

QRTV-06-09

Sounds for Electric Vehicles

Defining Sounder Criteria

Presented by Henry Morgan

**Edited from paper prepared and presented by Prof. Geoff
Leventhall to ISO Apr 2011**

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What Should a Sounder for Quite Cars Achieve?

Safety:

Audibility, Locatability, Directivity

Environmental:

Acceptability, Directivity, Attenuation

Audibility

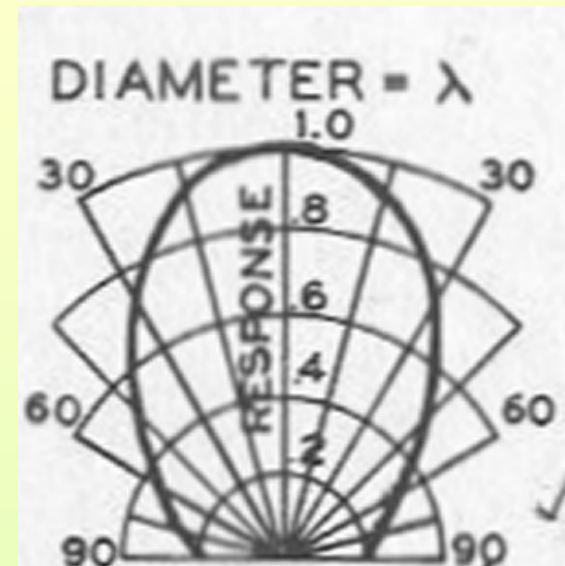
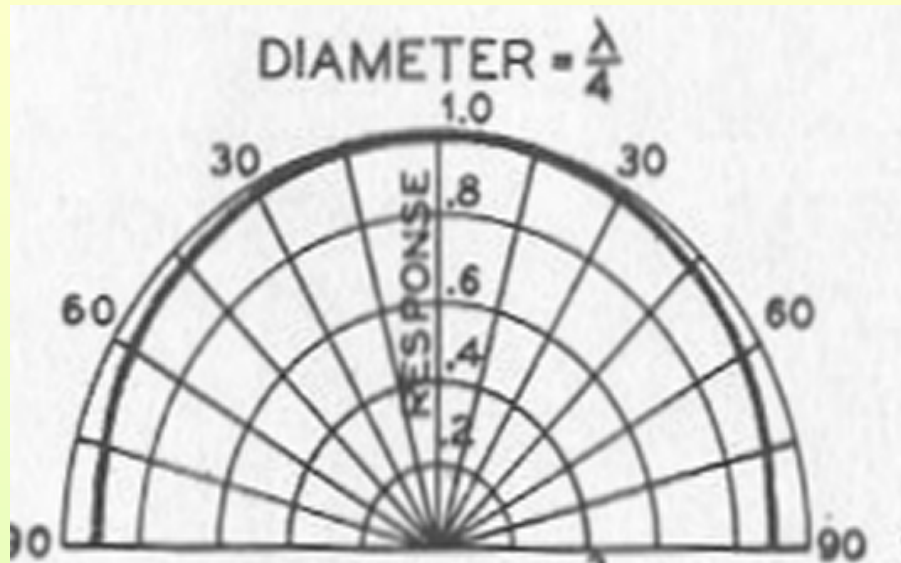
Depends on loudness (phons) or sound pressure level (dBA) compared with background noise

Why phons? Tests show that, for equal dBA, broadband sounds are louder than tonal sounds.

Loudness of broadband and tonal back alarms

ALARM SOUND	LAeq dBA	Loudness Phon
Broad band	92.3	103.2
Complex 1450Hz	92.1	98.5

Directional radiation from a piston source



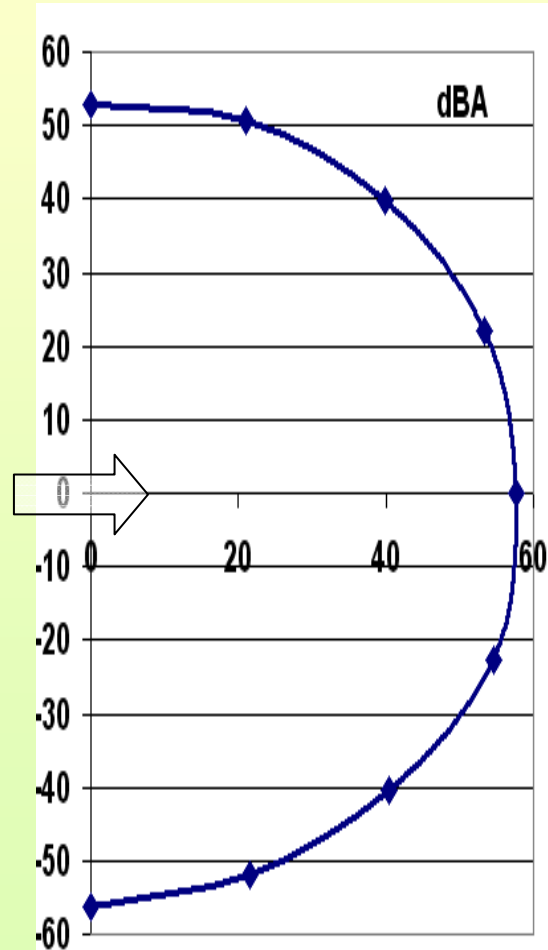
Depends on ratio source diameter to wavelength

