

Seat Belt Reminder System Test and Rating Protocol Version III

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DOCUMENT REVISION HISTORY

Revision to Version III

Added details about the sound pressure level evaluation for signals separated by more than 3 seconds.

Revision to Version II

When evaluating the audible reminder of a seat belt reminder system, the system's volume is set to the lowest setting (if applicable).

OVERVIEW

This document describes the Insurance Institute for Highway Safety (IIHS) protocol for testing and rating seat belt reminder systems on motor vehicles. It is available from the technical protocols section of the IIHS website.

Seat belts reduce the fatality risk of front-row passenger vehicle occupants involved in a crash by 45% (Kahane, 2000). While seat belts saved an estimated 14,955 lives of occupants ages 5 and older in 2017, nearly half of fatally injured front passenger vehicle occupants in 2017 were unbelted (National Center for Statistics and Analysis, 2019).

“Enhanced” seat belt reminder systems with audible signals lasting more than the required 8 seconds after ignition per Federal Motor Vehicle Safety Standard (FMVSS) 208 are effective for increasing driver seat belt use (Ferguson, Wells, & Kirley, 2007; Freedman, Levi, Zador, Lopdell, & Bergeron, 2007; Williams, Wells, & Farmer, 2002). Research studies suggest that enhanced seat belt reminders with a persistent audible signal lasting at least 90 seconds are the most effective (Kidd & Singer, 2019; Krafft, Kullgren, Lie, & Tingvall, 2006).

Most seat belt reminder systems target front-row occupant seat belt use, but seat belt use in rear seating positions is consistently lower than belt use in front seating positions, and more than half of fatally injured second-row occupants in 2017 were unrestrained (National Center for Statistics and Analysis, 2019). Seat belt reminder systems that provide notifications when rear passengers are unrestrained can help encourage seat belt use by rear occupants.

SEAT BELT REMINDER SYSTEM REQUIREMENTS

Definitions

The following terms are used in this protocol.

Vehicle in motion

The vehicle is in motion when its forward motion exceeds 10 km/h.

Primary audible signal

In a seat belt reminder system, the primary audible signal has the longest duration of all audible reminder signals for a specific seating position. A primary audible signal is either

- a single audible signal, or
- a group of consecutive audible signals separated by no more than 3 seconds.

Primary audible signal duration

The elapsed time between the beginning and end of a primary audible signal.

Audible signals separated by more than 3 seconds are not combined when determining the primary audible signal duration.

General requirements

Prior to the evaluation, the vehicle's owner manual is reviewed to determine where the visual indicators are located and to verify how the system behaves during unbelted conditions for each seating position.

The audible reminder of a seat belt reminder system must exceed the background sound pressure level in the vehicle cabin by at least 6 dB(A) when the

- vehicle's forward speed is at 24 km/h $-0/+8$ km/h and at 40 km/h $-0/+8$ km/h;
- windows are closed;
- ventilation system is set to the lowest fan speed (not off);
- entertainment system is muted; and
- seat belt reminder system's volume is set to the lowest setting (if applicable).

The sound pressure level of the audible reminder is measured during a 2-minute period or until all audible reminder signals cease, whichever is shorter.

The audible reminder of the seat belt reminder system must include a primary audible signal with

- a sound pressure level in the audible frequency range (20 Hz – 20,000 Hz); and
- at least one dominant frequency between 500 and 2,250 Hz.

A concurrent steady or flashing visual seat belt reminder signal indicating an outboard front-row or rear seating position with an unfastened seat belt must be displayed in the instrument panel, overhead panel, or center console.

Outboard front-row seating positions

When the primary audible signal must begin

If a seat belt at an occupied outboard front-row seating position is unfastened at ignition and the vehicle achieves continuous forward motion (at least 10 km/h), then the primary audible signal must begin

- within 30 seconds when the vehicle speed remains between 10 and 40 km/h; and
- within 2 seconds once the vehicle speed exceeds 40 km/h, if not already active.

If a fastened seat belt at an occupied outboard front-row seating position is unfastened when the vehicle's forward motion is between 10 and 40 km/h, then the primary audible signal must begin within 30 seconds of continuous forward motion.

If a seat belt at an occupied outboard front-row seating position is unfastened when the vehicle's forward motion exceeds 40 km/h, then the primary audible signal must begin within 2 seconds if it has not already begun.

When the primary audible signal and visual signal can cease

The primary audible signal and the visual signal can cease when the

- seat belts at the occupied outboard front-row seating positions are fastened;
- vehicle is no longer in forward motion (0–10 km/h); or
- outboard front passenger seat that triggered the warning is no longer occupied.

The thresholds to trigger the primary audible signal may be reset if any doors have been opened when the vehicle is not in motion.

