Tutorial – Environmental Noise Measurement and Interpretation

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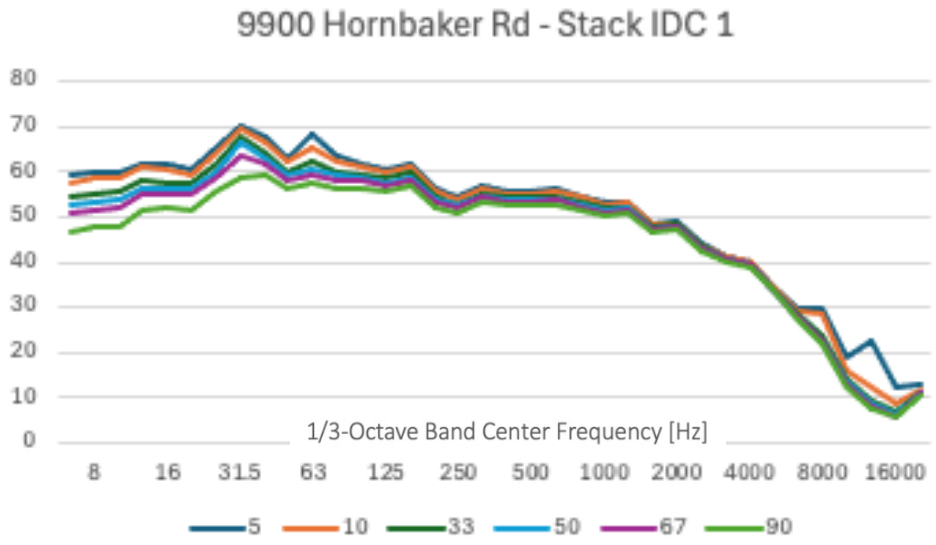


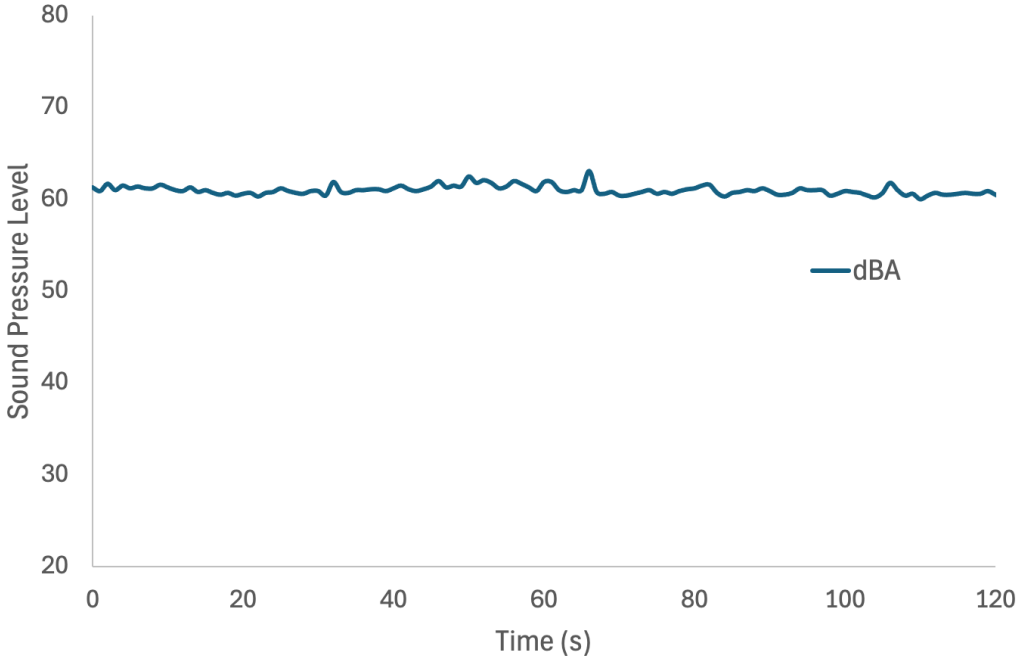
The challenge

- Many noise sources may be present in addition to the one(s) causing complaints.
  - Some of these are “steady” continuous sounds
  - Others fluctuate noticeably with time
- The human brain is capable of focusing attention on a particular sound source that commands attention – sound levels meters do not have that capability.
- Enforcement requires isolating problem sounds from non-problem sounds.
- The acoustic environment can be reluctant to cooperate.

