BASIC NOISE TERMINOLOGY

NZIEH CONFERENCE
CHRISTCHURCH 2009

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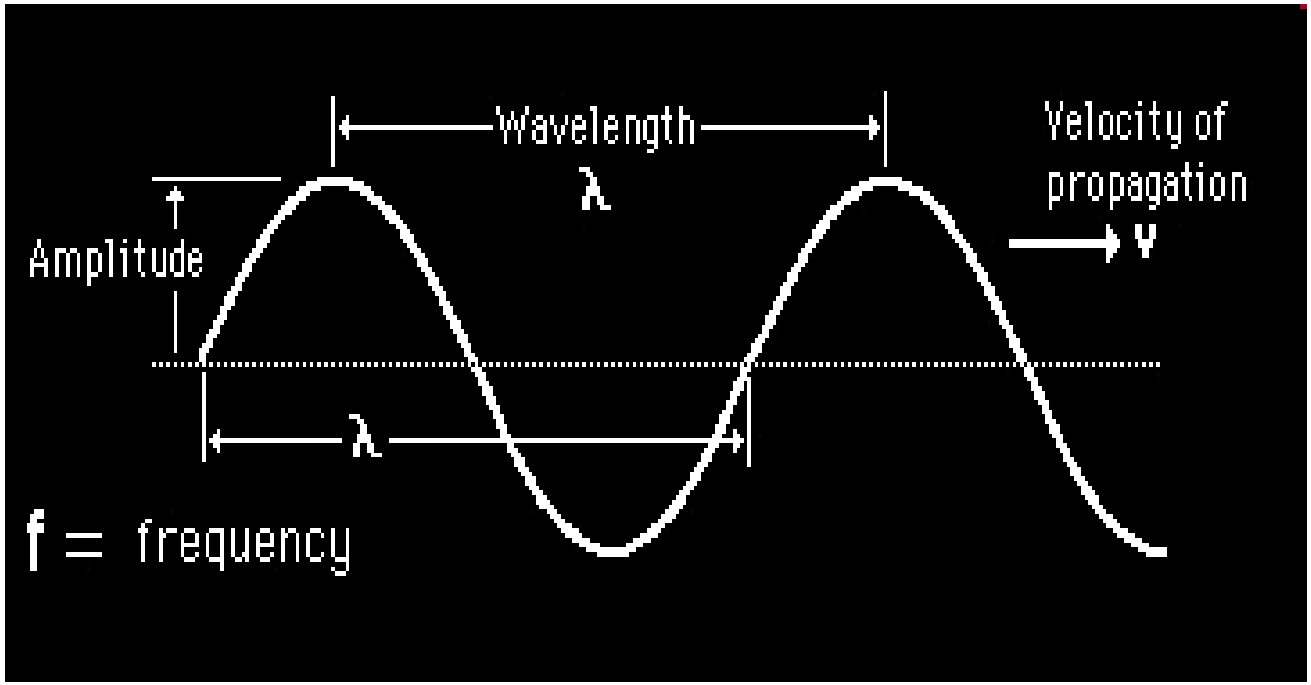
What is Noise?

- Noise may be considered as sound which serves little or no purpose for the exposed persons and is commonly described as “unwanted sound” - *(NZS 6802:2008)*

Sound wave characteristics



Frequency is expressed in Hertz (Hz) i.e. cycles per second
(number of wavelengths passing a point in one second)
e.g. 1 Hz = 1 cycle/second, 500 Hz = 500 cycles/second

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Range of human hearing

- Sound frequencies from approximately 20 Hz to 20,000 Hz
  - Speech is about 400 to 5000 Hz
  - Stereo bass, thunder are below 400Hz
  - Birds chirping, cicadas are above 5000Hz

- Sound pressure levels from 20 micropascals to over 100 pascals (100 million micropascals)

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Decibel (dB)

