

Educational Series: Introduction to CA Title 21 Noise Standards and Aviation Noise Terminology

January 2023

California – Title 21 Noise Problem Airports

California Department of Transportation (Caltrans),
Division of Aeronautics, Title 21 Subchapter 6. Noise Standards
(Register 90, No. 10—3-10-90)

- County designates an Airport as having a “Noise Problem” and then must submit quarterly noise reports to the State with:
 - A map showing the noise impact boundary (65 CNEL)
 - The annual noise impact area (incompatible land uses w/in 65 CNEL)
 - Daily CNEL measurements
 - *Form DOA 617* (inventory of aircraft operations, number of people exposed to 65 CNEL and above, etc.)



California – Title 21 Requirements

- Noise Monitoring Requirements
 - Continuous (48 weeks /year), if ≥ 1000 homes in 70 dB CNEL contour
 - or Intermittent (1 week/quarter)
 - Determine CNEL within 1.5 dB
- Measurement of CNEL
 - Threshold noise level of 55 dB (or waiver)
 - Capture Single Event levels (in SENEL)
 - Calculate hourly levels (HNL) from single events, then CNEL from HNL
- Variances, granted by Caltrans for ≤ 3 years, are required for noise problem airports with incompatible land uses, which consider:
 - Feasibility of complying with Noise Standards,
 - Level of noise impact,
 - Value of airport services to the public, and
 - Whether airport proprietor is making good faith measures



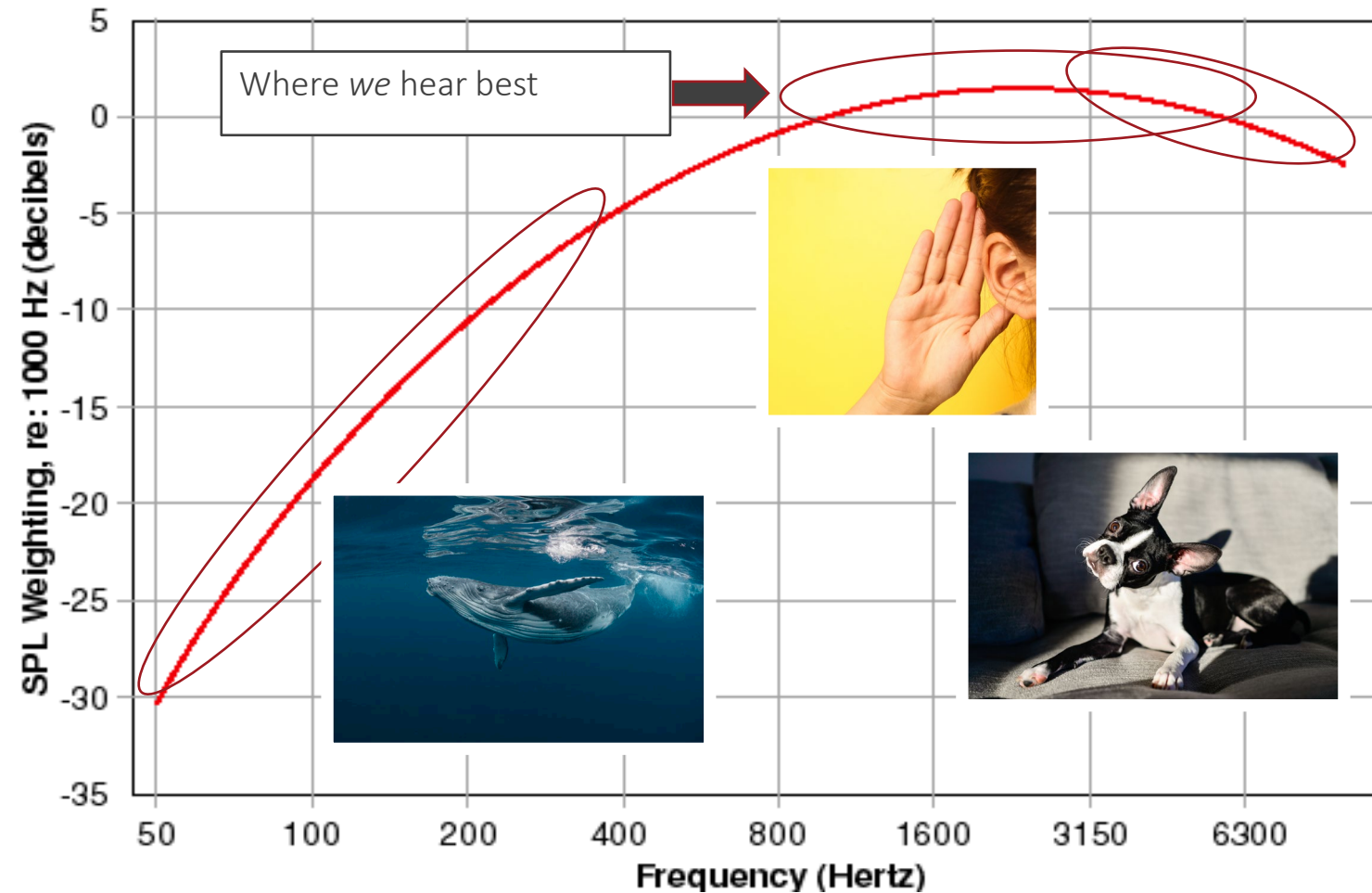
Incompatible Land Uses within the Noise Impact Boundary per Title 21