How people tend to think about sound

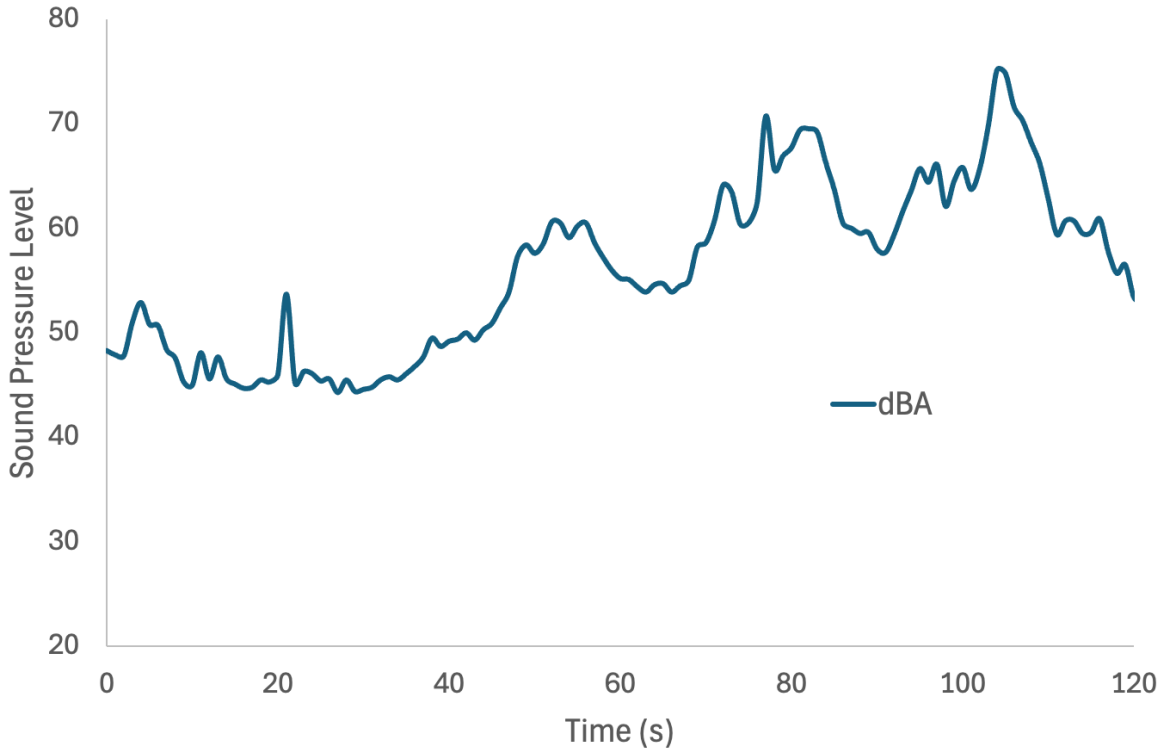
- Only 1 kind of decibel: dBA
- dBA correlates 100% to annoyance
- 1 simple unchanging value
- Easy to measure, easy to enforce

- None of these things are true



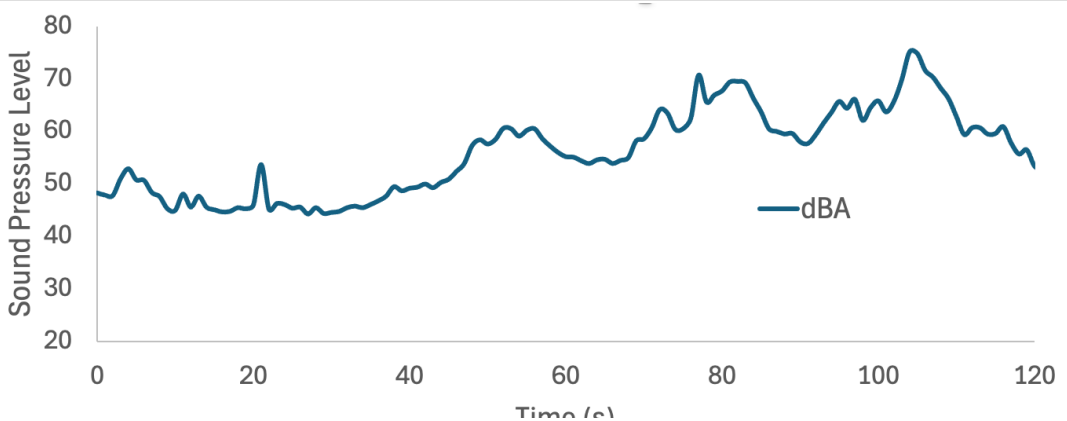
Significant fluctuations more common

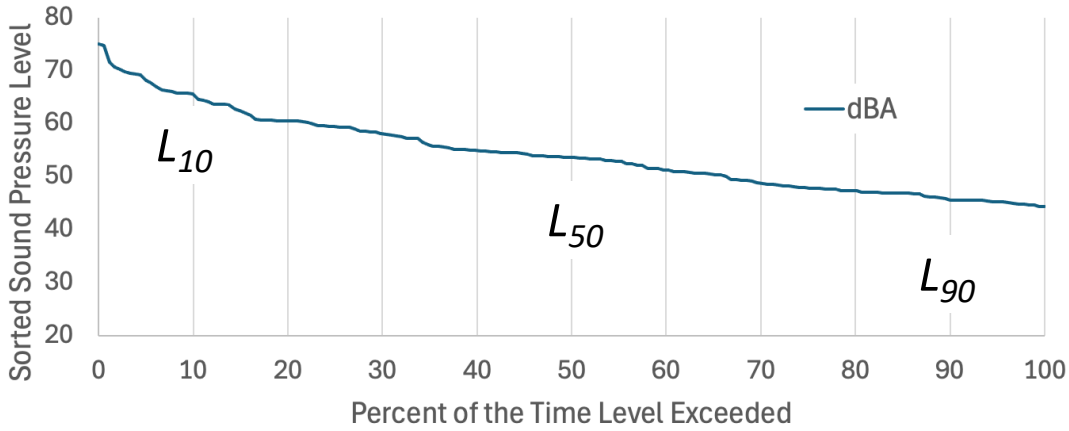
- Lower levels may be steady state sound from mechanical equipment
  - Or from distant highway traffic…..?
- Higher levels may be passing trucks



