

Broadband – an alerting and locating sound for electric vehicles

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What Should a Sounder for Quite Cars Achieve?

Audibility:

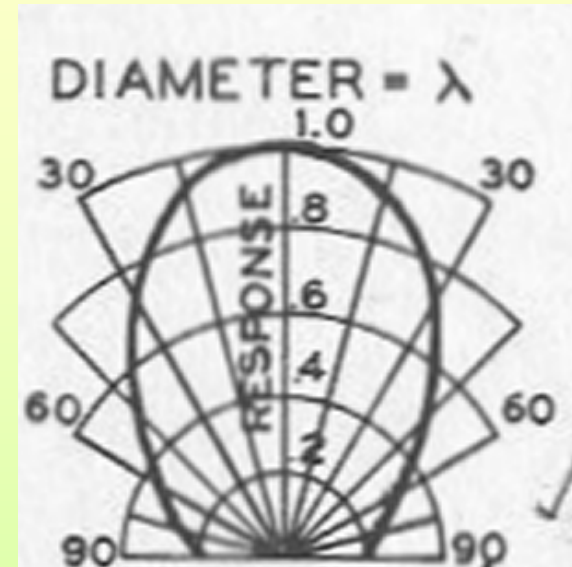
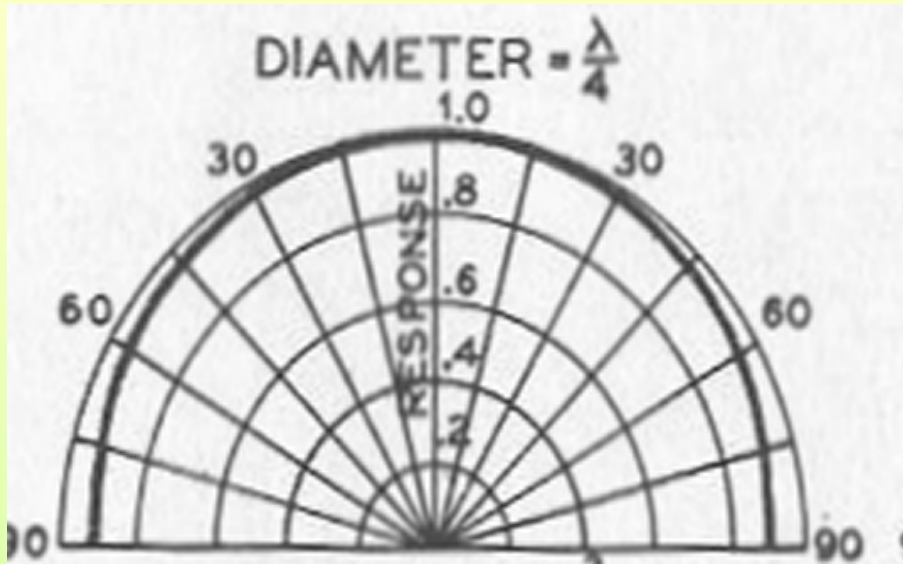
- **Elderly, hearing damaged, blind, young**
- **Unambiguous as a vehicle sounder**
- **Quickly locatable**
- **Not be easily masked**

Environmentally acceptable

Not an added noise nuisance

- **Good directivity**
- **Attenuation with distance**
- **Attenuation into buildings**

Directional radiation from a piston source



Depends on ratio source diameter to wavelength

For 0.1m source,

$D/\lambda = 0.25$ at 850Hz

$D/\lambda = 1$ at 3400Hz

Penetration into buildings

Façade attenuation increases with frequency, say ~ 5dB per octave

Higher frequencies in broadband are attenuated more.

