

AVAS

AVAS : Approaching Vehicle Audible System

7th September, 2010

JASIC

Contents

- What is AVAS?
- What is an ideal sound for AVAS?
- Concept of Sound
- Summary

What is AVAS?

AVAS : Approaching Vehicle Audible System

AVAS meets the Japanese Guideline

■ Scope

- ✓ Electric vehicles and hybrid electric vehicles which are capable of running exclusively on motor power.

■ Activation condition

- ✓ Automatically generate a sound
- ✓ The minimum range of vehicle speed from starting to 20 km/h forward and backward.
- ✓ May equip manual pause switch

■ Sound level

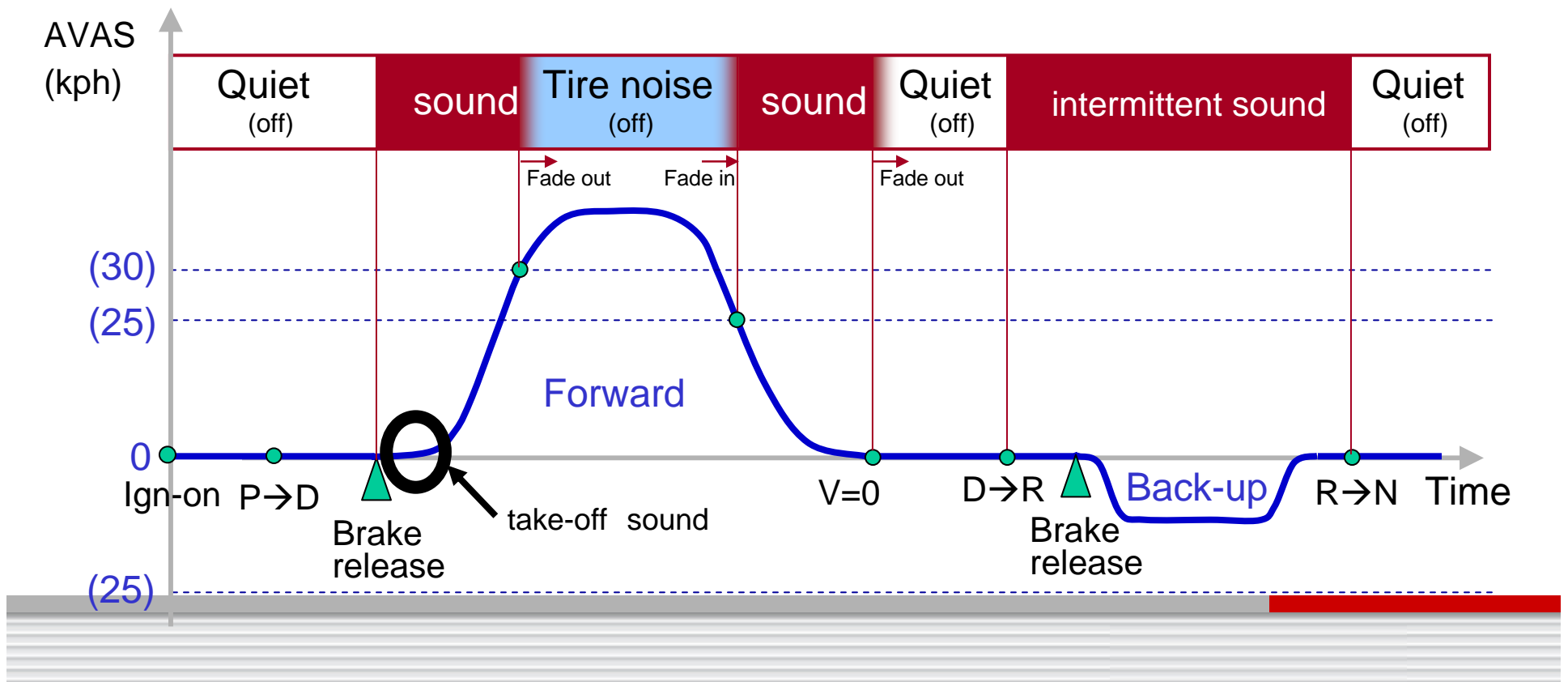
- ✓ Not exceed the sound level of ICE which runs at speed of 20km/h.