- **Residences**, unless:
 - An aviation easement is acquired by the airport
 - The dwelling unit was in existence at the same location prior to January 1, 1989, AND interior CNEL due to aircraft noise 45 dB or less
 - The residence is a high-rise apartment or condominium having interior CNEL due to aircraft noise 45 dB or less and an air circulation or air conditioning system
 - The airport has made a genuine effort to acoustically treat residences or acquire an aviation easement or both, but the property owner refused
 - The residence is owned by the airport
- **Public and private schools** of standard construction, unless:
 - An aviation easement is acquired by the airport
 - Adequate acoustic performance ensures an interior CNEL of 45 dB or less in all classrooms due to aircraft noise
- **Hospitals and convalescent homes**, unless:
 - An aviation easement is acquired by the airport
 - Adequate acoustic performance ensures an interior CNEL of 45 dB or less in all rooms used for patient care
- **Churches, synagogues, temples and other places of worship**, unless:
 - An aviation easement is acquired by the airport
 - Adequate acoustic performance ensures an interior CNEL of 45 dB or less

Aviation Noise Terminology

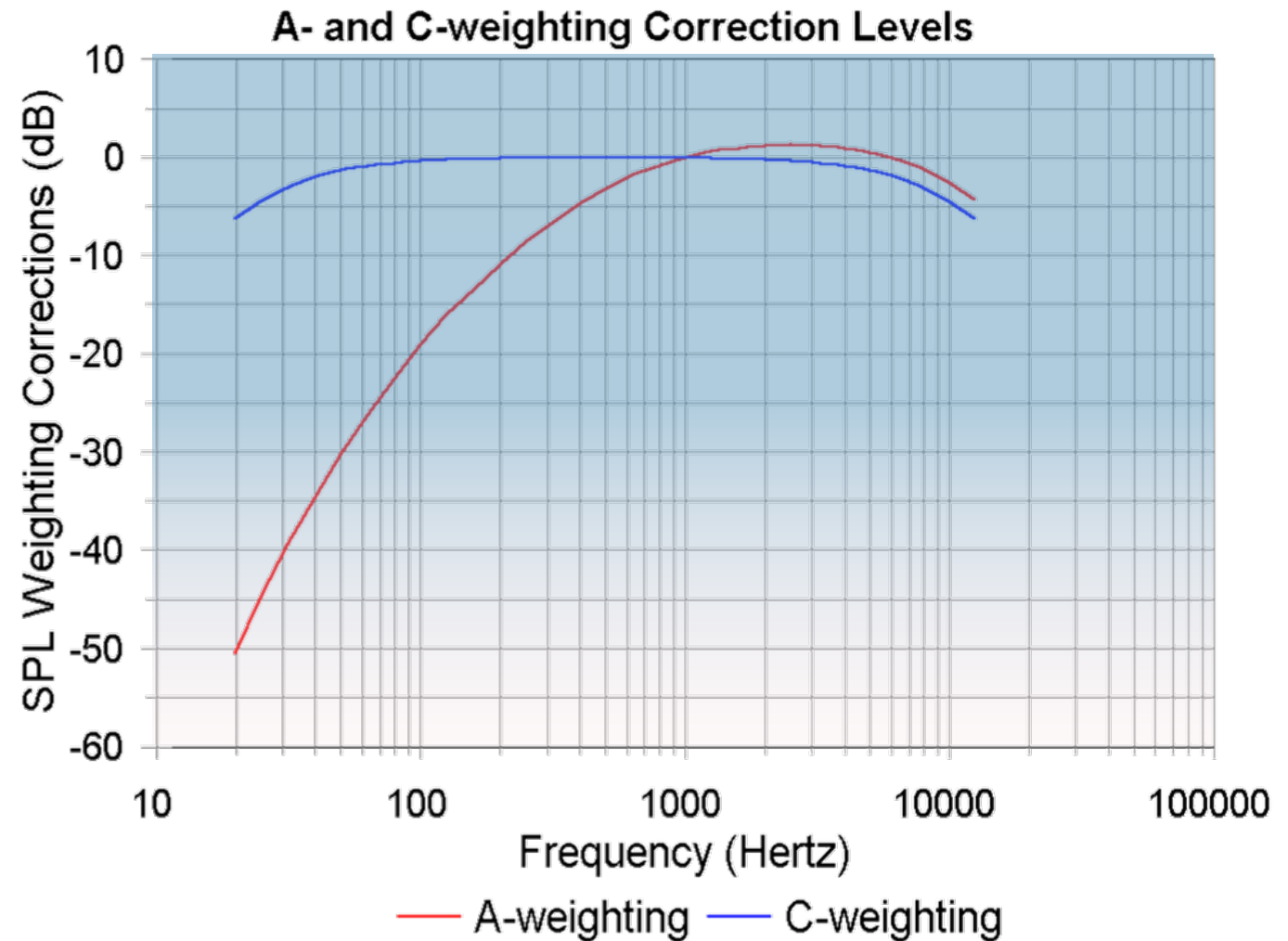
A-Weighted Sound Level

- Human auditory system not equally sensitive to all frequencies
- A-weighting measures sound the way we hear it
- The EPA (and subsequently FAA) has adopted the A-weighted sound level for environmental analyses



