[NHTSA notes: The NHTSA Associate Administrator for Rulemaking has signed the following document and we are submitting it for publication in the Federal Register. While we have taken steps to ensure the accuracy of this Internet version of the document, it is not the official version. Please refer to the official version in a forthcoming Federal Register publication or on GPO's Web Site. You can access the Federal Register at http://www.archives.gov/federal-register/index.html]

DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

49 CFR Part 571

Docket No. NHTSA-2015-0118

RIN 2127-AL58

Rear Impact Guards, Rear Impact Protection

AGENCY: National Highway Traffic Safety Administration (NHTSA), Department of Transportation.

ACTION: Notice of proposed rulemaking (NPRM).

SUMMARY: This NPRM proposes to upgrade the Federal motor vehicle safety standards that address rear underride protection in crashes into trailers and semitrailers. NHTSA is proposing to adopt requirements of Transport Canada's standard for underride guards, which require rear impact guards to provide sufficient strength and energy absorption to protect occupants of compact and subcompact passenger cars impacting the rear of trailers at 56 kilometers per hour (km/h) (35 miles per hour (mph)). NHTSA is issuing this NPRM in response to a petition for rulemaking from the Insurance Institute for Highway Safety (IIHS), and from Ms. Marianne Karth and the Truck Safety Coalition (TSC). This is the second of two documents issued in response to the Karth/TSC petition. Earlier, NHTSA published an advanced notice of proposed

rulemaking requesting comment on strategies pertaining to underride protection afforded by single unit trucks.

DATES: You should submit your comments early enough to ensure that the docket receives them not later than [INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER].

ADDRESSES: You may submit comments to the docket number identified in the heading of this document by any of the following methods:

- Federal eRulemaking Portal: Go to http://www.regulations.gov. Follow the online instructions for submitting comments.
- Mail: Docket Management Facility, M-30, U.S. Department of Transportation, West Building, Ground Floor, Rm. W12-140, 1200 New Jersey Avenue, S.E., Washington, D.C. 20590.
- Hand Delivery or Courier: West Building Ground Floor, Room W12-140, 1200 New Jersey Avenue, S.E., between 9 am and 5 pm Eastern Time, Monday through Friday, except Federal holidays.
- Fax: (202) 493-2251.

Regardless of how you submit your comments, please mention the docket number of this document.

You may also call the Docket at 202-366-9324.

Instructions: For detailed instructions on submitting comments and additional information on the rulemaking process, see the Public Participation heading of the Supplementary Information section of this document. Note that all comments received will be

posted without change to http://www.regulations.gov, including any personal information provided.

Privacy Act: Please see the Privacy Act heading under Rulemaking Analyses and Notices.

FOR FURTHER INFORMATION CONTACT:

For technical issues, you may contact Robert Mazurowski, Office of Crashworthiness Standards (telephone: 202-366-1012) (fax: 202-493-2990). For legal issues, you may contact Deirdre Fujita, Office of Chief Counsel (telephone: 202-366-2992) (fax: 202-366-3820). The address for these officials is: National Highway Traffic Safety Administration, U.S. Department of Transportation, 1200 New Jersey Avenue, S.E., West Building, Washington, D.C. 20590.

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I. Executive Summary

Introduction

This NPRM proposes to upgrade Federal Motor Vehicle Safety Standard (FMVSS) No. 223, “Rear impact guards,” and FMVSS No. 224, “Rear impact protection,” which together address rear underride protection in crashes into trailers and semitrailers. NHTSA is proposing to adopt requirements of the Canada Motor Vehicle Safety Standard (CMVSS) for underride guards (CMVSS No. 223, “Rear impact guards,”) that became effective in 2007. The CMVSS No. 223 requirements are intended to provide rear impact guards with sufficient strength and energy absorption capability to protect occupants of compact and subcompact passenger cars impacting the rear of trailers at 56 km/h (35 mph). As the current requirements in FMVSS Nos. 223 and 224 were developed with the intent of providing underride crash protection to occupants of compact and subcompact passenger cars in impacts up to 48 km/h (30 mph) into the rear of trailers, increasing the robustness of the trailer/guard design such that it will be able to withstand crash velocities up to 56 km/h (35 mph) represents a substantial increase in the stringency of FMVSS Nos. 223 and 224.

This NPRM also proposes to adopt Transport Canada’s definition of “rear extremity” to define where on a trailer aerodynamic fairings are to be located to avoid posing a safety hazard in rear underride crashes.

Rear underride crashes are those in which the front end of a vehicle impacts the rear of a generally larger vehicle, and slides under the rear-impacted vehicle. Underride may occur to some extent in collisions in which a small passenger vehicle crashes into the rear end of a large trailer or semi-trailer because the bed and chassis of the impacted vehicle is higher than the hood of the passenger vehicle. In excessive underride crashes, there is “passenger compartment intrusion” (PCI) as the passenger vehicle underrides so far that the rear end of the struck vehicle collides with and enters the passenger compartment of the striking passenger vehicle. PCI can

result in severe injuries and fatalities to occupants contacting the rear end of the struck vehicle. An underride guard prevents PCI when it engages the striking end of the smaller vehicle and stops the vehicle from sliding too far under the struck vehicle's bed and chassis.

The occupant crash protection features built into today's passenger vehicles are able to provide high levels of occupant protection in 56 km/h (35 mph) frontal crashes.[1] If guards were made stronger to remain in place and prevent PCI in crashes of severities of up to 56 km/h (35 mph), the impacting vehicle's occupant protection technologies could absorb enough of the crash forces resulting from the impact to significantly reduce the risk of fatality and serious injury to the occupants of the colliding vehicle.

Origins of this Rulemaking

NHTSA's interest in this rulemaking originated from the findings of a 2009 NHTSA study[2] to evaluate why fatalities were still occurring in frontal crashes despite high rates of seat belt use and the presence of air bags and other advanced safety features. NHTSA reviewed cases of frontal crash fatalities to belted drivers and/or right-front passengers in model year (MY) 2000 or newer vehicles in the Crashworthiness Data System of the National Automotive Sampling System (NASS-CDS) through calendar year 2007. Among the 122 fatalities examined in this review, 49 (40 percent) were in exceedingly severe crashes that were not survivable, 29 (24 percent) were in oblique or corner impact crashes where there was low engagement of the

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[1] When FMVSS Nos. 223 and 224 were promulgated, FMVSS No. 208, "Occupant crash protection," required all passenger cars to comply to a full frontal 48 km/h (30 mph) rigid barrier crash test by ensuring that the injury measures of crash test dummies positioned in the front seating positions were within the allowable limits. In 2000, NHTSA amended FMVSS No. 208 to provide improved frontal crash protection for all occupants by means that include advanced air bag technology. The upgraded standard requires passenger cars to comply with a full frontal 56 km/h (35 mph) rigid barrier crash test by ensuring that the injury measures of crash test dummies restrained in front seating positions are within the allowable limits. In addition, passenger vehicles are tested in frontal crash tests in NHTSA's New Car Assessment Program (NCAP) at crash speeds of 56 km/h (35 mph) and perform very well providing frontal crash occupant protection.

[2] Kahane, et al. "Fatalities in Frontal Crashes Despite Seat Belts and Air Bags – Review of All CDS Cases – Model and Calendar Years 2000-2007 – 122 Fatalities," September 2009, DOT-HS-811102.

striking vehicle's structural members (a factor which would have resulted in the striking vehicle absorbing more of the crash energy), and 17 (14 percent) were underrides into single unit trucks (SUTs) [3] and trailers (14 were rear underride and 3 were side underride).[4] In survivable frontal crashes of newer vehicle models resulting in fatalities to belted vehicle occupants, rear underrides into large SUTs and trailers were the second highest cause of fatality.

In 2010, NHTSA published the results of a study, analyzing several data sources, to determine the effectiveness of trailer rear impact guards compliant with FMVSS Nos. 223 and 224 in preventing fatalities and serious injuries.[5] The agency's analysis of the Fatality Analysis Reporting System (FARS) could not establish a nationwide downward trend in fatalities to passenger vehicle occupants in impacts with the rear of trailers subsequent to the implementation of FMVSS Nos. 223 and 224. While supplemental data collected in Florida and North Carolina showed decreases in fatalities and serious injuries, the observed decrease in fatalities in these two States was not statistically significant, possibly due to small sample sizes of the data.

Following these two studies, NHTSA undertook research to examine the agency's underride protection requirements, highlighting this program as a significant one in the "NHTSA Vehicle Safety and Fuel Economy Rulemaking and Research Priority Plan 2011-2013 (March 2011)."

One of the resulting research projects began in 2010, as NHTSA initiated research with the University of Michigan Transportation Research Institute (UMTRI) to gather data on the rear geometry of SUTs and trailers, the configuration of rear impact guards on SUTs and trailers, and

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[3] SUTs are trucks with a gross vehicle weight rating (GVWR) greater than 4,536 kilograms (kg) (10,000 pounds (lb)) with no trailer. They are primarily straight trucks, in which the engine, cab, drive train, and cargo area are mounted on one chassis.

[4] In addition, 15 (12 percent) were fatalities to vulnerable occupants (occupants 75 years and older), 4 (3.3 percent) were narrow object impacts, and 8 (6.6 percent) were other types of impact conditions.

[5] Allen, Kirk, "The Effectiveness of Underride Guards for Heavy Trailers," October 2010, DOT HS 811 375. http://www-nrd.nhtsa.dot.gov/Pubs/811375.pdf. Last accessed on March 25, 2015.

the incidence and extent of underride and fatalities in rear impacts with SUTs and trailers. UMTRI collected the supplemental information as part of its Trucks Involved in Fatal Accidents (TIFA) survey for the years 2008 and 2009.[6,7] These data enabled NHTSA to obtain national estimates of rear impact crashes into heavy vehicles that resulted in PCI. We discuss details of the study in Appendix A of this preamble.

More information was obtained in 2011 from IIHS, which petitioned NHTSA to upgrade FMVSS Nos. 223 and 224 to improve the strength and energy-absorbing capabilities of rear impact guards.[8] IIHS based its petition on a detailed review of rear impacts into trucks and trailers from DOT's Large Truck Crash Causation Study (LTCCS)[9, 10] and from an initial test series IIHS conducted of 56 km/h (35 mph) passenger car-to-trailer rear impact crashes.[11] Subsequently, IIHS conducted follow on testing of 8 trailer models manufactured in 2012 and 2013 that were equipped with rear impact guards compliant with CMVSS No. 223. NHTSA obtained test data of the initial test series and the follow on testing of trailers. We summarize the IIHS petition and test data below in this preamble and in detail in Appendix B.[12] IIHS suggests that trailers with rear impact guards compliant with CMVSS No. 223 are superior to those compliant with FMVSS No. 224 in mitigating PCI of the striking passenger car. NHTSA has

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[6] Analysis of Rear Underride in Fatal Truck Crashes, 2008, DOT HS 811 652, August 2012, infra.
[7] Heavy-Vehicle Crash Data Collection and Analysis to Characterize Rear and Side Underride and Front Override in Fatal Truck Crashes, DOT HS 811 725, March 2013, infra.
[8] A copy of the petition is in the docket for this NPRM.
[9] LTCCS is based on a 3-year data collection project by NHTSA and FMCSA and is the first-ever national study to attempt to determine the critical events and associated factors that contribute to serious large truck crashes. http://ai.fmcsa.dot.gov/ltccs/default.asp, last accessed on March 10, 2015.
[10] Brumbelow, M.L. and Blanar, L., "Evaluation of US Rear Underride Guard Regulation for Large Trucks Using Real-World Crashes," Proceedings of the 54th Stapp Car Crash Conference, 119-131, 2010, Warrendale, PA, SAE International.
[11] A discussion of the tests can be found in Brumbelow, M. L., "Crash Test Performance of Large Truck Rear Impact Guards," 22nd International Conference on the Enhanced Safety of Vehicles (ESV), 2011. http://www-nrd.nhtsa.dot.gov/pdf/esv/esv22/22ESV-000074.pdf.
[12] In addition, copies of test reports from the program have been placed in NHTSA's general reference docket for rear impact protection, NHTSA-2015-0014.

evaluated the data and has agreed with IIHS on that point. Accordingly, we grant the petition and issue this NPRM in response.

In addition, this NPRM responds to a petition for rulemaking from Mrs. Marianne Karth and the Truck Safety Coalition (TSC) (Karth/TSC petition), requesting that NHTSA require underride guards on SUTs and other vehicles not currently required by the FMVSSs to have guards, and improve the standards' requirements for all guards. On July 10, 2014, NHTSA granted the Karth/TSC petition and announced[13] that NHTSA would be pursuing possible rulemaking through: (a) an ANPRM pertaining to rear impact guards for SUTs and other safety strategies not currently required for those vehicles;[14] and (b) an NPRM (which is today's NPRM) to upgrade FMVSS Nos. 223 and 224.

This NPRM also accords with an April 3, 2014, recommendation from the National Transportation Safety Board (NTSB) regarding tractor-trailer safety (H-14-004). NTSB recommends that NHTSA revise FMVSS Nos. 223 and 224 to ensure that newly manufactured trailers over 4,536 kilograms (kg) (10,000 pounds (lb)) gross vehicle weight rating (GVWR) provide adequate protection of passenger vehicle occupants from fatalities and serious injuries resulting from full-width and offset trailer rear impacts. In its recommendation, NTSB makes favorable reference to IIHS's petition for rulemaking and the testing IIHS conducted. We have carefully considered H-14-004 and have issued this NPRM in response.

Impacts of the Rulemaking

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[13] 79 FR 39362.

