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Aircraft Noise Terminology

Noise 101 – Chapter 2

July 23, 2013

Courtesy of: HARRIS MILLER MILLER & HANSON INC.

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Definition of Noise

What is Noise?

- Noise is unwanted sound
- Noise is subjective
- We measure sound not noise
- Relate sound levels to percent annoyed and activity interference

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Sound Descriptors

Sound Pressure

The Decibel, dB

A-Weighted Decibel, dBA

Maximum A-weighted Sound Level, Lmax

Single Event Noise Exposure Level, SENEL

Day-Night Average Sound Level, DNL

Community Noise Equivalent Level, CNEL

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Sound Pressure

- Is any pressure variation that the *human ear* can detect
- Consists of very small variations above and below atmospheric pressure
- Standard atmospheric variations associated with weather occur much slower and are much larger than sound pressure variations we hear

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The Decibel, dB

The decibel is a ratio of measured sound pressure to a reference sound pressure

- **A healthy human ear can detect sound amplitudes from 20 millionths of a Pascal (20□Pa)**
- **The ear can tolerate sound pressures more than a million times higher**
- **The decibel (dB) scale is used to accommodate this very large range of pressures**

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The Decibel, dB

Important benchmarks:

- **Threshold of hearing is 0 dB**
- **Normal speaking voice at 3 ft. 65 dB**
- **1 million times 20 □Pa is 120 dB**
- **Threshold of pain is about 130-140 dB**

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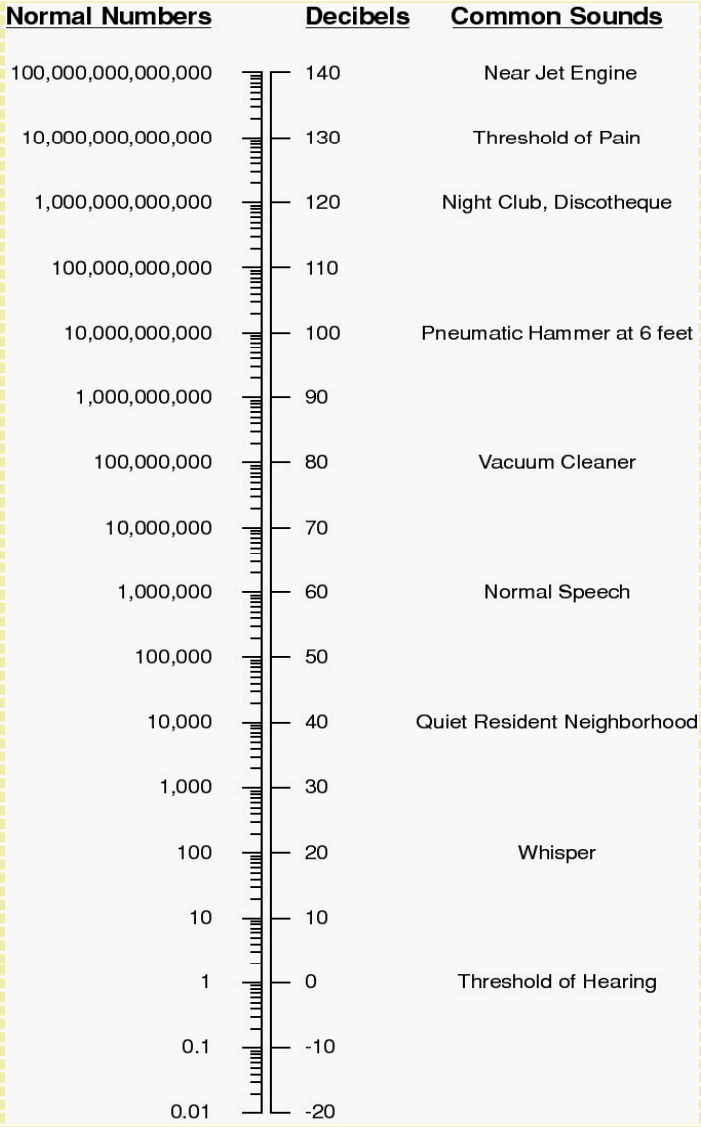
The Decibel Scale



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The Decibel Scale

- The smallest change in sound pressure amplitude that can be detected in a laboratory is about 1 dB
- Outside of the lab a change of 3 dB is barely perceptible
  - **A 3-dB increase requires *two times* the sound energy**