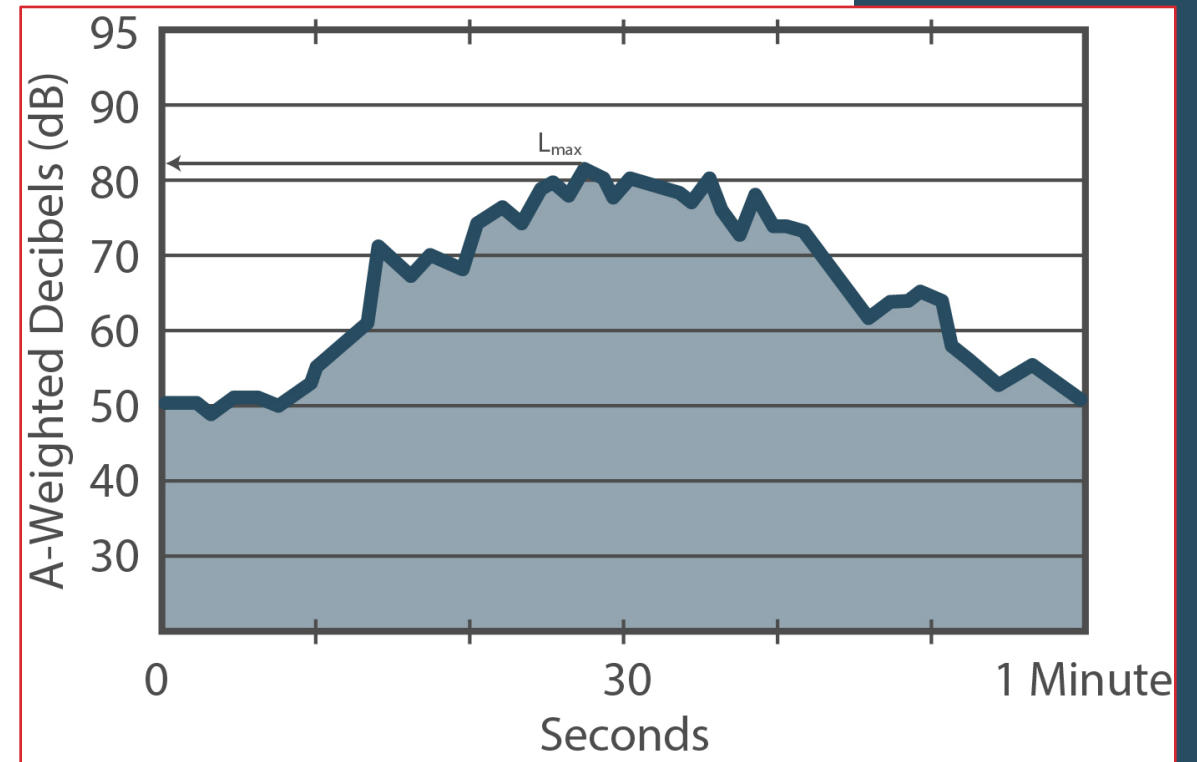
C-Weighting Versus A-Weighting

- **A-Weighting:** Like the human ear, discounts the lower and higher frequencies that the average person does not hear well
- **C-Weighting:** Represents what humans hear when the sound is louder; becoming more sensitive to the lower frequencies



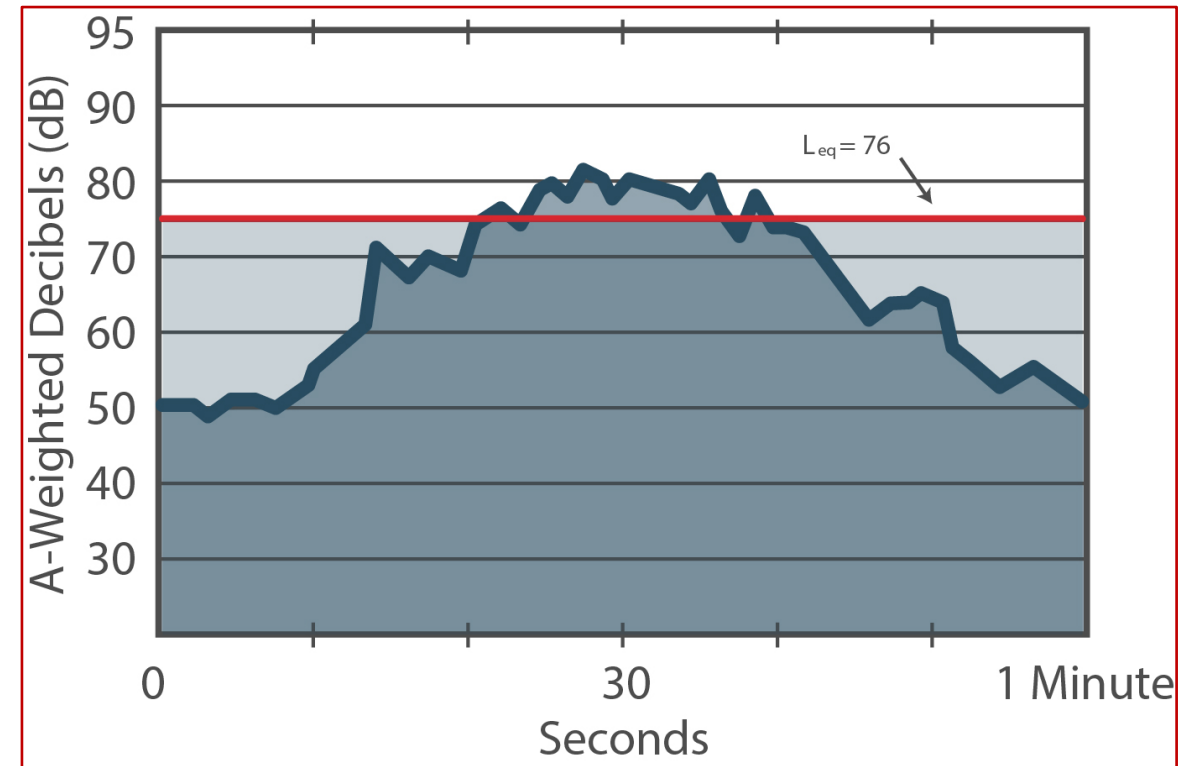
Maximum Sound Level

- Because of the variation in level of a sound event, it is convenient to describe the event with its maximum sound level, abbreviated as L_{\max}
- L_{\max} accounts only for sound amplitude (A-weighted sound level), not duration
- Two events may have the same maximum level, but much different exposures