[14] In July 2015 (80 FR 43663) (Docket No. NHTSA-2015-0070), NHTSA published the ANPRM relating to SUTs. The ANPRM requests comment on NHTSA's estimated cost and benefits of expanding FMVSS Nos. 223 and 224, to require CMVSS No. 223 guards on SUTs, and of amending FMVSS No. 108, "Lamps, reflective devices, and associated equipment," to require the type of retroreflective material on the rear and sides of SUTs that is now required to be placed on the rear and sides of trailers to improve the conspicuity of the vehicles to other motorists. NHTSA will be following up on issues presented on SUTs in an action separate from today's NPRM.

Based on information from the Truck Trailer Manufacturers Association (TTMA),[15] NHTSA estimates that 93 percent of new trailers sold in the U.S. subject to FMVSS Nos. 223 and 224 are already designed to comply with CMVSS No. 223. The agency estimates that about one life and three serious injuries would be saved annually by requiring all applicable trailers to be equipped with CMVSS No. 223 compliant guards. The undiscounted equivalent lives saved are 1.3 per year.

The average incremental cost of equipping CMVSS No. 223 compliant rear impact guards on an applicable new trailer is about $229 and the corresponding average incremental weight increase is 49 lb. The annual average incremental material and fuel cost of requiring all applicable new trailers in the fleet with CMVSS No. 223 guards is $13 million.

Table 1 below presents the net cost and net benefits estimates for requiring CMVSS No. 223 compliant rear impact guards on all applicable new trailers in the fleet. The net cost per equivalent lives saved in 2013 dollars is $9.1 million and $9.5 million discounted at 3 percent and 7 percent, respectively. The net benefit of this proposal in 2013 dollars is $0.59 million and $0.13 million discounted at 3 percent and 7 percent, respectively.

Table 1: Benefit and Cost, Net Cost per Equivalent Lives Saved, and Net Benefit
All monetized values are in million 2013 dollars

	Undiscounted	3% Discount	7% Discount
Societal Economic Benefits (a)	$1.72	$1.52	$1.35
Total Safety Benefits (b)	$14.13	$12.37	$10.89
Total Equivalent Lives Saved (c)	1.29	1.13	0.99

[15] TTMA Joint Industry/Government Meeting on July 24, 2014, Embassy Suites Hotel, Alexandria, VA.

Total annual material + fuel Cost (d)	$12.98	$11.77	$10.76
Net Cost (e) = (d) – (a)	$11.26	$10.25	$9.40
Net Cost per Equivalent Lives Saved = (e) / (c)	$8.71	$9.07	$9.47
Net Benefit = (b) – (d)	$1.15	$0.59	$0.13

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II. Overview of Existing Standards

FMVSSs

FMVSS Nos. 223 and 224 were established in 1998 to reduce the risk of PCI by upgrading then-existing rear impact guards to make them stronger but energy-absorbing as well. FMVSS No. 223, an equipment standard, specifies strength and energy absorption requirements in quasi-static force tests of rear impact guards sold for installation on new trailers and semitrailers. FMVSS No. 224, a vehicle standard, requires new trailers and semitrailers with a GVWR of 4,536 kg (10,000 lb) or more to be equipped with a rear impact guard meeting FMVSS No. 223.[16] NHTSA established the two-standard approach to provide underride protection in a manner that imposes reasonable compliance burdens on small trailer manufacturers.[17]

[16] Excluded from FMVSS No. 224 are pole trailers, logging trailers, low chassis trailers (trailers where the ground clearance of the chassis is no more than 560 mm (22 inches)), wheels back trailers (trailers with rearmost point of rear wheels within 305 mm (12 inches) of the rear extremity of the trailer), and special purpose trailers (trailers with equipment in the rear and those intended for certain special operations). The exclusions are based on practical problems with meeting the standard or an absence of a need to meet the standard due to, e.g., vehicle configuration.

[17] There are a significant number of small trailer manufacturers. Under FMVSS No. 223, the guard may be tested for compliance while mounted to a test fixture or to a complete trailer. FMVSS No. 224 requires that the guard be mounted on the trailer or semitrailer in accordance with the instructions provided with the guard by the guard manufacturer. Under this approach, a small manufacturer that produces relatively few trailers can certify its trailers to FMVSS No. 224 without feeling compelled to undertake destructive testing of what could be a substantial portion of its production. The two-standard approach was devised to provide small manufacturers a practicable and reasonable means of meeting the safety need served by an underride guard requirement.

Briefly summarized, the requirements of FMVSS No. 223 relevant to this NPRM are as follows. FMVSS No. 223 requires the guard to meet the strength requirements of the standard at certain specified test locations, and the energy absorption requirements of the standard at location "P3." (See Figure 1 below for a depiction of P3 and the other test locations (P1 and P2) on the guard.) Test location P1 is at a distance of 3/8th of the width of the horizontal member on either side of the centerline of the horizontal member. Test location P2 is at the centerline of the horizontal member. Test location P3 is 355 millimeters (mm) (14 inches) to 635 mm (25 inches) from the horizontal member centerline. The strength tests are conducted separately from the energy absorption test.

The strength requirements (S5.2.1 of FMVSS No. 223) specify that the guard must resist the following force levels without deflecting by more than 125 mm (4.9 inches):

- 50,000 Newtons (N) (or 50 kiloNewtons (kN)) at "P1" on either the left or the right side of the guard; 50,000 N at "P2"; and,
- 100,000 N at P3 on either the left or the right side of the guard.

In the strength test, the force is applied by a force application device (rectangular rigid steel solid face of 203 mm x 203 mm and thickness of 25 mm) until the force level is exceeded or until the displacement device is displaced at least 125 mm, whichever occurs first.

The energy absorption requirements (S5.2.2) specify that the guard (other than a hydraulic guard) must absorb, by plastic deformation, within the first 125 mm of deflection at least 5,650 Joules (J) of energy at each test location P3, as illustrated in Figure 2 of the standard. In the test procedure, force is applied to the guard using the force application device until displacement of the device has reached 125 mm, recording the value of force at least 10 times per 25 mm of displacement. The force is then reduced until the guard no longer offers resistance

to the force application device. A force versus deflection diagram is plotted with deflection (measured displacement of the force application device) along the abscissa (x-axis) and the measured force along the ordinate (y-axis), as shown in Figure 2 of the standard, and the energy absorbed by the guard is determined by calculating the shaded area bounded by the curve in the diagram.

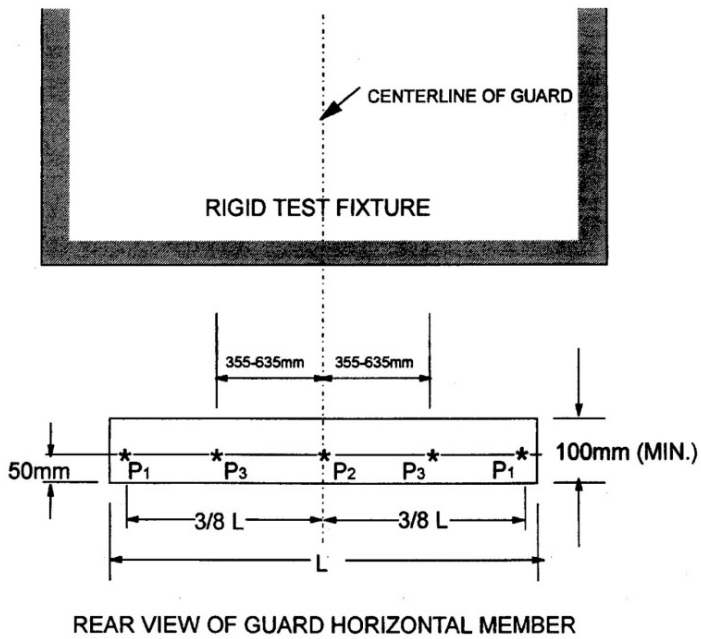

Figure 1: FMVSS No. 223 quasi-static test loading locations

FMVSS No. 224 specifies that the ground clearance (vertical distance of the bottom of the horizontal member from ground) of the rear impact guard be no more than 560 mm (22 inches) and located not more than 305 mm (12 inches) forward of the rear extremity of the trailer and extend laterally to within 100 mm (4 inches) of each side of the vehicle.

CMVSS

Transport Canada's upgraded CMVSS No. 223, "Rear impact guards," was issued in 2005 and became effective in 2007.[18] Given that passenger car models manufactured on or after 2005 in Canada are required to provide adequate occupant protection to restrained occupants in 56 km/h (35 mph) full frontal rigid barrier crashes, Transport Canada requires rear impact guards to provide sufficient strength and energy absorption to prevent PCI of compact and subcompact passenger cars impacting the rear of trailers at 56 km/h (35 mph).[19]

CMVSS No. 223 applies to trailers and semitrailers and specifies quasi-static loading tests similar to those in FMVSS No. 223. However, CMVSS No. 223 replaces the 100,000 N quasi-static point load test at the P3 location in FMVSS No. 223 with a 350,000 N uniform distributed load test on the horizontal member.[20] The guard is required to withstand this load and absorb at least 20,000 J of energy within 125 mm of deflection, and have a ground clearance before and after the test not exceeding 560 mm (22 inches). Optionally, manufacturers may choose to forgo the energy absorption requirement if the guard can resist a uniform distributed load of more than 700,000 N, but would need to ensure that the ground clearance does not exceed 560 mm (22 inches) after the uniform distributed load test. Similar to FMVSS No. 223, CMVSS No. 223 permits testing the rear impact guard when attached, per manufacturer's instructions, to a rigid test fixture or to a complete trailer. Through extensive testing,[21] Transport Canada demonstrated that these requirements would ensure that compact and subcompact

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[18] Canada Gazette Part II, Vol. 138, No. 20, 2004-10-06.

[19] Boucher, D. and Davis, D., "A Discussion on Rear Underride Protection in Canada," Informal Document, 127th WP.29, 25-28 June 2002, http://www.unece.org/fileadmin/DAM/trans/doc/2002/wp29/TRANS-WP29-127-inf05e.pdf.

[20] The load is applied uniformly across the horizontal member by a uniform load application structure with length that exceeds the distance between the outside edges of the vertical support of the horizontal member and which is centered on the horizontal member of the guard.

[21] Boucher, D., "Heavy Trailer rear underride crash tests performed with passenger vehicles," Technical Memorandum No. TMVS-0001, Transport Canada, Road Safety and Motor Vehicle Regulation Directorate, July 2000.

passenger cars would not have PCI when rear-ending a CMVSS No. 223 compliant trailer at 56 km/h (35 mph).

CMVSS No. 223 also has similar geometric specifications for rear impact guards as FMVSS No. 224.

Table 2 presents a general comparison of rear impact protection requirements in the U.S. and Canada.

Table 2: Comparison of rear impact protection requirements in the U.S. and Canada

Requirement	**U.S.**	**Canada**
Applicable standards	FMVSS No. 223/224	CMVSS No. 223
Applicable vehicles	Trailers	Trailers
Ground clearance	560 mm measured before test	560 mm measured before and after energy absorption test (or after the uniform distributed load test for guards with strength exceeding 700,000 N.)
Longitudinal distance from rear extremity	305 mm	305 mm
Lateral distance from side of vehicle	100 mm	100 mm
Point load at P1 (outer edge of guard)	50 kN	50 kN
Point load at P2 (center of guard)	50 kN	50 kN
Point load at P3 (at the guard supports)	100 kN with no more than 125 mm displacement, 5,650 J energy absorption within 125 mm displacement	----
Distributed load across width of the guard	----	350 kN with no more than 125 mm displacement and 20,000 J energy absorption within 125 mm displacement; or 700 kN with no more than 125 mm displacement

III. IIHS Petition for Rulemaking[22]

In 2011, IIHS petitioned NHTSA to upgrade FMVSS No. 223 and 224 "to require underride guards that are strong enough to [allow] the energy absorbing structures of passenger vehicles to deform and provide protection to their occupants."

IIHS conducted crash tests in which a model year (MY) 2010 Chevrolet Malibu (a midsize sedan) impacted the rear of various trailers equipped with rear impact guards (full overlap of the rear impact guard with the front end of the sedan) at 56 km/h (35 mph).[23] ("Overlap" refers to the portion of the striking passenger vehicle's width overlapping the underride guard.) A 50th percentile male Hybrid III dummy (HIII 50M) was in each of the front outboard seating positions of the Malibu. IIHS evaluated trailers manufactured by Hyundai, Vanguard, and Wabash. According to the petition, all three trailer/guard designs easily passed FMVSS No. 223's quasi-static tests at P1 and P3 locations, while the Vanguard and Wabash trailers/guards also met the more stringent P3 requirements of CMVSS No. 223.

The Hyundai guard, which only met FMVSS No. 223, resulted in "catastrophic" underride of the Malibu ("complete loss of the front occupant survival space") in the full-overlap test.

In contrast, the Wabash guard (built to CMVSS No. 223 requirements) "performed well in the full-width and 50 percent overlap conditions, providing much greater protection against underride than the other two guards."[24] That is, the rear impact guard on the Wabash trailer, certified to meet FMVSS No. 223 and CMVSS No. 223 requirements, prevented PCI in the 56

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[22] IIHS conducted more testing after the initial test program discussed in its petition. NHTSA discusses IIHS's test program in Appendix B of this preamble.

[23] See Brumbelow, M. L., "Crash Test Performance of Large Truck Rear Impact Guards," 22nd International Conference on the Enhanced Safety of Vehicles (ESV), 2011. http://www-nrd.nhtsa.dot.gov/pdf/esv/esv22/22ESV-000074.pdf.

[24] In the 30 percent overlap test, the end of the guard bent forward and allowed underride of the Malibu.

km/h (35 mph) crash tests, while the Hyundai guard (certified only to FMVSS No. 223) did not. The Wabash trailer/guard design prevented PCI in both the full-width and the more demanding 50 percent overlap tests.