Statistical levels: Sorting continuous vs transient noise

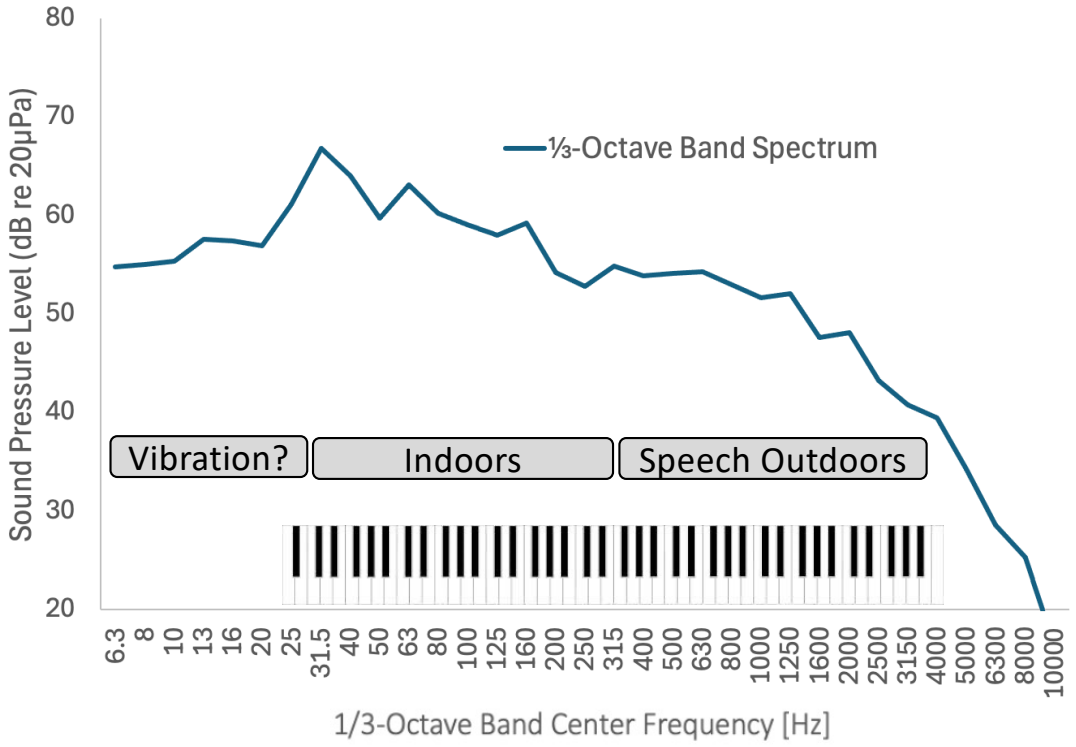
- Tabulate sound pressure levels vs time
- Sort them in descending order
- Versus percentage of time
- Level exceed xx% of the time is L_{xx}
- This can be done with ALL the data
  - A-weighted
  - C-weighted
  - Octave bands
  - 1/3-octave bands