For 0.1m source,

$D/\lambda = 0.25$ at 850Hz

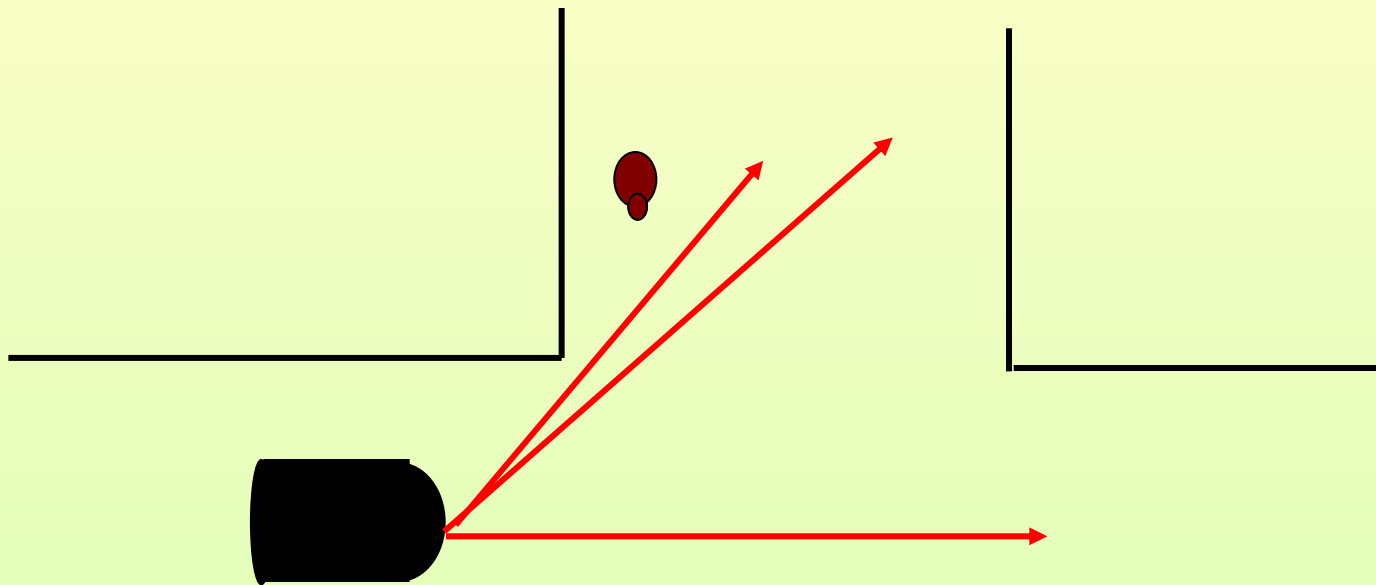
$D/\lambda = 1$ at 3400Hz

A-Weighted Directivity



**Prius Hybrid fitted
with Brigade broad
band prototype
sounder**

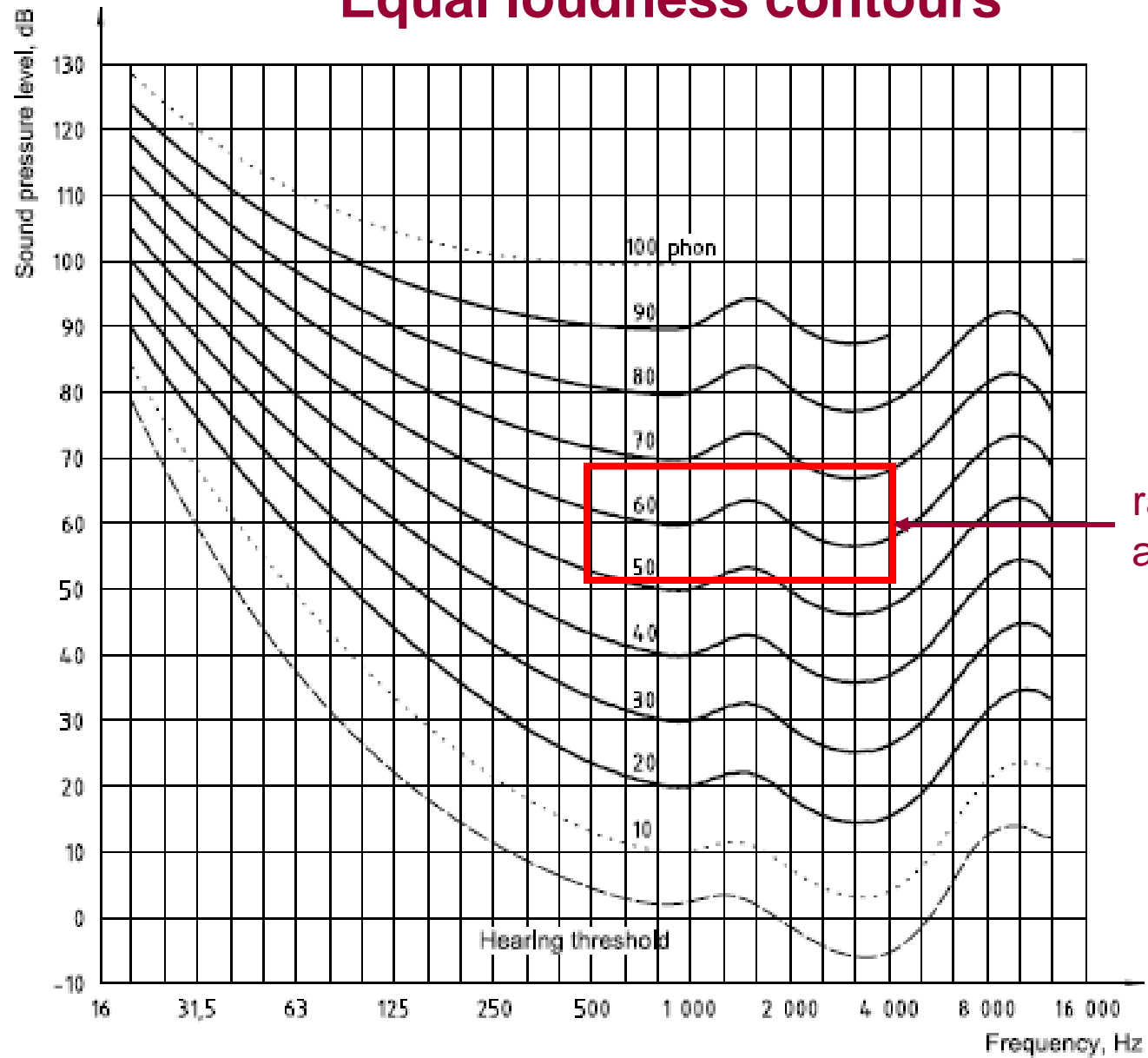
Limit the directionality



Broadband Sound

- Broadband sound contains complete auditory information for location
- Greater higher frequency content gives:
 - greater directivity
 - greater attenuation