The Vanguard trailer rear impact guard, certified to FMVSS No. 223 and to CMVSS No. 223, resulted in "moderate"[25] and "severe" underride ("intrusion extending into the occupant compartment") in 50 percent overlap tests. IIHS believes that the problem with the Vanguard was that the guard is deemed to have met FMVSS No. 223 and CMVSS No. 223 even though the attachment bolts sheared or pulled away from the guard during the quasi-static test. The petitioner suggests "the regulations should include a stipulation that all attachment hardware must remain intact for the duration of the test or until reaching a force threshold that is much higher than that required for the guard itself."

Table 3 summarizes the results of the initial six 56 km/h (35 mph) crash tests. In the first test of the 2007 Hyundai guard, the guard was ripped from the trailer's rear cross member early in the crash, allowing the Malibu to underride the trailer almost to the B-pillar. The heads of both dummies were struck by the hood of the Malibu as it deformed against the rear surface of the trailer. In contrast, under the same test conditions, the main horizontal member of the 2011 Wabash guard bent forward in the center but remained attached to the vertical support members, which showed no signs of separating from the trailer chassis.

Table 3: IIHS's Table of Its Front-Into-Trailer Rear Crash Tests; 2010 Chevolet Malibu

Trailer	Speed (km/h)	Malibu's overlap with guard	Guard ground clearance (centimeters)	Guard performance	Underride
2007 Hyundai	56	Full-width	47.6	Attachments failed	Catastrophic

[25] IIHS did not define "moderate" underride.

2007 Vanguard	40	50%	42.2	Attachments failed	Moderate
2007 Vanguard	56	50%	42.7	Attachments failed	Severe
2011 Wabash	56	Full-width	44.5	Good	None
2011 Wabash	56	50%	44.3	End bent forward	None
2011 Wabash	56	30%	45.3	End bent forward	Catastrophic

In its petition, IIHS requests that NHTSA:

- Increase the strength requirements for rear impact guards (at least to the levels that are currently required in Canada);
- Evaluate whether ground clearance of rear impact guards can be further reduced;
- Reduce the number of heavy vehicles (trucks and trailers) exempted from requiring rear impact guards;
- Require attachment hardware to remain intact during the quasi-static tests;
- Require rear impact guards to be certified while attached to the trailer for which it is designed; and
- Move the P1 location[26] for the 50,000 N point load quasi-static test more outboard "to improve offset crash protection."

IV. Overview of Proposed Changes

This NPRM proposes the following changes to FMVSS Nos. 223 and 224.[27]

1. Performance requirements.

[26] See Figure 1 of this preamble for the location of P1, supra.

[27] In addition, a few housekeeping amendments are proposed. NHTSA would add back "low chassis vehicles" into the list of vehicles excluded from FMVSS No. 224 in the applicability section (S3). The vehicles were excluded from the standard in the January 24, 1996 final rule establishing FMVSS No. 224 (see 61 FR at 2035) but were inadvertently omitted from S3 when S3 was amended by a final rule responding to petitions for reconsideration (63 FR 3654, January 26, 1998). Typographical errors would also be corrected.

NHTSA has reviewed CMVSS No. 223 and the information provided by IIHS and agrees that CMVSS No. 223's performance requirements for underride guards appear practicable, needed for safety, and objective.[28] Accordingly, NHTSA proposes that the current loading and performance requirements of FMVSS No. 223 be replaced with the specifications in CMVSS No. 223. Specifically:

- Rear impact guards (except as noted below) would be required to resist a uniform distributed load of 350,000 N without deflecting more than 125 mm and while absorbing at least 20,000 J of energy by plastic deformation within the first 125 mm of deflection;
- Alternatively, rear impact guards may resist a minimum uniform distributed load of 700,000 N without deflecting 125 mm.
- In accordance with CMVSS No. 223, we propose to require that rear impact guards be required to maintain a ground clearance after the energy absorption test not exceeding 560 mm. For rear impact guards with strength exceeding 700,000 N in the uniform distributed load test, the post-test ground clearance is measured after the uniform distributed load test. A definition of "ground clearance" would be added to FMVSS No. 223.
- NHTSA tentatively agrees with IIHS that FMVSS No. 223 should require that any portion of the rear impact guard and attachments not separate from their mounting structure after completion of the uniform distributed loading test and the energy absorption test.

2. <u>Definition of "rear extremity."</u> [29]

[28] See National Traffic and Motor Vehicle Safety Act, 49 U.S.C. § 30111(a).
[29] This proposal would also further harmonize FMVSS No. 224 with CMVSS No. 223.

We propose to replace the current definition of “rear extremity” in FMVSS No. 224 with that specified in CMVSS No. 223. The change is intended to ensure that aerodynamic fairings are located within a certain safe zone at the rear of the trailer. Aerodynamic fairings on the rear of trailers, also known as “boat tails,” are rear-mounted panels on trailers that reduce aerodynamic drag and fuel consumption.

The safety concern about boat tails is that they generally extend beyond the rear extremity of trailers and thus can negate the crash protection provided by underride guards. That is, there is a possibility that a boat tail can protrude so far rearward that it can intrude into the passenger compartment in a crash and cause injury, notwithstanding the presence of an upgraded underride guard.

V. Specific Aspects of the Proposal to Upgrade the Standards

Although NHTSA has granted the IIHS and Karth/TSC petitions, not all aspects of the petitions have been granted. Specific aspects of the petitions are discussed below. To the extent NHTSA disagrees with suggested changes to FMVSS Nos. 223 and 224 in the petitions, NHTSA denies the requested change.

a. Strength and Energy Absorption Requirements

Since submitting the petition in 2011, IIHS conducted crash tests with 8 trailer models that were designed to comply with CMVSS No. 223 (see Appendix B of this preamble). As discussed in Appendix B, the dynamic crash tests conducted by IIHS showed that all 8 trailer models that were designed to comply with CMVSS No. 223 were capable of preventing PCI when struck by a mid-sized sedan at 56 km/h (35 mph) and full overlap. Furthermore, 7 of the 8 guards were capable of preventing PCI when struck by a mid-sized sedan at 56 km/h (35 mph) and 50 percent overlap. These data suggest that upgrading the FMVSS No. 223 strength and

energy absorption requirements to that of the CMVSS No. 223 requirements would improve guard performance in crashes involving full and 50 percent overlap scenarios.

Agency Decision

NHTSA proposes to harmonize FMVSS No. 223's test and performance requirement at the P3 location to that specified in CMVSS No. 223. Our decision is based on the testing conducted by IIHS and that by Transport Canada, which show that the Canadian compliant guards are able to prevent PCI in 56 km/h light (35 mph) vehicle impacts into the rear of trailers with 100 percent and 50 percent overlap with the guard.

The quasi-static point load test at the P3 location would be replaced by a uniform distributed load test of 350,000 N. The force application device for the uniform distributed load test would be rigid, with a height of 203 mm and a width that exceeds the distance between the outside edges of the outermost load-bearing supports to which the horizontal member is attached. The load would be applied using this load application device, in a similar manner to that currently specified in FMVSS No. 223. The performance requirements would require the rear impact guard to resist the 350,000 N load without deflecting more than 125 mm, absorb at least 20,000 J of energy within 125 mm of guard deflection,[30] and have a ground clearance not exceeding 560 mm after completion of the test.

CMVSS No. 223 permits an option that a rear impact guard does not have to meet energy absorption requirements if it is able to resist 700,000 N of force using the distributed load application device without deflecting more than 125 mm. For guards that can withstand 700,000 N in the uniform distributed load test, the guard is required to have a ground clearance of 560 mm after the uniform distributed load test. Transport Canada states that it permitted this option

[30] Canada believes that the energy absorption requirement helps ensure that the guard will not sever from the trailer chassis when an equivalent load is applied. Canada Gazette Part II, Vol. 138, No. 20, 2004-10-06, p. 1335.

based on rigid barrier crash test results suggesting that a resistance to a uniform load of at least 700,000 N would help ensure that the rear impact guard will stay in place in an impact with a passenger car at impact speeds of 56 km/h (35 mph) or more.[31] Canada's view is that, given that modern day passenger vehicles are able to protect occupants in rigid barrier tests of up to 56 km/h (35 mph), a rear impact guard that is strong enough to resist loads greater than 700,000 N would not pose any additional injury to occupants at crash speeds of up to 56 km/h (35mph). NHTSA is proposing to include this optional test in FMVSS No. 223, but the agency does not believe guards are or will likely be manufactured to this test. We seek comment on the need for including the test in FMVSS No. 223.

CMVSS No. 223 also permits testing with half of the rear impact guard (for symmetric guards) by applying a 175,000 N distributed load along the length of half of the horizontal member (at the P3 location). The rear impact guard is required to resist this load by deflecting no more than 125 mm, and must absorb at least 10,000 J of energy within 125 mm of guard deflection. At the end of the energy absorption test, the guard must have a ground clearance not exceeding 560 mm. Transport Canada permitted this testing option to reduce costs associated with testing, as manufacturers would be able to use existing testing equipment to demonstrate compliance.[32, 33]

NHTSA is not inclined to include this testing option in FMVSS No. 223. According to the data from 6 trailer manufacturers presented in Table B-3 of Appendix B of this preamble, only one manufacturer conducted the test using half the rear impact guard. We believe that most

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[31] Id., p. 1349.

[32] In 2005, guard manufacturers did not have the equipment and loading apparatus to apply a distributed force of 350,000 N required in the full guard test. Therefore, Transport Canada permits testing with half of the guard with the option of applying a point load of 175,000 N at the P2 location. This option permits the manufacturers to utilize then-existing equipment used for certifying FMVSS No. 223 rear impact guards.

[33] Transport Canada noted that a half guard test could potentially be more stringent than a full guard test, but provided no data to support this statement.

trailer and rear impact guard manufacturers will not avail themselves of this option, as they are now capable of testing with the uniform distributed load applied to the complete guard. Additionally, testing the full guard may be more beneficial to safety, as such a test is more representative of the guard's performance in the field than testing the guard cut in half. Therefore, the agency is not including this option of testing with half of the rear impact guard in the proposed regulatory text. We seek comment on whether this option should be included in FMVSS No. 223.

b. Ground Clearance

FMVSS No. 224 and CMVSS No. 223 require the bottom edge of the horizontal member of the rear impact guard of the trailer to be no more than 560 mm (22 inches) above the ground when the trailer is unloaded and on level ground. IIHS requests that NHTSA evaluate whether the ground clearance of rear impact guards can be reduced. The Karth/TSC petition suggests that NHTSA require rear impact guards on trailers and semitrailers be mounted 406 mm (16 inches) from the ground.[34]

Agency Decision

NHTSA has considered the petitions and is generally denying the request to lower the ground clearance requirement.

The issue of appropriate rear impact guard ground clearance involves balancing the ability of the guard to provide crashworthiness protection with the operational restrictions associated with lower guard heights. This issue was discussed in detail in the 1996 final rule establishing FMVSS Nos. 223 and 224.[35] At that time, the agency analyzed public comments, vehicle geometry, heavy vehicle operations, and crash test data and concluded that requiring a

[34] The agency interprets this request to mean that the ground clearance of rear impact guards (vertical distance of the bottom of the horizontal member from ground surface) on trailers and semi-trailers be less than or equal to 406 mm.
[35] 61 FR 2004

guard ground clearance lower than 560 mm (22 inches) would cause an undue burden on the industry. The agency was concerned that ground clearance lower than 560 mm (22 inches) would not only cause interference in intermodal operations but also increase the probability that the guard would scrape or snag during normal vehicle operations and be damaged as a result.

For the 1996 final rule, NHTSA conducted a survey of engine block heights and front end profiles of a sample of 40 vehicles and found that the top of the engine block for these vehicles was between 660 and 790 mm (26 and 31 inches, respectively), with an average height of 711 mm (28 inches). The agency's crash tests indicated that rear impact guards with ground clearances of 560 mm (22 inches) that met FMVSS No. 223 prevented PCI in light vehicles. During these tests, the impacting cars had their front ends depressed to simulate the lowering that would be experienced during heavy braking, to simulate a "worst case scenario" with regard to guard height. Even in these conditions, the rear impact guard engaged the structure (engine block) of each car, resulting in air bag deployment and low injury measures on the dummies in the front row. Accordingly, the agency decided in the 1996 final rule to specify a ground clearance requirement of 560 mm (22 inches).

Since the 1996 final rule, Transport Canada issued upgraded rear impact guard tests and performance requirements that are intended to prevent PCI in light vehicles at speeds up to 56 km/h (35 mph). According to CMVSS No. 223, after the energy absorption test where the guard is displaced 125 mm, the rear impact guard has to maintain a ground clearance not exceeding 560 mm (22 inches). Transport Canada crash tests showed that rear impact guards with an initial ground clearance of 560 mm that were designed to meet the strength, energy absorption, and ground clearance requirements after the test were able to prevent PCI in small passenger cars

impacting the guard at 56 km/h (35 mph).[36] Thus, in response to commenters that suggested further lowering of the guard ground clearance, Transport Canada stated that while it agrees that the ground clearance of rear impact guards is an important factor to preventing PCI, its crash tests of passenger cars into rear impact guards of different heights found that sufficient strength of the guard and a 560 mm (22 inch) ground clearance after the test were more important factors in preventing PCI than a reduced initial ground clearance and no post-test ground clearance requirement.[37]

NHTSA concurs with Transport Canada's position on maintaining the maximum allowable ground clearance of rear impact guards at 560 mm (22 inches). Because the upgrades to FMVSS Nos. 223 and 224 will require substantially increased strength of rear impact guards and require 560 mm (22 inches) maximum ground clearance of the guards before and after the energy absorption test, the agency believes reducing the ground clearance of trailer rear impact guards from 560 mm (22 inches) to a lower level is not needed.