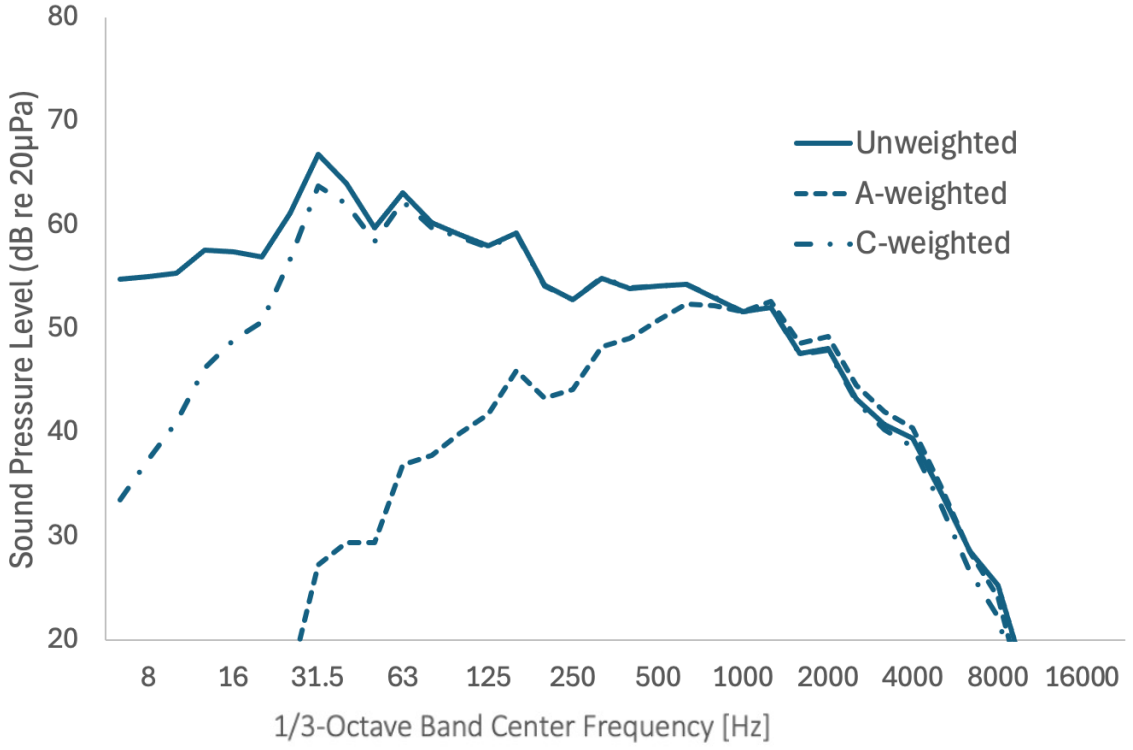
Sound pressure spectrum

- Sound Pressure Level present in each “band”
  - Octave
  - 1/3-octave
- If too much
  - Interference w/ speech outdoors
  - Audible indoors
  - Feelable Vibration possible
- High frequency energy is more audible than low frequency



Weighted Sound pressure spectrum

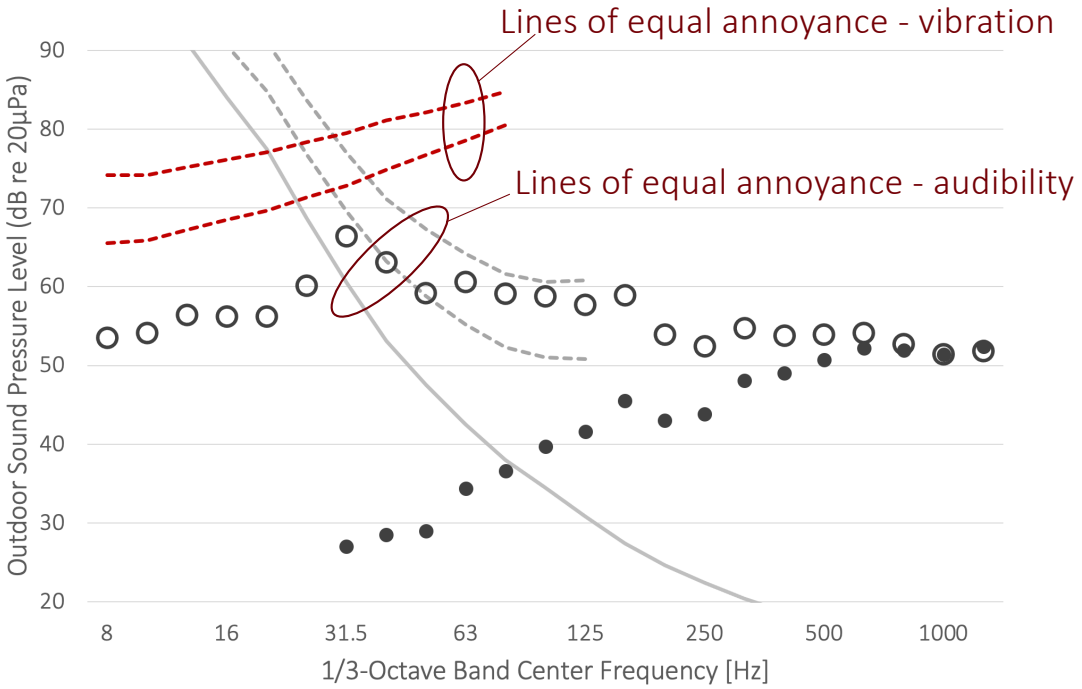
- Weighted sound pressure levels
  - The sum of the *frequency-weighted* energy across frequencies
- A-weighted Sound Pressure Level L_{pA} is reported in dBA
- C-weighted Sound Pressure Level L_{pC} is reported in dBC
- dB with no letter following signifies an "unweighted" total
  - Overall, or in a band



Only show "octave band center frequencies" – reduce clutter
Even for 1/3-octave band data