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The Decibel Scale

- A change of 6 dB is clearly perceptible
  - **A 6-dB increase requires *four times* the sound energy**
- A change of 10 dB is required before the sound subjectively appears to be twice as loud
  - **A 10-dB increase requires *ten times* the sound energy**

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Decibel Addition

- 100 dB + 100 dB =
  103 dB
- 100 dB + 100 dB + 100 dB + 100 dB =
  106 dB
- 100 dB + 100 dB + 100 dB + 100 dB + 100 dB + 100 dB + 100 dB + 100 dB + 100 db + 100 dB =
  110 dB

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Decibel Addition
Rule of Thumb Method

When adding two sound levels that

Differ by:	Add to the higher level
0 to 1 dB	3 dB
2 to 3 dB	2 dB
4 to 9 dB	1 dB
10 dB	0 dB

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A-Weighted Decibel, dBA

Frequency (Hz) is the number of pressure variations per second

- The frequency of a sound produces it's distinctive tone
  - Rumble of distant thunder is low frequency
  - A whistle is high frequency
- Normal range of hearing for a healthy young person is 20 Hz to 20,000 Hz (or 20 kHz)
- Range of the lowest to highest piano note is 27.5 Hz to 4186 Hz

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A-weighted Decibel, dBA

- The human auditory system is not equally sensitive to all frequencies
- To be a useful environmental analysis tool we need a way to measure sound the same way the ear hears it
- The A-weighted sound level achieves this goal
- The FAA has adopted the A-weighted sound level for environmental analyses

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Maximum A-weighted Sound Level (Amax)

- Because of the variation in level of a sound event, it is often convenient to describe the event by using its maximum sound level, abbreviated as Amax
- Amax accounts only for sound amplitude
- Two events may have the same maximum level, but very different sound exposure levels

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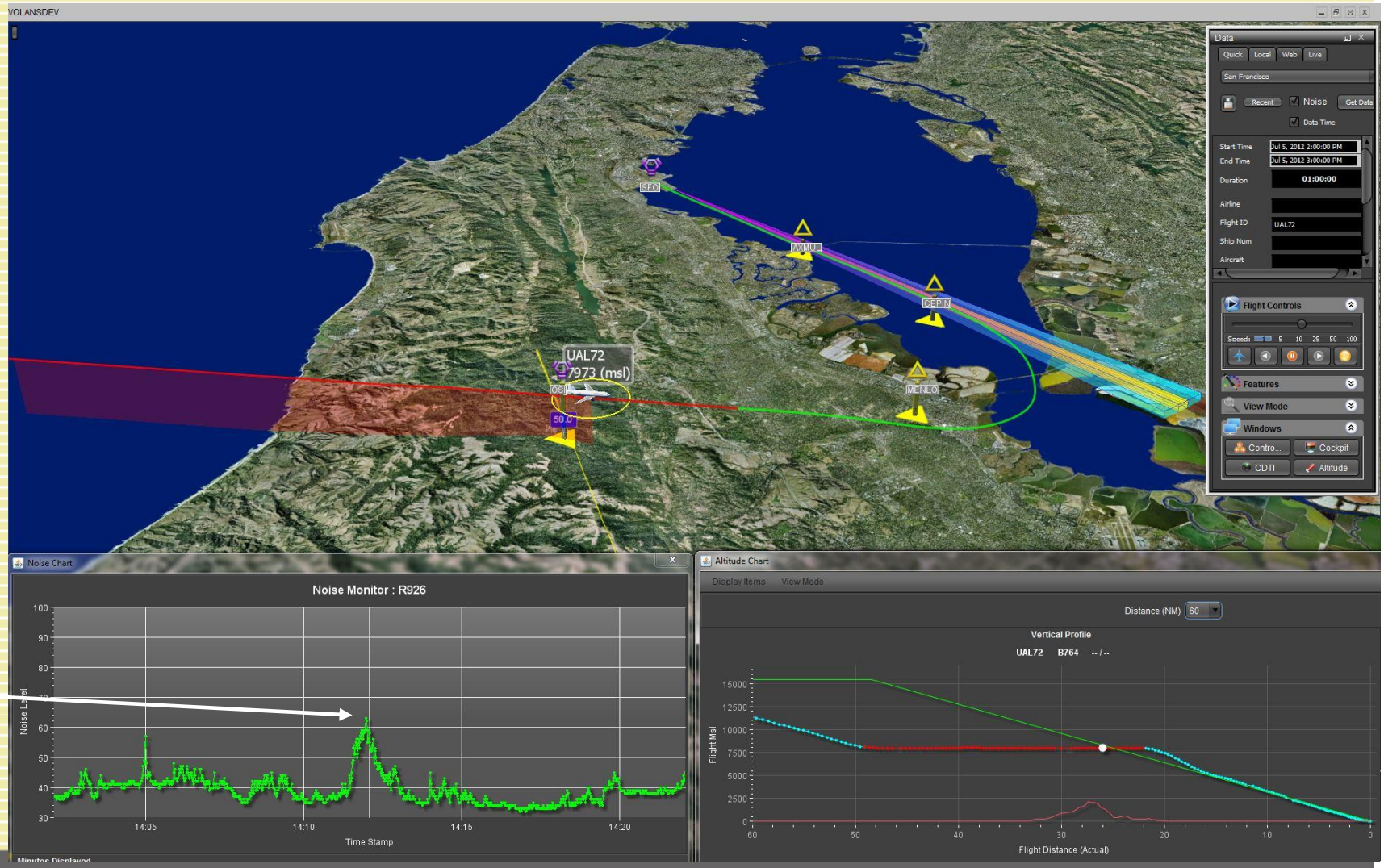
A-weighted Sound Pressure Level