Estimation shows that for equal external dBA level, broadband internal level is about 4dBA lower than a typical tonal sound at 1kHz

Loudness of broadband and tonal alarms

ALARM SOUND	LAeq dBA	Loudness Phon
Broad band	92.3	103.2
Tonal 1250Hz	93.0	95
Tonal 1450Hz	92.2	95.8
Complex 1450Hz	92.1	98.5

Broadband sound contains complete auditory information

Contains continuous frequencies between its lower and upper band limits which helps

- **the elderly**
- **people with hearing loss occurring in a specific frequency region**

AND: It is difficult to mask

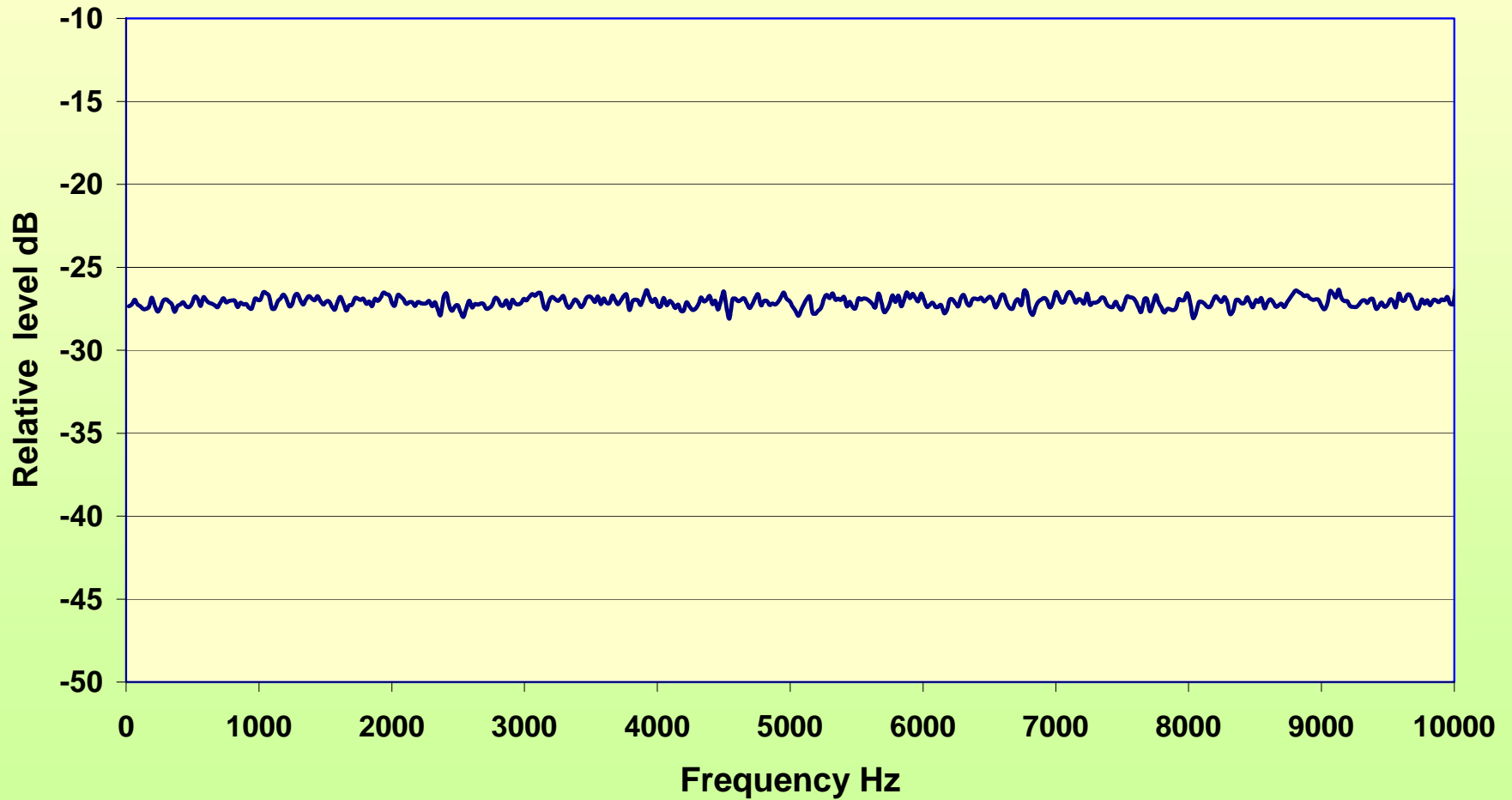
Broadband sound contains the information required for location