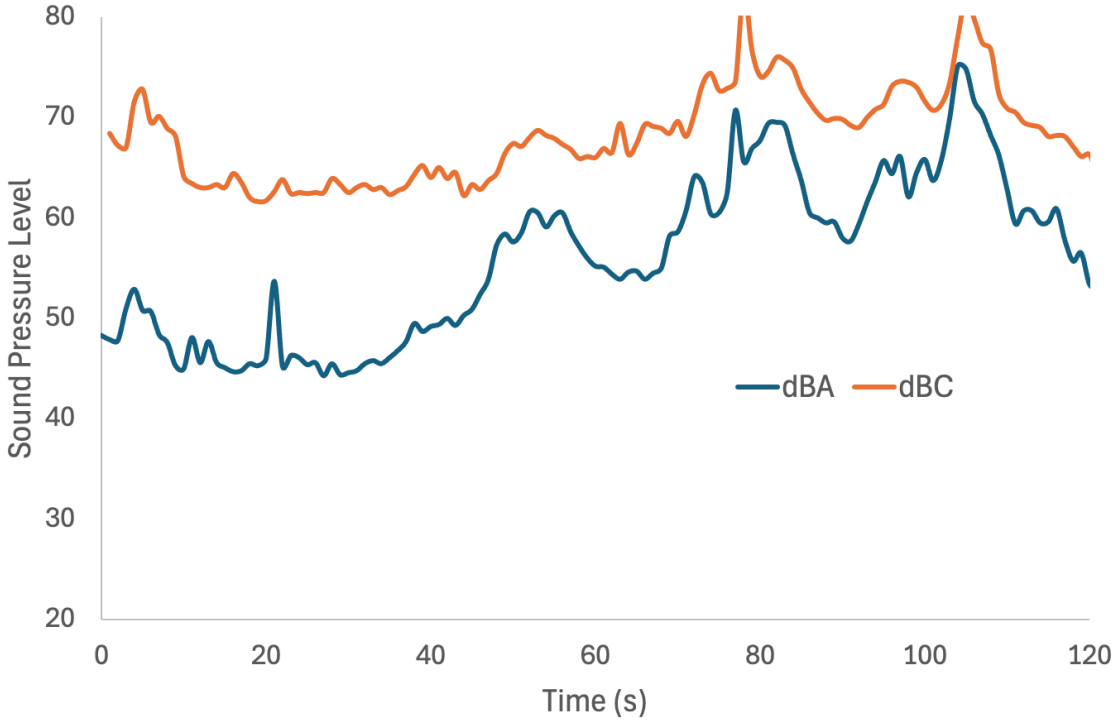
Because Annoyance depends strongly on frequency

- High frequencies interfere with speech
  - Mainly an issue outdoors
- Low frequencies penetrate into homes
  - Mainly an issue indoors