■ Type of sound

- ✓ Siren, chime, bells, melody, horn sound, etc. are not allowed.
- ✓ Continuous sound associating running vehicle

AVAS Logic (example of Nissan)

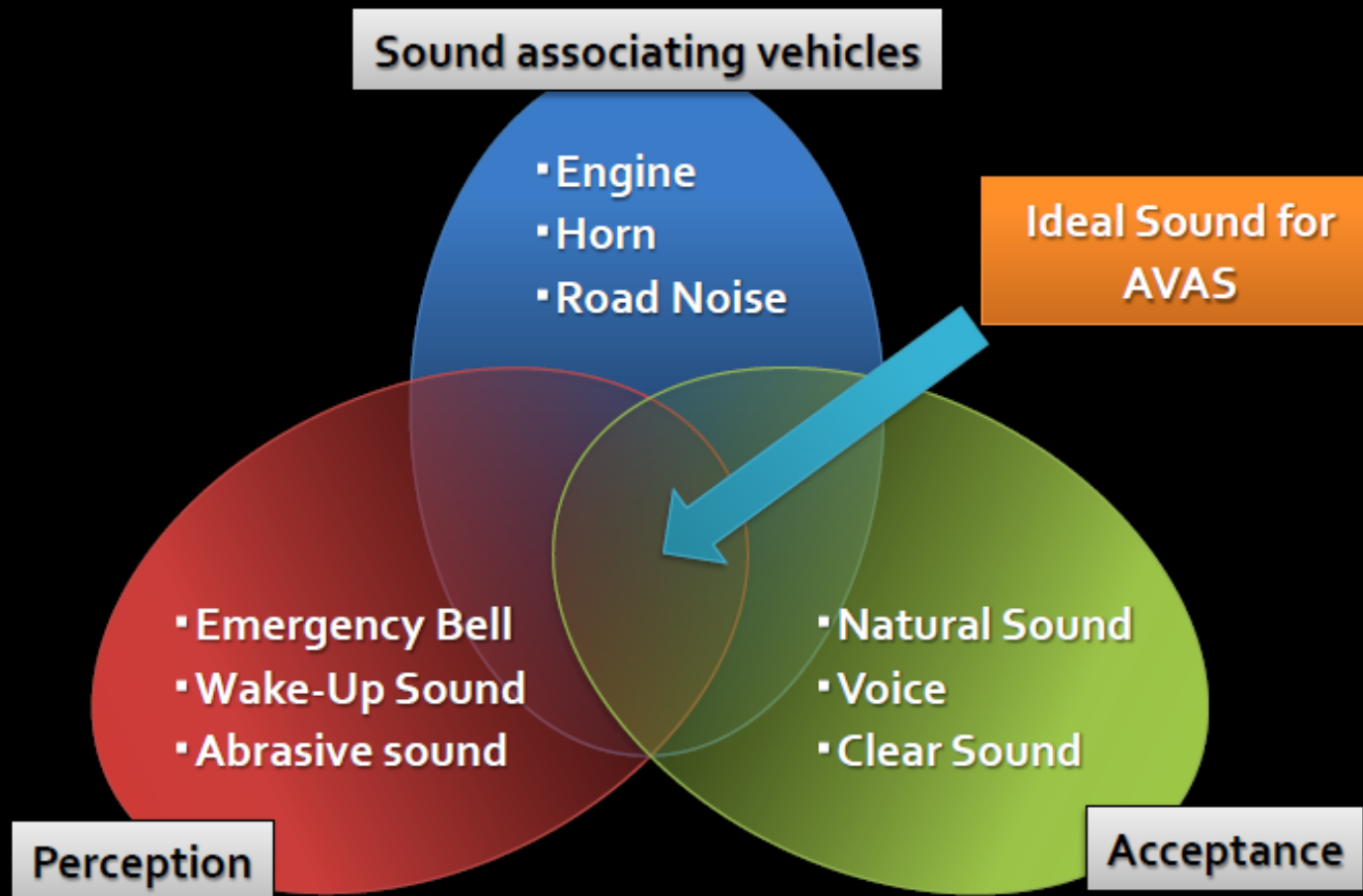
- The system automatically activate and do not rely on the driver's decision to manually activate it.
 - No sound while stopped, sound starts when brake released.
 - sound fades-out when vehicle speed is approx. 30kph
 - sound fades-in when vehicle speed is reduced to approx. 25kph
 - system emits sound while reverse gear position engaged



What is an ideal sound for AVAS?

What is an ideal sound for AVAS?

- Requirement for sound of AVAS?
 - Noticeable & Acceptable Sound associating motor vehicles

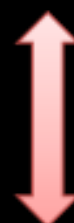


What are important factors for sound of AVAS?