The maximum required ground clearance of 560 mm (22 inches) is sufficiently low to engage the engine block of an impacting passenger vehicle. NHTSA gathered data on the vertical height of passenger vehicle bumpers and the top of the engine block from the ground on 50 vehicles crash-tested in 2013 under the agency's New Car Assessment Program, as shown in Table 4. NHTSA chose the engine block height as a suitable metric to represent a major structural element of the striking vehicle that would engage the rear impact guard to mitigate PCI. These light vehicles consisted of hatchbacks, sedans, coupes, minivans, station wagons, utility vehicles, and extended cab pickups.

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[36] Boucher, D., Davis, D. T., "Trailer Underride Protection – A Canadian perspective," SAE technical paper 2000-01-3522, Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096-0001.
[37] Canada Gazette Part II, Vol. 138, No. 20 SOR/DORS/2004-195.

The average height of the top of the engine block was 889 mm (35 inches) with a standard deviation of 102 mm (4.0 inches), and a range of 739 mm (29.1 inches) to 1300 mm (51.2 inches). The lowest average height of the top of the engine block was a 5-door hatchback with a height of 804 mm (31.7 inches).[38]

Table 4: Engine block vertical height from ground level in MY 2013 vehicles[39]

Vehicle Type	**Quantity**	**Percent of Population Sampled**	**Average Height of Engine Block Top (mm)**
Five Door Hatchback	5	10%	804
Four Door Sedan	19	38%	862
Two Door Coupe	4	8%	848
Minivan	1	2%	822
Station Wagon	2	4%	853
Utility Vehicle	17	34%	924
Extended Cab Pickup	2	4%	1235

NHTSA also does not believe that the ground clearance of the guard needs to be reduced because fleet data suggest that where possible, trailer manufacturers are voluntarily installing rear impact guards with ground clearances under 560 mm (22 inches).

NHTSA evaluated the ground clearance of rear impact guards in the current trailer fleet by analyzing the supplemental data on the rear geometry of trailers that UMTRI collected as part of 2008 and 2009 TIFA survey.[40] Guard ground clearance was reported for trailers that had rear impact guards in the combined TIFA data for 2008 and 2009. The mean, median, mode, and standard deviation of the ground clearance is shown for rear impact guards on trailers (Table 5). The data indicate that the mean ground clearance of rear impact guards on trailers in the current fleet is 536 mm (21.1 inches), lower than the maximum allowable ground clearance of 560 mm

[38] It is noteworthy that the top of the engine block is higher in the MY 2013 vehicles than in the vehicles surveyed by NHTSA in 1993, which had showed an average top of engine block height of 711 mm (28 inches).
[39] From Safercar.gov at http://www.safercar.gov/Vehicle+Shoppers/5-Star+Safety+Ratings/1990-2010+Vehicles.
[40] Heavy-Vehicle Crash Data Collection and Analysis to Characterize Rear and Side Underride and Front Override in Fatal Truck Crashes, DOT HS 811 725, March 2013.

(22 inches). Further, an evaluation of trailers manufactured in 1998 and later in the 2008-2009 TIFA data files from UMTRI showed that the average ground clearance of rear impact guards for newer (MY 1998+) trailer models was 457 mm (18 inches).

Table 5: Rear Impact Guard Ground Clearance from the 2013 UMTRI Study (Supplemental Data in 2008 and 2009 TIFA Datafiles)

Truck Configuration	Max. Allowable Ground Clearance mm (inches)	N	Mean mm (inches)	Median mm (inches)	Mode mm (inches)	Standard Deviation mm (inches)
Trailer	560 (22)	3380	536 (21.1)	508 (20)	610 (24)	107 (4.2)

The agency also conducted an informal survey of trailers at a weigh station by the southbound lanes of I-81 near Stephen City, Virginia in August 2012. The sample consisted of 47 trailers (van and flatbed) that were directed to the inspection lot after passing through the weigh scales. Thirty of the trailers had guards and the ground clearance of the rear impact guards on these trailers ranged from 376 mm to 546 mm (14.8 inches to 21.5 inches) with an average value of 472 mm (18.6 inches).

Another reason not to reduce the current ground clearance requirement of 560 mm is because NHTSA is proposing to adopt the CMVSS No. 223 requirement that the rear impact guard must maintain the 560 mm (22 inches) of ground clearance <u>after</u> the energy absorption uniform distributed load test. It is possible that to meet the post-test ground clearance requirements, the rear impact guards will be installed with ground clearance lower than the required 560 mm. For trailers involved in IIHS testing, the average ground clearance of the guards that were certified to CMVSS No. 223 was 443 mm.

NHTSA is not proposing to reduce the maximum allowable ground clearance of rear impact guards also because NHTSA continues to be concerned that a lower guard ground clearance requirement may interfere with functionality of some of the vehicles. For example, in

intermodal operations, some trailers are driven into ships on ramps instead of being crane loaded and some trailers need to drive up sloping driveways during normal operations. Some trailers may have the rear axle further forward to improve maneuverability of the trailer. NHTSA believes that, for such trailers, rear impact guards that are lower than 560 mm (22 inches) may scrape and snag with the ground and get damaged.

c. Types of Heavy Vehicles Excluded From FMVSS No. 224

IIHS requests that NHTSA evaluate whether FMVSS No. 224 can be applied to more vehicles. IIHS states that more than half of the truck units in the LTCCS cases studied by IIHS were excluded from FMVSS No. 224 requirements. IIHS stated that wheels back trailers and SUTs were most of the excluded vehicles. The Karth/TSC petition requests that NHTSA improve the rear impact protection provided by SUTs, a vehicle class currently excluded from FMVSS No. 224. FMVSS No. 224 does not apply to pole trailers, pulpwood trailers, wheels back vehicles, low chassis vehicles, road construction controlled horizontal discharger trailers,[41] special purpose vehicles,[42] or temporary living quarters as defined in 49 CFR 529.2.[43]

The issue of exclusions from FMVSS No. 224 was discussed in detail in the January 24, 1996 final rule and in subsequent final rules. Pole and pulpwood trailers lack structure in the rear for attaching rear impact guards and carry loads likely to substantially overhang the rear of the trailer. This attribute of pole and pulpwood trailers thereby negates the value of rear impact guards and consequently were excluded from FMVSS No. 224 requirements. Wheels back

[41] A road construction controlled horizontal discharge trailer is a trailer or semitrailer that is equipped with a mechanical drive and a conveyor to deliver asphalt and other road building materials for road construction operations.

[42] Special purpose vehicle is a trailer or semitrailer that has work performing equipment that resides in or moves through any portion of the area that is designated for the rear impact guard. Typically, trailers with equipment in the rear, such as lift gages, are categorized as special purpose vehicles and are excluded from the application of FMVSS No. 224.

[43] In addition, certain cargo tankers certified to carry hazardous materials with a bumper or device in the area where the horizontal member of a guard would be are excluded from having to comply with the energy absorption requirement of FMVSS No. 224.

vehicles were excluded because the agency's testing indicated that the rear wheels of wheels back trailers were able to prevent PCI into the impacting passenger car and also were adequate for managing the energy in such a crash.

Trailers with equipment in the rear, such as a lift gate, were excluded from FMVSS No. 224 because of the complexities associated with the installation of rear impact guards on these trailers, and because rear impact guards could interfere with the operation of some lift gates. There are practical problems to installing rear impact guards on trailers with equipment in the rear if the equipment resides at the location where the guard would be installed or if the guard interferes with the operation of the equipment. Thus, NHTSA excluded trailers with equipment in the rear which reside in or moves through any portion of the space designated for a rear impact guard.

Agency Decision[44]

To evaluate whether the exclusions in FMVSS No. 224 should be rescinded, the agency analyzed the supplemental data on rear geometry of trailers that UMTRI collected as part of 2008 and 2009 TIFA survey.[45] UMTRI collected specific data on the rear extremity of trailers and determined whether a rear impact guard was required, and if not required, what type of exclusion criterion was met. UMTRI also collected detailed information on fatal vehicle crashes into the rear of trailers and the extent of underride in these crashes.

For the combined 2008 and 2009 TIFA data (all fatal crashes involving trucks in 2008 and 2009), UMTRI estimated that 66.4 percent of trailers require rear impact guards per FMVSS No. 224 (see Table 6). Among the 33.6 percent of trailers not requiring rear impact guards per

[44] The ANPRM that was published prior to this NPRM discusses issues relating to applying FMVSS No. 224 to SUTs. Those issues will not be discussed in this NPRM.
[45] Heavy-Vehicle Crash Data Collection and Analysis to Characterize Rear and Side Underride and Front Override in Fatal Truck Crashes, DOT HS 811 725, March 2013.

FMVSS No. 224, 5.4 percent were types such as pole and logging trailers, 26.4 percent were wheels back trailers, 0.5 percent were low chassis trailers, and 1.2 percent had equipment in the rear.

Table 6: Rear impact guard status per FMVSS No. 224 for trailers; TIFA 2008 and 2009

	Guard Required	Guard not Required				
		Excluded Type	Low Chassis	Wheels Back	Wheels Back + Low Chassis	Equipment in Rear
Trailer	66.4%	5.4%	0.5%	26.4%	0.1%	1.2%

As shown in Table 7, among 217 light vehicle fatal crashes into the rear of trailers that occur annually, 115 are into trailers with guards, 15 are into excluded trailers (equipment in rear, low chassis, pole, pulpwood trailers), 44 are into wheels back trailers, and 43 are into other trailer types. Among 90 fatal light vehicle impact into the rear of trailers that result in PCI, 62 are into trailers with guards, 4 are into excluded trailers (equipment in rear, low chassis, pole, pulpwood trailers), 7 are into wheels back trailers, and 17 involve other truck/trailer types.

Table 7: Annual fatal light vehicle impacts into the rear of trailers by trailer configuration and whether PCI occurred

Trailer Configuration	Fatal Light Vehicle Crashes into the Rear of Trailers		Fatal Light Vehicle Crashes into the Rear of Trailers with PCI		Percentage of Fatal Light Vehicle Crashes into the Rear of Trailers Resulting in PCI
Trailer+guard	115	53%	62	69%	54%
Trailer Excluded	15	7%	4	4%	27%
Wheelsback	44	20%	7	8%	16%
Other unknown	43	20%	17	19%	40%
Total	217		90		41%

While 20 percent of fatal light vehicle impacts into the rear of trailers are wheels back trailers, they only represent 8 percent of those fatal crashes with PCI into the rear of trucks and

trailers. Additionally, only 16 percent of fatal light vehicle impacts into wheels back trailers resulted in PCI, while 54 percent of fatal light vehicle impacts into trailers with guards resulted in PCI. Excluded trailers (equipment in rear, pole, pulpwood, and low chassis trailers) only represent 4 percent of fatal light vehicle crashes into the rear of trailers with PCI. These statistics suggest that the exclusion of pole, logging, low chassis, and wheels back trailers and trailers with equipment in rear from FMVSS No. 224 requirements may not have significant safety consequence.

To better understand the circumstances resulting in PCI and fatality in light vehicle impacts into the rear of wheels back trailers, NHTSA reviewed the available details of all fatal light vehicle impacts into the rear of wheels back trailers that resulted in PCI in the 2009 TIFA data files, as supplemented with trailer and crash information. UMTRI defined PCI as vehicle front end deformation extending up to and beyond the windshield. The results of the review are presented in Table 8. The data shows that there were 6 light vehicle fatal crashes into the rear of wheels back trailers resulting in PCI in 2009. Of these, 4 impacts were at crash speeds greater than 80 km/h (50 mph), which are exceedingly severe.

The relative crash speeds were not known in the other two crashes. One was an impact of a Ford pickup which, with its high ride height construction, was not likely to underride the trailer. A review of this crash suggests that high crash speeds may have been the cause of PCI (defined by UMTRI as the deformation of the vehicle's front end extending up to and beyond the windshield) in the Ford pickup rather than underride of the pickup into the rear of a trailer. The other crash was a 1990 Buick Electra, a large sedan, impacting the rear of a wheels back van trailer. The Electra was traveling in a 55 mph speed zone and so may have also been in a high speed crash.

This analysis suggests that the available data support the exclusion of wheels back trailers in FMVSS No. 224. The analysis of the 2009 TIFA data for light vehicle crashes into the rear of wheels back trailers indicates that the crashes were generally at very high impact speeds that are considered unsurvivable. In all these crashes, it is unlikely that a rear impact guard designed to CMVSS No. 223 would have prevented PCI into these vehicles. Therefore, we do not believe that a rear impact guard would have prevented these fatalities. The agency is not proposing to extend the applicability of FMVSS No. 224 to wheels back trailers.

Table 8: All fatal crashes in 2009 of light vehicles into the rear of MY 1998 and newer wheels back trailers resulting in PCI in the light vehicle – 2009 TIFA data files.

