

# Semitrailer Underride Evaluation Crash Test Protocol

## Version II

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## DOCUMENT REVISION HISTORY

Revisions to Version II of the protocol compared with Version I:

- The Overview section was updated (added text about our quasi-static test and protocol).
- In the Test Vehicle Preparation section, the optional steps were removed.
- The Test Results section was updated to clarify the requirements for a successful test.

## OVERVIEW

This document describes the Insurance Institute for Highway Safety's (IIHS's) crash test protocol for evaluating rear underride guards on semitrailers.

As an alternative to the crash test, trailer manufacturers can evaluate their rear underride guards using our quasi-static test. For more information, see our *Semitrailer Rear Impact Guard Quasi-Static Test Protocol (Version I)*.

Supporting documents for the IIHS's crash test programs are available from the Technical Protocols section of the IIHS website.

## TEST CONDITIONS

Much of the pretest setup follows the *Moderate Overlap Frontal Crashworthiness Evaluation Crash Test Protocol (Version XIX)* (IIHS, 2021) with several deviations to account for the different test configuration. Most notably, in place of a deformable barrier face with a slotted bumper, the test vehicle strikes the rear of a semitrailer to test the ability of the trailer to prevent underride.

The IIHS underride test program has used a 2010 Chevrolet Malibu as the striking vehicle in each test. Each Malibu has been equipped with a four-cylinder engine, typically the 1LS or 1LT trim level. If desired, a different midsize sedan of comparable size and weight could be used as the striking vehicle. Each vehicle is inspected for prior damage before being prepared for the test. A vehicle history report also is obtained (e.g., from CARFAX).

The semitrailer is connected to a three-axle tractor and is loaded with ballast totaling approximately 18,700 kg. The sliding rear axles of the trailer are placed in their middle positions, with a target of 185- to 195-cm clearance between the rear of the trailer and the rearmost surface of the rear tires. Prior to the test, the trailer's brakes are pressurized to 40 psi to simulate being stopped in traffic.

Pre-crash static measurements of the underride guard are recorded using a coordinate measurement machine (CMM). These same areas are measured again after the crash to determine deformation.

## Impact Speed and Overlaps

Semitrailer underride crash tests are conducted at  $56.3 \pm 1$  km/h ( $35 \pm 0.6$  mi/h) and at three different vehicle-to-trailer overlaps: full-width,  $50 \pm 1\%$  overlap, and  $30 \pm 1\%$  overlap.

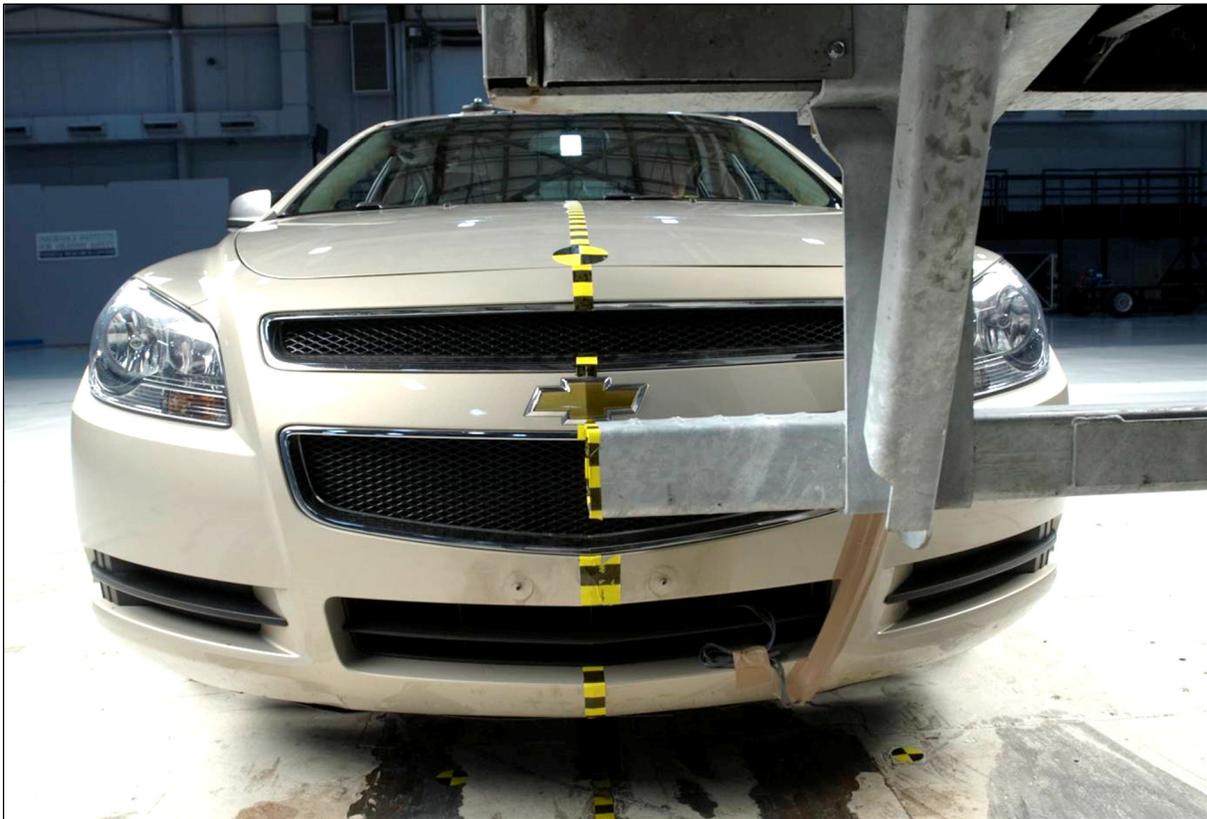
- **Full-width:** The midsize car is aligned with the rear of the semitrailer such that its lateral centerline is aligned with the centerline of the trailer's rear underride guard (Figure 1).
- **50% overlap:** The midsize car is aligned with the rear of the semitrailer such that its lateral centerline is aligned with the right edge of the trailer underride guard's horizontal member (Figure 2).
- **30% overlap:** The midsize car is aligned with the rear of the semitrailer such that the right edge of the trailer underride guard's horizontal member is offset to the left of the midsize car's centerline by 20% of the vehicle's overall width, resulting in a 30% vehicle overlap (Figure 3).