- Using decibels allows us to handle the huge range of sound pressure values more easily
- A decibel is a logarithmic unit of measurement used to express sound pressure levels, with 20 micropascals as the reference level
  - For the mathematically inclined:
    - A decibel is ten times the logarithm to the base 10 of the ratio of the square of the sound pressure to the square of the reference value.

$$10 \lg(p^2/p_0^2) \text{ dB} \quad \text{(NZS 6801:2008)}$$

(reference value p_0= 20 micropascals)

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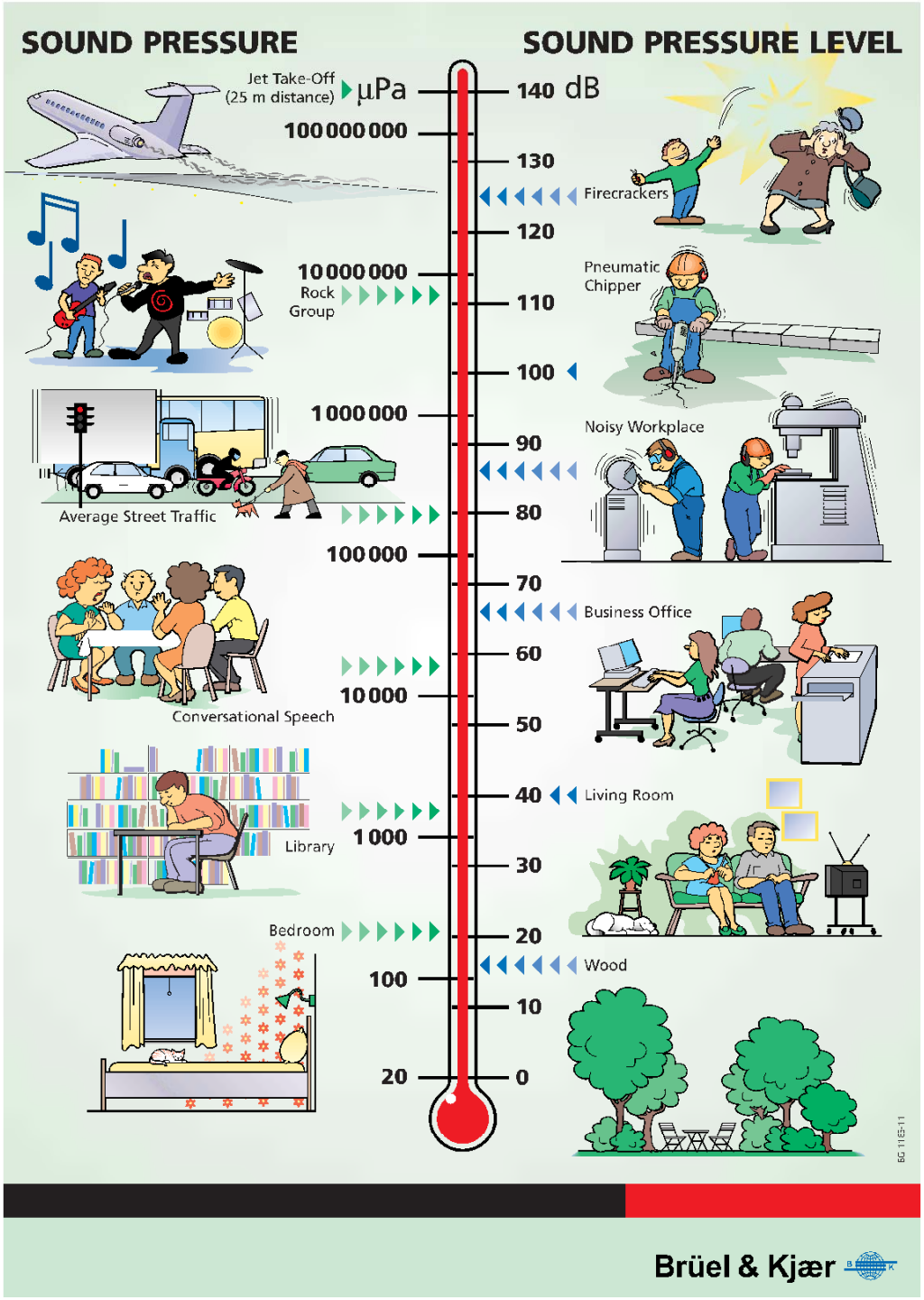

Adding sound levels

- 1 plus 1 = 3!