Equal loudness contours

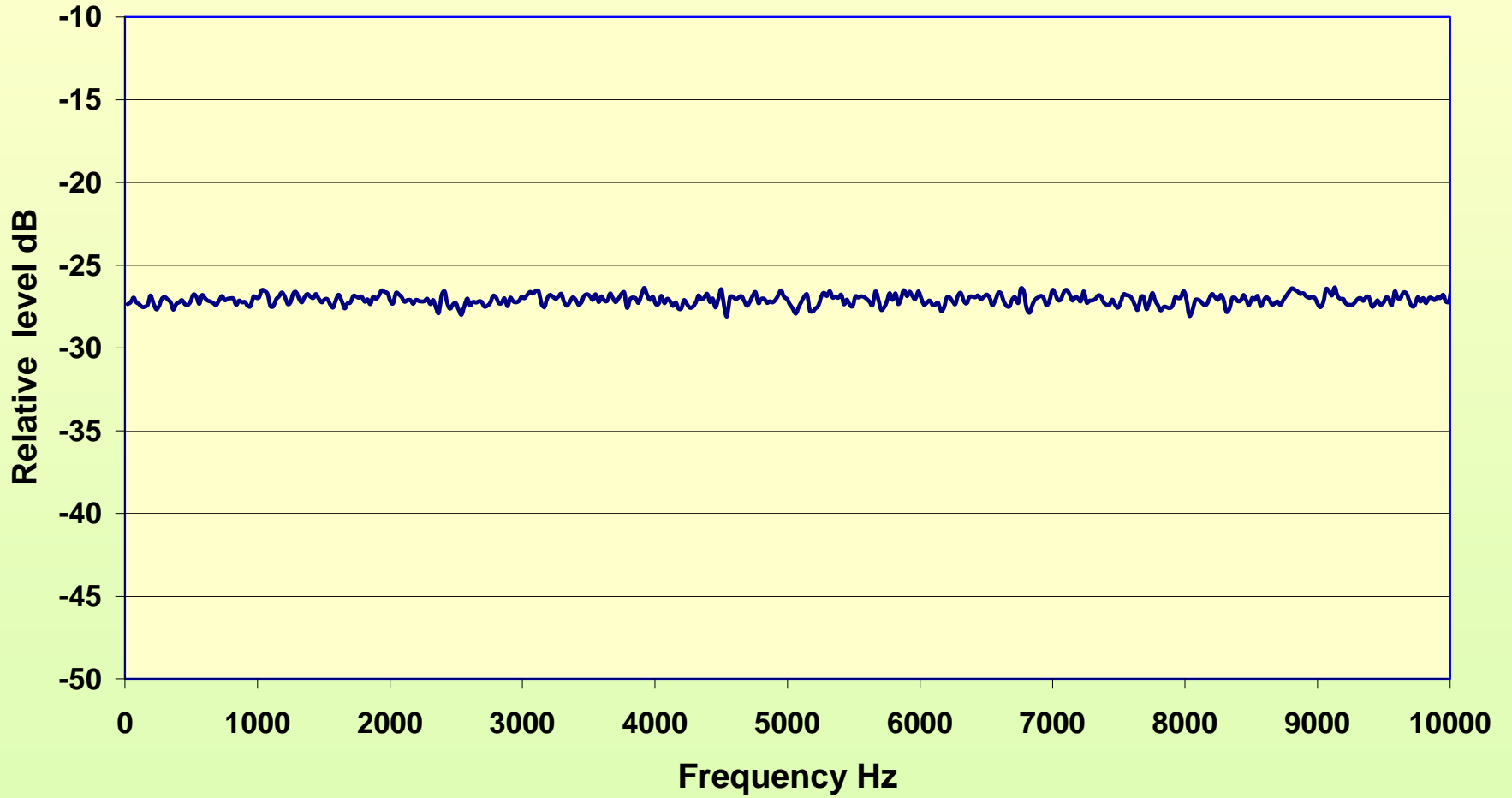


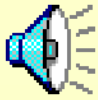
range of
added sound

White sound