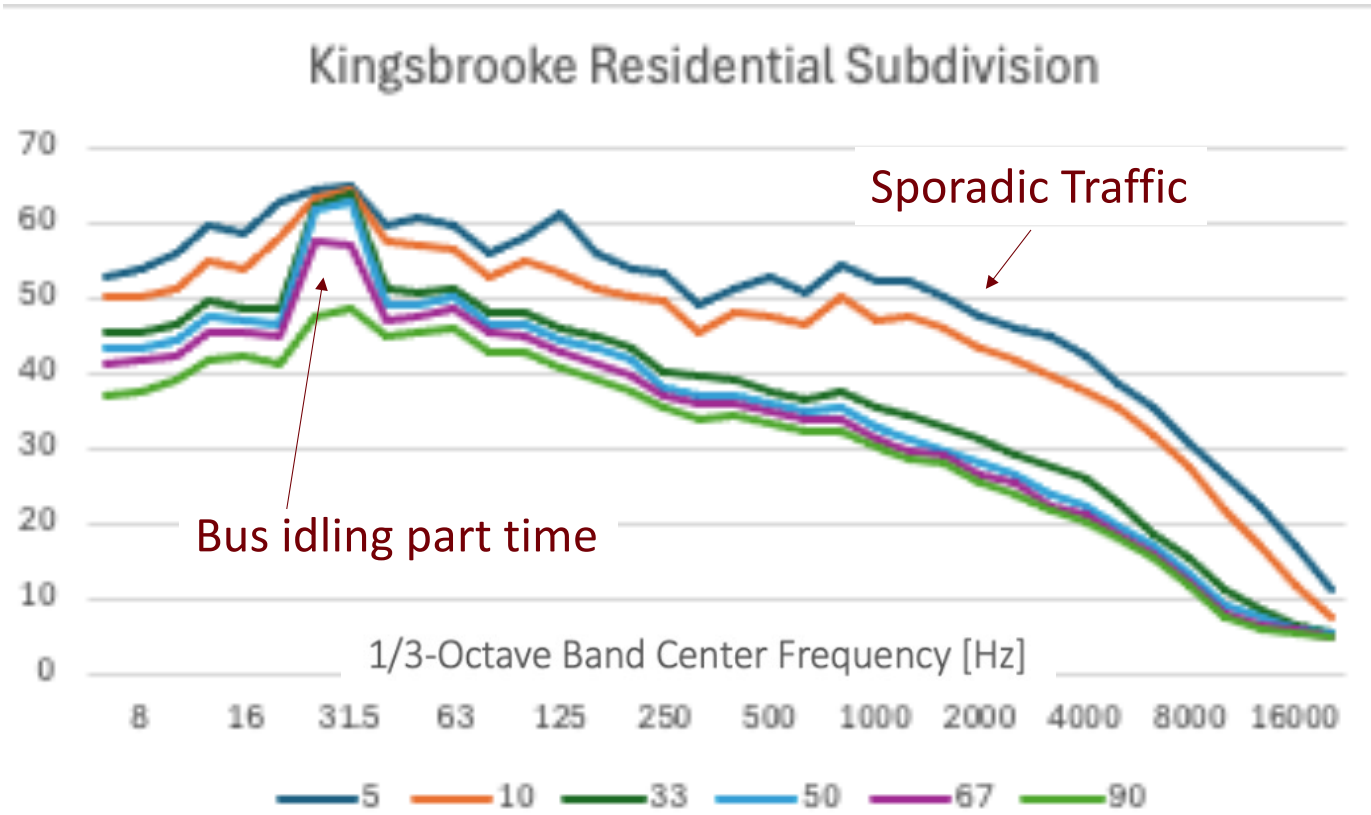


Weighted sound pressure levels

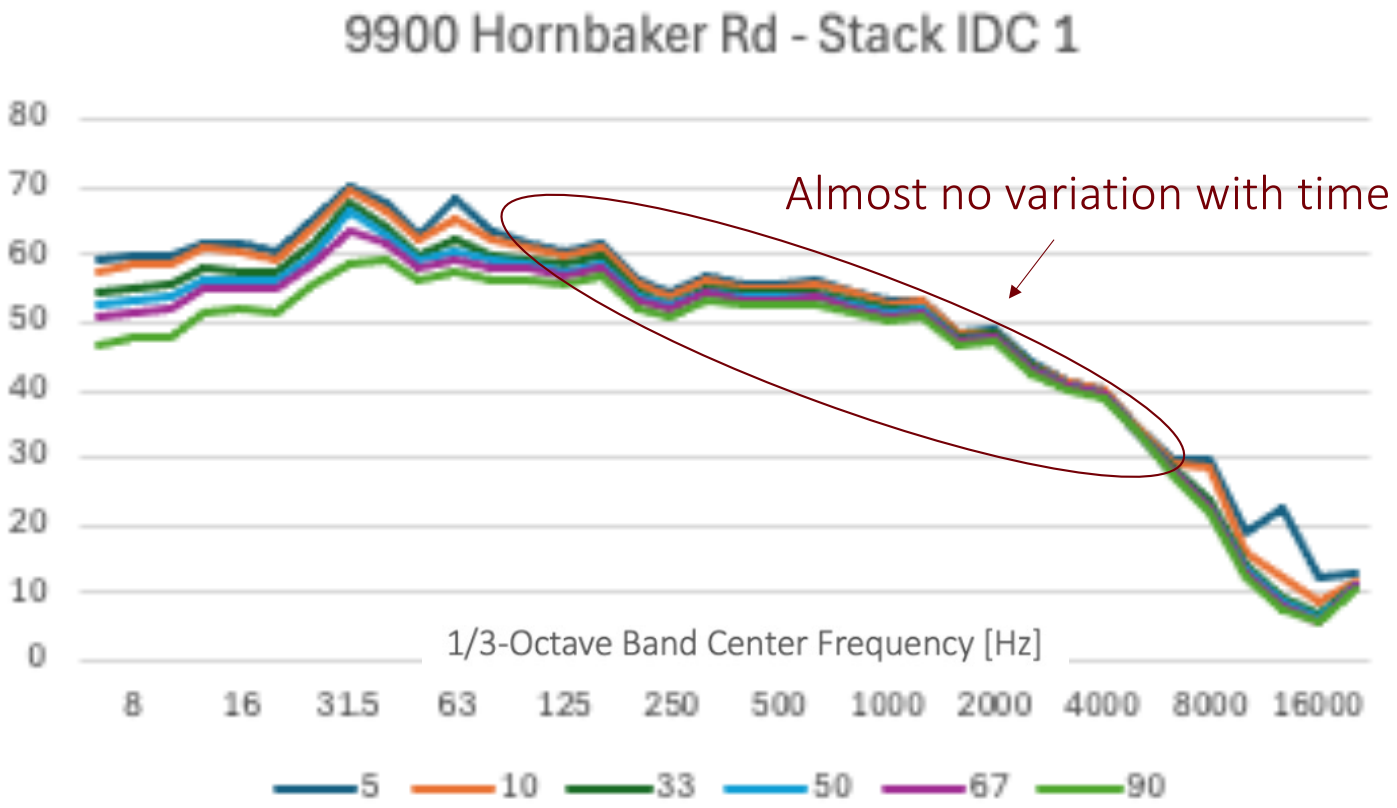
- Are meaningful if the filtering is appropriate to the situation
- Not possible to reconstruct the spectrum from the total
  - 73 cents in pocket, which coins?
- dBC > dBA
  - Because C includes low frequencies that A filters out
  - (Except in VERY rare circumstances)