(Adding two equal sound sources raises the level by 3 dB)

e.g. 50 dB + 50 dB = 53 dB

- If the difference between the two sound sources is 10 dB or more, there is no increase:

50 dB + 48 dB = 52 dB

50 dB + 44 dB = 51 dB

50 dB + 40 dB = 50 dB

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How we perceive changes of sound pressure level

- 2 or 3 dB change is just perceptible
- 5 dB is noticeable
- 10 dB change sounds twice as loud
- 20 dB change sounds 4x as loud
- 40 dB change sounds 8x as loud… etc

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A and C Weighting

- Noises at different frequencies are perceived differently
- Human hearing adjusts (or ‘weights’) lower frequencies so that they don’t sound as loud as higher ones
- In sound level meters, frequencies are ‘weighted’ (attenuated) in a similar way to our own hearing
- ‘A’ weighting approximates our normal hearing response, and is used in most noise standards in District Plans
- ‘C’ weighting is used in some Plans to control instantaneous loud noises such as blasting

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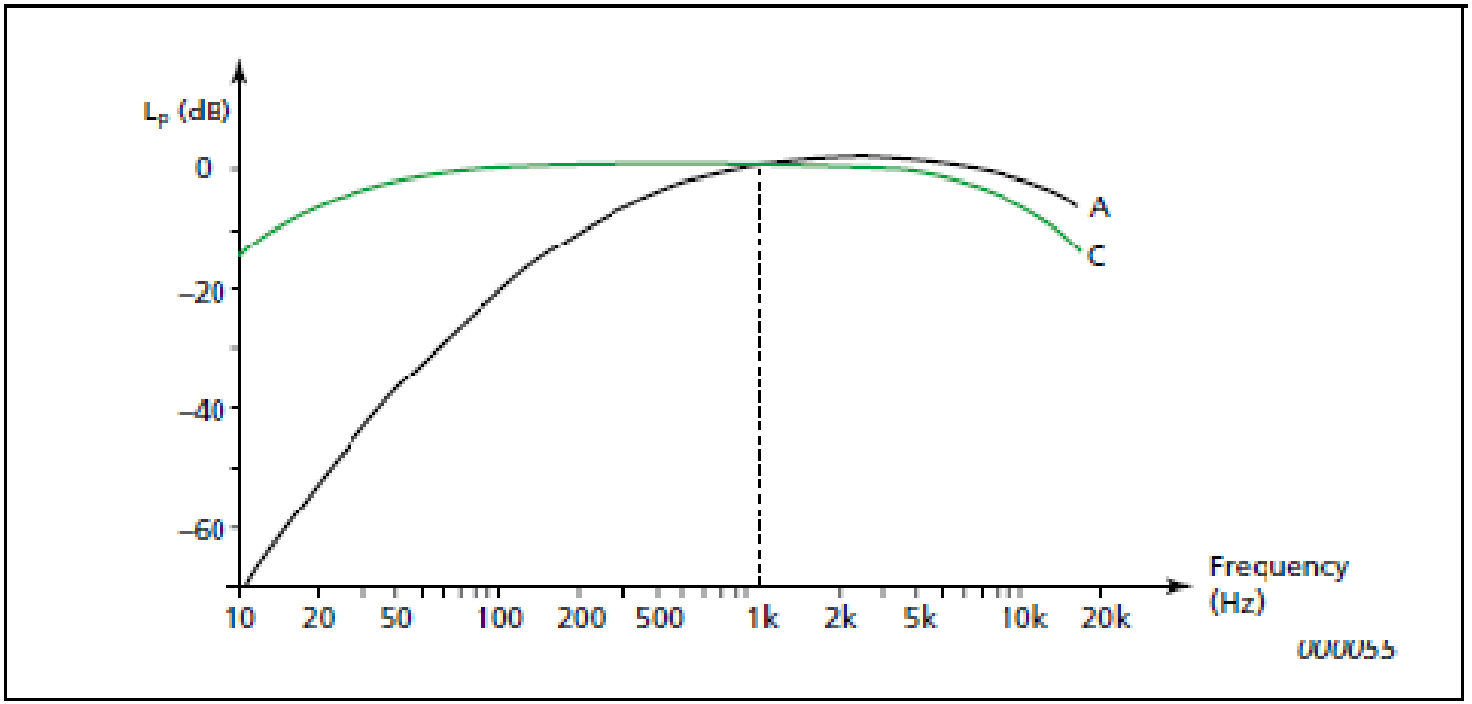
A weighting and C weighting curves