Time History



Maximum Level

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Single Event Noise Exposure Level (SENEL)

- Describes the “noisiness” of a complete noise event
- Accounts for sound amplitude, and
- For the noise event duration
- Equivalent to Sound Exposure Level (SEL)

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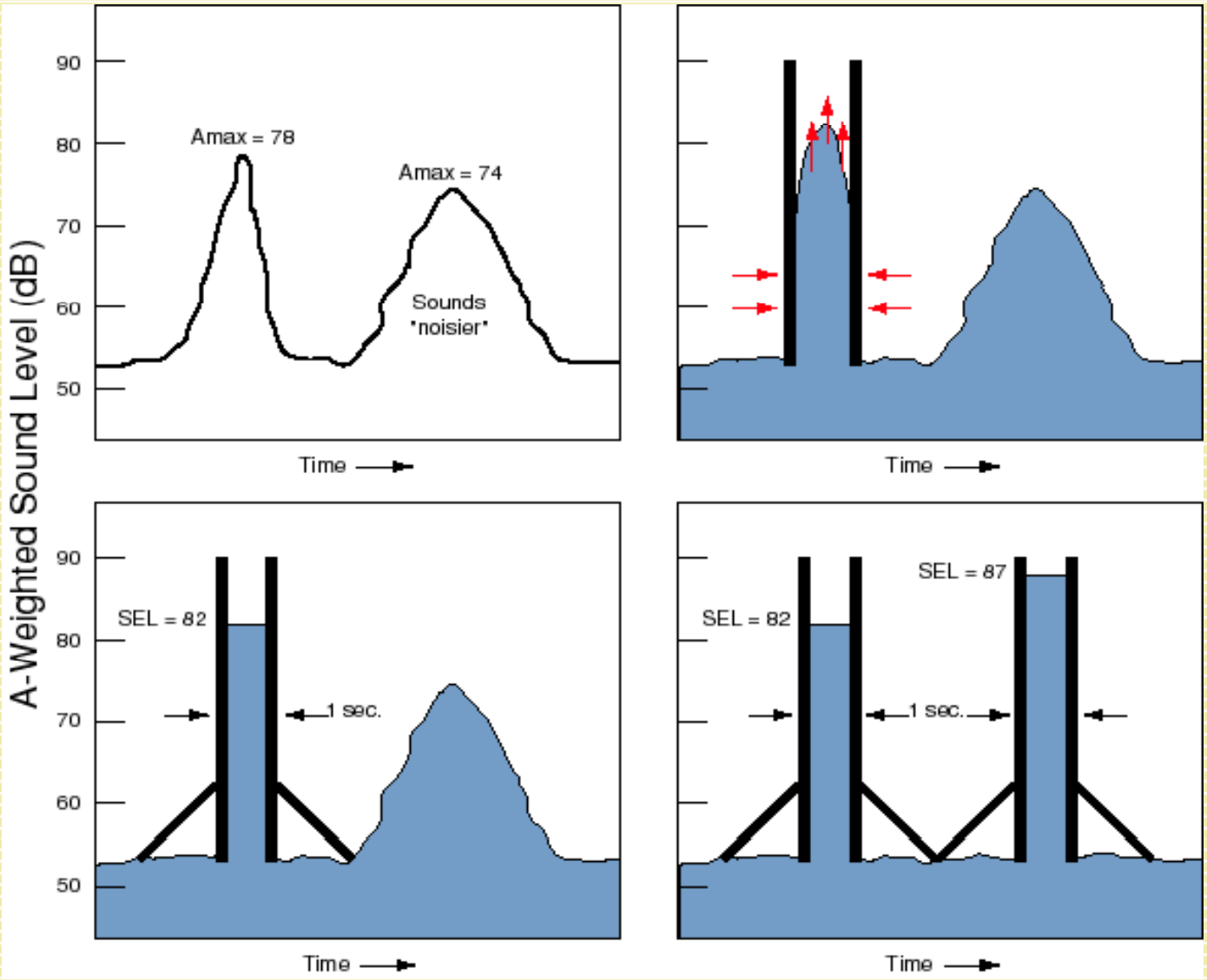
Sound Exposure Level (SEL)