- **Associative**
 - Associated with Vehicle running condition
 - Needs to vary according to drive information
 - Sounds like running vehicles
 - Associated with engine or motor behavior
- **Noticeable**
 - Noticeable in City Noise
 - Hard to be masked by background noise
 - Audible for wide age range
 - Sound rich in low ~ mid frequency
- **Acceptable**
 - Immune to frequency / repetition
 - Familiar sound
 - Immune to time length
 - Non-melodic nor non-tonality



Recognizable



Trade-off

Comfortable

Use of "Fluctuation"
is a key

Sound associating vehicles #1

- Vehicle's running condition shall be expressed by sound variation
 - Vehicle's running condition is judged from real time variation of sound according to the condition of acceleration, brake pedal and gear
 - Real time response enables pedestrians to notice
- distance from vehicles
 - speed of vehicles
 - vehicle's running condition (approaching/in halt/departing)
- Sound reflecting engine condition make pedestrians feel it associated with vehicles



Sound shall change according to
vehicles speed

Sound associating Vehicles #2

- Volume and/or Frequency need to vary (should not be constant)

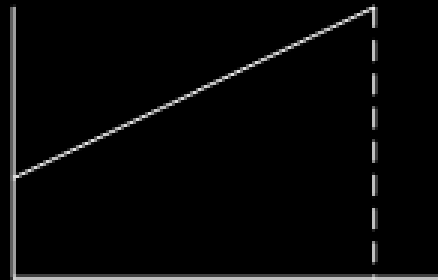


Figure 1 : Engine Frequency Variation



Figure 2 : Engine Volume Variation

With variation similar to engine sound, even Synth sounds like a vehicle

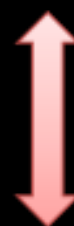
- Quick response is required
 - Pedestrians & drivers feel uncomfortable in failing to respond to speed variation in a real time manner
- Smooth fade out in reaching an upper limit speed is desirable
 - Fade out with break makes an undesirable effect on comfort & quality
 - Smooth cross-fade with Road noise is preferable