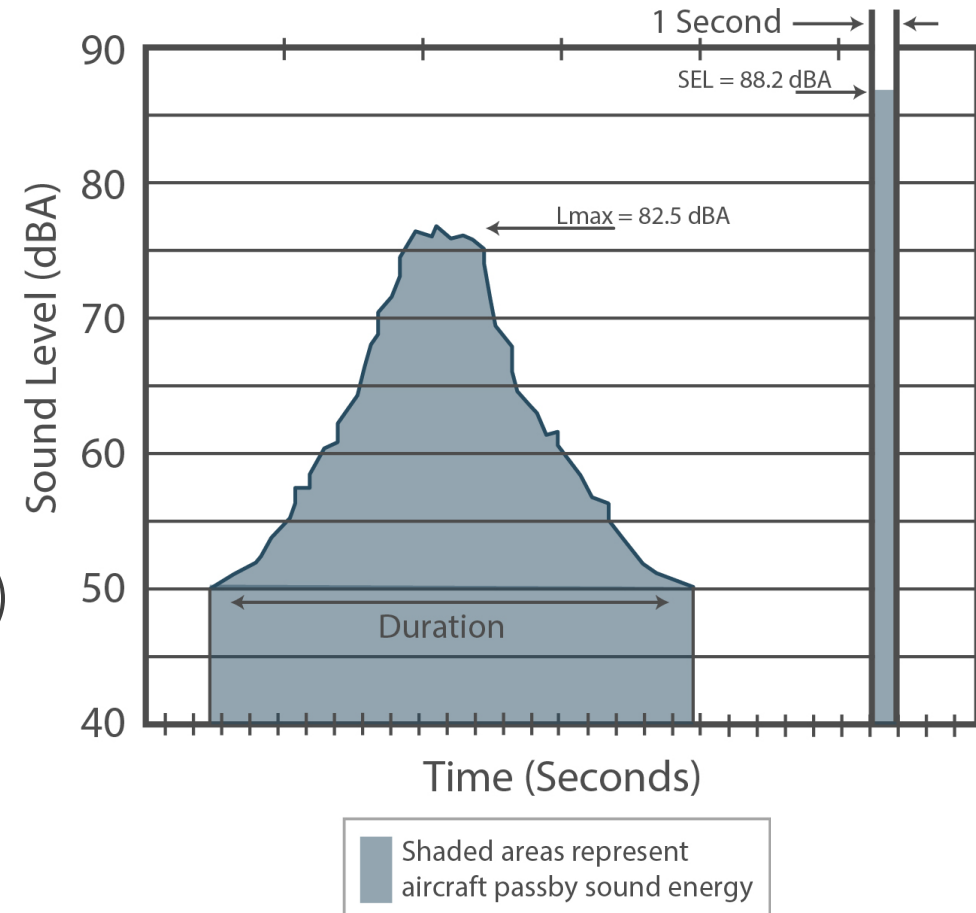
Equivalent Sound Level (L_{eq})

- L_{eq} is a constant sound level, “equivalent” (on an energy basis) to a time-varying sound level over the same duration
- L_{eq} is time-averaged
- L_{eq} accounts for sound amplitude and time
- L_{eq} is a “cumulative” metric



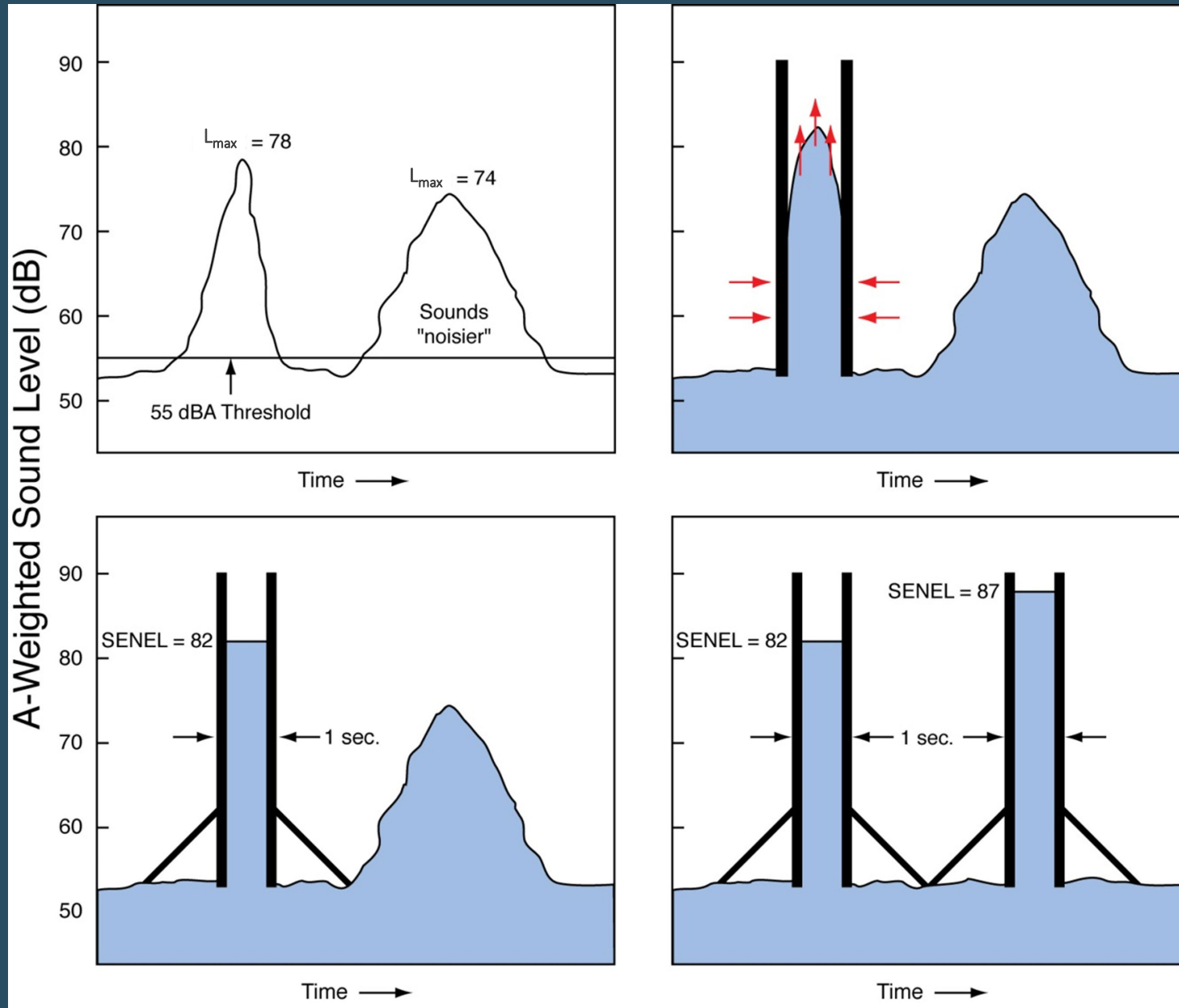
Sound Exposure Level (SEL)