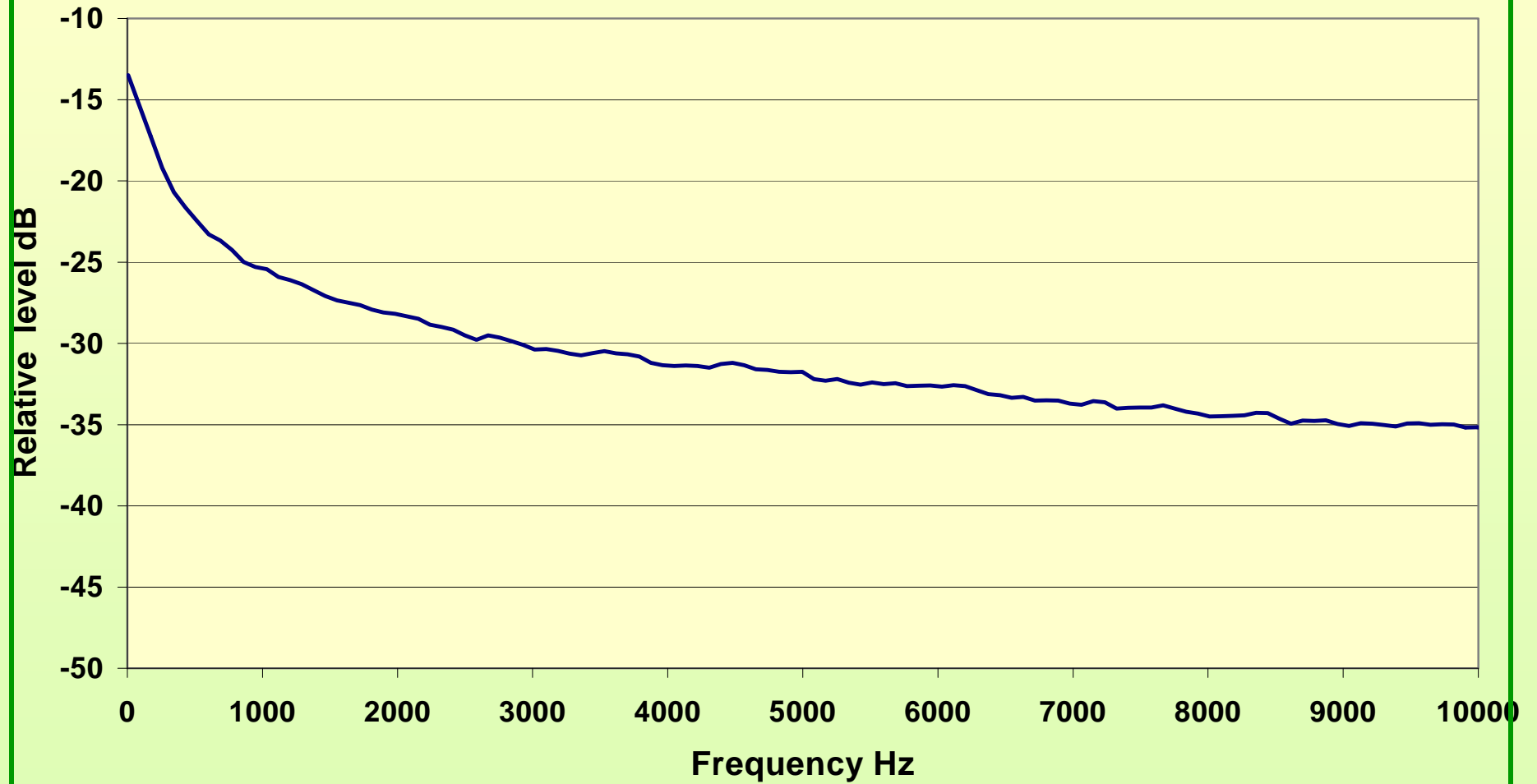
White





Pink Sound

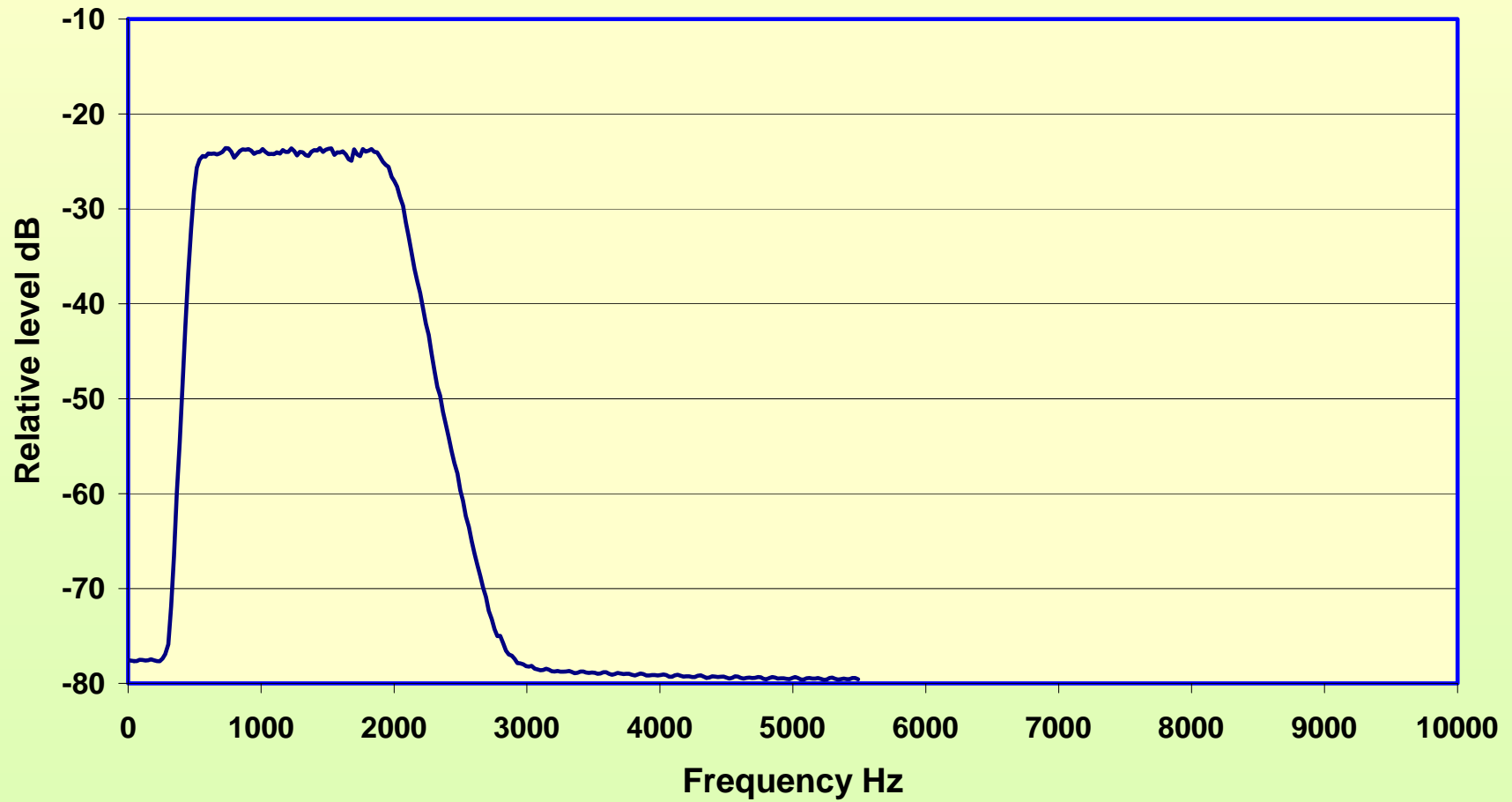
Pink

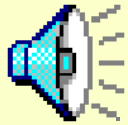