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Recognizable



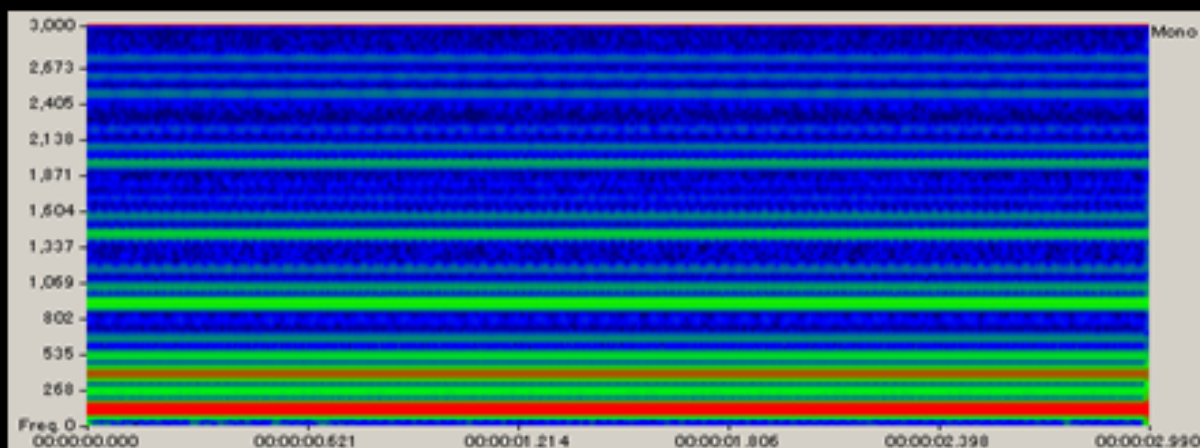
Trade-off

Comfortable

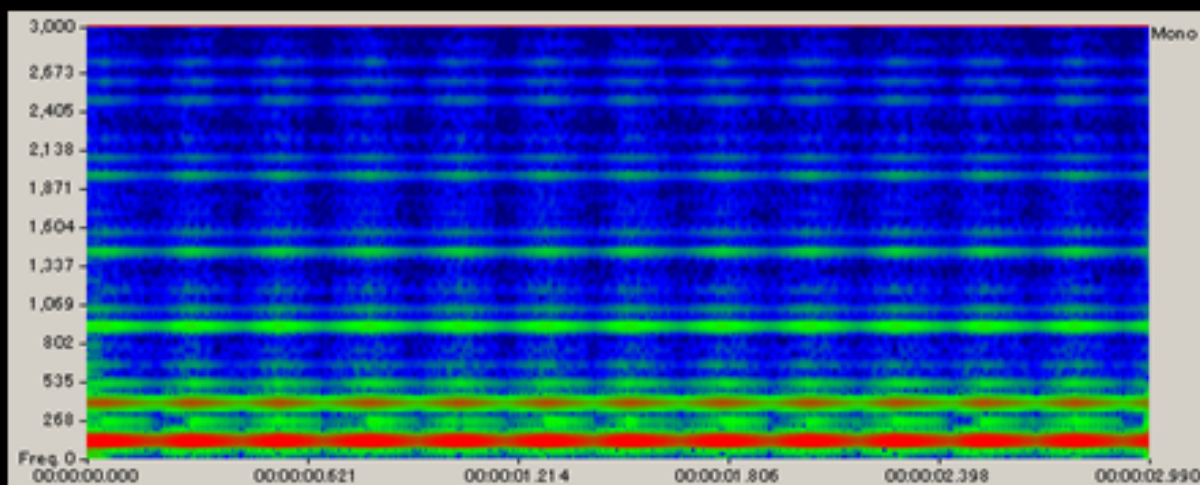
Use of "Fluctuation"
is a key

Effect of Fluctuation

- Without Fluctuation



- With Fluctuation



Fluctuation

- Fluctuation is important for Sound
- What is fluctuation ?
 - **Periodical variation** of Amplitude and/or Frequency
- Helpful for perception
 - Sound without fluctuation is easy to be masked by background noise
 - More noticeable by variation of sound
 - More sensitive to variation due to human ears' characteristics
 - Too much fluctuation leads to discomfort
- Sound with fluctuation can be associated with vehicles as conventional engine sound has fluctuation
 - Fluctuation can also express engine rotation

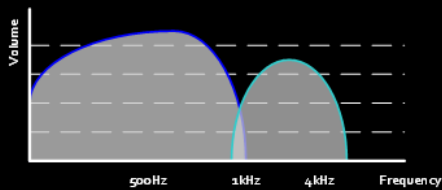
Comfortable

- Needs to be Immune to (frequent & long) hearing
 - Sound strong in pitch is noticeable but is vulnerable to (frequent & long) hearing
 - Horn/Alarm sound is noticeable but likely to stick in the ears or to scare pedestrians
- Non-melodic, natural & noticeable
 - Melodic sound is noticeable but vulnerable to frequent hearing
(air conditioner sound is not distinguished but immune to frequent hearing)
 - Mixing noise is also effective

Key Point of a Sound for AVAS

Key components
Important factors

Change frequency and/or volume
according to vehicle speed



Wide frequency range
not only one range

▪ Emergency Bell
▪ Wake-Up Sound
▪ Abrasive sound

▪ Engine
▪ Horn
▪ Road Noise

Ideal Sound for
AVAS

Comfortable
need to be immune
not strong pitch
non-melodic

Perception

Acceptance

Fluctuation
amplitude and/or frequency

Concept of Sound

Nissan's Sounds Strategy

A

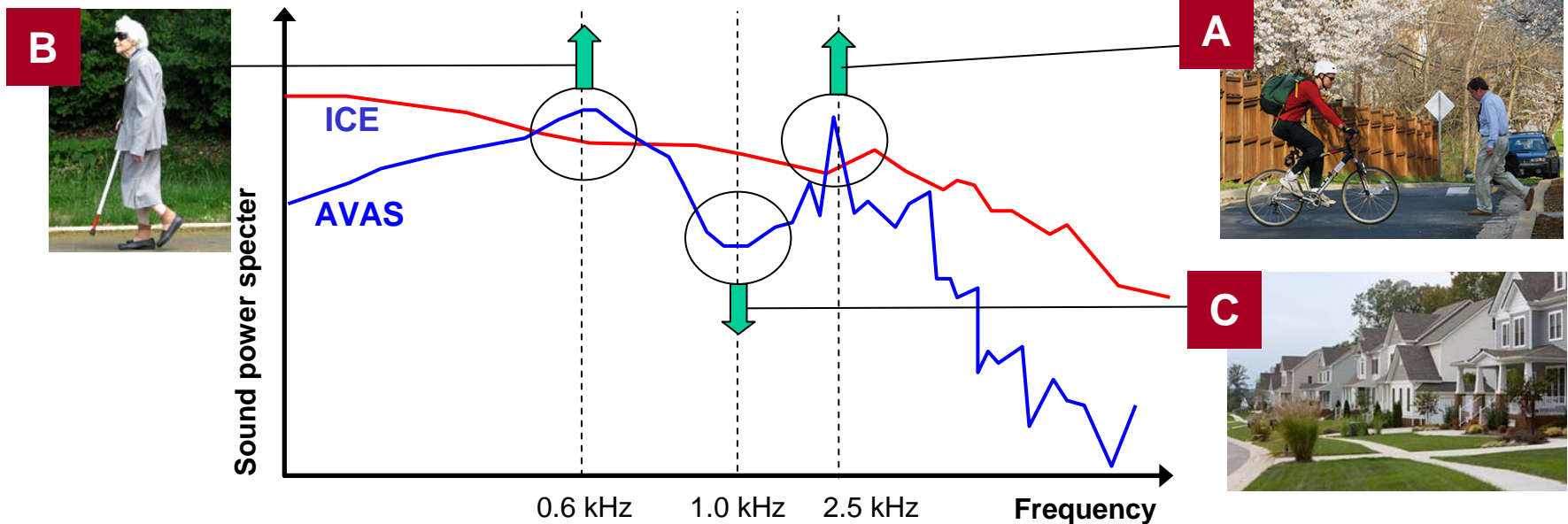
Outstanding peak frequency *between 1kHz and 5kHz* is effective for providing good detectability for *all pedestrians but B*.