- SEL is a way to describe the “noisiness” of a complete noise event
- SEL accounts for:
 - Sound amplitude (A-weighted sound level)
 - Noise event duration
- Single Event Noise Exposure Level (SENEL)
 - Essentially the same as SEL
 - Requires a “predetermined threshold noise level”

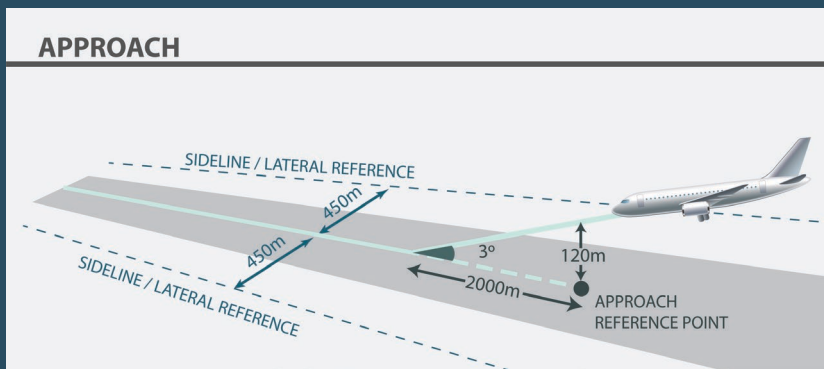
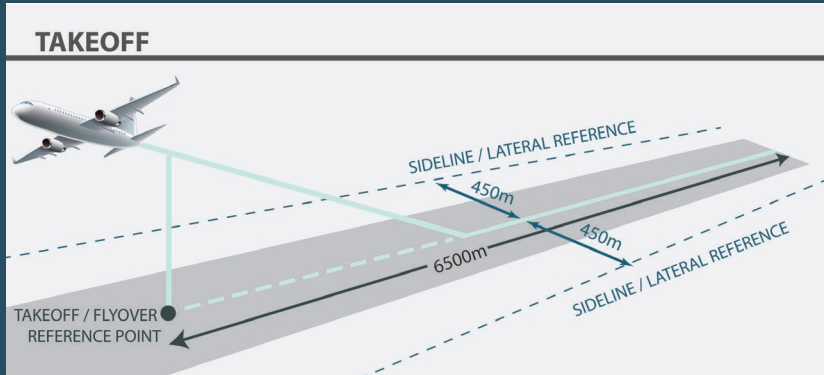


SENEL / L_{max} Comparison

Concept Illustration



Effective Perceived Noise Level (EPNL)



- Based on loudness curves and studies on “noisiness”, “annoyance” or “unacceptability” with Perceived Noise (PN) levels reported in units called **noys**

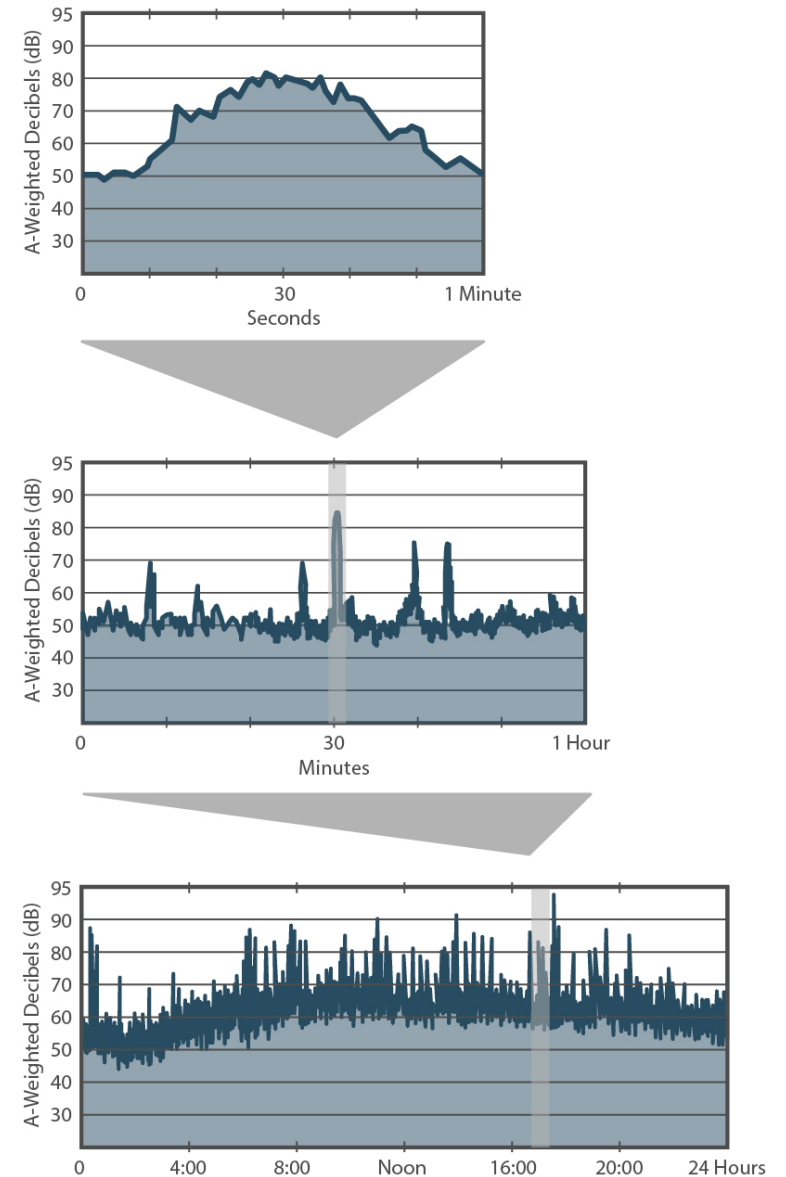
- Similar to SEL/SENEL (includes duration – D) with further refinements for presence of pure tones (C):