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Day-Night Average Sound Level (DNL)

- A way to describe the noise dose for a 24-hour period
- Accounts for noise event “noisiness” (SEL)
- Accounts for number of noise events
- Provides an additional weighting factor for nighttime (10X) operations
- Federal Aviation Regulation Standard
- Correlates well with community annoyance

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Community Noise Equivalent Level (CNEL)

- Another way to describe the noise dose for a 24-hour period
- Accounts for noise event “noisiness” (SENEL)
- Accounts for number of noise events
- Provides an additional weighting factor for evening (3X) and nighttime (10X) operations
- California Airport Noise Regulation Standard
- Correlates well with community annoyance

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Community Noise Equivalent Level (CNEL)

- DNL and CNEL are approximately equivalent
  - **65 dB CNEL incompatible with residential uses**
  - **These levels occur close to the airport**

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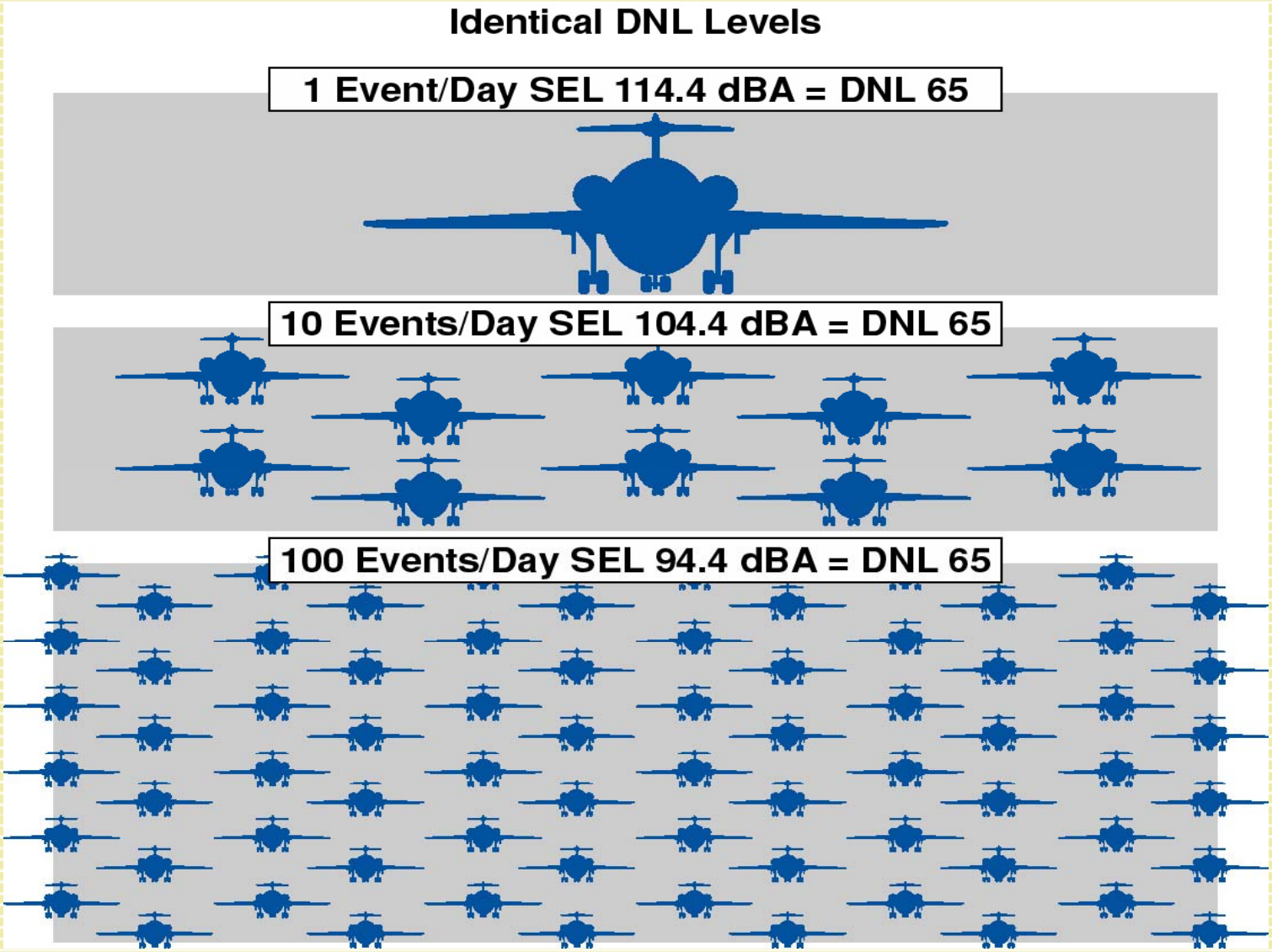
Different DNL 65 Environments



