levels for the period 10 p.m. to 7 a.m. is intended to account for the increased intrusiveness of noise at night. The ambient is generally lower and more people are at home during this period than at other times of the day. Thus, the opportunities for activity interference are much higher during nighttime which could lead to greater annoyance.

Continuing efforts to identify other dose-response relationships are being undertaken by standards-setting organizations, such as the American National Standards Institute. FICAN will evaluate proposed relationships developed by such groups as they are published; until that time, FICAN recommends the use of the curve presented here for assessing potential sleep disturbance caused by aircraft noise.

2. Background

2.1 The Nature of Sleep Disturbance

The effect of aviation noise on sleep is a long-recognized concern of those interested in addressing the impacts of noise on people. Historical studies of sleep disturbance were conducted mainly in laboratories, using various indicators of response (electroencephalographic recordings, verbal response, button push, etc). Field studies also were conducted, in which subjects were exposed to noise in their own homes, using real or simulated transportation noise [Lukas, 1975; Griefahn and Muzet, 1978; and Pearsons et al., 1989].

Based on a 1989 literature review by Pearsons for the U.S. Air Force, no specific adverse health effects have been clearly associated with sleep disturbance, characterized either by awakening or by sleep-state changes [Pearsons, 1989]. Nevertheless, sleep disturbance is deemed undesirable, and may be considered an impact caused by noise exposure.

2.2 Methodological Considerations

Sleep disturbance studies have employed a variety of factors in study design, sleep disturbance measurement, and noise exposure assessment. Differences in these techniques can have influences on the results of the studies, and a basic understanding of the differences is important for interpreting the results.

Study Design: Laboratory vs. Field Research

The most important issue with regard to the design of sleep disturbance studies has been the location of test subjects: as demonstrated in the meta-analysis by Pearsons, there has been a consistent, significant difference in the level of disturbance observed between laboratory studies, in which subjects are exposed to noise in a laboratory setting, and field studies, in which subjects are exposed to noise (actual or simulated) in their own home. Generally, laboratory studies have shown considerably more disturbance than field studies [Pearsons, 1995]. Finegold speculates that the significantly greater awakening observed in the laboratory is due to the lack of habituation [Finegold, 1993].

Measures of Sleep Disturbance

Distinctions can be made between a variety of sleep disturbance responses, which can be identified through different data collection methods in sleep studies.

Behavioral awakenings typically are defined as awakening by the subject enough to initiate a physical acknowledgment, such as button-pushing or verbal response. Sleep disturbance also can be defined as arousals or gross bodily movement (motility), identified by periods of actimetric responsei, or by electroencephalographic (EEG) response, which may or may not result in actual awakening. Researchers are careful to point out that the relationship between behaviorally-confirmed awakening and motility is not clear, though both show clearly defined dose-response relationships.

In addition to the variety of measures for identifying disturbances from individual events, most sleep disturbance studies collect data from subjects concerning cumulative sleep effects. For example, measurements can be made of the total sleep time and/or time to fall asleep, and subjects can be questioned on sleep quality (feeling upon arousal, etc.). Two major problems with collecting cumulative data are the potential influences of disturbance caused by non-noise sources, and the difficulty of avoiding bias in test subjects on self-report.

Noise Metrics

Similarly, the noise metrics used to quantify noise exposure in sleep research fall into two categories: (1) measures of individual events, and (2) cumulative measures. Single event measures that have been used in sleep disturbance studies include the Maximum A-weighted Level (Lmax), Perceived Noise Level (PNL), Sound Exposure Level (SEL), Effective Perceived Noise Level (EPNL), and C-Level (CL). Cumulative measures are used to characterize the noise events over an entire night or day, and have included the Equivalent Noise Level (Leq), Composite Noise Level (CNL), Day-Night Average Sound Level (DNL), Community Noise Equivalent Level (CNEL), and Cumulative Distribution Levels or Percentile Levels, (Lx).