$$EPNL = L_{PN} + C + D$$

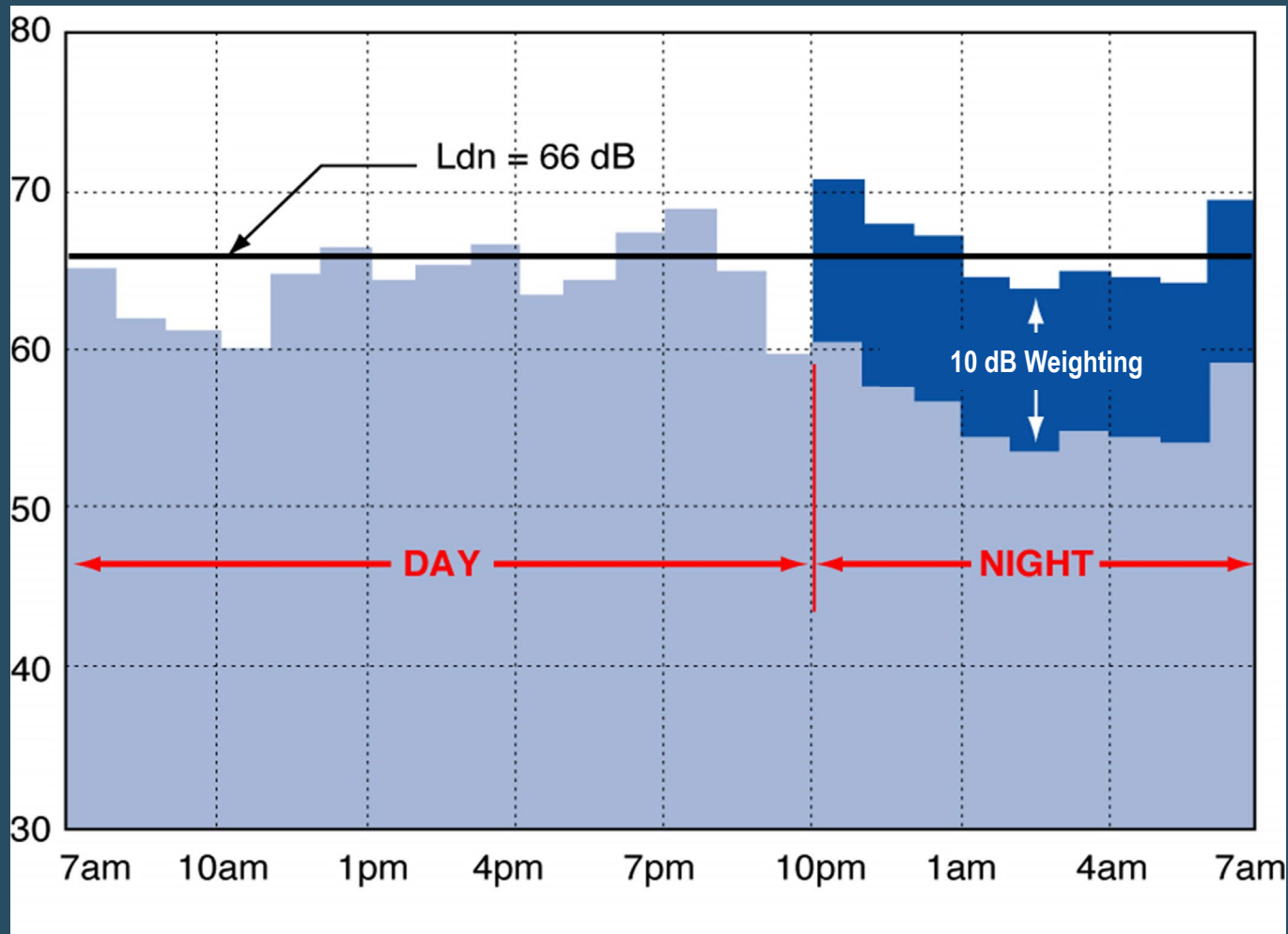
- Calculation of EPNL or EPNdB is complex, requires a spreadsheet.
- 14 CFR Part 36, App. A requires “measured” EPNdB as basis for noise certification of jet aircraft & helicopters

Day-Night Average Sound Level (DNL)

- DNL is a way to describe the noise dose for a 24-hour period
- DNL accounts for event “noisiness” (SEL)
- DNL accounts for number of noise events
- DNL provides an additional weighting for nighttime operations