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Non-Aircraft Noise Environments

- Nature contributes to our noise exposure
  - **Wind in the trees, birds chirping, dogs barking, waves crashing, etc.**
- Human activity contributes to our noise exposure
  - **Cars, trucks, mowers, leaf blowers, schools, sirens, arterials, freeways, etc.**
- The more urban our environment, the greater our level of noise exposure

Non-Aircraft Noise Environments

- Qualitative descriptions of non-aircraft noise environments:

DNL or CNEL, dB	Qualitative Description
~ 46 – 51	Quiet Suburban
~ 52 – 57	Suburban
~ 58 – 63	Urban
~ 64 – 69	Noisy Urban
~ 70 – 75	Very Noise Urban
~ 76 – 81	Downtown City Noise

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How do we quantify sound?

- Measurements
- Modeling

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How do we quantify sound?
Measurements

- Measurements accurately tell us:
    - The sound levels at a specific site
    - For a specific time period
- Measurements are an historical record
- Measurements are not predictive, but can show *historical* trends

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How do we quantify sound?

Measurements

- Two types of measurements:
  - Short-term (made with portable equipment)
  - Long-term (made with permanent monitors)

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Measuring Sound – Portable Monitors

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Measuring Sound – Permanent Monitors

Measuring Sound – Permanent Monitors

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How do we quantify sound?

- Measurements
- Modeling

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How do we quantify sound?

Modeling

- Modeling can accurately tell us sound levels:
    - Over abroad geographic area as well as at specific sites
    - For a specific time period
- Modeling can produce an historical record
- Modeling can be predictive by showing *expected* trends