Rear seating positions

Visual signal

No more than 10 seconds after the vehicle engine/motor is turned on (i.e., powered and capable of propulsion), a visual signal must indicate to the driver whether the seat belt at each rear seating position is fastened or unfastened. This visual signal must last at least 60 seconds.

No visual signal is required if the seat belt at each occupied rear seating position is in use or if the system determines that no rear occupants are present. The visual signal may be cancelled by the driver.

If a fastened seat belt is unfastened while the vehicle is in motion

If a fastened seat belt at a rear seating position is unfastened while the vehicle is in motion, then the rear seating position with a change in seat belt use status must be indicated using both a primary audible signal and a companion visual signal at least 30 seconds in duration. Also:

- When the vehicle's speed is between 10 and 40 km/h, then the primary audible signal and companion visual signal must start within 30 seconds of continuous forward motion.
- When the vehicle's speed exceeds 40 km/h, then the primary audible signal and companion visual signal must begin within 2 seconds if the signals have not already begun.

When the primary audible signal and visual signal can cease

The primary audible signal and visual signal can cease when seat belts at the occupied rear seating positions are fastened, the vehicle is no longer in forward motion (0–10 km/h), or the seat or seats that triggered the warning are no longer occupied. The thresholds to trigger the primary audible signal and visual signal may be reset if any doors have been opened when the vehicle is not in motion.

SEAT BELT REMINDER SYSTEM ASSESSMENT

The outboard front-row seating positions and one randomly selected second-row seating position (if available) are assessed.

Vehicle manufacturers will attest that the audio and visual signal properties of all second-row seating positions behave in the same way.

Third row seating positions may be assessed but will not contribute to the overall rating at this time. The driver's seat belt is fastened when evaluating other seating positions.

Occupancy is assumed in the driver's seating position. A human assistant or ballast dummy will occupy the front passenger seating position, and a human assistant will occupy the rear seating position being evaluated. Detection of occupancy in the outboard front-row seating positions is required.

Each seating position is evaluated by initiating the test with an unbelted occupant and initiating the test with a belted occupant that unbuckles after the test begins. Each test begins with the engine turned off and the vehicle parked. Per vehicle manufacturer recommendations, the vehicle may be shut off, with the driver exiting, between test runs.

The acoustic properties of the background noise in the vehicle cabin and the audible reminder signal is measured using a data recorder (Bruel & Kjaer Type 2270) with a microphone (B&K Type 4101-B) placed at the driver's right ear (Figure 1).

Figure 1. Data recorder and microphone location



The driver seat is positioned mid-track of its fore/aft range, and in the lowest position vertically, if adjustable. The seat back is set to a 19–21° recline, measured on the back of the seat.

The calibration of the measurement equipment is checked prior to evaluation. The data are recorded in LAeq format, 1/3 octave bandwidth.

The driver will steer primarily with their left arm as to not block the audible reminder signal while turning.

The tests are conducted on a large, flat, asphalt track, with enough room to maintain 40 km/h indefinitely without hard turning or braking.

Test runs

The following assessments of the seat belt reminder system are completed.

Outboard front row

Seat belt unfastened at ignition, 24 km/h –0/+8 km/h

1. The seat belt is unfastened at ignition (On).
2. Approximately 60 seconds after ignition, the vehicle is placed in forward gear and driven at 24 km/h –0/+8 km/h for at least 2 minutes, or until the primary audible signal ceases.
3. The test begins either
 - when the vehicle reaches speed, or
 - when the primary audible signal begins, if it begins after the vehicle is in forward motion and the speed is less than 24 km/h.
4. Audible signal duration, and the duration of the visual signal, are documented.

Seat belt unfastened at ignition, 40 km/h –0/+8 km/h

1. The seat belt is unfastened at ignition (On).
2. Approximately 60 seconds after ignition, the vehicle is placed in forward gear and driven at 40 km/h –0/+8 km/h or faster for at least 2 minutes, or until the primary audible signal ceases.
3. The test begins either when the
 - vehicle reaches speed, or
 - primary audible signal begins, if it begins after the vehicle is in forward motion and the speed is less than 40 km/h.
4. Audible signal duration, and the duration of the visual signal, are documented.

Second row only

Seat belt unfastened at ignition, 0 km/h

For the second-row seating position chosen to be evaluated:

1. The seat belt is unfastened at ignition (On).
2. Duration of visual signal is documented.

Front and second row

Seat belt fastened at ignition, 24 km/h –0/+8 km/h

1. The seat belt is fastened at ignition (On).
2. Approximately 60 seconds after ignition, the vehicle is placed in forward gear, and driven at 24 km/h –0/+8 km/h for at least 60 seconds.
3. The seat belt is unfastened and the vehicle continues to be driven at 24 km/h –0/+8 km/h for at least 2 minutes, or until the primary audible signal ceases.
4. The test begins when the seat belt is unfastened.
5. Audible signal duration, and the duration of the visual signal, are documented.