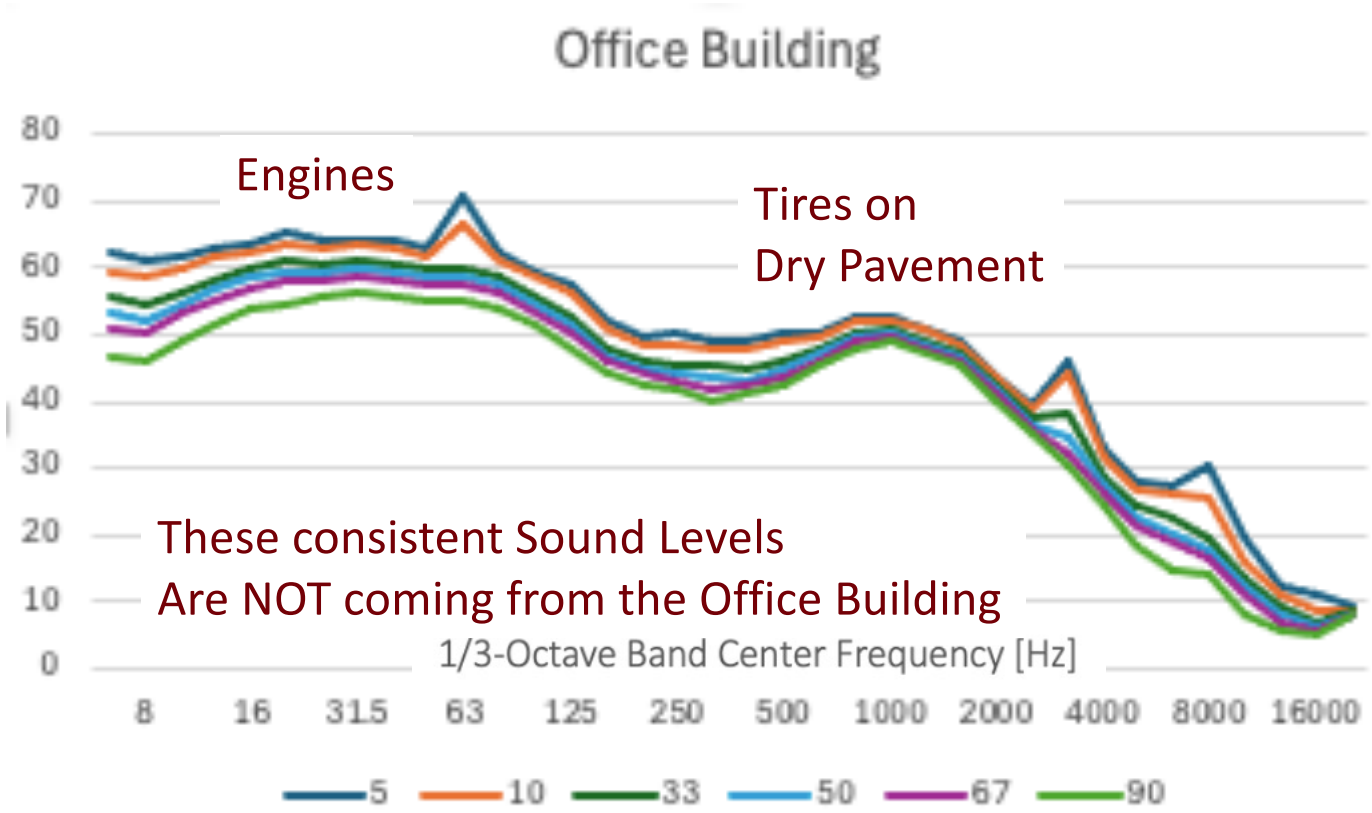
Steady background, passing vehicles, bus



