Noise Certification Workshop

Session2: EPNdB Metric

Why is it used in Aircraft Noise Certification?

How is it calculated?

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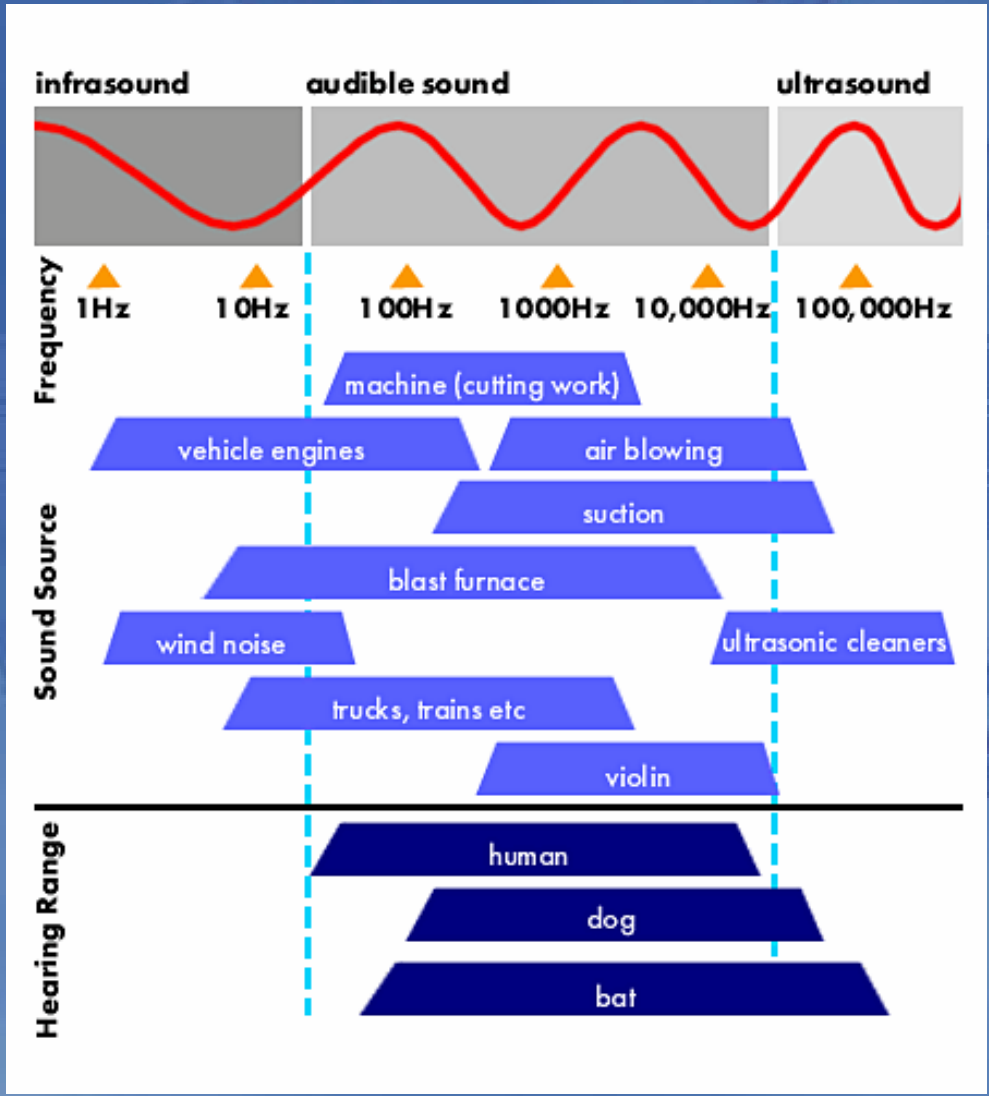
Human hearing system response

- The human hearing system respond to wide range of frequencies (20 to 20 K Hz) and tolerates tremendous range of fluctuating sound pressure levels.
  - For the purposes of aircraft noise certification 50 to 10 K Hz 1/3 Octave bands are considered.
- Human beings do not enjoy uniform response to sounds of the same intensity generated at different frequencies.
- Most annoyed by 2-4 K Hz noise and receptive to protrusive discreet tones.