DNL Nighttime Weighting

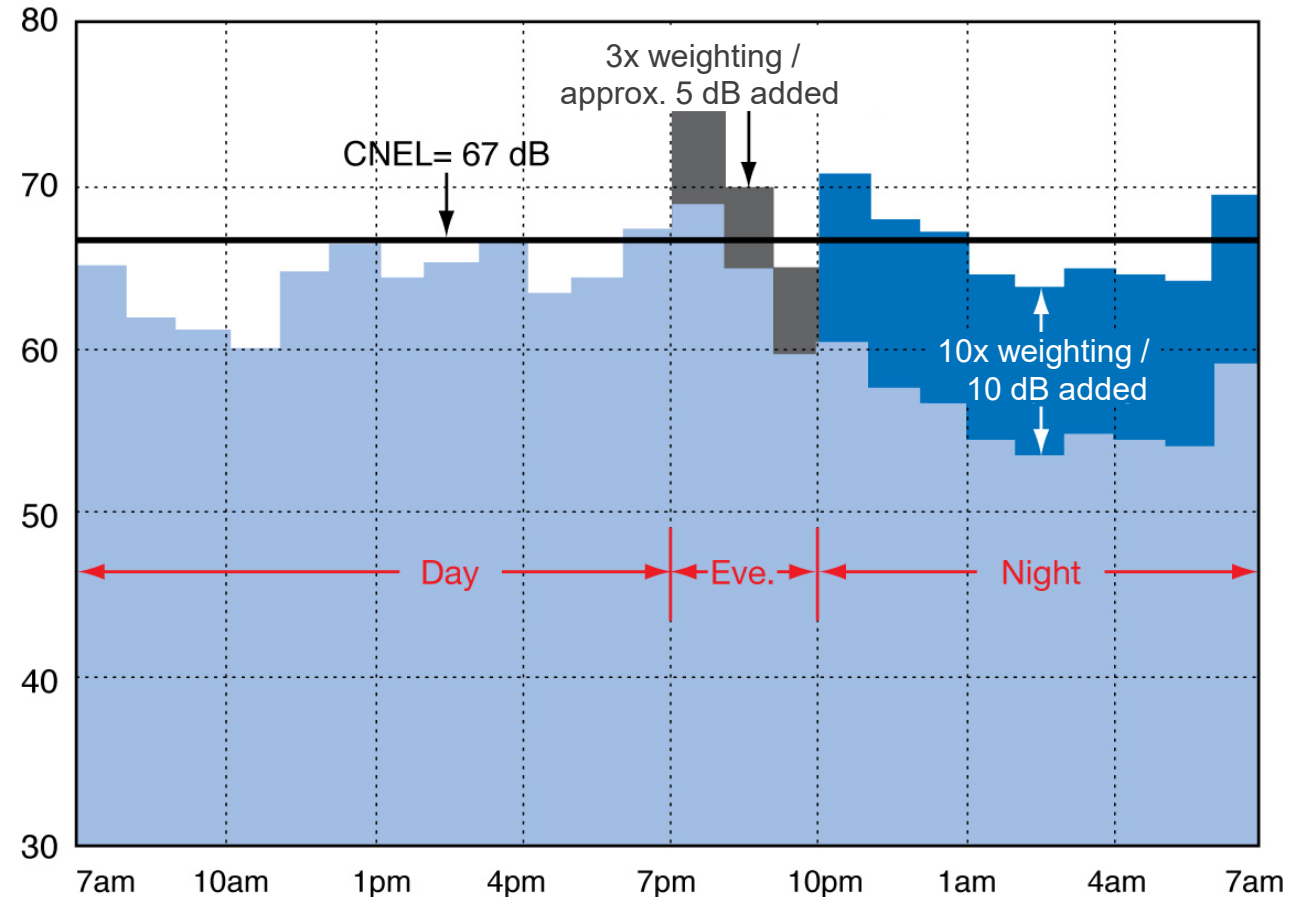


- Nighttime noise gets a 10 dB weighting
- Nighttime is defined as 10:00pm to 7:00am
- DNL may also be denoted as L_{dn}

Community Noise Equivalent Level (CNEL)

Similar concept to DNL, but CNEL includes an evening weighting

- Daytime is defined as 7:00 am to 7:00 pm
- Evening is defined as 7:00 pm to 10:00pm
- Nighttime is defined as 10:00pm to 7:00am



Cumulative (24 hour) Metrics

24-Hour Metric		based on Single Event Metric	Day Multiplier (7am - 7pm)	Evening Multiplier (7pm - 10pm)	Night Multiplier (10pm - 7am)	where used
DNL	Day-Night Average Sound Level	SEL	1	1	10	most of U.S.
CNEL	Community Noise Equivalent Level	SEL	1	3	10	California, Japan
LAeq (L _{eq(24)})	Equivalent A-weighted Sound Level (24 hrs)	SEL	1	1	1	
Lden	Day Evening Night Sound Level	SEL	1	3*	10*	European Union
NEF	Noise Exposure Forecast	EPNL	1	1	16.7	Canada
WECPNL	Weighted Equivalent Continuous Perceived Noise Level	EPNL	1	3	10	China