2009 TIFA 1998+ Trailers with PCI by Chassis Type Exemption (Wheels Back)								
Crash State	Case Number	Trailer Model Year	Body Type	Belt Use	Speed Limit	Difference in Travel Speeds	Crash narrative	Factors related to fatality
51 (VA)	18	1998	Van	Belted, front air bag deployed	55 mph (89 km/h)	Unknown	47 yr old fatality, left front 1990 Buick Electra into stopped van trailer	Unknown ΔV - 55 mph speed limit zone
6 (CA)	161	1998	Flatbed	Belted, air bag not equipped	55 mph (89 km/h)	55 mph (89 km/h)	20 yr old fatality, right front 1984 Chevrolet Impala traveling 89 km/h (55 mph) into double flatbed turning left	High ΔV
55 (WI)	443	2004	Van	Belted, front air bag deployed	65 mph (105 km/h)	65 mph (105 km/h)	57 yr old fatality, right front 2003 Dodge Caravan traveling 105 km/h (65 mph) into stopped van trailer Offset right front impact of car into left rear of trailer.	High ΔV
18 (IN)	47	2006	Van	Belted, unknown if air bag deployed	50 mph (81 km/h)	Unknown	42 yr old fatality 2002 Ford pickup into stopped trailer	Unknown ΔV Pickup into wheels back - PCI likely due to crash speed
22 (LA)	442	2006	Flatbed	Unbelted, air bag not depolyed	70 mph (113 km/h)	70 mph (113 km/h)	71 yr old fatality, unbelted 1992 Chevrolet Silverado traveling 113 km/h (70 mph) into stopped flatbed	Unbelted High ΔV Elderly
6 (CA)	1235	1996	Flatbed	Right front belted, air bag not deployed; middle and right rear - unbelted and no air bag	55 mph (89 km/h)	70 mph (113 km/h)	17 yr old right front, 31 yr old right rear, and 22 yr old middle rear seat position fatals 2001 Chevrolet Silverado traveling 134 km/h (83 mph) into double flatbed trailer traveling 21 km/h (13 mph) Offset right rear corner impact of trailer.	High ΔV

NHTSA conducted a similar analysis of 2009 TIFA data files of all fatal light vehicle crashes into the rear of pole, logging trailers and with trailers with equipment in the rear. Low chassis, pole, and pulpwood trailers and trailers with equipment in the rear account for 3 percent of fatal light vehicle impacts into the rear of trailers with resulting PCI. Annually there are 4 light vehicle impacts with PCI into the rear of these excluded vehicles.

Detailed analysis of light vehicle crashes into the rear of these excluded vehicles which resulted in PCI of the light vehicle suggest that all these crashes were very severe and that a CMVSS compliant rear impact guard, if present, would not have prevented the fatalities. Additionally, installing rear impact guards on these excluded vehicles is not necessarily feasible or practicable due to the geometry of the rear extremity. Given all the above, the agency is not proposing to remove the exclusion of low chassis, pole, pulpwood trailers, and trailers with equipment in the rear, from FMVSS No. 224.

d. Require Attachment Hardware to Remain Intact

Currently FMVSS No. 223 specifies strength requirements for the guard in terms of the forces that the guard must withstand to prevent PCI and the energy it must absorb to reduce injury to occupants of the impacting vehicle. It does not specify performance requirements relating to the attachment hardware itself of the rear impact guard, i.e., that the guard's attachments must remain attached, etc. IIHS requests that FMVSS No. 223 require that attachment hardware of the rear impact guard remain intact throughout the quasi-static tests.

IIHS suggests that its data demonstrate that simply increasing the overall peak force requirements of FMVSS No. 223 would be insufficient to improve the performance of rear impact guards. IIHS notes that, in its tests, the 2007 Hyundai and the 2007 Vanguard trailer rear impact guards met the quasi-static loads test requirements at the P3 location[46] by substantial margins, despite having attachment bolts that sheared or pulled away from the guard during the test. IIHS states that similar failures of the rear impact guard attachments were also observed in IIHS's 56 km/h (35 mph) crash tests of a MY 2010 Chevrolet Malibu into the rear of the 2007

[46] The 2007 Hyundai rear impact guard was certified and tested to the FMVSS No. 223 load test at the P3 location and the 2007 Vanguard rear impact guard was certified and tested to both the FMVSS No. 223 and CMVSS No. 223 load tests at the P3 location. When displaced to 125 mm, as required in the energy absorption test, IIHS found that the rear impact guard attachments failed. Such failure was not considered a failure to comply with the standards, however.

Hyundai and Vanguard trailers and which resulted in PCI of the Malibu. IIHS states that, in contrast, the 2011 Wabash trailer rear impact guard did not experience any attachment failures during the quasi-static test at the P3 location and performed well in the 56 km/h (35 mph) crash test with the Chevrolet Malibu with no PCI of the Malibu. IIHS states that to encourage intelligent guard designs, FMVSS Nos. 223 and 224 should include a stipulation that all attachment hardware must remain intact for the duration of the test or until reaching a force threshold that is much higher than that required for the guard itself.

IIHS provides further information on this issue in a 2011 paper[47] in which it describes the attachment hardware for the rear impact guards of the 2007 Hyundai, 2007 Vanguard, and the 2011 Wabash trailers that it tested. The 2007 Hyundai guard that was only certified to FMVSS No. 223 requirements, did not have any forward attachments points to the trailer side rails or structure, and the vertical supports of the guard were directly bolted to the lower rear cross-members of the trailer. The 2007 Vanguard rear impact guard that complied with CMVSS No. 223 requirements in addition to that of FMVSS No. 223, had diagonal gussets attached to forward portions of the trailer chassis using bolts that would be loaded in shear in a rear impact. The 2011 Wabash rear impact guard that was certified to CMVSS No. 223 in addition to FMVSS No. 223, had diagonal gussets attached to forward portions of the trailer chassis using bolts that transfer loads from the guard to the chassis through overlapping steel plates.

In the quasi-static load test at the P3 location of the rear impact guards, for the Hyundai guard, the vertical support member slowly pulled out from the bolts attaching it to the fixture. The peak load achieved by the 2007 Vanguard guard was 257,000 N, after which the attachment bolts of the Vanguard guard began to shear after 50 mm of guard displacement, causing the load

[47] Brumbelow, M.L., "Crash Test Performance of Large Truck Rear Underride Guards," Paper No. 11-0074. 22nd International Technical Conference on the Enhanced Safety of Vehicles, Washington D.C., 2011. http://www-esv.nhtsa.dot.gov/Proceedings/22/isv7/main.htm. Last accessed on March 15, 2015.

to drop below 100,000 N. On the other hand, the attachments of the Wabash guard remained intact throughout the test and the vertical member buckled near its attachment.

In the 56 km/h (35 mph) full overlap crash test of the Chevrolet Malibu with full overlap into the rear of the 2007 Hyundai trailer, the attachment bolts ripped from the trailer's rear cross-member resulting in PCI of the Malibu. In the crash test into the rear of the 2007 and the 2013 Vanguard trailer at 50 percent overlap with the guard, the attachments bolts sheared and the right half of the guard completely detached from the trailer resulting in PCI of the Malibu.

Agency Decision

NHTSA sees merit in IIHS's request for requiring the attachment hardware to remain intact in the quasi-static load tests, and is thus granting the request.

The agency tentatively concludes that the IIHS data indicate that a requirement that ensures the integrity of the guard attachments would reduce the likelihood of failure of the anchorages or attachments in real world crashes in crashes up to 56 km/h (35 mph). The IIHS testing showed that the Wabash rear impact guard that exhibited no attachment failure and deformed plastically during the quasi-static load tests, performed well in the 56 km/h (35 mph) crash test with full overlap and 50 percent overlap of the Chevrolet Malibu. Therefore, to maximize the performance potential of the rear impact guard, the agency is proposing to require that any portion of the guard and the guard attachments not completely separate from its mounting structure after completion of the quasi-static uniform distributed load test. The agency reviewed its compliance tests conducted in the past five years and found that no portion of the rear impact guards and their attachments completely separated from the mounting structure.[48]

[48] The agency did not test the rear impact guards of the 2007 Hyundai, 2007 Vanguard, or the 2013 Vanguard trailers.

We are interpreting "any portion of the guard and the guard attachment completely separating from it mounting structure" to mean the condition where any member of the guard becomes detached from any other member of the guard or from the trailer such that the joint is no longer mechanically bound together. We would not consider a partial separation of the members at a joint where there is still some degree of mechanical connection between the members as a "complete separation." We seek comment on this proposed performance criterion and whether its objectivity can be improved by, e.g., specifying the percentage of fasteners or welds that remain intact during the test.

e. Testing on a Trailer Rather Than a Fixture

Both FMVSS No. 223 and CMVSS No. 223 provide the option of testing the rear impact guard when attached to a rigid test fixture or when attached to a complete trailer. IIHS states that, to ensure the compliance tests correspond to on-road underride protection, rear impact guards should not be certified separately from the trailers to which they will be attached. IIHS states that several of its crash tests of a 2010 Chevrolet Malibu into the rear of trailers produced deformation to various portions of the trailer, and that this suggests that the total resistance of the guard-attachment-trailer system is lower than that of a guard alone when tested on a rigid fixture. IIHS states that ideally, FMVSS No. 223 should require guards to be certified while attached to complete trailers, and that at a minimum, guards should be tested while attached to sections of the trailer rear that include all the major structural components and that are constrained such that the load paths near the guard are not changed.

<u>Agency Decision</u>

NHTSA is denying the request to remove the option of testing guards on a rigid test fixture. Both FMVSS No. 223 and CMVSS No. 223 provide the option of testing the rear impact

guard when attached to a rigid test fixture or when attached to a complete trailer. NHTSA believes the rigid test fixture and complete trailer tests are essentially equivalent. In NHTSA rigid test fixture compliance tests, the rear impact guards contain part of the trailer frame rails and/or cross beams to which the rear impact guard is attached. When testing on a trailer, the trailer chassis is secured so it behaves essentially as a fixed object during the test.

FMVSS No. 223 and CMVSS No. 223 specify that the guard be attached to the test device (rigid test fixture or complete trailer) in accordance with the instruction or procedures for guard attachment provided by the manufacturer. The specification assists in ensuring that the rear impact guard is evaluated in representative real world-installed conditions.

We do not agree with IIHS's conclusion that, when tested on a trailer, the total resistance of the guard-attachment-trailer system is lower than that of the guard alone on a rigid fixture due to deformation of the trailer structure. We believe that in the crash tests, the trailer structure along with the guard offered resistance to the dynamic loads and that is why the trailer structure also deformed.

We believe that testing a rear impact guard when attached to the rigid structure could be more stringent than when testing the guard while attached to the trailer. If the trailer structure is resisting a portion of the load as noted by IIHS, testing a guard on a rigid fixture may result in a more stringent test than testing it when attached to the trailer. When the guard is attached to a rigid fixture, it has to resist all the loads and absorb all the energy, whereas when it is installed on a trailer, the designs could be such that the trailer structure could resist a portion of the load.

NHTSA is also denying the request because requiring that the guard be tested when attached to the trailer would be a significant cost burden to trailer manufacturers. Trailer manufacturers typically design and fabricate their own guards in conjunction with the rest of the

vehicle. Trailer manufacturers typically test rear impact guards when attached to components of the trailer such as the frame rails and/or the cross member, similar to NHTSA's compliance testing program. Though the trailer manufacturers have access to their trailers for testing, it is expensive to conduct a full trailer test, which is a destructive test, and so they do not conduct the FMVSS No. 223 specified quasi-static tests when the guard is attached to the full trailer.

Requiring that the guard be tested when attached to the trailer would be an unnecessary and significant cost burden for the manufacturers, especially for small trailer manufacturers with low sales volumes. If those manufacturers were to test the guard on the trailer, this testing would entail sacrificing what could be a large part of their overall trailer production for such testing. Additionally, NHTSA also acknowledges there are a few rear impact guard manufacturers who are not trailer manufacturers (some of which are small businesses), and a requirement that the guard be tested when installed on the trailer could substantially and unnecessarily impact these entities.

For the reasons stated above, NHTSA believes it is beneficial to retain the current option of testing rear impact guards when attached either to a rigid test fixture or a trailer to ensure flexibility in testing capability. The agency's position is consistent with CMVSS No. 223 and with the test methods used for verifying compliance to the Canadian standard.

f. Moving P1 More Outboard

FMVSS No. 223 and CMVSS No. 223 specify that the P1 test location is at a distance from the centerline of the horizontal member of 3/8th of the width of the horizontal member, the P2 test location is at the centerline of the horizontal member, and the P3 test location is 355 mm (14 inches) to 635 mm (25 inches) from the horizontal member centerline (see Figure 1 of this preamble, supra).

IIHS requests that NHTSA evaluate relocating the quasi-static point load test at the P_1 location further outboard toward the end of the guard horizontal member. IIHS states that the crash tests of the 2010 Chevrolet Malibu into the rear of the 2011 Wabash trailer with full, 50 percent, and 30 percent overlap of the Malibu front end show that the CMVSS No. 223 certified guards prevented underride in the full and 50 percent overlap crashes by transferring the crash loads to stiff portions of the trailer chassis. IIHS suggests that, to extend the same level of underride protection to 30 percent overlap crashes, the test at the P1 location should be moved farther outboard, as well as subjected to a higher force requirement. (IIHS did not specify a specific location for P1 nor did it specify a specific force level for the test.) IIHS believes that on many trailers, the strong side rails would provide an acceptable location for attaching a guard to protect against underride in small engagement crashes.

The Karth/TSC petition requests that the agency improve the safety of rear impact guards on trailers in low overlap crashes by specifying the guard vertical supports be located 457 mm (18 inches) from the "outer edges." (It is not clear from the petition whether the "outer edges" refers to the outer edge of the rear impact guard horizontal member or that of the trailer body. NHTSA assumes "outer edges" refers to the lateral edges of the trailer.) Figure 2 shows where we believe the petition suggests placing the guard supports.

The width of a typical trailer is 2,600 mm (102 inches) and so the width of the horizontal member of the rear impact guard for the typical trailer is 2,400 mm (94.5 inches). For such a guard, the location of P1, P2 and P3, and the average location of the vertical attachments, are shown in Figure 2.