Picture source: Bruel and Kjaer

Noise attenuation

Noise is reduced (attenuated) through

- distance from the source
  - Point source (e.g. generator): 6 dB per doubling of distance
  - Line source (e.g. road): 3 dB per doubling of distance
- air absorption
- buildings and other barriers
- meteorological conditions
- natural features such as terrain and forests

- But ground or water surface reflection and wind can increase the noise level at the receiving point
- High frequencies are easier to shield by buildings and barriers than low frequencies (i.e. bass)

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Environmental noise terms

Term	NZS6801:2008 symbol	Previous NZS version symbols
Decibel (dB)		
• A or C weighting		
• Maximum noise level	• dB L_{AFMAX}	• dBA Lmax
• 10 Percentile level	• dB L_{A10}	• dBA L10
• Background noise level	• dB L_{A90}/dB L_{A95}	• dBA L90/dBA L95
• Equivalent sound level	• dB $L_{Aeq(t)}$	• dBA Leq
• Sound exposure level	• dB L_{AE}	• dBA SEL
• Peak sound level	• dB L_{Cpeak}	• LPeak

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Noise parameters: Leq

$dBL_{Aeq(t)}$ (NZS 6801:2008)

- The time-average A-weighted sound pressure level
- The level of steady noise which would contain the same sound energy as all the noise variations over the measurement period
- Can be used for a variety of noise types (steady, fluctuating etc)
- Good correlation with annoyance studies
- Accepted and applied universally

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Percentile (Centile) levels

$dBL_{A10(t)}$ - "the L10"

- The level met or exceeded for 10% of the measurement interval
- Widely used in District Plans to control a variety of noise situations, but more appropriate for steady noise
- Will be replaced by L_{Aeq} as District Plans are gradually updated to include 2008 versions of NZS6801 and 6802

$dBL_{A90(t)}$ - "the L90"

- The 'background' noise level – the level met or exceeded for 90% of the measurement interval
- L95 used in earlier versions of NZ Acoustic Standards