A-weighted measures of single events have been most often used in sleep disturbance studies, with either Lmax or SEL being used in most of the recent studies, based on general consensus that single event metrics are more useful for predicting sleep disturbance than cumulative measuresii.

2.3 FICON Sleep Disturbance Recommendations

In 1992, the Federal Interagency Committee on Noise (FICON) recommended an interim dose-response curve to predict the percent of the exposed population expected to be awakened (% awakening) as a function of the exposure to single event noise levels expressed in terms of the sound exposure level, SEL [FICON, 1992]. This interim curve was based on statistical adjustment of Pearsons' 1989 analysis, and included data from both laboratory and field studies [Finegold, 1993]. The recommended dose-response relationship is shown in Figure 1, and can be expressed by the following equation:

Awakenings = 0.000007079 x SEL3.496

The FICON report also recommended continued research into community reactions to aircraft noise, including sleep disturbance.

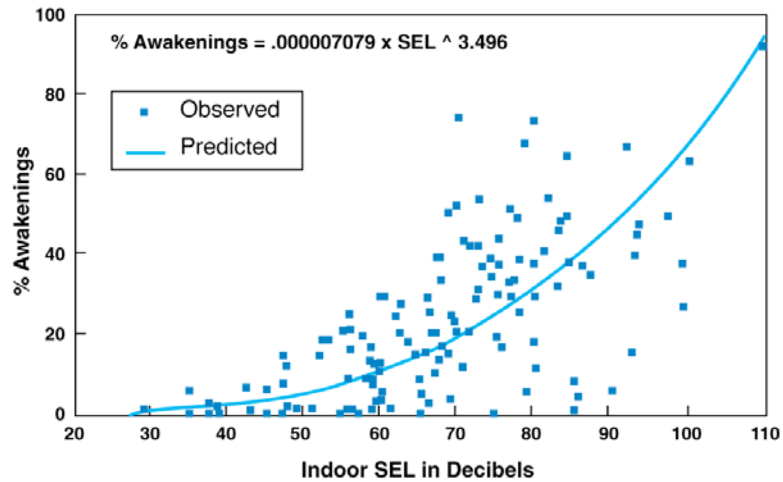

Figure 1. Interim Sleep Disturbance Dose-Response Relationship Recommended by FICON (FICON, 1992)

3. Recent Sleep Disturbance Research

Three recent studies have added considerably to the stock of data on sleep disturbance caused by aviation noise. The first of these was conducted in the United Kingdom in 1992; the second in the U.S. near Castle Air Force Base and near Los Angeles International Airport in California in 1992; and the most recent study was conducted in communities near Stapleton International Airport (DEN) and near Denver International Airport (DIA) in Colorado, both before and after the opening of DIA in 1995. These studies are summarized below.

3.1 U.K. Study

The United Kingdom's (U.K.'s) Civil Aviation Authority initiated a study of aircraft noise and sleep disturbance in 1990 to assist the U.K. Department of Transport in developing proposals for future restrictions on nighttime aircraft operations at the London airports [Ollerhead et al., 1992]. In this field study, nearly 50,000 subject-hours of sleep disturbance were collected at four airports, using both activity meters (actimeters) and EEG to measure sleep disturbance in test subjects. In total, 5,742 subject-nights of actimetry data and 178 subject-nights of sleep-EEG data were collected.

The major conclusions of the study are as follows:

- All subjective reactions to noise vary greatly from person to person and from time to time and sleep disturbance is no exception; deviations from the average can be very large. Even so, this study indicates that, once asleep, very few people living near airports are at risk of any substantial sleep disturbance due to aircraft noise, even at the high event levels.
- At outdoor event levels below 90 dBA SEL (80 dBA Lmax), average sleep disturbance rates are unlikely to be affected by aircraft noise. At higher levels, and most of the events upon which these

> conclusions are based were in the range 90 to 100 dBA SEL (80 to 95 dBA Lmax), the chance of the average person being wakened is about 1 in 75. Compared with the overall average of about 18 nightly awakenings, this probability indicates that even large numbers of noisy nighttime aircraft movements will cause very little increase in the average person's nightly awakenings. Therefore, based on expert opinion on the consequences of sleep disturbance, the results of this study provide no evidence to suggest that aircraft noise is likely to cause harmful after effects [Ollerhead et al., 1992].