Seat belt fastened at ignition, 40 km/h –0/+8 km/h

1. The seat belt is fastened at ignition (On).
2. Approximately 60 seconds after ignition, the vehicle is placed in forward gear, and driven at 40 km/h –0/+8 km/h for at least 60 seconds.
3. The seat belt is unfastened and the vehicle continues to be driven at 40 km/h –0/+8 km/h for at least 2 minutes, or until the primary audible signal ceases.
4. The test begins when the seat belt is unfastened.
5. Audible signal duration, and the duration of the visual signal, are documented.

Vehicle cabin sound level measurements

Before the assessments are completed, two test runs are conducted to record background cabin sound levels in the audible frequency range (20 Hz – 20,000 Hz) for 30 seconds; one at 24 km/h –0/+8 km/h, and another at 40 km/h –0/+8 km/h. The recordings are made with the vehicle at speed.

Two test runs are then conducted to record the acoustic properties of the audible signal; one at 24 km/h –0/+8 km/h, and another at 40 km/h –0/+8 km/h. The test begins when the vehicle reaches speed and the seat belt is unbuckled. The recording continues for 2 minutes, or until the primary audible signal ceases.

The Appendix includes a checklist that may be used for documenting the results of each assessment.

AUDIBLE SIGNAL ANALYSIS

All primary audible signals are analyzed using Bruel & Kjaer Connect software.

The background sound pressure level is determined by averaging the A-weighted sound pressure level of the vehicle cabin noise in the audible frequency range (20 Hz–20,000 Hz) during the 30-second test runs.

The sound pressure level of the audible reminder signal is determined by averaging the A-weighted sound pressure level in the audible frequency range (20 Hz – 20,000 Hz) during the vehicle cabin sound level measurement. If the sound pressure level falls between 5.6 and 5.9 dB over the background cabin results, a second measurement is recorded on the same vehicle. The greater measurement is used in the final assessment.

For audible signals separated by more than 3 seconds, we evaluate only one primary signal that is chosen at random.

Example of determining differential audible signal to background sound pressure

Signal pressure level: $SPL_S = 20 \log_{10}(P^{\text{signal}}/P^{\text{reference}})$, $P^{\text{reference}}$ is $20 \mu\text{Pa}$

$SPL_B = 20 \log_{10}(P^{\text{background}}/P^{\text{reference}})$

Differential sound pressure level (dB_A) = $SPL_S - SPL_B$

One-third octave band filters are applied to the primary audible signal recorded in each test run to identify the dominant frequency or frequencies of the primary audible signal.

RATING PROCEDURE

The possible overall ratings for seat belt reminder systems are poor, marginal, acceptable, and good.

The overall ratings of poor, marginal, and acceptable are based on the lowest rating from the assessment of each outboard front-row seating position.

Table 1. Seat belt reminder system ratings and requirements

Rating	Requirements
 Poor	At least one outboard front-row seating position has a primary audible reminder signal less than 8 seconds in total duration.
 Marginal	Front-row seating positions have a primary audible reminder signal of at least 8 but less than 90 seconds in total duration, or the system does not meet the seat belt reminder system requirements for outboard front-row seating positions.
 Acceptable	Front-row seating positions have a primary audible reminder signal 90 seconds or more in total duration and meet the seat belt reminder system requirements for outboard front-row seating positions.
 Good	In addition to meeting the requirements of the acceptable rating, the seat belt reminder system meets the requirements for rear seating positions. Vehicles without a second row that meet the requirements of the acceptable rating will receive a good rating.

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APPENDIX: EXAMPLE CHECKLIST

Seat belt reminder system requirement	✓	Comments
SPL \geq 6 dB at 24 km/h		
SPL \geq 6 dB at 40 km/h		
Front row, 24 km/h, unfastened at ignition (signals begin within 30 seconds when speed is between 10 and 40 km/h)		
Front row, 40 km/h, unfastened at ignition (signals begin within 2 seconds once speed exceeds 40 km/h, if not already active)		
Front row, 24 km/h, fastened at ignition / unfastened during drive (signals begin within 30 seconds of unbuckle)		
Front row, 40 km/h, fastened at ignition / unfastened during drive (signals begin within 2 seconds of unbuckle, if not already active)		
Second row, unfastened at ignition (rear occupant detected, visual signal > 60 seconds)		
Second row, 24 km/h, fastened at ignition / unfastened during drive (signals begin within 30 seconds of unbuckle)		
Second row, 40 km/h, fastened at ignition / unfastened during drive (signals begin within 2 seconds of unbuckle, if not already active)		

Note: dB = decibels. SPL= sound pressure level.