

# Commercial Vehicle Seat Belt Reminder Evaluation Protocol

## Version I

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## Contents

<b>OVERVIEW .....</b>	<b>3</b>
<b>SEAT BELT REMINDER SYSTEM REQUIREMENTS.....</b>	<b>3</b>
Definitions .....	3
<i>Vehicle in motion</i> .....	3
<i>Primary audible signal</i> .....	3
<i>Primary audible signal duration</i> .....	3
Sound requirements .....	4
Visual signal location.....	4
When the primary audible signal must begin.....	5
When the primary audible signal and visual signal can cease .....	5
<b>SEAT BELT REMINDER SYSTEM ASSESSMENT .....</b>	<b>6</b>
Test runs.....	7
<i>Vehicle cabin sound level measurements</i> .....	8
<b>AUDIBLE SIGNAL ANALYSIS.....</b>	<b>9</b>
Example of determining differential audible signal to background sound pressure .....	9
<b>PASS/FAIL DETERMINATION.....</b>	<b>10</b>
<b>REFERENCES .....</b>	<b>11</b>
<b>APPENDIX: EXAMPLE CHECKLIST.....</b>	<b>12</b>

## OVERVIEW

This document describes the Insurance Institute for Highway Safety (IIHS) protocol for testing and evaluating seat belt reminder systems on motor vehicles with a gross vehicle weight rating of 10,001 lb or more.

Seat belts reduce the fatality risk of front-row passenger vehicle occupants involved in a crash (Kahane, 2000). Seat belt reminder systems with audible signals lasting more than 8 seconds after ignition are effective for increasing driver seat belt use (Ferguson et al., 2007; Freedman et al., 2007; Williams et al., 2002). Reminders with a persistent audible signal lasting at least 90 seconds are the most effective (Kidd & Singer, 2019; Krafft et al., 2006).

## 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.

## Sound requirements

Prior to the evaluation, the owner's manual of the vehicle is reviewed to determine where the visual indicators are located and to verify how the system behaves when the driver is unbelted.

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;
- the windows are closed;
- the ventilation system is set to the lowest fan speed (not off);
- the entertainment system is muted; and
- the 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.

## Visual signal location

A concurrent steady or flashing visual seat belt reminder signal for an unfastened driver seat belt must be displayed in the instrument panel, overhead panel, or center console.

### **When the primary audible signal must begin**

If the driver seat belt 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 as long as the vehicle speed remains between 10 and 40 km/h; or
- within 2 seconds once the vehicle speed exceeds 40 km/h, if not already active.

If a fastened driver seat belt is unfastened while 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 driver seat belt is unfastened while 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 driver seat belt is fastened;
- the vehicle is no longer in forward motion (0–10 km/h); or
- the driver seat is no longer occupied.

Absent any of those conditions, the primary audible signal must continue for 90 seconds or more. The thresholds to trigger the primary audible signal may be reset if the driver door has been opened when the vehicle is not in motion.

## SEAT BELT REMINDER SYSTEM ASSESSMENT

The driver seating position is assessed by initiating the test with an unbelted driver and a belted driver 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, if adjustable, 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 so 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 for the driver seating position.

### Driver 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.

### Driver 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
  - the 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 visual signal duration are documented.

### Driver 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 visual signal duration are documented.

### **Driver 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 visual signal duration 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 at the driver seating position 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 driver 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.

### 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.

## **PASS/FAIL DETERMINATION**

A seat belt reminder system that meets the system requirements outlined above as determined by the assessment will be designated as passing the IIHS seat belt reminder system evaluation for commercial vehicles.

## REFERENCES

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## APPENDIX: EXAMPLE CHECKLIST

Driver seat belt reminder system requirement	✓	Comments
SPL ≥ 6 dB at 24 km/h		
SPL ≥ 6 dB at 40 km/h		
Driver seat, 24 km/h, unfastened at ignition (signals begin within 30 seconds when speed is between 10 and 40 km/h)		
Driver seat, 40 km/h, unfastened at ignition (signals begin within 2 seconds once speed exceeds 40 km/h, if not already active)		
Driver seat, 24 km/h, fastened at ignition / unfastened during drive (signals begin within 30 seconds of unbuckle)		
Driver seat, 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.