B

AVAS needs an outstanding peak *under 1kHz* frequency to ensure good detectability for elderly (*suffering from high-frequency hearing loss by aging*).

C

AVAS frequency peaks at the '*shoulders of the 1 kHz peak*' will allow the lowest sound level possible while maintaining its effectiveness and a quiet environment for *neighborhoods*



NISSAN

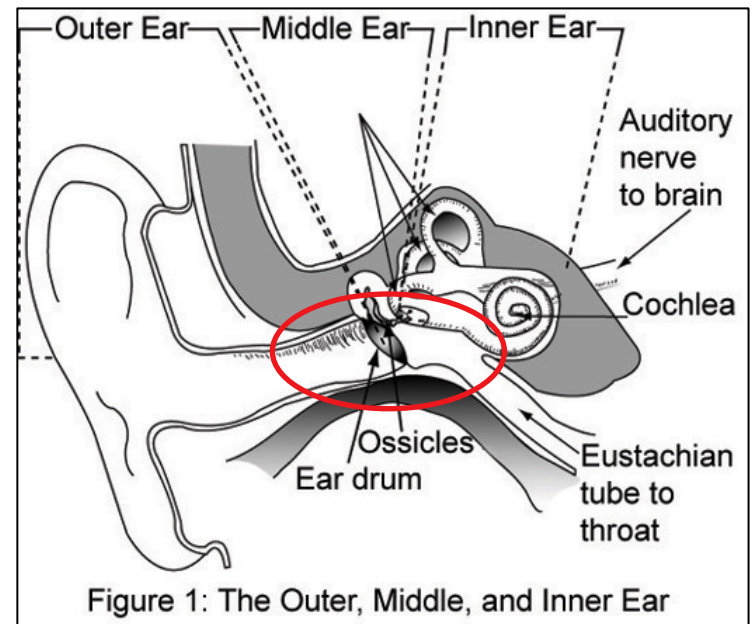
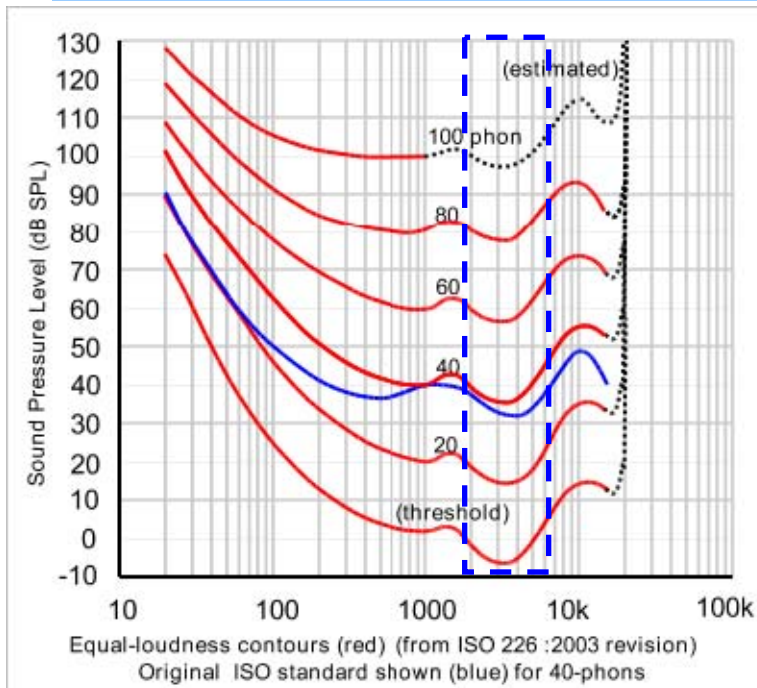
Sound for all Pedestrian



- For persons with normal hearing, the ear is most sensitive to frequencies between 1 and 5 kHz due to the resonance of the ear canal and the transfer function of the ossicles of the middle ear.

A

Outstanding peak frequency *between 1kHz and 5kHz* is effective for providing good detectability for *pedestrians*.





Sound for elderly suffering from hearing loss by aging (most of visually impaired)



- More than 70% of visually impaired are over 60 years old.
- Elderly persons more than 60 years old have difficulty detecting sounds higher than 2kHz due to age related hearing loss.