- **Low frequencies for interaural time difference: range up to about 750Hz**
- **Medium frequencies for interaural intensity difference: range above about 700Hz**
- **Higher frequencies for effects of pinnae, facial features etc: range above about 5kHz**

White sound



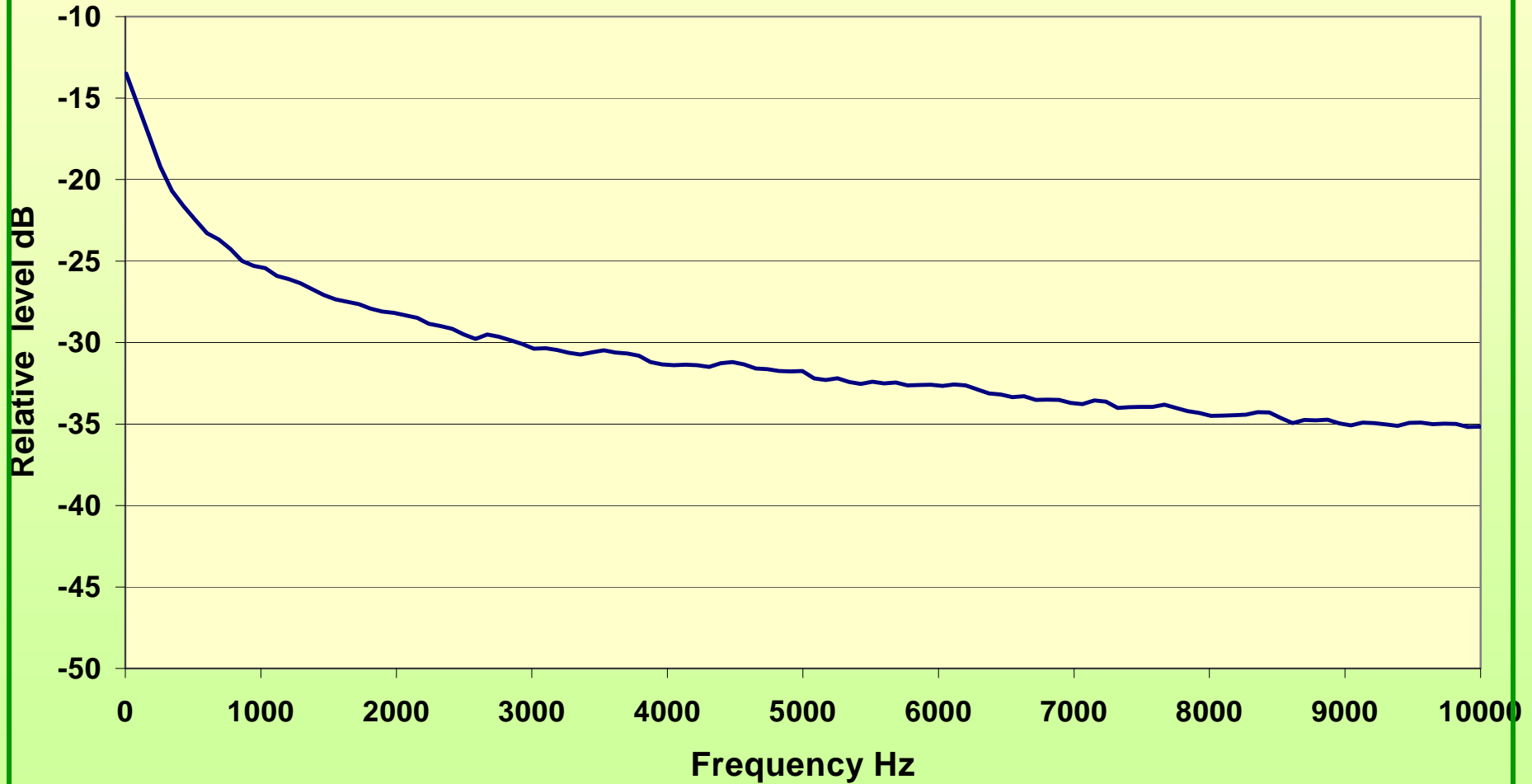
White





Pink Sound

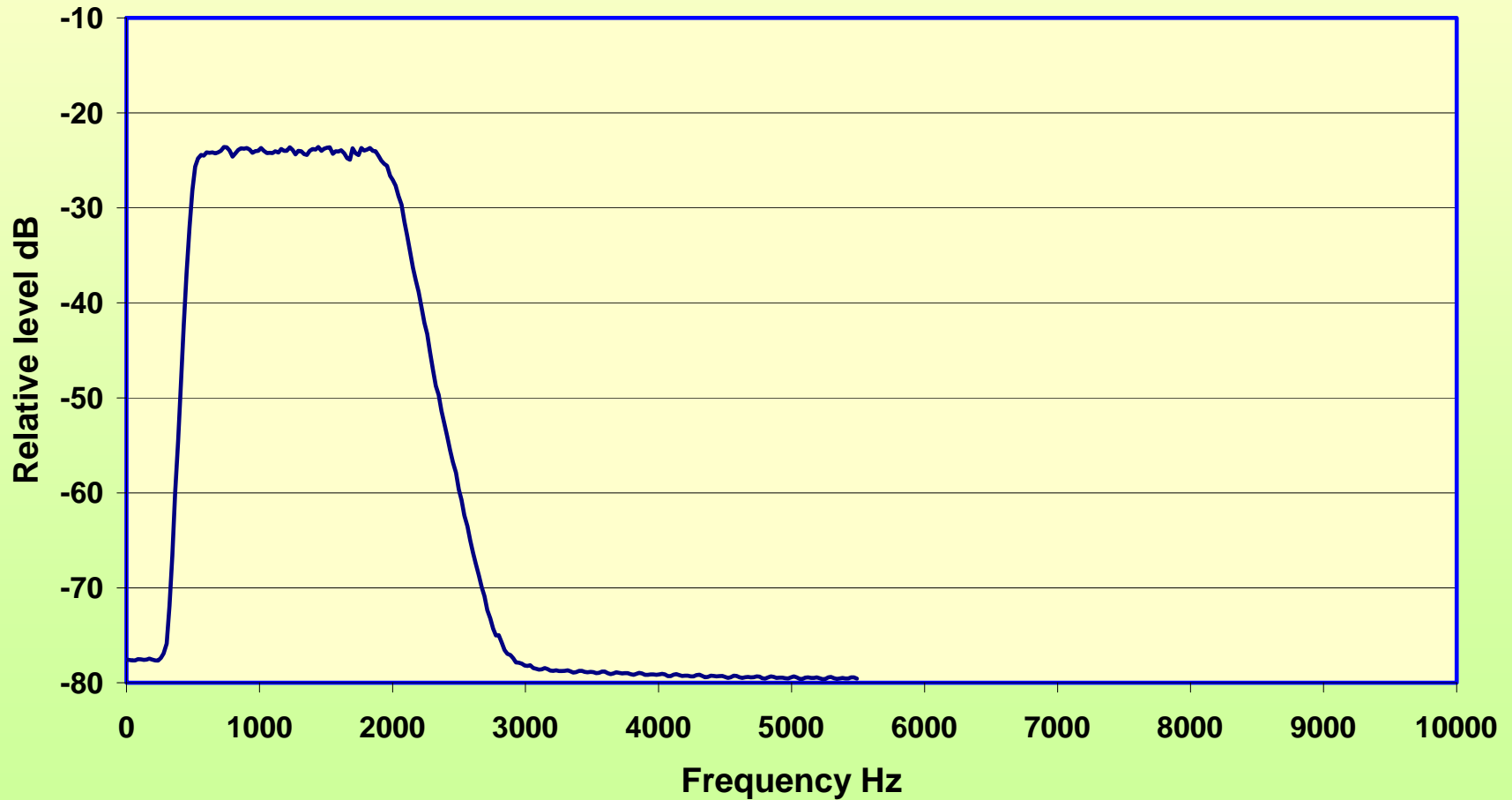
Pink





Band Limited Sound