Frequency and Audibility

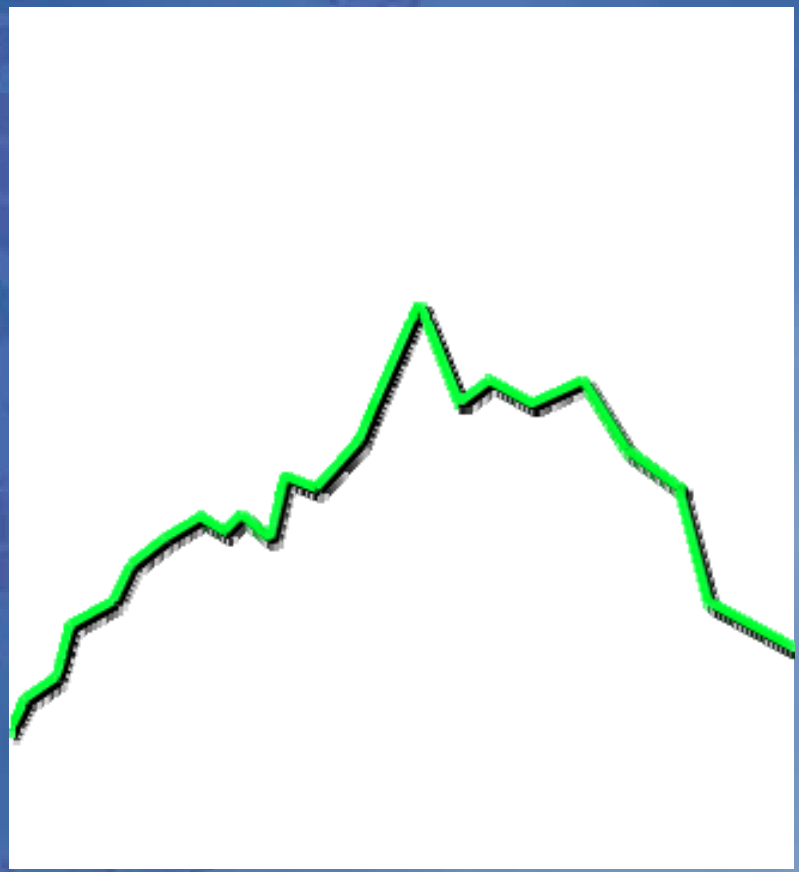
Sound Spectra



Aeroplane noise has wide ranging and variable spectral character and transient intensity time relationship

Source

Sound Spectra at Peak Level



Metrics used in Aircraft Noise Certification

- A metric that varies both with intensity and frequency of noise is needed to express human response to either loudness or annoyance (also called perceived noisiness).

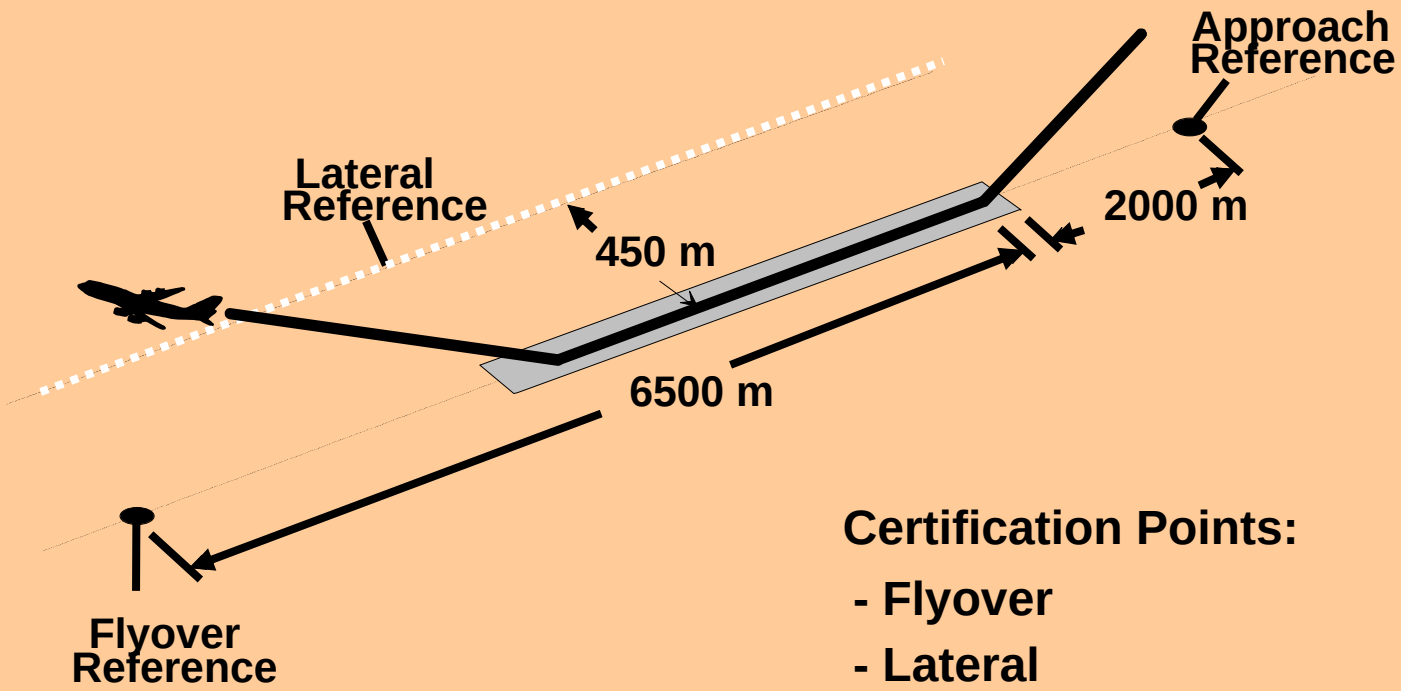
	Loudness based	**Annoyance based**
Certification Metric	Max dBA Sound Exposure Level in dBA	Effective Perceived Noise (EPNdB)
Certification of	Propeller driven light airplanes and light helicopters	Jets, propeller driven heavy aircraft and heavy helicopters