Finally, the study emphasized that these are estimates of average awakenings, and it acknowledges that some individuals in any exposed population are likely to be more sensitive to nighttime noise, while others will be less sensitive.

3.2 Los Angeles Study

The 1992 study conducted for the USAF [Fidell et al., 1994] observed the effects of nighttime noise exposure on the in-home sleep of residents near Castle Air Force Base and near Los Angeles International Airport and in several suburban control households with negligible aircraft noise exposure. Test participants pressed a button upon awakening for any reason, after retiring for the evening. A total of 1,887 subject-nights of data were collected from 38 men and 47 women living in 45 different homes. Length of residence for the test subjects ranged from two to more than 40 years. Major findings of the study are as follows:

- A statistically reliable relationship was observed between sound exposure levels of noise intrusions in sleeping quarters and behaviorally confirmed awakenings within five minutes of occurrence of noise intrusions.
- Although outdoor noise exposure level at the test sites varied over the range of levels of principal interest for environmental analysis purposesiii, the prevalence for awakening among test participants did not increase greatly with sound exposure levels of noise intrusions in sleeping quarters.
- Of a total of 4,452 awakening responses, only 326 could be associated with noise events.
- The average spontaneous rate of behaviorally confirmed awakenings among test participants at all sites was approximately two per night. This figure did not differ significantly across sites with varying levels of nighttime noise exposure [Fidell et al., 1994].
- The authors cautioned that the test subjects may not be representative of all residential situations, and that generalizations of the data obtained in the study should be limited to long term residents of areas with stable nighttime noise exposure.

3.3 Denver Study

A large scale field study of noise-induced sleep disturbance was conducted in the vicinities of Stapleton International Airport (DEN) and Denver International Airport (DIA) in anticipation of the closure of DEN and the opening of DIA. Both indoor and outdoor measurements of aircraft and other nighttime noises were made during four data collection periods. Measurements were made in 57 homes, over a total of 2,717 subject-nights of observations. Sleep disturbance was measured by several methods, including button pushes upon awakening and body movements, recorded by actimeters.

Although average noise event levels measured outdoors decreased significantly at sites near DEN after its closure and increased slightly at sites near DIA after its opening, indoor noise levels varied much less in homes near both airports. No large differences were observed in noise-induced sleep disturbance at either airport, as measured before and after the DIA opening. Indoor Sound Exposure Levels of noise events were, however, closely related to and good predictors of actimetrically defined motility and arousal.

The major findings of the Denver study are the following:

- The current findings closely resemble those of prior field studies of noise-induced sleep disturbance.
- Outdoor nighttime Leq decreased about 12 dB on average at DEN upon closure of the airport, but increased only about 3 dB at DIA after opening of the airport. Indoor nighttime Leq varied little at either location with the transfer of flight operations from DEN to DIA.

- The average number of behavioral awakenings per night was 1.8 at DEN and 1.5 at DIA. The number of spontaneous awakening responses (unassociated with noise events) was 1.5 per night at DEN and 1.3 at DIA.
- Statistically reliable relationships were observed between sound exposure levels of individual noise intrusions as measured inside sleeping quarters and several measures of sleep disturbance. [Fidell et al., 1995]

4. Recommended Revised Sleep Disturbance Relationship

FICAN has evaluated the data and conclusions of the three field studies described in this paper. The combined data are presented in Figure 2, along with data from six previous field studies [Pearsons, 1989]. The "FICAN 1997" curve shown in Figure 2 predicts a conservative dose-response relationship for the combined field data. The FICON curve is also depicted, for comparison purposes; based on the current field data, the dose-response relationship given by this older curve significantly overestimates the extent of aircraft noise-related awakenings for a given SEL exposure.