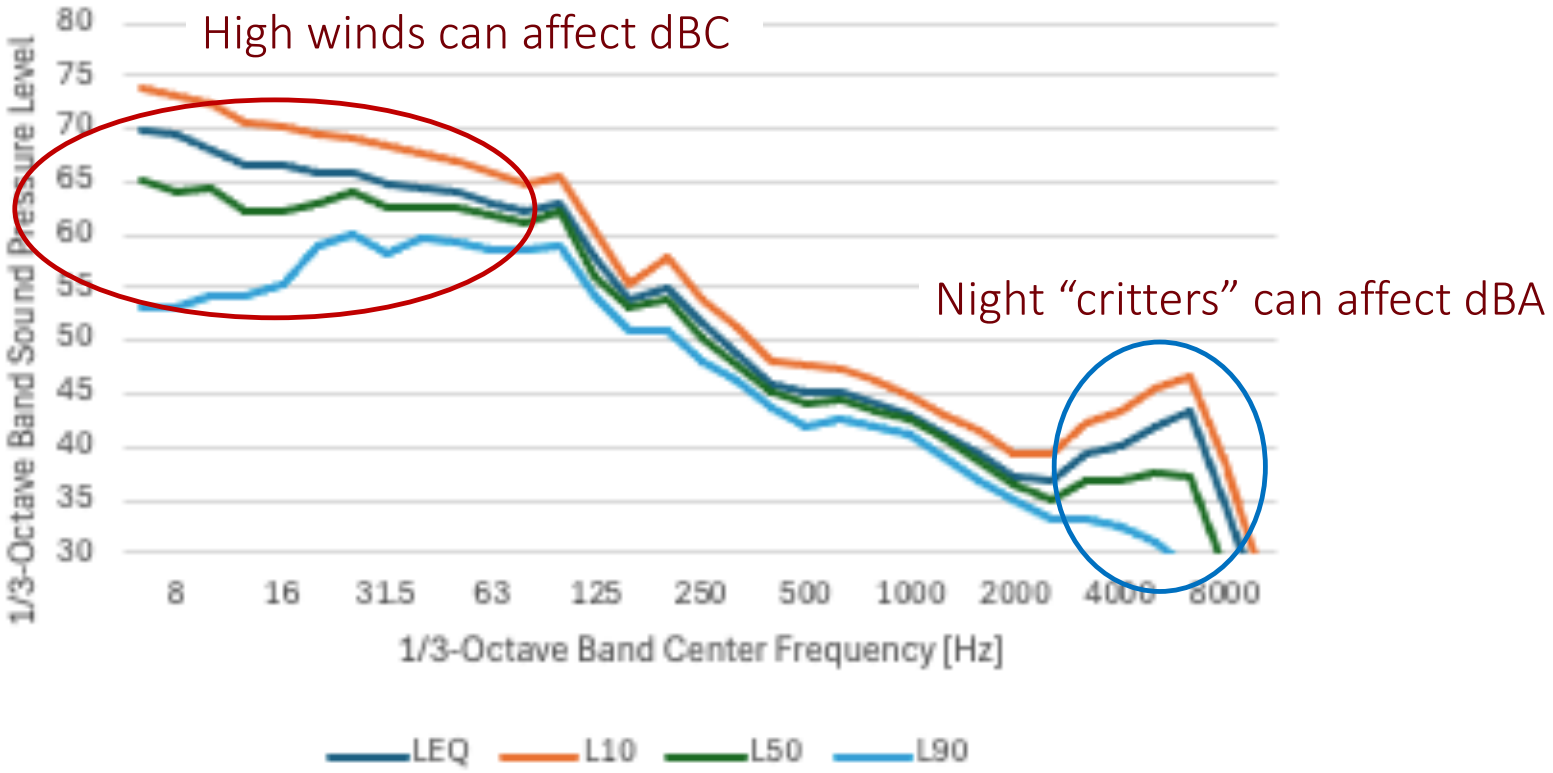
Steady Data Center noise



Distant Heavy Traffic is hardest to sort out



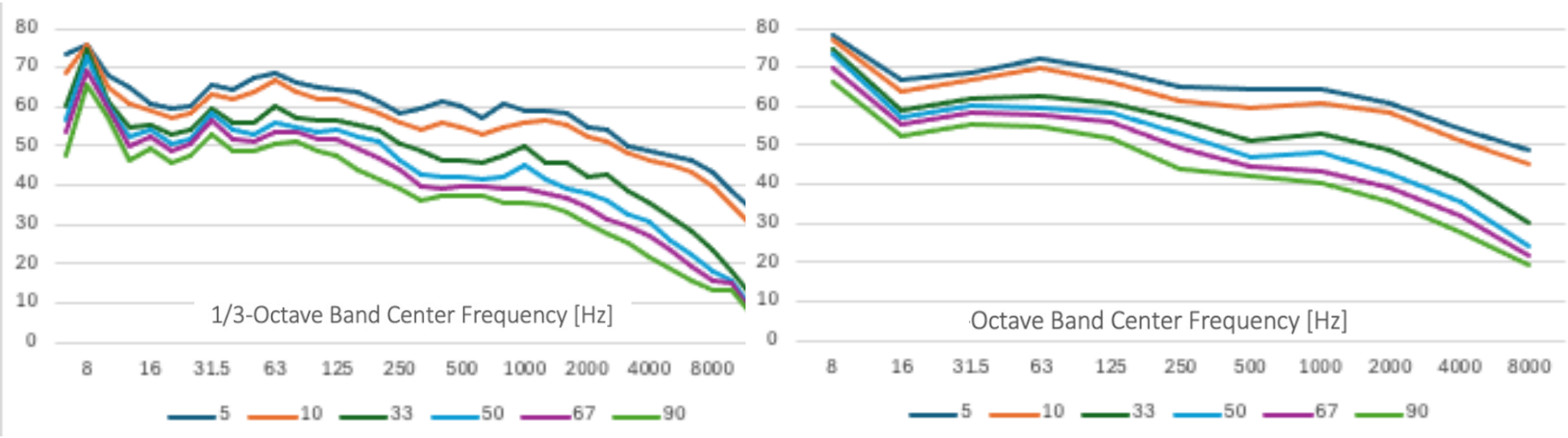
Other tricky situations



So what's an Leq?

- The equivalent sound level
- An energy average over the measurement period
- For a stead sound $L_{eq} \approx L_{50}$
- If there are a lot of strong transients, $L_{eq} > L_{50}$
- Avoids dogs, birds, aircraft, individual vehicles, brief talking

Octave Band Data is easier to work with



1/3-octave band
33 values

Octave band
11 values

Sounds in the Community

- Can vary over time
  - In overall magnitude
  - And frequency composition (spectrum)
- Can originate from various sources
  - Continuous sounds
  - Transient sounds
- Potential “false positives”
  - Crickets/cicadas, animals
  - Vehicles, aircraft
  - Wind in trees, brief talking

Ramifications for Enforcement

- Screen out false positives
  - Screen out “bug” noise
  - Screen out traffic noise
- Sound Levels Meters just report energy
  - Can’t distinguish sources without “help”
  - Can’t focus attention
  - Can’t assign meaning
  - Aren’t aware of context
- Noise Ordinance
  - Will be designed to assist Enforcement process in limiting false positives
  - Will be designed to balance simplicity with effectiveness
  - Cannot perform perfectly in all situations