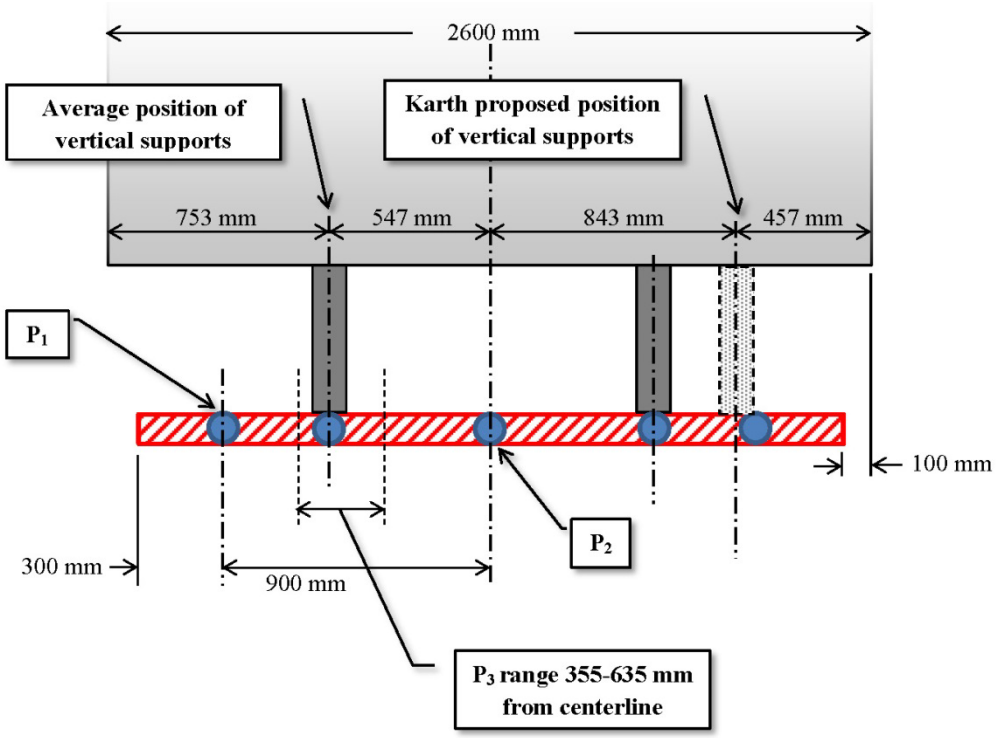

Figure 2: Rear impact guard geometry of a typical rear impact guard installed on a 2600 mm wide trailer along with the test locations P1, P2, and P3. (Drawing not to scale)

In this configuration, P1 is 400 mm (16 inches) from the lateral edge of the trailer and the centerline of the vertical support is 753 mm (30 inches) from the lateral edge of the trailer.

Agency Decision

NHTSA is not proposing to move the P1 location farther outboard. The P1 location is about 300 mm (12 inches) from the lateral edge for typical rear impact guards. NHTSA is concerned that moving the P1 location would not benefit safety overall.

First, NHTSA's analysis of field data found that underride crashes of 30 percent or less appear to represent a small portion of the rear underride fatality problem. The agency reviewed the UMTRI special study of 2008 and 2009 TIFA data to evaluate the requested amendment. UMTRI defined "offset crashes" as impacts with the outer one-third or less of the rear plane of

the truck or trailer. (For a 2,600 mm wide trailer, one third of the trailer width is 867 mm from the lateral edge of the trailer. As shown in Figure 2, the vertical members are typically 753 mm from the lateral edge of the trailer.)

The study found that most underride crashes into the rear of trailers are not offset impacts. UMTRI found that 40 percent of light vehicle impacts into the rear end of trucks and trailers in fatal crashes met the UMTRI definition of "offset crashes,"[49] and that 60 percent were non-offset impacts.[50] Moreover, the non-offset crashes appear to be more destructive (potentially harmful) than offset crashes. UMTRI noted that only 38.7 percent of light vehicle offset impacts into rear guards resulted in major damage to the guard, while almost half of the light vehicle non-offset impacts into rear guards resulted in major damage to the guard, including tearing it off. UMTRI also found for trailers with rear impact guards, there was virtually no difference in the percentage of light vehicle crashes with PCI in offset crashes (53.3 percent) and non-offset crashes (51.9 percent) as shown in Table 9.

Table 9: Underride extent in light vehicle fatal crashes into the rear of trailers with rear impact guards, by whether the impact was "offset" or not (TIFA 2008 and 2009)

Impact Type	Underride Extent[51] (percentage of light vehicle rear impacts into trailers)				
	N	None	Less than halfway	Halfway+	Windshield+
Offset	105	17.1%	14.3%	15.2%	53.3%
Non-Offset	135	18.5%	14.1%	15.6%	51.9%

Given that the majority of fatal light vehicle crashes into the rear of trucks and trailer were non-offset crashes, the percentage of light vehicle crashes with major rear impact guard

[49] UMTRI defined "offset crashes" as impacts with the outer one-third or less of the rear plane of the trailer. For a 2,600 mm wide trailer, one-third of the trailer width is 867 mm from the lateral edge of the trailer.
[50] Heavy-Vehicle Crash Data Collection and Analysis to Characterize Rear and Side Underride and Front Override in Fatal Truck Crashes, DOT HS 811 725, March 2013.
[51] "None" means no underride, "Less than halfway" means underride extent of less than halfway up the hood, "Halfway+" means underride extent at or more than halfway up the hood but short of the base of the windshield and "Windshield+" means intrusion at or beyond the base of the windshield. This is also considered PCI.

damage is greater in non-offset crashes than in offset crashes, and that there was virtually no difference in the percentage of light vehicle crashes with PCI in offset crashes and in non-offset crashes, NHTSA believes that the performance of rear impact guards in the fleet[52] in non-offset crashes should be enhanced before turning to the issue of improving the performance of the guards in offset crashes.

IIHS conducted 56 km/h crash tests of the 2010 Chevrolet Malibu into the rear of trailers with full, 50 percent, and 30 percent overlap of the Malibu front end with the rear impact guard. (The width of the Chevrolet Malibu is 1790 mm. Therefore, 50 percent overlap is 995 (=1790 x 0.5 +100[53]) mm from the rear lateral edge of the trailer and 30 percent overlap is 637 (=1790 x 0.3+100) mm from the rear lateral edge of the trailer.) See Figure 3. Since the vertical supports of a typical trailer are located 753 mm from the lateral edge of the trailer, we calculate that the vertical supports are engaged in crashes with 50 percent overlap of the Malibu but not in 30 percent overlap crashes. The percentage of light vehicle rear impacts with only 30 percent overlap with the rear impact guard (with the Malibu this would be 637 mm from the lateral edge of the trailer or 25 percent of the rear of the trailer engaged) would likely be a small percentage of rear impact crashes into trailers.[54]

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[52] The 2013 UMTRI study was conducted using 2008 and 2009 TIFA data files. The rear impact guards of the 2008-2009 trailers fleet were mainly FMVSS No. 223 certified and some (pre-1998 models) were FMCSR 393.86(b) certified.

[53] 100 mm is the maximum allowable distance between lateral edge of the rear impact guard and the lateral edge of the trailer per FMVSS No. 224.

[54] The UMTRI study of 2008-2009 TIFA data files indicated that light vehicle offset crashes into the rear of trailers (about 867 mm from the edge of a 2,600 mm width trailer engaged) is about 40 percent of all light vehicle crashes into the rear of trailers. Therefore, crashes with 25 percent of the trailer (637 mm for a 2,600 mm width trailer) would represent a significantly lower percentage of light vehicle crashes into the rear of trailers.

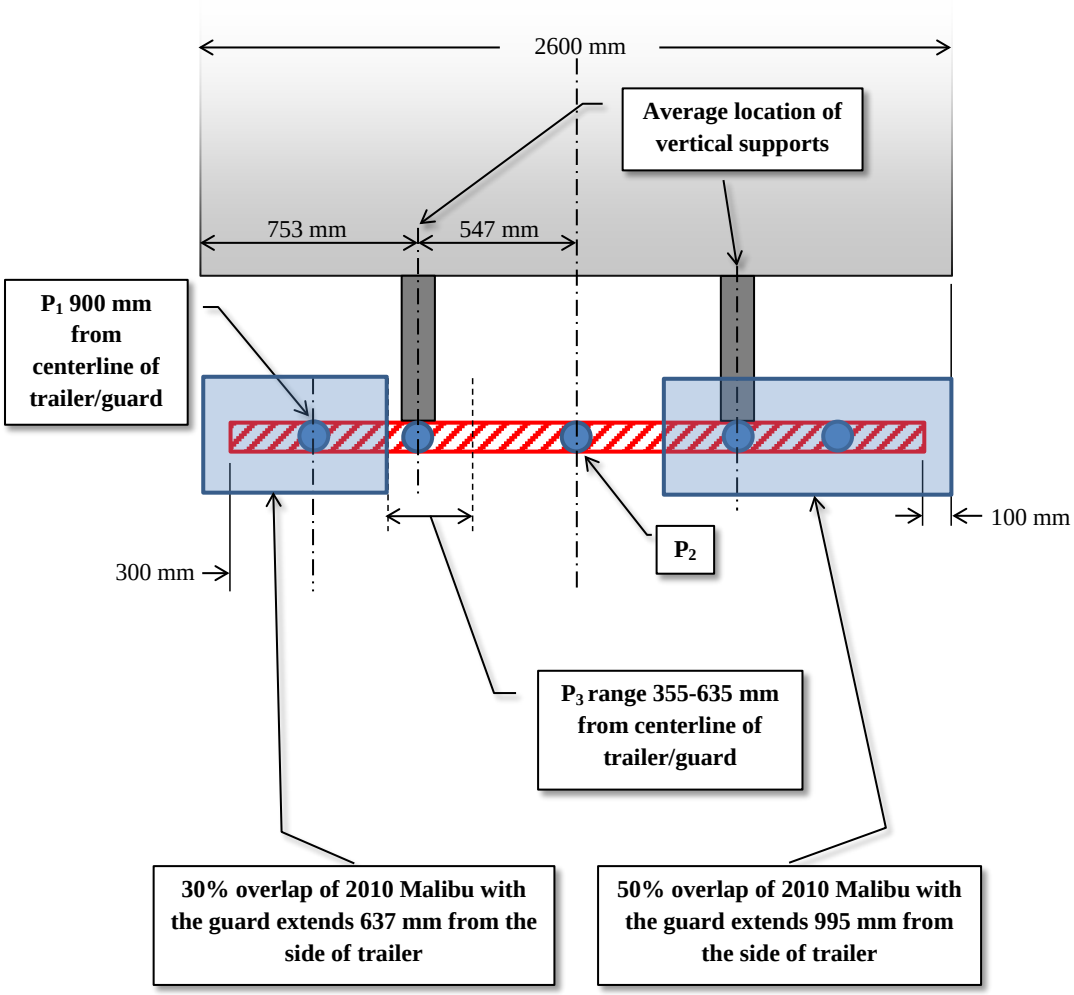


Figure 3: Diagram illustrating 50 and 30 percent overlap collision into a typical trailer as defined in the IIHS tests. (Drawing not to scale)

Second, we are concerned that moving the P1 location would not benefit safety overall. A comparison of the rear impact guard performance of the Manac trailer and the Wabash trailer in the IIHS crash tests of the Malibu indicate that moving the vertical supports towards the lateral edges of the trailer, as with the Manac guard, does show improved performance in the 30 percent overlap crash in the IIHS test. However, moving the supports may reduce the performance of rear impact guards in preventing PCI in the more common 50 and 100 percent overlap crashes at higher speeds.

In the crash tests conducted by IIHS, the Manac rear impact guard was able to prevent PCI in the Chevy Malibu in the 56 km/h (35 mph) 30 percent overlap condition. Manac attaches the main vertical supports outside of the axle rails. It fastens the guard to a reinforced floor section. Moving the vertical supports further outboard as requested by the petitioners may improve rear impact protection in small overlap crashes of light vehicles into the rear of trailers, but mounting the vertical supports further outboard may reduce guard strength near the center of the horizontal member of the rear impact guard. In the 56 km/h (35 mph) full overlap crash tests of the Malibu, the greatest amount of underride (1,350 mm) was in the test with the Manac trailer. In contrast, the extent of the underride was 990 mm in the test with the Wabash trailer.

The Manac rear impact guard prevented PCI in 56 km/h (35 mph) crash tests with full overlap, 50 percent and 30 percent overlap of the Malibu. However, the full overlap crash test results indicate that trailers that have the main vertical supports for the guard more outboard may not perform as well in full overlap crashes as trailers that have the vertical supports more inboard for crash speeds greater than 56 km/h (35 mph). Since full and 50 percent overlap crashes are more frequent than low overlap (30 percent or less) crashes, and since most fatal light vehicle impacts into the rear of trailers are at speeds greater than 56 km/h (35 mph), such guard designs may reduce protection against PCI in higher speed full and 50 percent overlap crashes. It has not been shown that protection in the 30 percent overlap crashes can be provided without degrading protection in the 50 and 100 percent overlap crashes. NHTSA is not convinced that improved protection in the less frequent 30 percent overlap crashes should come at the cost of adequate protection in the more common 50 and 100 percent overlap crashes.

In addition, the suggested amendment to move the vertical supports more outboard may not be practical for different trailer types. Typically, the vertical supports of rear impact guards

are attached to the longitudinal members of the trailer frame that have sufficient strength to withstand loads transferred from the guard in the event of a rear impact. Moving the vertical supports further outboard would require changes to trailer designs so that in a rear impact, the loads from the guard can be transferred to substantially strong structural members of the trailer. Such changes in trailer design may add weight to the trailer, reduce payload, and may not be practicable for all trailer types.

IIHS suggested moving the P1 test location further outboard or increasing the load in the quasi-static test at P1. However, IIHS did not provide specifics on this request. As shown in Figure 2, the P1 test location is about 300 mm (12 inches) from the edge of a typical trailer rear impact guard. It is not clear how moving the P1 location further outboard or increasing the load in the quasi-static test would improve guard performance in 56 km/h 30 percent overlap crashes and what impact that would have on crashes with a full or 50 percent overlap.