Band Limited Sound

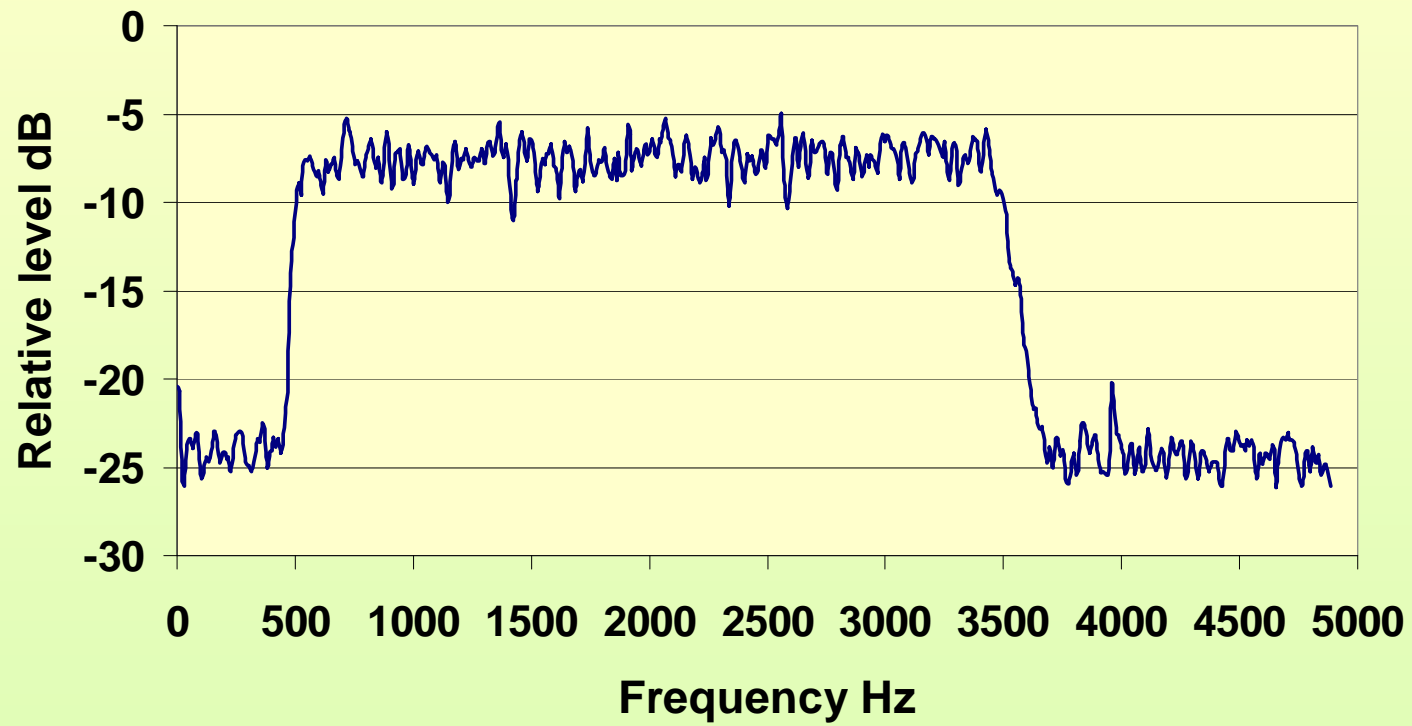
Band limited

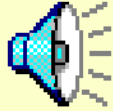