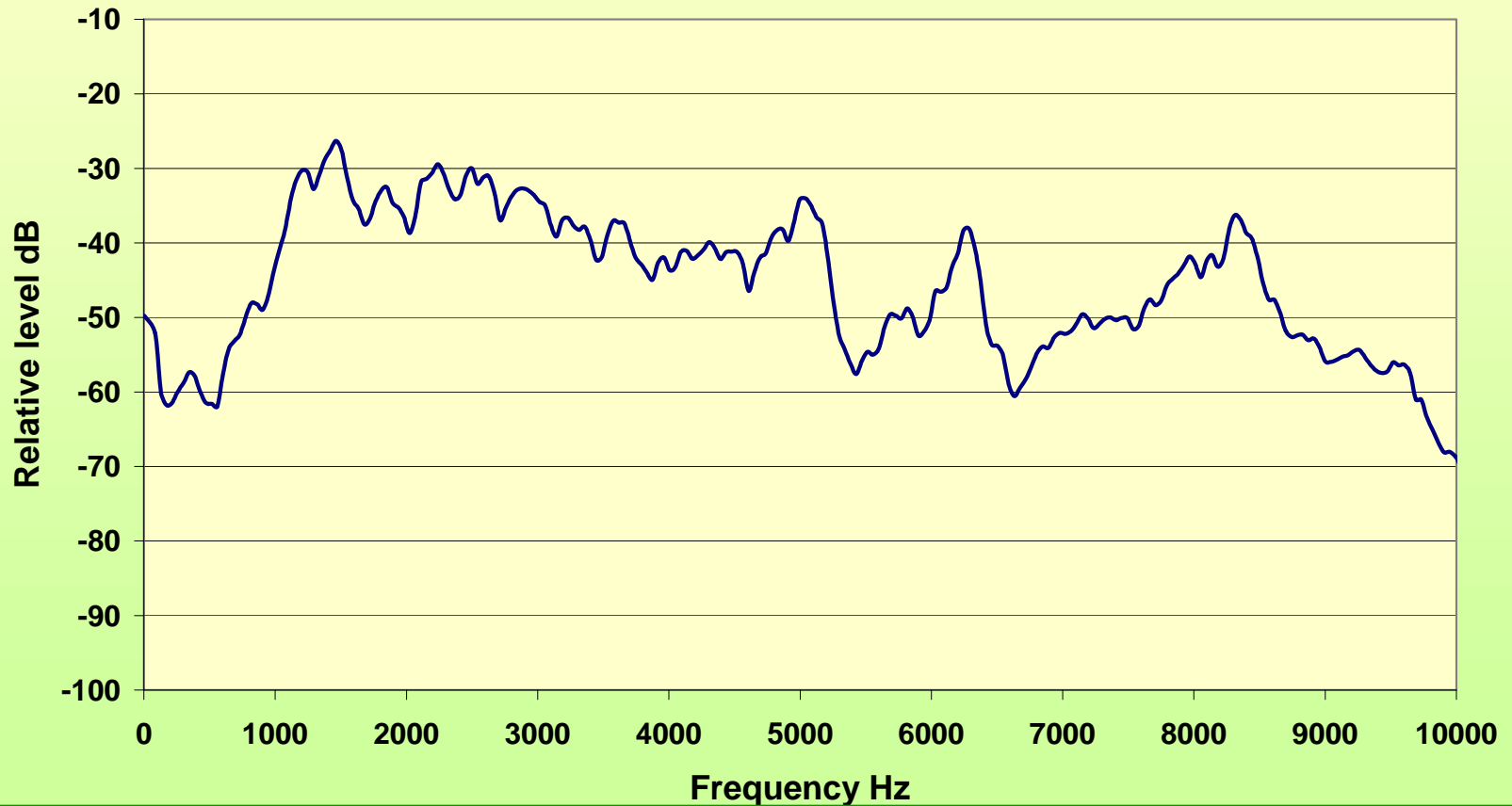
Band limited





A real radiated sound

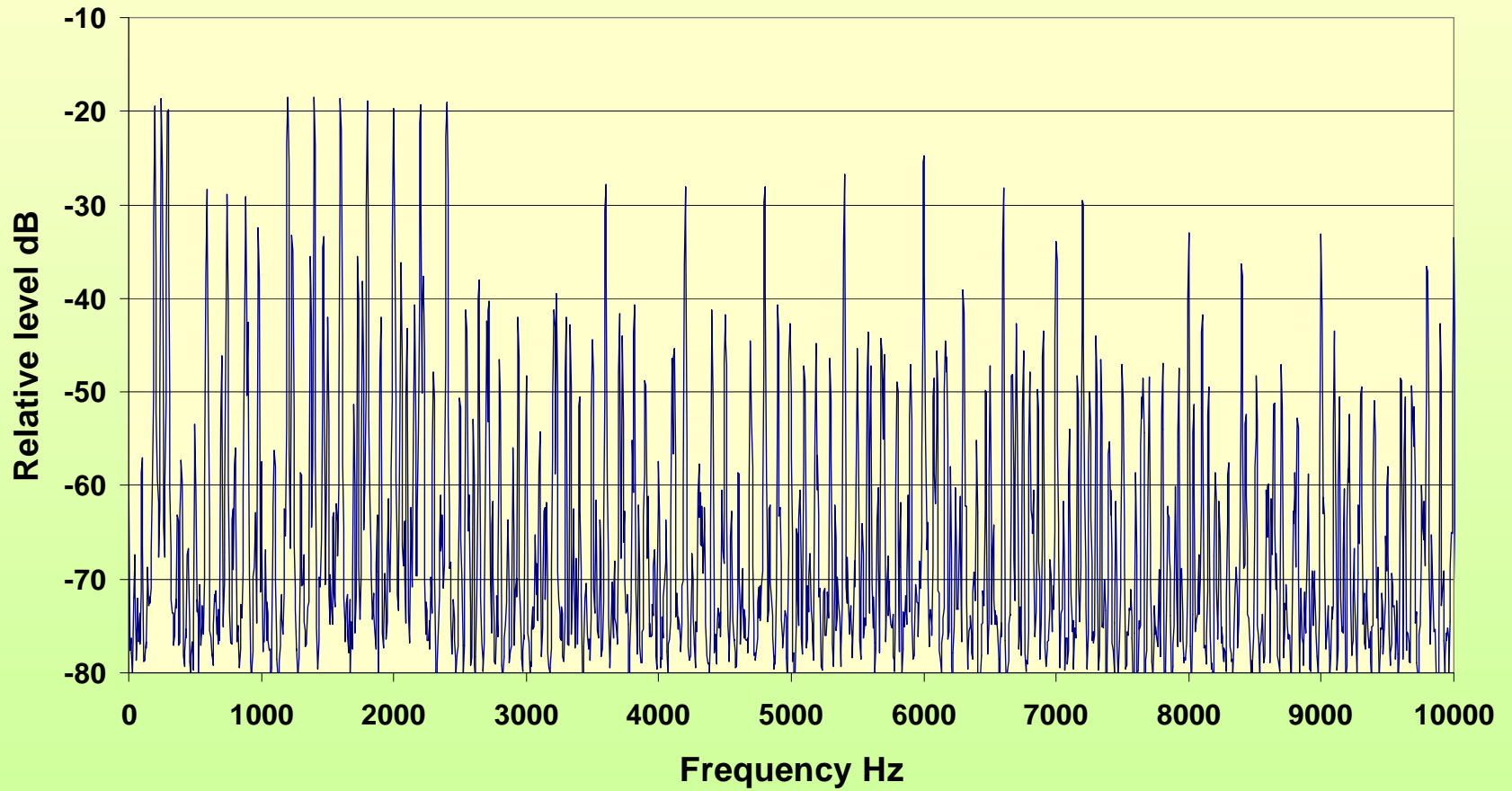
BB reversing alarm





Multiple tone sound

Tones



Broadband sound and electric vehicles