VI. Definition of "Rear Extremity" to Accommodate Aerodynamic Devices on Trailers

Aerodynamic fairings on the rear of trailers, also known as "boat tails," are rear-mounted panels on trailers that reduce aerodynamic drag and fuel consumption. Boat tails generally extend several feet beyond the end of the trailer.[55] Some boat tails protrude so far rearward that they could strike the passenger compartment of a vehicle that impacts the trailer from the rear, notwithstanding the presence of an upgraded underride guard.

[55] The Federal Highway Administration's (FHWA's) regulation 23 CFR part 658, "Truck size and weight, route designations," limits the length, width, and weight of trailers for purposes of ensuring the highways can safely and efficiently accommodate large vehicles. 23 CFR 658.16, "Exclusions from length and width determinations," excludes aerodynamic devices that extend a maximum of 1,524 mm (5 feet) beyond the rear of the vehicle from either the measured length or width of a trailer. (Also, among other things, the aerodynamic devices must "have neither the strength, rigidity nor mass to damage a vehicle, or injure a passenger in a vehicle, that strikes a trailer so equipped from the rear, and provided also that they do not obscure tail lamps, turn signals, marker lamps, identification lamps, or any other required safety devices, such as hazardous materials placards or conspicuity markings. Id.) This regulation has the effect of limiting aerodynamic devices to 1,524 mm (5 feet)) when deployed.

Currently, there is some ambiguity in FMVSS No. 224 as to how boat tails are covered under the standard. FMVSS No. 224 (S5.1.3) requires rear impact guards to be located at a maximum distance of 305 mm (12 inches) forward of the "rear extremity" of the trailer. One question is whether a boat tail on a new trailer constitutes the "rear extremity" of the vehicle. If it constitutes the rear extremity of the vehicle, the underride guard must be positioned no further than 305 mm (12 inches) forward of the boat tail. Another question is if the features and design of the aerodynamic device matter as to whether it should be considered the rear extremity of the vehicle.

We propose amending FMVSS No. 224 to answer those questions and make clearer its regulation of trailers with boat tails. We are proposing to achieve this by replacing the current definition of "rear extremity" in FMVSS No. 224 with that specified in CMVSS No. 223. The amendment would better ensure that boat tails are located within a certain safe zone at the rear of the trailer, and have features that are beneficial to crash protection.

In 2008, CMVSS No. 223 had the same definition of "rear extremity" as FMVSS No. 224, and Transport Canada had challenges similar to ours regarding boat tails. Transport Canada contracted the Centre for Surface Transportation Technology of the National Research Council (NRC) in Canada to study the aerodynamic gains of boat tails and determine which types of vehicles and what percentage of vehicles on the Canadian roads would strike the boat tail before striking the rear underride guard of trailers. NRC also examined the effect of snow, ice, and debris accumulation by boat tails, as well as downstream visibility.

NRC conducted wind tunnel experiments with different lengths, heights, and shapes of aerodynamic rear-mounted trailer panels (boat tails) to assess their drag reduction capability. Collision risk analysis with boat tails was conducted using dimensional data and population data

of motor vehicles registered in Canada. The NRC also developed computational fluid dynamics models to evaluate visibility and particulate accumulation.

The NRC report was published in December 2010.[56] The main findings of the NRC study are as follows:

- Reduction in drag and fuel consumption: The boat tails reduced aerodynamic drag by 7.6 to 11.8 percent when the vehicle is operating at 65 mph. This corresponds to an estimated 4.7 to 7.3 percent reduction in fuel consumption.
- Length of boat tails: The most significant aerodynamic drag reduction occurred for boat tail lengths from 0 to 2 feet. For boat tails longer than 2 feet, there is further drag reduction, but only incrementally. Boat tails longer than 4 feet offered minimal or no additional reduction in drag compared to shorter boat tails.
- Height of boat tails: Boat tails were most effective if at least 75 percent of the height of the trailer has full length boat tails. For most trailers, this corresponds to having full length boat tails at heights above 1,800 mm from the ground.
- Boat tail length and shape at lower heights: Although full length side panel boat tails that extend the entire height of the trailer offered the best reduction in drag, nearly the same level of drag reduction could be achieved by less. However, it was found that there should be at least some boat tail structure at the lower part of the trailer, even if it is significantly shorter than the higher section of the boat tail. The complete absence of boat tail structure at the bottom of the trailer significantly reduced the effectiveness of the boat tails.

[56] "Trailer Boat Tail Aerodynamic and Collision Study, Technical Report," National Research Council, Canada, Project 54-A3871, CSTT-HVC-TR-169, December 2010.

- Boat tail bottom panel: The presence of the bottom panel was found to be more critical than the length of the side panels for drag reduction. As much as 20 percent of the aerodynamic drag reduction was from the bottom panel.
- Visibility and particulate material: Both 2 feet and 4 feet boat tail lengths provided a significant improvement in reduced turbulence downstream of the trailer. However, there was a risk of particulate accumulation (snow and ice) on the bottom panel of boat tails.
- Collision Risk:
    - If 4 foot long boat tails are fitted to trailers along their entire height, 33.6 percent of vehicles on Canadian roads would strike the boat tail before striking the rear impact underride guard, however many of these contacts with the boat tail could be to the grille/hood rather than the windshield.
    - In order to prevent at least 90 percent of the vehicles on the roads from initial boat tail strikes, the full length boat tails (1,219 mm (4 feet)) should be mounted on the trailer higher than 1,740 mm (68 inches) from the ground.
    - There are boat tail configurations that provide up to a 9 percent reduction in aerodynamic drag and less than a 15% risk of collision before striking the underride guard. These configurations have shorter boat tail lengths (610 mm (2 feet)) at heights below 1,740 mm (68 inches) above ground.

Following the completion of the NRC of Canada study, Transport Canada undertook rulemaking to develop a clearance zone to allow aerodynamic devices (boat tails) that, in a collision, would not reduce safety for occupants of vehicles which may strike the rear of a trailer.[57] The regulation, finalized on August 8, 2011, modified the definition of "rear extremity"

[57] Transport Canada consulted with NHTSA on its rulemaking before it issued its proposal on a revised definition of rear extremity of a trailer.

of the trailer (which was similar to that currently specified in FMVSS No. 224) to read as follows:

> "Rear extremity" means the rearmost point on a trailer that is above a horizontal plane located above the ground clearance and below a horizontal plane located 1,900 mm above the ground when the trailer is configured as specified in subsection (7) and when the trailer's cargo doors, tailgate and other permanent structures are positioned as they normally are when the trailer is in motion. However, nonstructural protrusions, including but not limited to the following, are excluded from the determination of the rearmost point:
>
> (a) tail lamps;
>
> (b) rubber bumpers;
>
> (c) hinges and latches; and
>
> (d) flexible aerodynamic devices that are capable of being folded to within 305 mm from the transverse vertical plane tangent to the rearmost surface of the horizontal member and that, while positioned as they normally are when the trailer is in motion, are located forward of the transverse plane that is tangent to the rear bottom edge of the horizontal member and that intersects a point located 1,210 mm rearward of the rearmost surface of the horizontal member and 1,740 mm above the ground.

Based on this language, the permitted zone for boat tails at the rear of trailers is as shown in Figure 4, below.[58] The reference to "subsection (7)" in the Transport Canada regulation set forth above means the trailer is resting on level ground, unloaded, with its full capacity of fuel, its tires inflated and its air suspension, if so equipped, pressurized in accordance with the manufacturer's recommendations.

[58] The maximum length of aerodynamic devices of 1,542 mm (5 feet), specified in 23 CFR 658.16, "Exclusions from length and width determinations," applies at heights above 1900 mm from ground level, as shown in Figure 4.

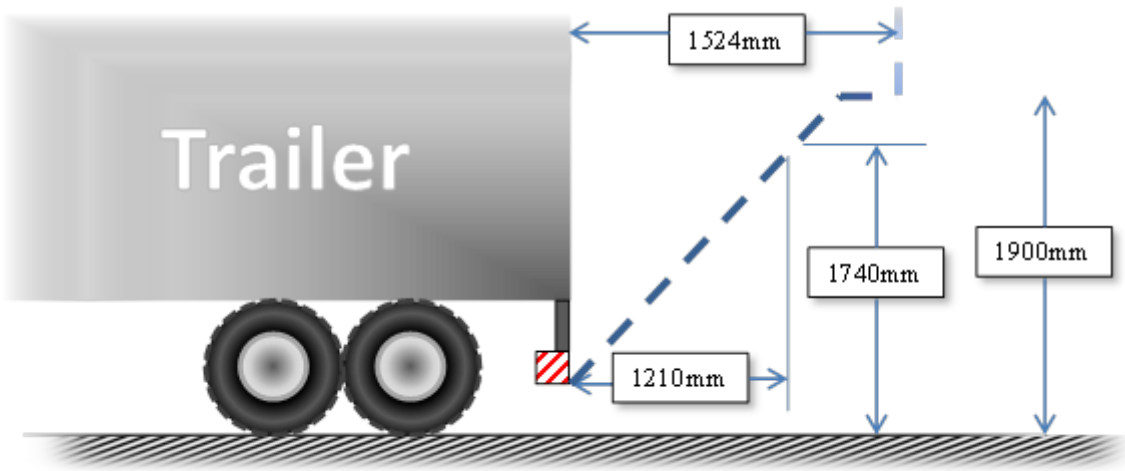


Figure 4: Permissible zone for locating aerodynamic devices per CMVSS rear extremity definition. (Drawing not to scale)

NHTSA is proposing to revise the definition of rear extremity in FMVSS No. 224 to adopt that of Transport Canada, so as to define a zone in which aerodynamic devices (boat tails) may be placed where, in a collision, they would not reduce the safety of occupants of vehicles striking the rear of a trailer. The agency expects that there will be an increased use of aerodynamic devices in the rear of trailers in the coming years for fuel efficiency purposes. NHTSA intends this proposal to address the installation of aerodynamic devices on trailers and to harmonize with the requirements of Transport Canada. Comments are requested on the proposed amendment.

VII. Cost and Benefits Analysis

NHTSA has prepared a Preliminary Regulatory Evaluation (PRE) for this NPRM and has placed a copy of the PRE in the docket.

For estimating the benefits of requiring applicable trailers to be equipped with CMVSS No. 223 certified guards, NHTSA estimated the annual number of fatalities in light vehicle crashes with PCI into the rear of trailers. NHTSA only considered fatal crashes with PCI for the

target population because the IIHS test data presented in Appendix A of this preamble show that when PCI was prevented, the dummy injury measures were significantly below the injury assessment reference values of NHTSA's occupant crash protection standard, and are likely similar to values in crashes into the rear of passenger vehicles. In non-PCI crashes into the rear of trailers, the IIHS test data indicate that the passenger vehicle's restraint system, when used, would mitigate injury. Therefore, non-PCI crashes were not considered as part of the target population for estimating benefits.

Annually, there are 72 light vehicle occupant fatalities in crashes into the rear of trailers with rear impact guards with PCI. About 26 percent of fatal light vehicle crashes into the rear of trailers is at speeds 56 km/h (35 mph) or less. The agency estimates that 19 fatalities (=72 x 0.26) are in crashes with relative velocity of 56 km/h (35 mph) or less. CMVSS No. 223 guards may not be able to mitigate all fatalities in crashes into the rear of trailers with relative velocity of 56 km/h or less because some crashes may involve low overlap (30 percent or less) and some fatalities may be due to circumstances other than underride (i.e. unrestrained status of occupants, elderly and other vulnerable occupants). For the purpose of this analysis, NHTSA assumed that the incremental effectiveness of CMVSS No. 223 compliant guards over FMVSS No. 223 compliant guards in preventing fatalities in light vehicle impacts with PCI into the rear of trailers with crash speeds less than 56 km/h is 50 percent. Since only 26 percent of light vehicle crashes with PCI into the rear of trailers are at relative velocity less than or equal to 56 km/h, NHTSA estimated the overall effectiveness of upgrading to CMVSS No. 223 compliant guards to be 13 percent (=26% x 50%)

The target population of fatalities considered is representative of fatalities occurring in light vehicle crashes into the rear of trailers that result in PCI. As noted above, in estimating

benefits, the agency assumed that the upgraded rear impact guards would mitigate fatalities and injuries in light vehicle impacts with PCI into the rear of trailers at impact speeds up to 56 km/h (35 mph), since the requirements of CMVSS No. 223 are intended to prevent PCI in impacts with speeds up to 56 km/h (35 mph). We recognize, however, that benefits may accrue from underride crashes at speeds higher than 56 km/h (35 mph), if, e.g., a vehicle's guard exceeded the minimum performance requirements of the FMVSS. NHTSA requests information that would assist the agency in quantifying the possible benefits of CMVSS No. 223 rear impact guards in crashes with speeds higher than 56 km/h (35 mph).

We note also that, while CMVSS No. 223 requirements are intended for mitigating PCI in light vehicle rear impacts at speeds less than or equal to 56 km/h (35 mph),[59] CMVSS No. 223 certified rear impact guards may not be able to mitigate all fatalities in such crashes because some of the crashes may be low overlap (30 percent or less)[60] and because some fatalities are not as a result of PCI but are due to other circumstances (e.g. unrestrained status of occupants, elderly occupants) in which improved rear impact guards may not have prevented the fatalities.

The agency estimates that 93 percent of new trailers are already equipped with CMVSS No. 223 compliant guards. Assuming 13 percent effectiveness of these guards in fatal crashes with PCI into the rear of trailers, the agency estimates that about 0.66 (= 72 x (1-0.93) x 0.13) lives would be saved annually by requiring all applicable trailers to be equipped with CMVSS No. 223 compliant guards. The agency also estimated that a total of 2.7 serious injuries would

[59] Transport Canada testing of minimally compliant CMVSS No. 223 rear impact guards indicated that such guards could prevent PCI in light vehicle impacts with full overlap with the guard at crash speeds up to 56 km/h (35 mph). See Boucher D., Davis D., "Trailer Underride Protection – A Canadian Perspective," SAE Paper No. 2000-01-3522, Truck and Bus Meeting and Exposition, December 2000, Society of Automotive Engineers.