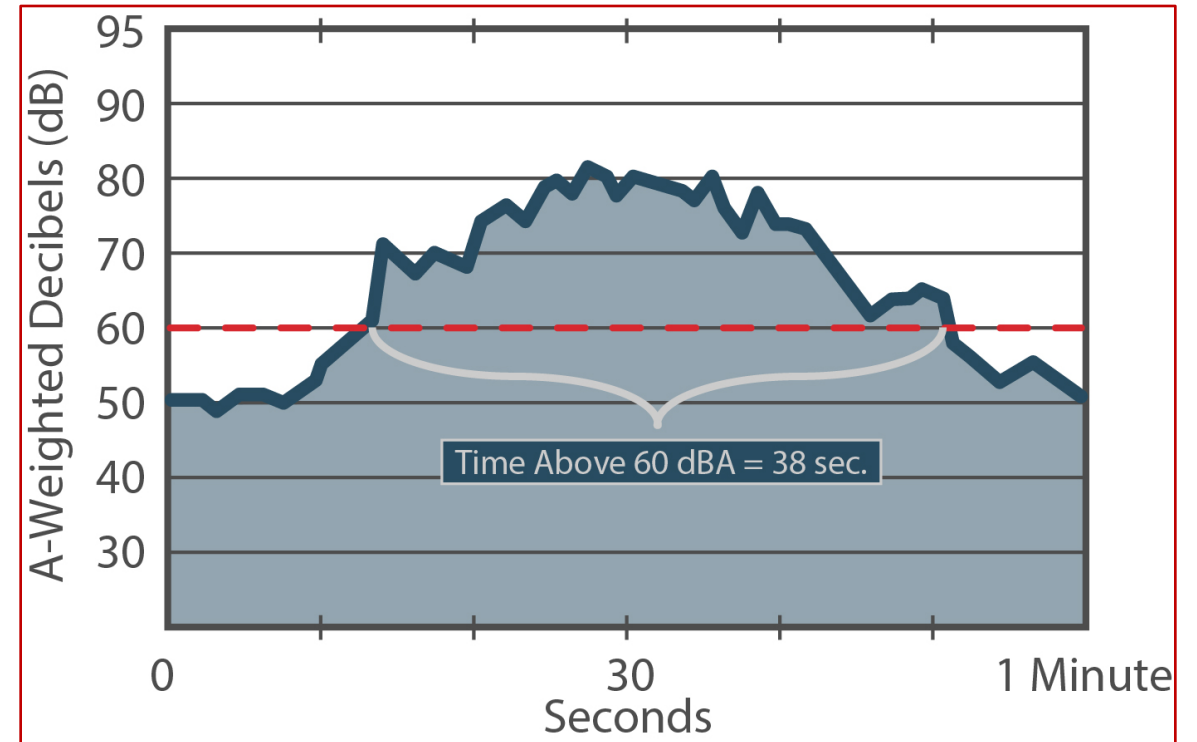
* L_{den} definition of evening and night timeframes is left to the state to determine

a multiplier of $\frac{3}{10}$ Adds $\frac{4.77}{10}$ dB
$\frac{16.7}{12.23}$

Other Noise Metrics

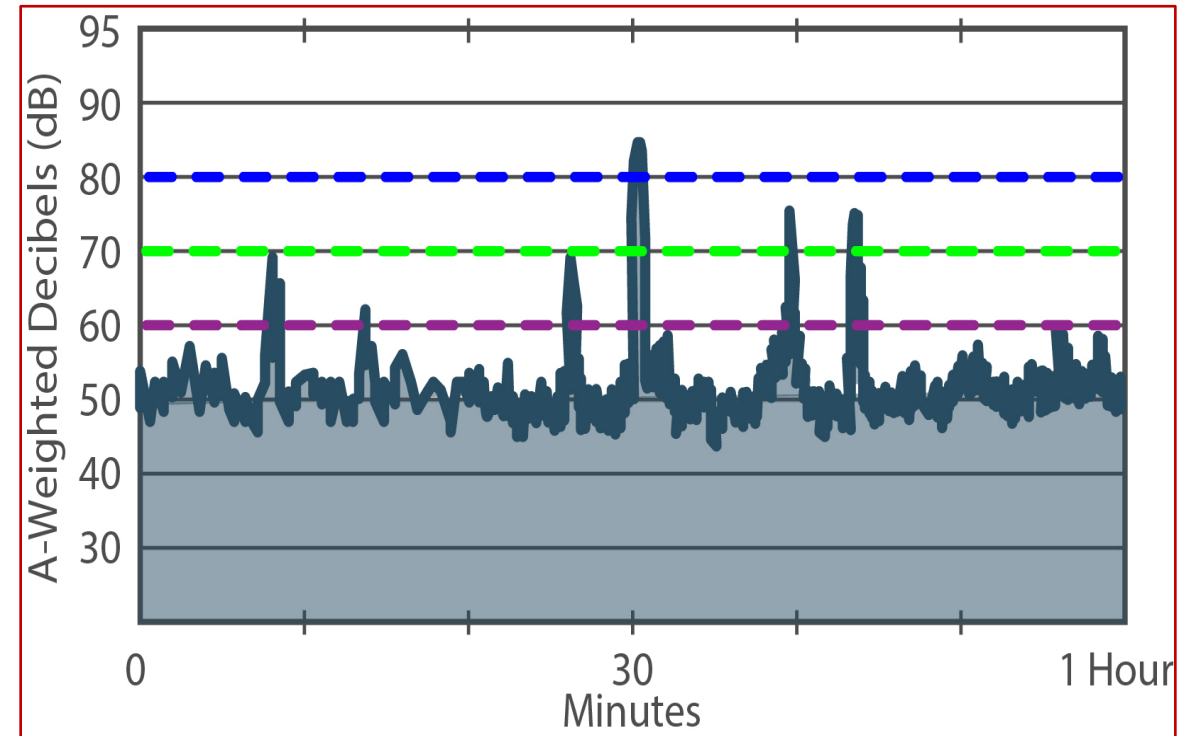
Time Above a Threshold Level (TA)

- Another means of describing sound events is TA, the amount of time the level is above a threshold sound level
- TA accounts only for duration, but not magnitude
- TA is an unreliable metric for assessing human reaction
 - Louder events can have a lower TA



Number of Events Above a Threshold Level (NA)

- People often understand number of events above a given level better than DNL
- In this example:
 - N80= 1
 - N70= 3
 - N60= 6
- NA can refer to L_{\max} or SEL threshold values
- NA is useful for evaluating sleep disturbance (select threshold based on sleep disturbance criterion)



FAA-Recommended “Supplemental” Metrics

- Sound Exposure Level (SEL):
 - For analysis of noise abatement flight tracks, procedures
- Maximum Sound Level, L_{\max}
 - For analysis of noise abatement flight tracks, procedures
 - For assessment of speech, sleep interference
- Time Above Threshold (TA):
 - For informational purposes
- Equivalent Noise Level ($L_{\text{eq}(x)}$):
 - For analysis of schools, etc.
- Number of events Above Threshold (NA)
 - For informational purposes

Questions/Discussion

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