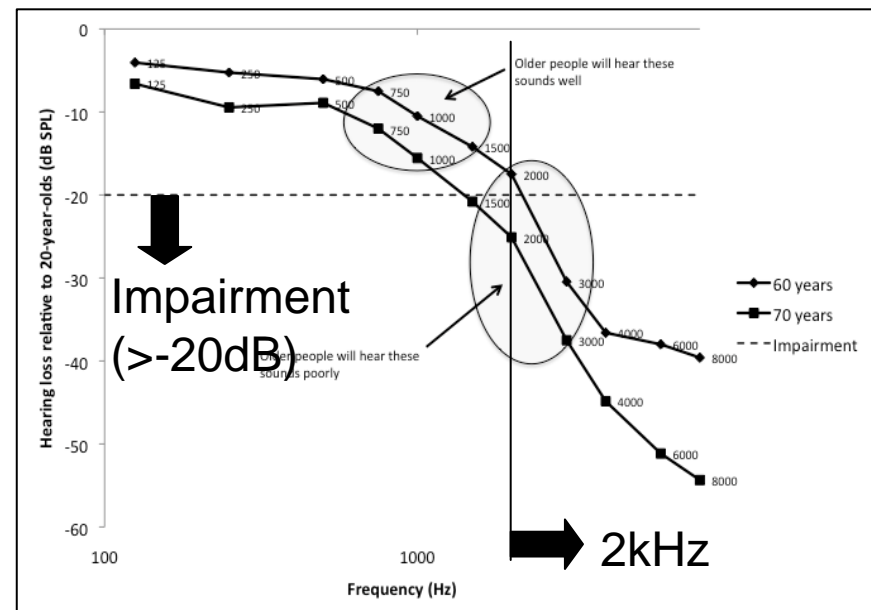
B AVAS needs outstanding peak *under 1kHz frequency* to ensure good detectability for the majority of *blind people*.

	Population of Visually Impaired	impaired over 60 years old
	1.64 million	72%
	4.15 million*	73%

“Visually Impaired” includes people with “Legal Blindness” and “Low Vision”

Japan Data: Brant, M. Yamada et al (2010) Ophthalmic Epidemiology, 17(1), 50-57

US Data : National Eye Institute (NEI) “Prevalence of Blindness Data, *850,000 added to NEI estimate to account for ages <40 years based on Lighthouse International data



Source: Brant, L.J. & Fozard, J.L. (1990). Journal of the Acoustical Society of America