500Hz to 3500Hz

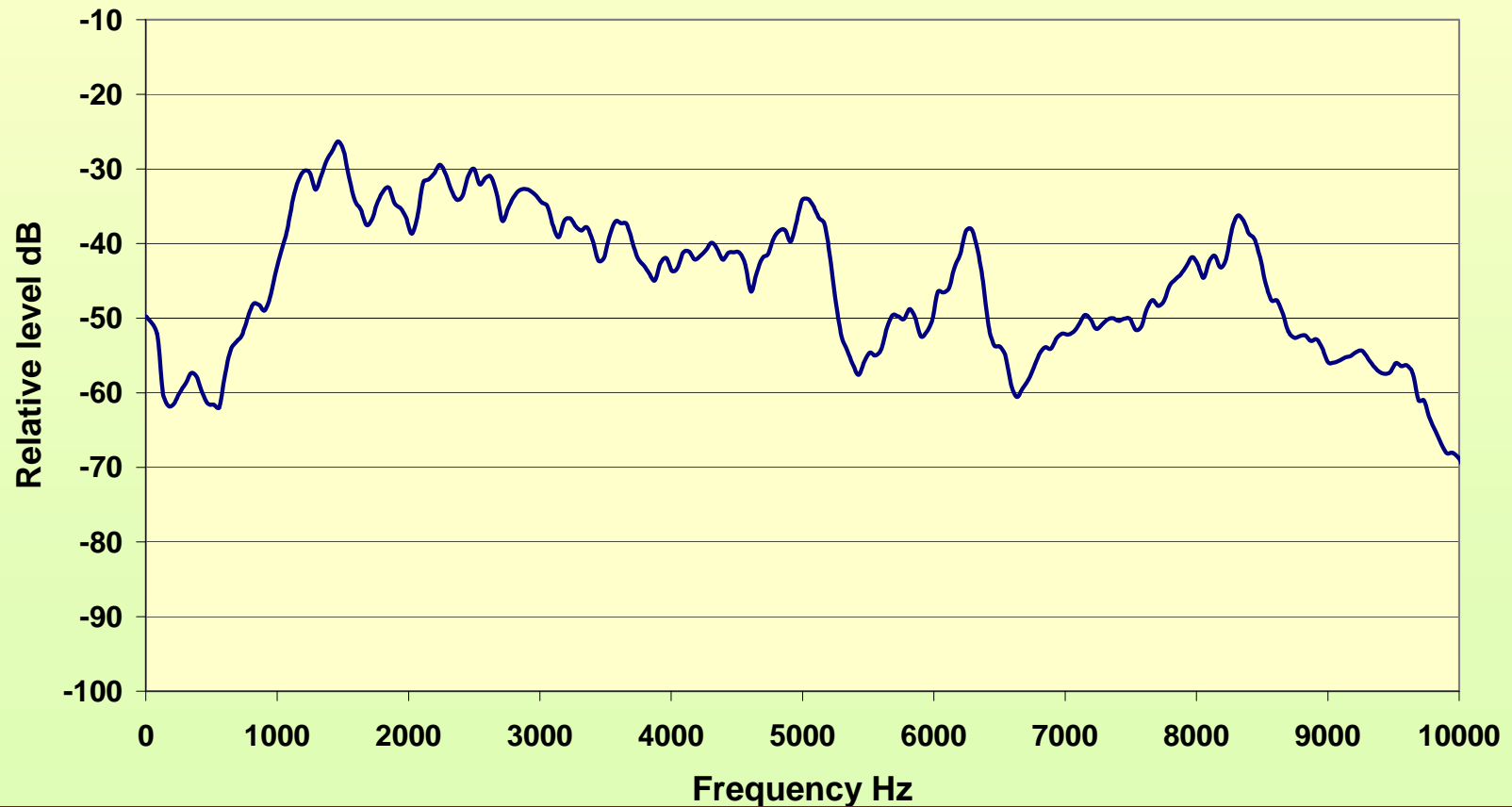
500Hz to 3500Hz





A back alarm sound

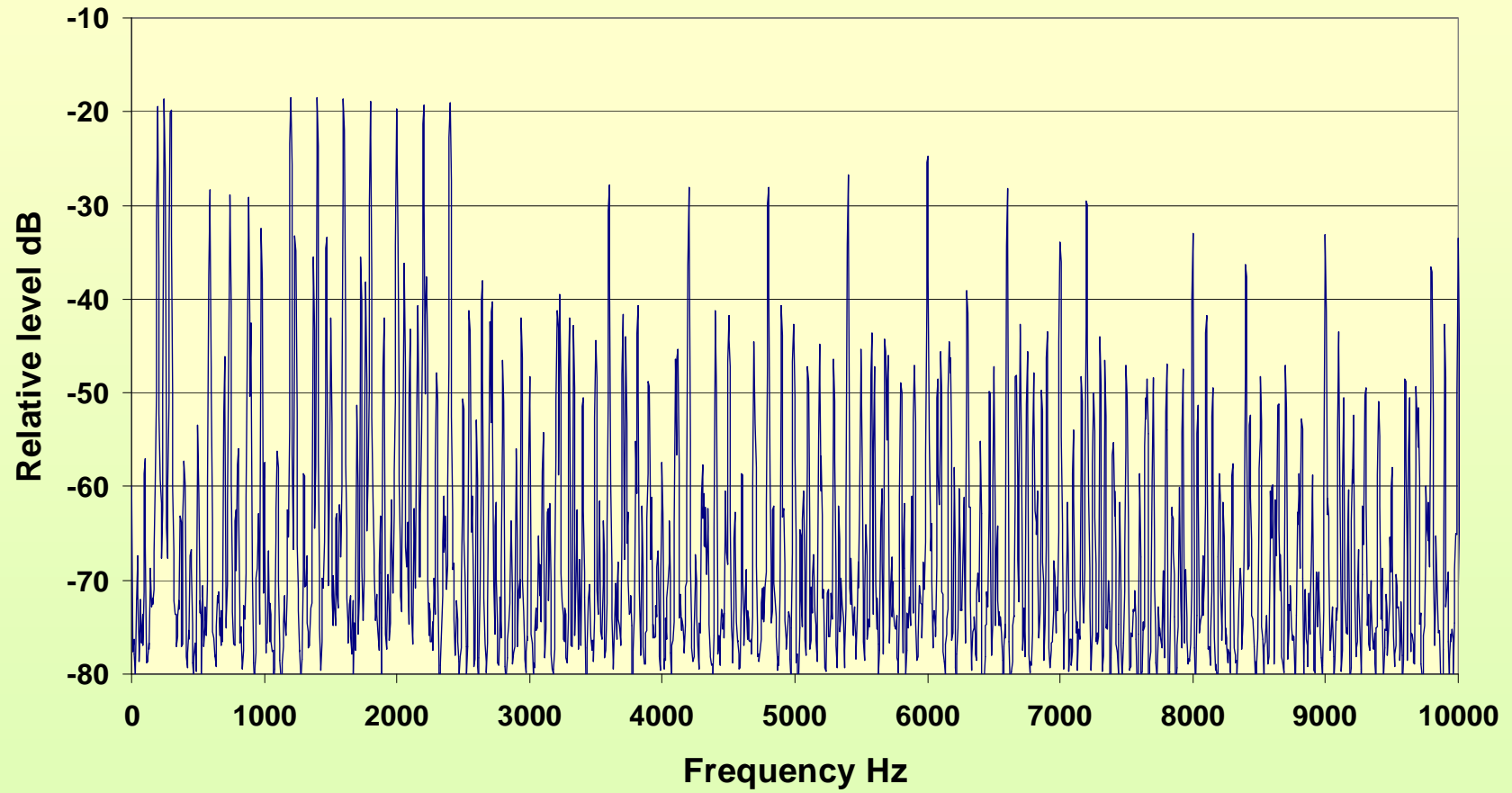
BB reversing alarm