The FICAN 1997 curve represents the upper limit of the observed field data, and should be interpreted as predicting the "maximum percent of the exposed population expected to be behaviorally awakened", or the "maximum % awakened" for a given residential population. The central tendency of the recent data was not chosen as the recommended curve because it could underestimate awakenings for some situations or communities. FICAN cautions that the dose-response relationship presented here relies on behavioral awakening as the indicator of sleep disturbance; relationships between aircraft noise and other potential sleep disturbance or related health effects responses have not been established by any of these newer studies.

FICAN further cautions that these data should be applied only to long term residents, although the inclusion of data from the opening of Denver International Airport suggests that people adapt to "new" noise rapidly. This curve should not be applied to estimate sleep disturbance in campgrounds, trailer parks, or other temporary residences. Nor should it be assumed that the curve can be generalized to include children, as only adults were included in the field studies.

The FICAN 1997 curve also is represented by the following equation:

$$\text{Awakenings} = 0.0087 \times (\text{SEL}-30)1.79$$

Continuing efforts to identify other dose-response relationships are being undertaken by standards-setting organizations, such as the American National Standards Institute. FICAN will evaluate proposed relationships developed by such groups as they are published; until that time, FICAN recommends the use of the curve presented here for assessing potential sleep disturbance caused by aircraft noise.

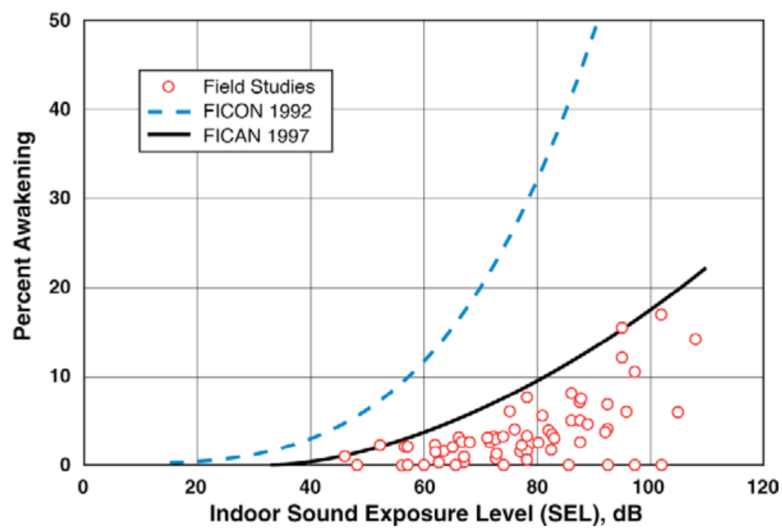

Figure 2. Recommended Sleep Disturbance Dose-Response Relationship

Footnotes

[i] Actimeters are activity monitors, which record significant limb movements over a long period of time. In sleep disturbance studies, they generally are strapped to the wrist. Actimeters are generally considered to be a more practical and cost-effective method of collecting physical sleep disturbance data.
[ii] The use of single event measures in sleep disturbance studies does not suggest that the nighttime penalties used to assess noise in Day-Night Average Sound Level or other cumulative measures are incorrect or need re-evaluation; FICAN continues to support the use of DNL for addressing cumulative impact and its underlying assumptions regarding nighttime noise events.
[iii] Day-Night Average Sound Levels (DNL) at sites near Castle AFB ranged from 50 to 90 dB, while DNL at sites near LAX ranged from 60 to 70 dB. DNL at control sites ranged from about 50 to 70 dB (some control sites were exposed to high levels of road traffic noise).