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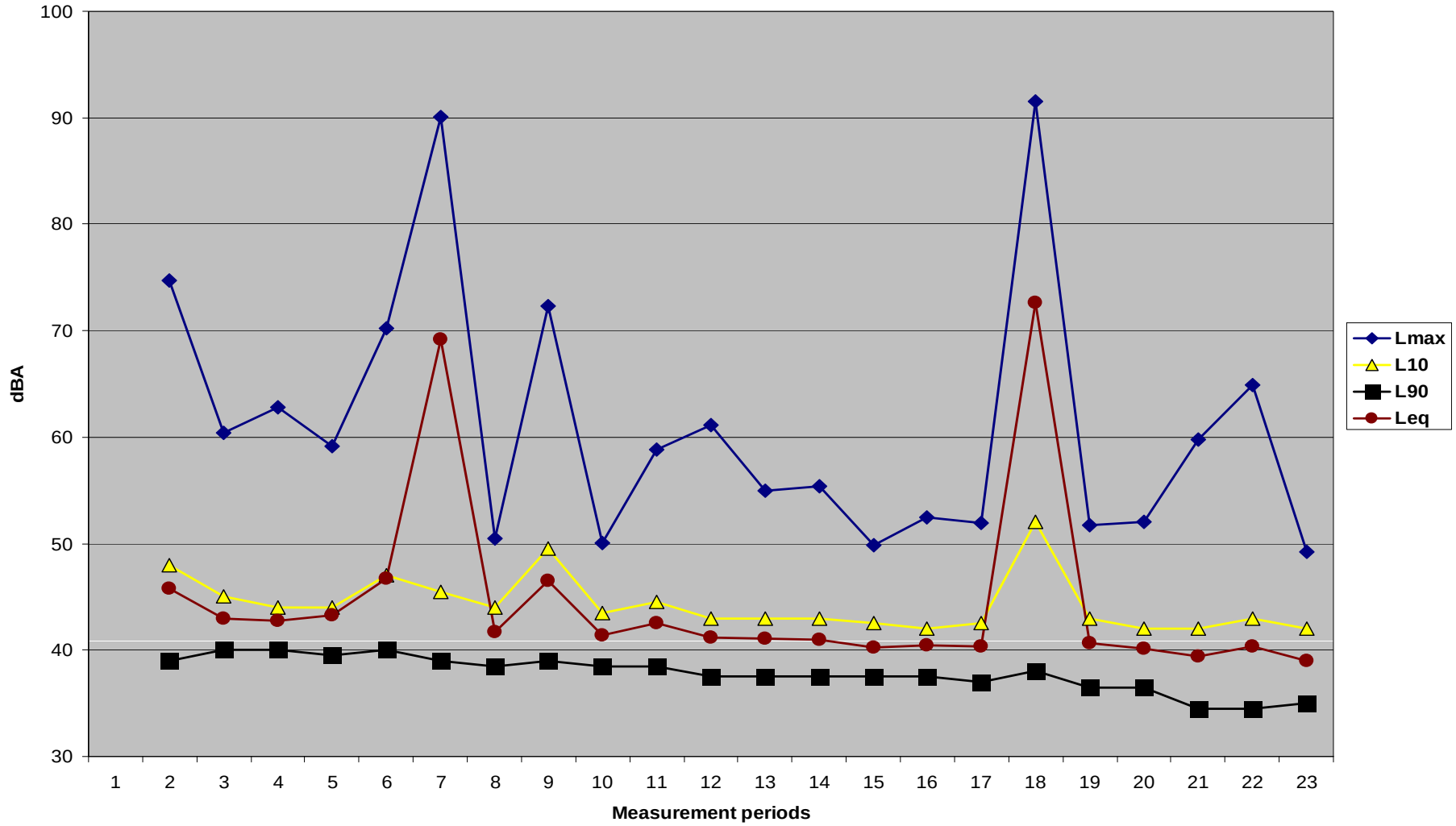
Maximum noise level

- dBL_{AFMAX} (NZS 6801:2008)
  - Used as a ‘cap’ for noise emissions, to control brief loud noises which may not be controlled by L_{Aeq} or L_{A10}

Ln, Lmax and Leq compared



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Sound exposure level

- dB SEL or dBL_{AE}
  - The sound level which, if maintained constant for one second, would convey the same sound energy as a given noise event
  - i.e. the energy of the event is normalised to 1 second
  - Allows the Leq from a number of similar discrete noise events (e.g. car or aircraft movements) to be calculated for any assessment period
  - Allows the sound energy from different events to be compared

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Day/night level

- Ldn
  - = Leq $_{(24\ hours)}$ with 10 decibels added during the night period because night-time noise events are more annoying
    - Ld = Leq (15 hrs) between 0700 -2200hrs
    - Ln = Leq (9 hrs) + 10dB between 2200 and 0700 hrs

Adding 10dB over the night period penalises any noise event during that period

- e.g. one night flight = 10 day flights

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Thank you!

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