What is EPNdB?
Why is it used in aircraft noise certification?

- EPNdB is a measure of human annoyance to aircraft noise which has special spectral characteristics and persistence of sounds.
- It accounts for human response to spectral shape, intensity, tonal content and duration of noise from an aircraft.
- Certification quality EPNdB cannot be directly measured, it has to be calculated in a standard manner as described in Annex 16.

Aircraft Noise Certification Measurement Points

Trajectory and Certification Locations

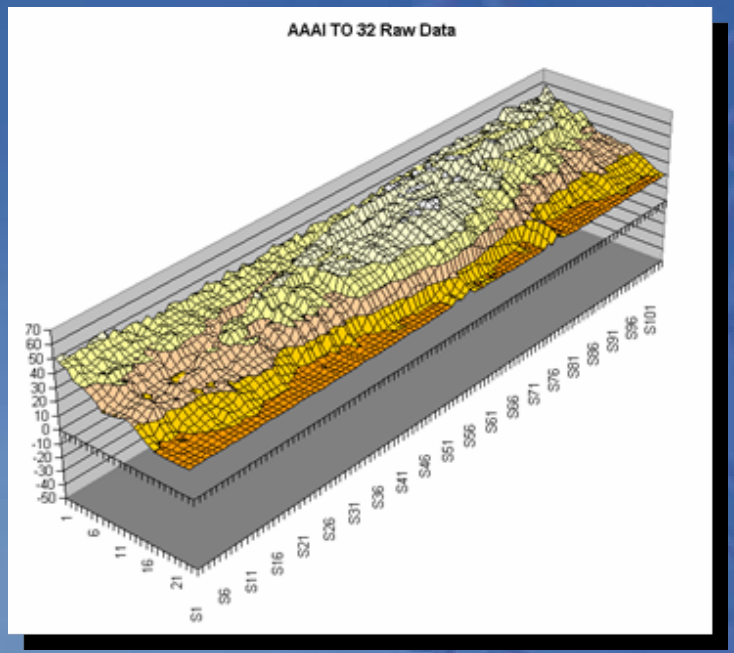


Certification Points:

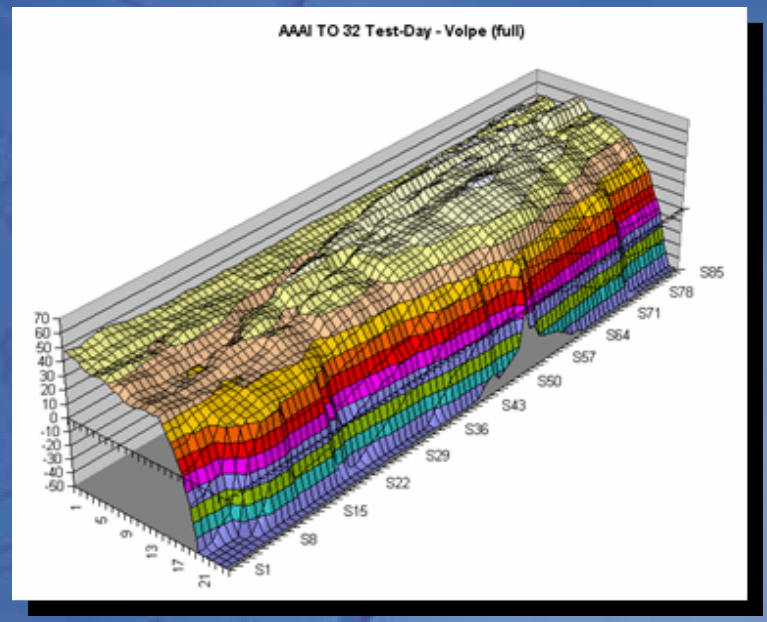
- **Flyover**
- **Lateral**
- **Approach**

Adjustments/Corrections applied to measured spectra ½ second apart

As Measured



Adjusted/Corrected



- Microphone, recording system corrections and background noise adjustments are applied to the measured data before calculating EPNdB.

According to ICAO Annex 16 Appendix 2

4.1.1 …, EPNL shall consist of instantaneous perceived noise level, PNL, corrected for spectral irregularities (the correction, called “tone correction factor”, is made for the maximum tone only at each increment of time) and for duration.

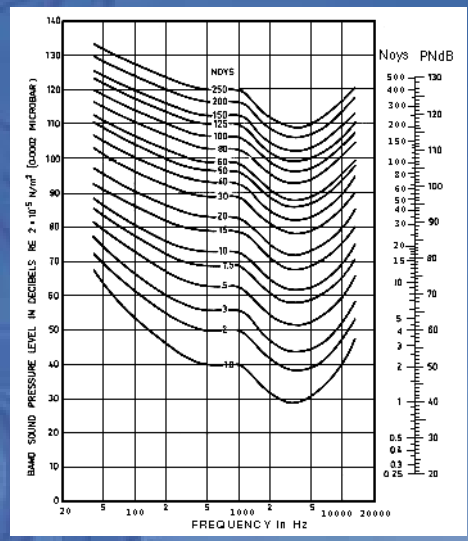
4.1.2 …the instantaneous sound pressure level in each of 24 one-third octave bands of the noise shall be required for each 500 ms increment of time during the aircraft noise measurement.

4.1.3 The calculation procedure which utilizes physical measurements of noise to derive the EPNL evaluation measure of subjective response shall consist of the following five steps:

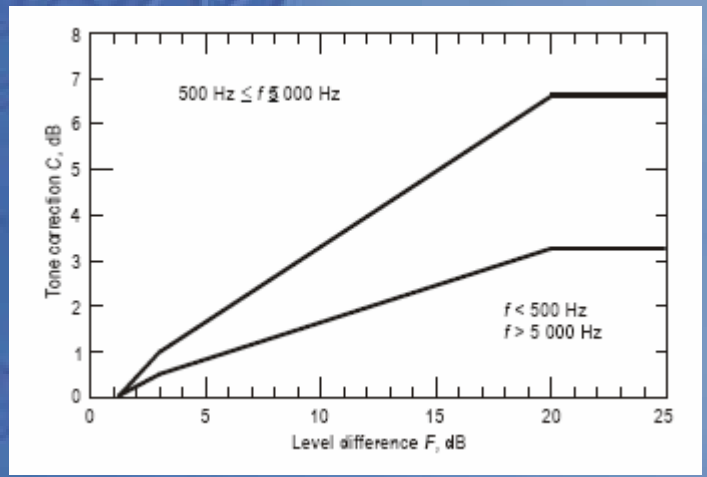
5 steps of EPNL calculation

For each ½ second sample.