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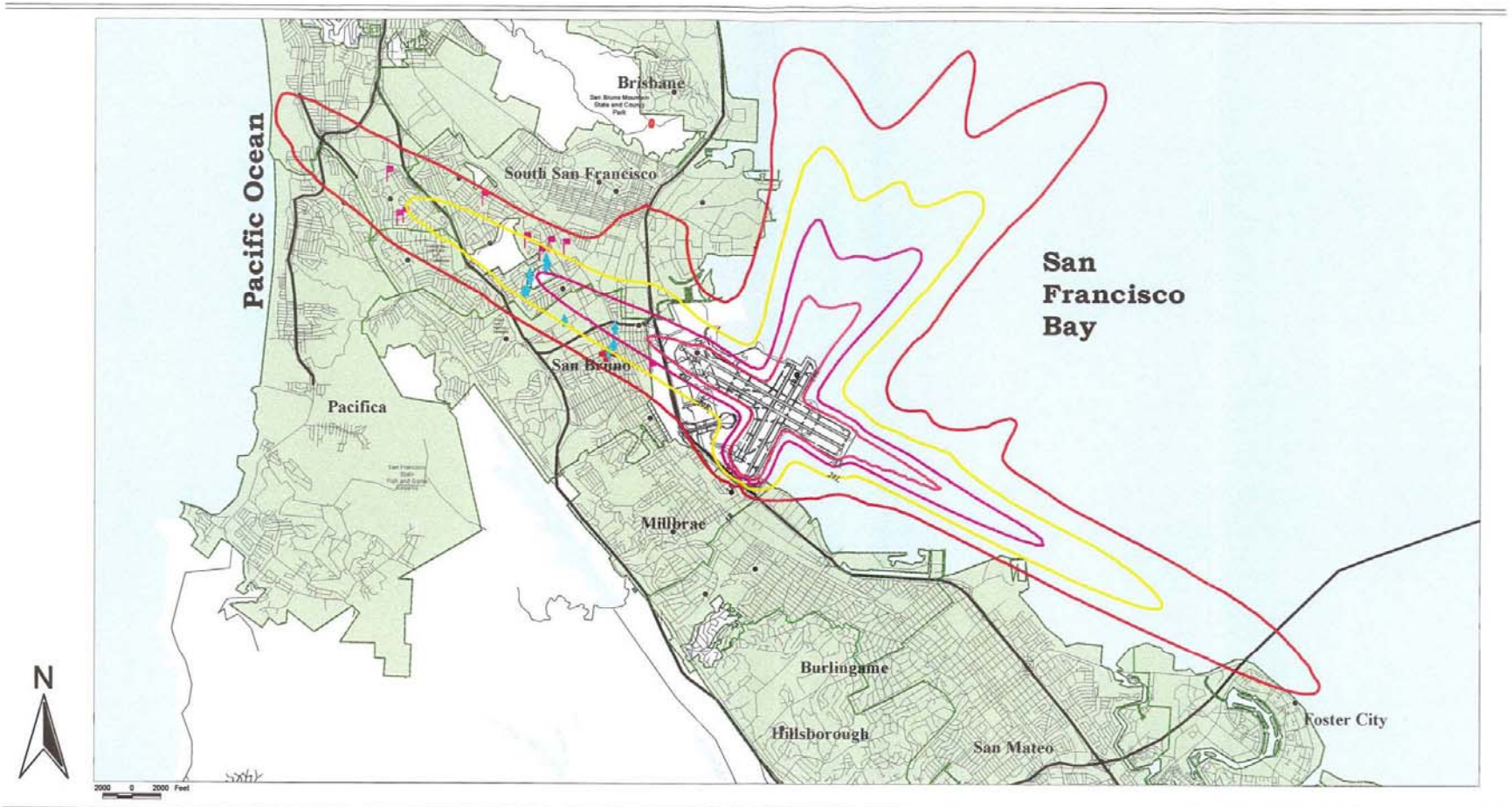
CNEL Contours



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Aircraft Noise Effects
Near An Airport

- Source of annoyance
- Not a threat to hearing or structures
- Potential for speech interference
- Other potential health effects are being studied
  - **Learning in children**
  - **Sleep disturbance**

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Aircraft Noise Effects
Away From An Airport

- Source of annoyance
  - **More complaints come from outside of the 65 dB CNEL contours than from within**
- Identifying the responsible agency can be frustrating
- Change in level more important than the absolute level

Aircraft Noise Resources

- Airport/Community Roundtable
  - James Castaneda, (650) 821-3571
  - Website: WWW.SFOROUNDTABLE.ORG
- SFO Aircraft Noise Abatement Office
  - Bert Ganoung, (650) 821-5100
  - SFO Website: WWW.FLYQUIETSFO.COM
- N.O.I.S.E.
  - Annual conference
  - Website: WWW.AVIATIONNOISE.ORG
- Airport Noise Report
  - A weekly update on aviation noise issues
  - Editor@airportnoisereport.com
  - Anne Kohut, (703)-729-4867

Aircraft Noise Resources (cont.)

- UC Davis Air Quality and Noise Symposium
  - Donna Reid, 530-752-8374
  - Dvreid@ucdavis.edu
- Harris Miller Miller & Hanson Inc.
  - Website: WWW.HMMH.COM
  - Technical papers on aviation noise
  - Links to other airports
  - ereindel@hmmh.com
  - Gene Reindel, (916) 568-1116
- Federal Interagency Committee on Aircraft Noise (FICAN)
  - Website: WWW.FICAN.ORG
  - Maryellen Eagan, (781) 229-0707
- FAA Aviation Noise Ombudsman
  - Paul Dykeman, (202) 267-3577

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Aircraft Noise Terminology
Summary

- Noise is unwanted sound
- Decibels do not add arithmetically
- Cumulative noise metrics (CNEL) correlate well with annoyance
- Sound levels can be measured and modeled
- Aircraft noise is not a threat to hearing or structures
- Resources are available to “get up to speed”

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Thank you!