The striking vehicle width is defined and measured as indicated in the Society of Automotive Engineers (SAE, 2009) *Surface Vehicle Recommended Practice J1100*, which states, "The maximum dimension measured between the widest part on the vehicle, excluding exterior mirrors, flexible mud flaps, and marker lamps, but including bumpers, moldings, sheet metal protrusions, or dual wheels, if standard equipment."

**Figure 1**  
**Full-Width Vehicle Overlap with Semitrailer**



**Figure 2**  
**50% Vehicle Overlap with Semitrailer**



**Figure 3**  
**30% Vehicle Overlap with Semitrailer**



The striking vehicle is accelerated by the propulsion system until it reaches the test speed and then is released from the propulsion system approximately 25 cm before impact with the semitrailer. The onboard braking system, which applies the vehicle's service brakes on all four wheels, is activated 1.0 second after the vehicle is released from the propulsion system.

To verify test impact position, segmented tape is applied to both the semitrailer underride guard's horizontal member and the striking vehicle's front bumper to highlight them for the overhead and under-trailer camera views.

## Test Vehicle Preparation

Preparation of the striking vehicle follows the Test Vehicle Preparation section of the *Moderate Overlap Frontal Crashworthiness Evaluation Crash Test Protocol (Version XIX)* (IIHS, 2021) with the following deviation.

The weight of the striking vehicle is adjusted to a target mass, instead of 100–175 kg greater than the measured curb weight specified in the *Moderate Overlap Frontal Crashworthiness Evaluation Crash Test Protocol (Version XIX)* (IIHS, 2021). The target mass is  $1,811 \pm 20$  kg for the full-width test and  $1,709 \pm 16$  kg for the 50 and 30% overlap tests.

A pressure-sensitive tape switch is applied to the vehicle such that it makes first contact with the semitrailer's underride guard during the crash. Pressure applied to this tape completes an electrical circuit that signals the start of the crash (time-zero) for the data acquisition system.

## Crash Dummy Preparation and Setup

For the evaluation tests conducted at IIHS, test dummies are installed in the striking vehicle. However, because the dummy response is not used for evaluating the prevention of underride, 77 kg of ballast weight can be used in lieu of each dummy. The dummy/ballast weights are included in the target test mass of the vehicle given above.

For the full-width crash tests, 50th percentile male Hybrid III dummies are installed in the driver and right front passenger seats. For the 50 and 30% overlap tests, one dummy is installed in the driver seat. The driver dummies are positioned in the seat according to the *Guidelines for Using the UMTRI ATD Positioning Procedure for ATD and Seat Positioning (Version V)* (IIHS, 2004). The right front passenger seat is positioned to match the driver seat, and the passenger dummy's H-point is set to mirror that of the driver dummy.

## TEST RESULTS

To be considered a successful test (i.e., no underride):

- The semitrailer's underride guard will prevent the trailer from contacting the windshield, A-pillars, and roof of the striking vehicle.
- The rear guard may deform, break, or collapse but must not allow any portion of the trailer to contact the striking vehicle above the base of the A-pillar.

## REFERENCES

Insurance Institute for Highway Safety. (2004). *Guidelines for using the UMTRI ATD positioning procedure for ATD and seat positioning (Version V)*. Ruckersville, VA.

Insurance Institute for Highway Safety. (2021). *Moderate overlap frontal crashworthiness evaluation crash test protocol (Version XIX)*. Ruckersville, VA.

Society of Automotive Engineers. (2009). *Surface vehicle recommended practice J1100; Motor vehicle dimensions*. Warrendale, PA.