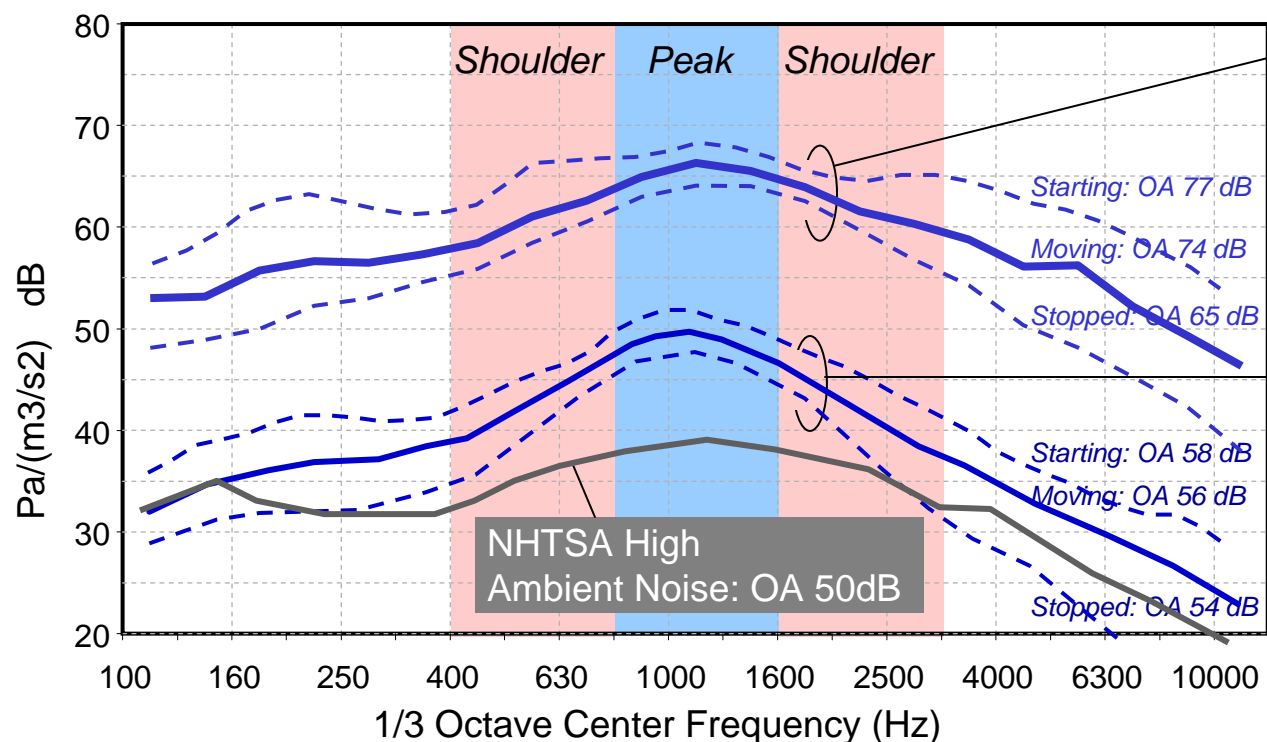
NISSAN

Sound for Neighborhood Community

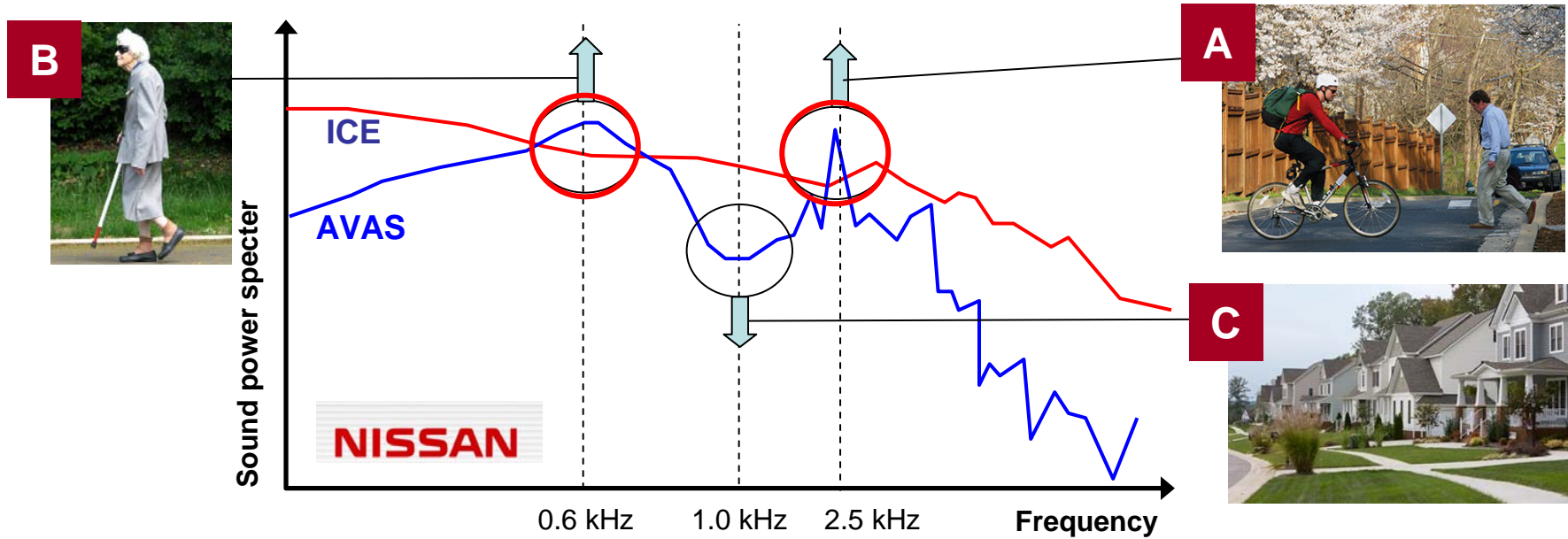


- Ambient noise measurements taken at different locations in Detroit.
 - Ambient noise peaked at approx. 1kHz for each traffic condition

C AVAS frequency peaks at the *'shoulders of the 1 kHz peak'* will allow the lowest sound level possible while maintaining its effectiveness and a quiet environment for *neighborhoods*

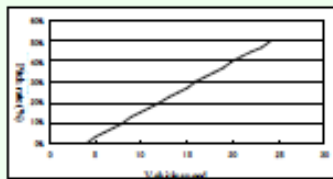


Cover wide frequency band and focus important frequencies



Continuous chord of 175 Hz and 233 Hz as its base-frequency with sound around 2kHz in addition.

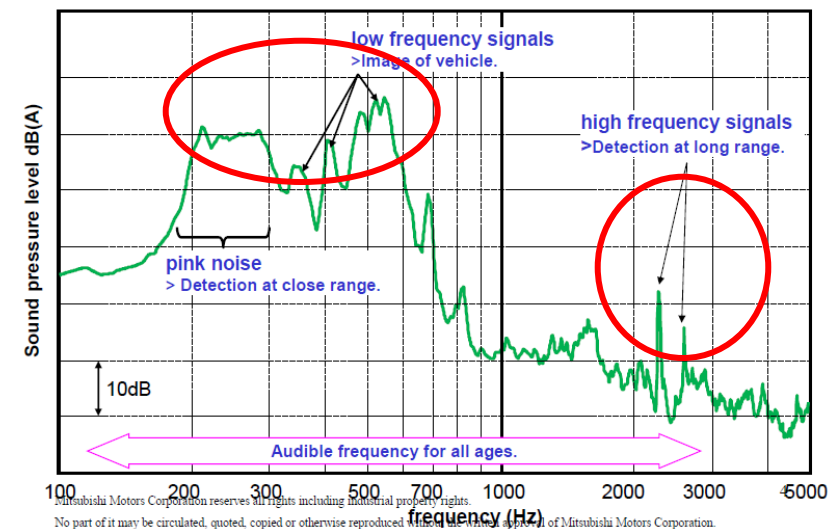
The sound pressure and scale change in response to the vehicle speed while the sound has moderate fluctuation.



