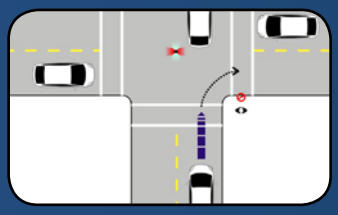
RITA Volpe National Transportation Systems Center

Quieter Cars and the Safety of Blind Pedestrians: Phase I



Purpose:

The National Highway Traffic Safety Administration (NHTSA) tasked the Volpe Center to examine the issue of quieter cars and the safety of pedestrians who are blind. The primary concern is that hybrid-electric vehicles (HEVs) can operate in electric-motor-only low speeds when other auditory cues, such as tire and wind noise, are limited. This perceived reduction in sound emitted by the HEVs creates a safety concern because these sounds are often the best; if not, the only source of information that pedestrians who are blind use to travel or navigate. This study examined the acoustic characteristics of a selection of HEVs and internal combustion engine (ICE) vehicles, assessed their auditory detectability in various operations and ambient sound conditions, and discussed potential countermeasures.

Methodology:

Sound pressure level in one-third octave bands of three HEVs and three corresponding ICE vehicles were measured for the following operating conditions: idle, backing up at 5 mph; approaching at a constant speed (6, 10, 20, 30, and 40 mph); accelerating from stop, and slowing from 20 to 10 mph.

Recordings for two ICE vehicles and their HEV twins, operating in electric mode, were combined with one of two recorded ambient sounds: a relatively quiet rural ambient sound level [31.2 dB(A)] and a moderately noisy suburban ambient sound level [49.8 dB(A)].

Human-subjects studies examined whether participants detected a target vehicle and how soon they detected it before the vehicle reached their position (time-to-vehicle-arrival is the metric for pedestrian performance). Participants were legally blind, self-reported to have normal hearing, independent travelers, and 18 or older. Participants listened to each individual recording using headphones and indicated, by pressing the space bar on a computer keyboard, the instant they detected and recognized the sound of a vehicle that would affect their decision to cross a street.

Three scenarios were used in the human-subjects study:

- Vehicle backing out at 5 mph (mimicking a vehicle backing out of a driveway);
- Vehicle approaching at a constant low speed of 6 mph; and
- Vehicle slowing from 20 to 10 mph (mimicking a vehicle preparing to turn right from the parallel street).

All images: Volpe Center

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U.S. Department of Transportation
Research and Innovative Technology Administration

Results:

In general, HEVs tested have lower sound levels than ICE vehicles for operating conditions below 20 mph, but above 20 mph, the sound from road-tire interactions dominates, and the sound levels of the two vehicle types converge.

Overall, participants were generally able to detect a target vehicle present in a given scenario:

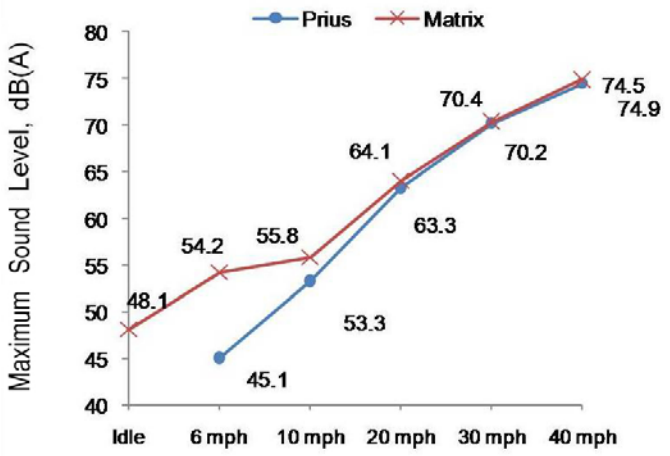
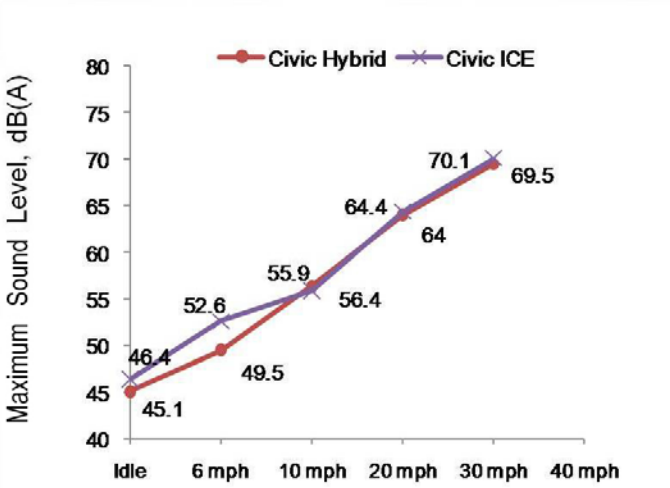
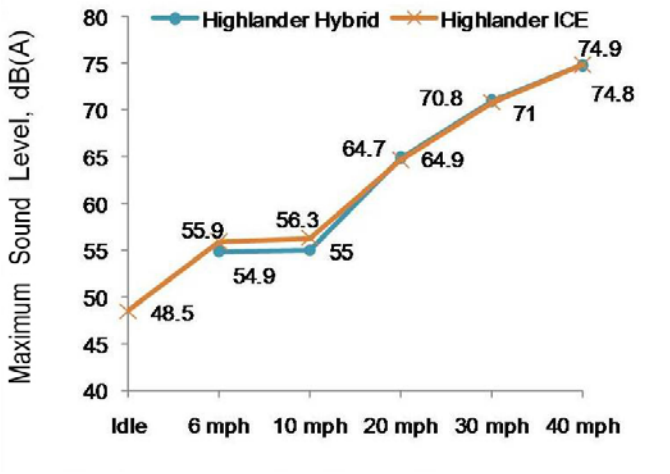
- 89.6% of the participants detected a vehicle backing out at 5 mph,
- 95.8% detected a vehicle approaching at 6 mph, and
- 83.3% detected a vehicle slowing from 20 to 10 mph.

Average Time-to-Vehicle Arrival by Scenario, Vehicle Type and Ambient Sound in Seconds

	Low Ambient		High Ambient	
Scenario	HEVs	ICEs	HEVs	ICEs
Backing out (5mph)	3.7	5.2	2.0	3.5
Approaching at 6mph	4.8	6.2	3.3	5.5
Slowing from 10 to 20 mph	2.5	1.3	2.3	1.1

- The differences in time-to-vehicle-arrival between HEVs tested and their ICE twins were statistically significant within a vehicle maneuver and ambient sound level condition.
- Time-to-vehicle-arrival were shorter in the high ambient sound condition than in the low ambient sound condition.
- Time-to-vehicle arrival for ICE vehicles tested were longer than for HEVs except in the slowing maneuver.

The results of this study provided data on the acoustic characteristics and auditory detectability of HEVs and ICE vehicles. Potential countermeasures and comments on additional research needs are discussed.

For more information: **Quieter Cars and the Safety of Bind Pedestrians: Phase 1 (2010).** DOT HS 811 304 National Highway Traffic Safety Administration. Available at: http://www.nhtsa.gov

Sound Pressure Levels as a Function of Vehicle Speed