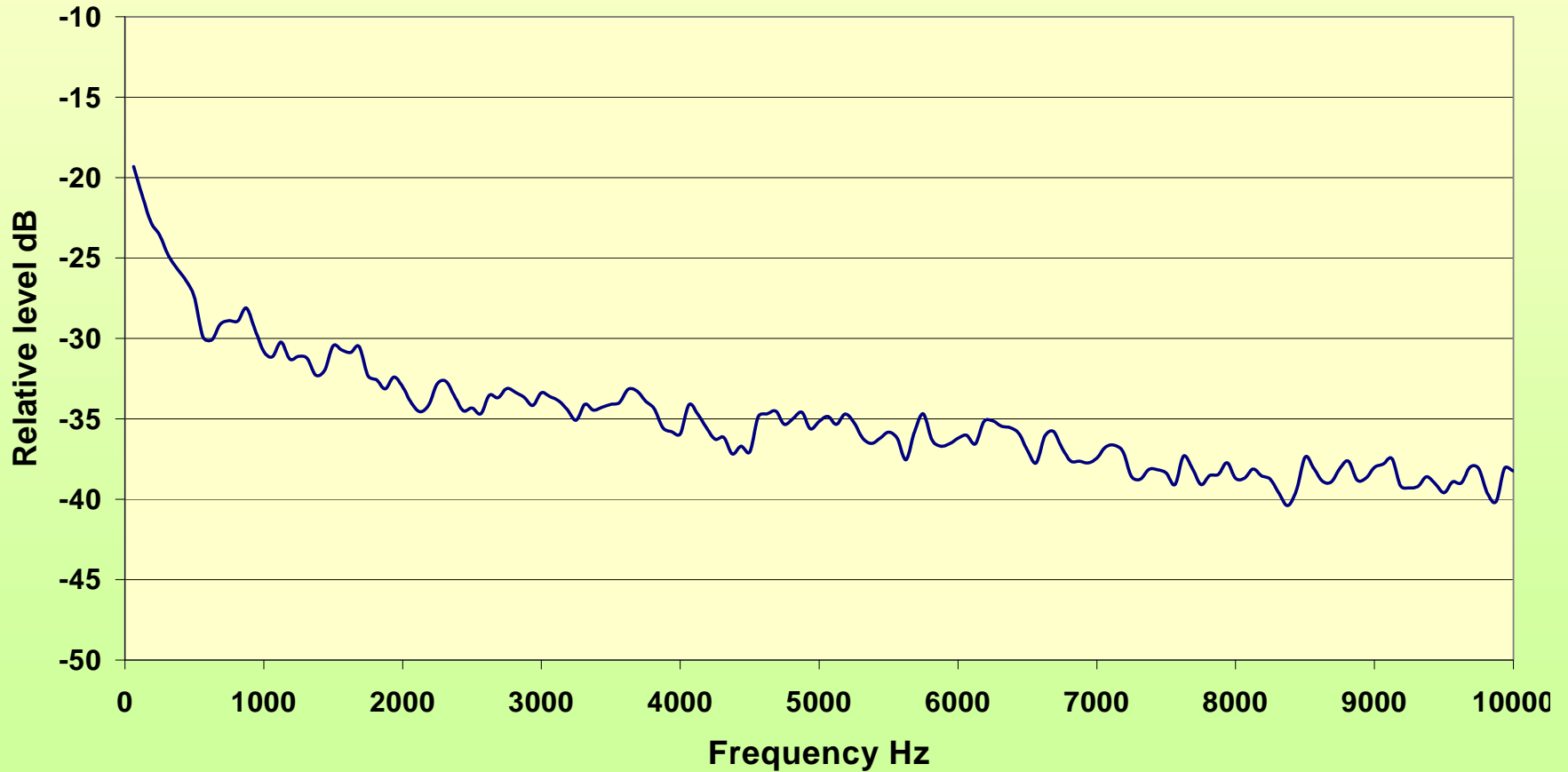
“The sound to be generated by the Approaching Vehicle Audible Systems should be a continuous sound easily reminding the pedestrians, etc. of an approaching vehicle”.

Broadband sound satisfies this condition and can be given the characteristics of an ICE.

Pink Broadband sound for EVs



Car sound



All the sounds

White



Pink



Band limited



Radiated



Multiple tone



Pink BB for EVs