TOYOTA

Sound Type

Frequency characteristic of AVAS proto



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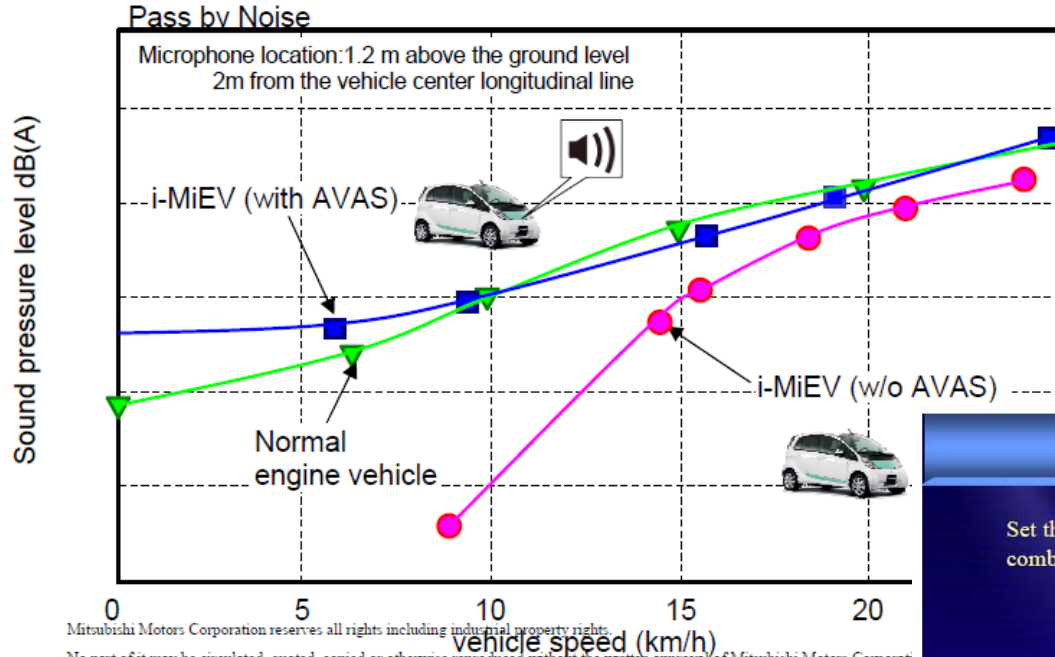
Sound level of AVAS is same as that of ICE



Sound pressure level

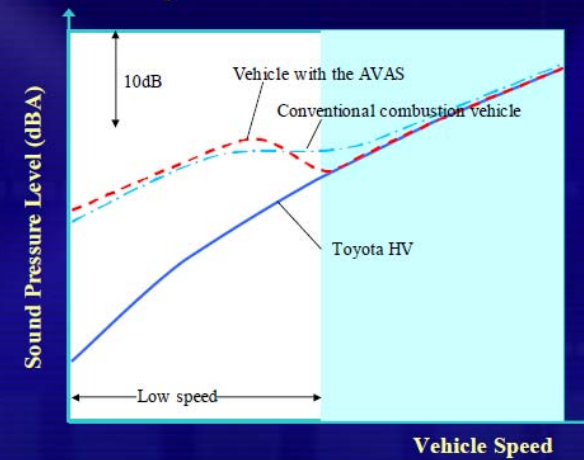


AVAS proto sound pressure level is almost same level as normal engine vehicle.



Sound Pressure Level in Operating Condition

Set the sound pressure level to have the equivalent detectability as conventional combustion vehicles at low speed



Summary

- Three manufactures in Japan have developed AVAS for EV and Hybrid Vehicle.

AVAS strategy addresses concerns of three key Stakeholders

- ✓ Pedestrian (especially visually Impaired persons)
providing good detectability and giving an image of a car behavior(recognizablily)
 - ✓ Environment for neighborhoods
maintain a quiet environment
 - ✓ Driver
acceptance of sound so he/she does not turn the sound off
- Detactability and reconizability studies in cooperation with visually impaired persons and elderly persons have been conducted by each manufacturer and the Study committee organized by MLIT.
 - It is important to be widely spread and known of the sound.
New Electrical Vehicle sound!

Demonstration today

Please have an experience of AVAS.

To help understanding AVAS for those who could not attend #3 QRTV meeting in Tokyo



iMiEV (EV)

Prius (HEV)

Altima (HEV)

Thank you for your attention