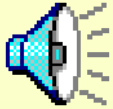


Multiple tone sound

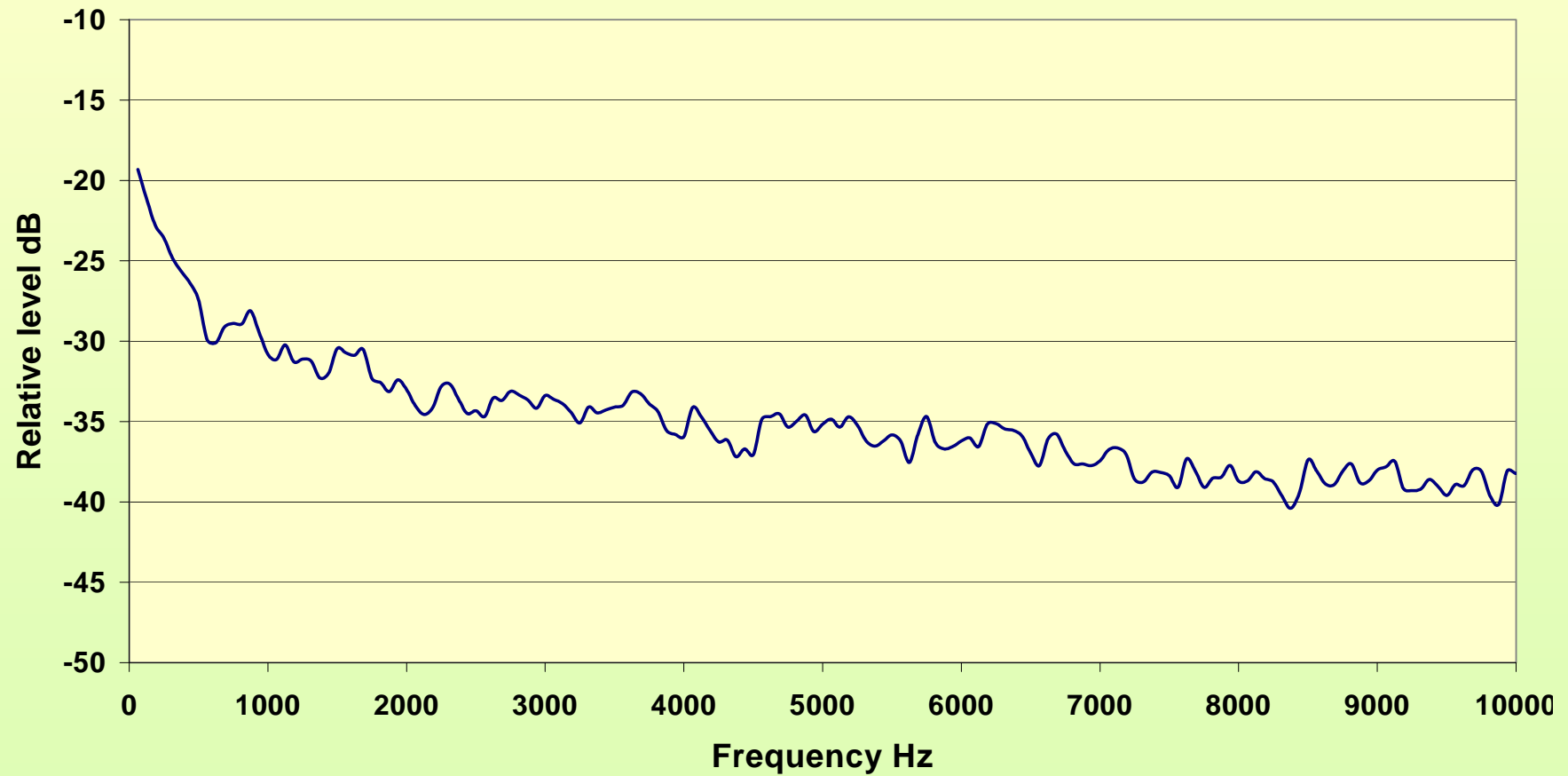
Tones



Pink Broadband sound for EVs



Car sound



All the sounds

White



Pink



Band limited 1



band limited 2



Back alarm



Multiple tone



Pink BB for EVs