1. SPL converted to PNL



2. Tone correction factor C is calculated



3. PNLT = PNL + C

5 steps of EPNL calculation

For the entire flight

4. Duration correction D is calculated

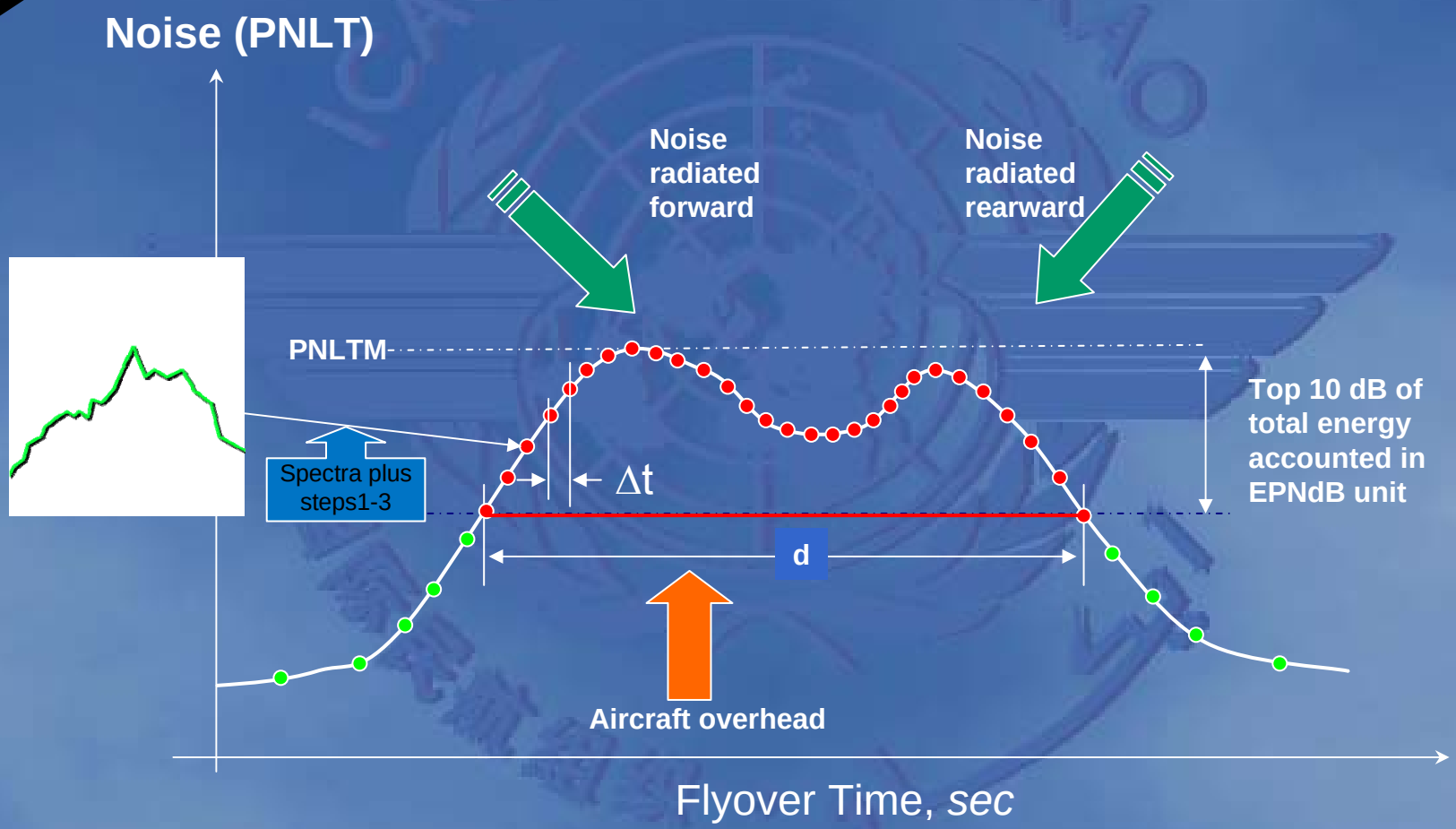
$$D = 10 \log \left[\left(\frac{1}{T} \right) \sum_{k=0}^{d/\Delta t} \Delta t \cdot \text{antilog} \frac{\text{PNLT}(k)}{10} \right] - \text{PNLTM}$$

where T= 10 sec and Δt=0.5 sec

5. EPNL=PNLTM + D

where PNLTM= Max(PNLT)

PNL corrected for tones as a function of flyover time



Adjustment of Flight Results

- Following adjustment also applied to the measured noise values to account for:
  - attenuation of the noise along its path as affected by “inverse square” and atmospheric attenuation
  - duration of the noise as affected by distance and speed of aircraft relative to measuring point
  - source noise emitted by engine as affected by the relevant parameters
  - aircraft /engine source noise as affected by large differences between test and reference airspeeds.