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Appendix B

SEL THRESHOLD OF SIGNIFICANCE

Appendix
LAX Master Plan Supplement to the Draft EIS/EIR

S-C1. Supplemental Aircraft Noise Technical Report

June 2003

Prepared for:

Los Angeles World Airports

U.S. Department of Transportation
Federal Aviation Administration

Prepared by:

Landrum & Brown

6.1 Nighttime Awakenings Analysis

While sleep disturbance and awakenings have been the subject of much research, the Federal Interagency Committee on Aviation Noise (FICAN)[13] in a 1997 report selected one study as the most widely accepted information upon which to base the advisory group's selection of a defensible relationship between single event noise and awakenings. The FICAN report cites a study conducted by Finegold and Fidell, which relates the proportion of persons awakened by noise events at differing Sound Exposure Levels (SEL). The Finegold report includes a formula that allows the user to compute, for any given SEL, the percentage of the population that may be awakened by an aircraft single event.

The analysis of nighttime sleep awakenings in this Supplement to the Draft EIS/EIR is limited to the hours between 10:00 p.m. and 7:00 a.m., the hours used by all Federal agencies and Caltrans to evaluate impacts of noise on traditional night activities. The elements of the analysis include: determination of the appropriate threshold of significance for nighttime awakenings; selection of a methodology to enable the consistent comparison of the nighttime impacts with baseline conditions; delineation of areas of exposure to nighttime single event noise impacts; determination of the area and number of residences, with associated population, within the area of significant nighttime noise exposure; and the development of actions to mitigate the effects of nighttime single event impacts.

6.1.1 Threshold of Significance

After evaluation of the relationship between potential sleep awakening and aircraft noise exposure, LAWA selected a threshold of significance for use in the Supplement to the Draft EIS/EIR. LAWA determined that the threshold of significance for awakenings should be the A-weighted Sound Exposure Level (SEL) at which 10 percent of the population would be awakened, assuming windows in dwellings remain open, and for further clarity, that a single event of that level should occur at least once every 10 days. The selection of a frequency of once every 10 days provides an effective probability of an individual being awakened of one percent if his/her residence is located on the contour line representing the threshold of significance. With these criteria in mind, the following was determined:

- **10 Percent Awakening Level** - based on Figure 2 of FICAN's awakenings document, the interior noise level at which 10 percent awakenings occur is 81 decibels of SEL.[14]

The noise computations of the INM are for exterior noise levels. To determine the exterior noise level at which interior noise levels of 81 decibels of SEL are achieved, information on the attenuation provided by typical residential construction must be available. As part of its on-going Aircraft Noise Mitigation Program (ANMP), LAWA's Environmental Management Bureau has conducted noise measurements prior to its acoustic treatment of dwellings that indicate, on average, that residential construction in the airport environs provides an exterior-to-interior attenuation of 27.5 decibels with windows closed.[15] This means that for 10 percent of the residents of the area surrounding LAX to be awakened, the SEL would have to be 109 decibels or more if their windows are closed.

Given the climate of the airport environs, it is unlikely that windows would remain closed at all times. Moderate temperatures frequently lead residents of the area to leave their windows open, and numerous comments during the public review process indicated that this ability was severely restricted by the presence of nighttime aircraft noise events. Furthermore, cost of maintaining air conditioning systems with windows closed is considered an imposition on the effected communities that would not otherwise be present without the aircraft noise events. Aerospace Information Report 1081 by the Society of Automotive Engineers (SAE),[16] provides information about the difference between exterior-to-interior noise attenuation rates with windows open and windows closed. Based on the information in the SAE document, in bedrooms in the LAX area the exterior-interior difference would average 14.3 decibels.[17]

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13 The FICAN 1997 report on the "Effects of Aviation Noise on Awakenings from Sleep" may be found on the internet at http://www.fican.org/pages/sleepdst.html.

14 According text accompanying Figure 2 of the awakenings document, the percentage of awakenings at any interior SEL level may be computed using the formula: Awakenings = $0.0087 \times (\text{SEL}-30)^{1.79}$.

15 Information provided by Dave Brown, Wyle Labs, via fax from Scott Tatro, LAWA Environmental Management Bureau, May 14, 2002.

16 "House Noise-Reduction Measurements For Use In Studies of Aircraft Flyover Noise", Aerospace Information Report AIR1081, Society of Automotive Engineers, October 1971.

17 Ibid., Table V, page 8.