[60] Table 13 shows that 8 of the 9 rear impact guards tested by IIHS could not prevent PCI in a 56 km/h (35 mph) crash with 30 percent overlap of the Chevrolet Malibu.

be prevented annually with the proposed underride guard rule. The equivalent lives saved were estimated to be 1.1 and 1 lives discounted at 3 percent and 7 percent, respectively.

NHTSA conducted a study to develop cost and weight estimates for rear impact guards on heavy trailers.[61] In this study, the agency estimated the cost and weight of FMCSR 393.86(b) compliant rear impact guards, FMVSS No. 223 compliant rear impact guards, and CMVSS No. 223 compliant rear impact guards (Table 10). All costs are presented in 2013 dollars.

In estimating the cost and weight of guards in this study, an engineering analysis of the guard system for each trailer was conducted, including material composition, manufacturing and construction methods and processes, component size, and attachment methods. However, the researchers did not take into account the construction, costs, and weight changes in the trailer structure in order to withstand loads from the stronger guards. A limitation of this analysis is the fact that the authors did not evaluate the changes in design of the rear beam, frame rails, and floor of the trailer when replacing a rear impact guard compliant with FMCSR 393.86(b) with an FMVSS No. 224 compliant guard and then to a CMVSS No. 223 compliant guard.

Table 10: Cost (2013 dollars) and weight of different types of rear impact guards

Type of Rear Impact Guard	Trailer Model Year/Make	*Guard Assembly*	*Installation Cost*	*Total Cost*	Weight (lb)
FMCSR 393.86(b)	*1993 Great Dane*	$65.31	$41.92	$107.23	78
FMVSS No. 224	*2001 Great Dane*	$153.22	$109.75	$262.86	172
CMVSS No. 223	*2012 Great Dane*	$191.17	$153.25	$344.05	193
	2012 Manac	$302.05	$248.74	$550.08	307
	2012 Stoughton	$248.02	$222.37	$470.91	191
	2012 Wabash	$447.05	$155.21	$601.84	243

[61] Cost and weight analysis for rear impact guards on heavy trucks, Docket No. NHTSA-2011-0066-0086, June 2013.

The average cost of a Canadian compliant rear impact guard is $492, which is $229 more than an FMVSS No. 224 compliant guard. The incremental cost of equipping CMVSS No. 223 compliant rear impact guards on applicable new trailers (those that are subject to FMVSS No. 223) is $229. There are 243,873 trailers sold in 2013,[62] among which 65 percent (see Appendix A to this preamble, Table A-1) are required to be equipped with rear impact guards. Of those, 93 percent are already equipped with CMVSS No. 223 compliant guards. The annual incremental fleet cost of equipping all applicable trailers with CMVSS No. 223 rear impact guards is approximately $2.5 million (=243,873 x 0.65 x (1.0-0.93) x $229).

As shown in Table 10, upgrading from the FMVSS No. 224 compliant guard to the CMVSS No. 223 compliant guard would add an average incremental weight of 48.9 lb to the trailer, thereby reducing the overall fuel economy during the lifetime of the trailer. The incremental increase in lifetime fuel cost for a 48.9 lb weight increase of a trailer was estimated to be $1,042.2 and $927.7 discounted at 3 percent and 7 percent, respectively. The annual incremental lifetime fuel cost of equipping all applicable trailers with CMVSS No. 223 rear impact guards is $9.2 million and $8.2 million discounted at 3 percent and 7 percent, respectively. Therefore the total cost of the proposed rule, including material and fuel costs is $11.77 million discounted at 3 percent and $10.76 million discounted at 7 percent (Table 11).

Table 11: Cost of Proposed Rule with Average Increase in Weight, in millions, in 2013 dollars

Cost	No-discount	3%	7%
Material	$2.54	$2.54	$2.54
Fuel	$10.44	$9.23	$8.22
Total	$12.98	$11.77	$10.76

[62] http://trailer-bodybuilders.com/trailer-output/2014-trailer-production-figures-table

The agency estimates that the net cost per equivalent lives saved is $9.1 million and $9.5 million discounted at 3 percent and 7 percent, respectively. A summary of the regulatory cost and net benefit of the proposed rule at the 3 percent and 7 percent discount rates are presented in Table 12. At 3 percent discount rate, the net benefit of the proposed rule is $0.59 million. At 7 percent discount rate, the net benefit of the proposed rule is $0.13 million.

Table 12: Cost-Effectiveness and Net Benefits (2013 dollars), in million

Discount	Regulatory Cost	Societal Econ. Savings	VSL* savings	Total Benefits(1)	Net Benefits(2)
3%	$11.77	$1.52	$10.85	$12.37	$0.59
7%	$10.76	$1.35	$9.54	$10.89	$0.13

* Value of Statistical Life
(1) Total Benefit = Societal Economic Benefit + VSL Benefit
(2) Net Benefit = Total Benefit – Regulatory Cost

For further information regarding the aforementioned cost and benefit estimates, please reference the preliminary regulatory evaluation (PRE) that NHTSA prepared and placed in the Docket.[63]

We have tentatively decided not to require used trailers be retrofitted with CMVSS No. 223 compliant rear impact guards. Our analysis indicates such a retrofitting requirement would be very costly without sufficient safety benefits. The net benefit for a retrofitting requirement was estimated to be -$402 million at 3 percent discount rate and -$414 million at 7 percent discount rate. Details of the analysis for a retrofitting requirement are provided in the PRE.

VIII. Proposed Lead Time

NHTSA proposes a lead time of two years following date of publication of a final rule. NHTSA provided a two year lead time when FMVSS Nos. 223 and 224 were adopted. We note

[63] The PRE discusses issues relating to the potential costs, benefits, and other impacts of this regulatory action. The PRE is available in the docket for this NPRM and may be obtained by downloading it or by contacting Docket Management at the address or telephone number provided at the beginning of this document.

that 93 percent of trailers already meet the requirements of CMVSS No. 223, so we tentatively conclude that two years will provide sufficient time for guard and trailer manufacturers to meet the requirements proposed today. Comments are requested on whether the lead time is appropriate.

IX. Regulatory Notices and Analyses

Executive Order (E.O.) 12866 (Regulatory Planning and Review), E.O. 13563, and DOT Regulatory Policies and Procedures

The agency has considered the impact of this rulemaking action under E.O. 12866, E.O. 13563, and the Department of Transportation's regulatory policies and procedures. This rulemaking was not reviewed by the Office of Management and Budget under E.O. 12866, "Regulatory Planning and Review." The rulemaking action has also been determined to be not significant under the Department's regulatory policies and procedures. NHTSA's Preliminary Regulatory Evaluation fully discusses the estimated costs, benefits and other impacts of this NPRM.

As discussed in the PRE and summarized in the section above, the annual incremental fleet cost of equipping all applicable trailers with CMVSS No. 223 rear impact guards is estimated to be approximately $2.5 million (=243,873 x 0.65 x (1.0-0.93) x $229). The agency estimates that 93 percent of new trailers in the U.S. are already equipped with CMVSS No. 223 compliant guards. The agency estimates that the incremental effectiveness of CMVSS No. 223 guards over FMVSS No. 223 guards is 13 percent in preventing fatalities in light vehicle crashes with PCI into the rear of trailers. The agency estimates that about 0.66 life (= 72 x (1-0.93) x 0.13) would be saved annually by requiring all applicable trailers to be equipped with CMVSS

No. 223 compliant guards.[64] The agency also estimated that a total of 2.7 serious injuries would be prevented annually with the proposed underride guard rule. The equivalent lives saved were estimated to be 1.1 and 1 lives discounted at 3 percent and 7 percent, respectively. The agency estimates that the net cost per equivalent lives saved is $9.1 million and $9.5 million discounted at 3 percent and 7 percent, respectively.

Consistent with E.O. 13563, "Improving Regulation and Regulatory Review," NHTSA is proposing to amend FMVSS Nos. 223 and 224 as a result of retrospectively analyzing the effectiveness of the standards. NHTSA realized the merits of CMVSS No. 223 in addressing the same safety need that is the subject of FMVSS Nos. 223 and 224, and has undertaken rulemaking to adopt upgraded strength and other requirements of CMVSS No. 223.

Regulatory Flexibility Act

Pursuant to the Regulatory Flexibility Act (5 U.S.C. 601 et seq., as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996) whenever an agency is required to publish a notice of proposed rulemaking or final rule, it must prepare and make available for public comment a regulatory flexibility analysis that describes the effect of the rule on small entities (i.e., small businesses, small organizations, and small governmental jurisdictions), unless the head of an agency certifies the rule will not have a significant economic impact on a substantial number of small entities. Agencies must also provide a statement of the factual basis for this certification.

I certify that this proposed rule would not have a significant economic impact on a substantial number of small entities. NHTSA estimates there to be 354 manufacturers of trailers

[64] CMVSS No. 223 compliant rear impact guards may mitigate the severity of impact into the rear of trailers at speeds greater than 56 km/h (35 mph), but NHTSA is unable to quantify this possible benefit at this time. We seek comment on this issue.

in the U.S., 331 of which are small businesses. The impacts of this proposed rule on small trailer manufacturers would not be significant. This NPRM proposes changes to the strength requirements applying to underride guards, but would not be amending the method by which small trailer manufacturers can certify compliance with FMVSS Nos. 223 and 224.

FMVSS No. 223, an equipment standard, specifies strength and energy absorption requirements in quasi-static force tests of rear impact guards sold for installation on new trailers and semitrailers. FMVSS No. 224, a vehicle standard, requires new trailers and semitrailers with a GVWR of 4,536 kg (10,000 lb) or more to be equipped with a rear impact guard meeting FMVSS No. 223. NHTSA established the two-standard approach to provide underride protection in a manner that imposes reasonable compliance burdens on small trailer manufacturers.

Under FMVSS No. 223, the guard may be tested for compliance while mounted to a test fixture or to a complete trailer. FMVSS No. 224 requires that the guard be mounted on the trailer or semitrailer in accordance with the instructions provided with the guard by the guard manufacturer. Under this approach, a small manufacturer that produces relatively few trailers can certify its trailers to FMVSS No. 224 without feeling compelled to undertake destructive testing of what could be a substantial portion of its production. The two-standard approach was devised to provide small manufacturers a practicable and reasonable means of meeting the safety need served by an underride guard requirement. This NPRM does not propose changing the method of certifying compliance to the underride guard requirements of FMVSS Nos. 223 and 224.

National Environmental Policy Act

NHTSA has analyzed this proposed rule for the purposes of the National Environmental Policy Act and determined that it would not have any significant impact on the quality of the human environment.

Executive Order 13132 (Federalism)

NHTSA has examined today's proposed rule pursuant to Executive Order 13132 (64 FR 43255, August 10, 1999) and concluded that no additional consultation with States, local governments or their representatives is mandated beyond the rulemaking process. The agency has concluded that the rulemaking would not have sufficient federalism implications to warrant consultation with State and local officials or the preparation of a federalism summary impact statement. The proposed rule would not have "substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government."

NHTSA rules can preempt in two ways. First, the National Traffic and Motor Vehicle Safety Act contains an express preemption provision: When a motor vehicle safety standard is in effect under this chapter, a State or a political subdivision of a State may prescribe or continue in effect a standard applicable to the same aspect of performance of a motor vehicle or motor vehicle equipment only if the standard is identical to the standard prescribed under this chapter. 49 U.S.C. § 30103(b)(1). It is this statutory command by Congress that preempts any non-identical State legislative and administrative law addressing the same aspect of performance.

The express preemption provision described above is subject to a savings clause under which "[c]ompliance with a motor vehicle safety standard prescribed under this chapter does not exempt a person from liability at common law." 49 U.S.C. § 30103(e) Pursuant to this provision, State common law tort causes of action against motor vehicle manufacturers that

might otherwise be preempted by the express preemption provision are generally preserved. However, the Supreme Court has recognized the possibility, in some instances, of implied preemption of such State common law tort causes of action by virtue of NHTSA's rules, even if not expressly preempted. This second way that NHTSA rules can preempt is dependent upon there being an actual conflict between an FMVSS and the higher standard that would effectively be imposed on motor vehicle manufacturers if someone obtained a State common law tort judgment against the manufacturer, notwithstanding the manufacturer's compliance with the NHTSA standard. Because most NHTSA standards established by an FMVSS are minimum standards, a State common law tort cause of action that seeks to impose a higher standard on motor vehicle manufacturers will generally not be preempted. However, if and when such a conflict does exist - for example, when the standard at issue is both a minimum and a maximum standard - the State common law tort cause of action is impliedly preempted. See Geier v. American Honda Motor Co., 529 U.S. 861 (2000).

Pursuant to Executive Order 13132 and 12988, NHTSA has considered whether this proposed rule could or should preempt State common law causes of action. The agency's ability to announce its conclusion regarding the preemptive effect of one of its rules reduces the likelihood that preemption will be an issue in any subsequent tort litigation. To this end, the agency has examined the nature (e.g., the language and structure of the regulatory text) and objectives of today's proposed rule and finds that this proposed rule, like many NHTSA rules, would prescribe only a minimum safety standard. As such, NHTSA does not intend that this proposed rule would preempt state tort law that would effectively impose a higher standard on motor vehicle manufacturers than that established by today's proposed rule. Establishment of a higher standard by means of State tort law would not conflict with the minimum standard

proposed here. Without any conflict, there could not be any implied preemption of a State common law tort cause of action.

Civil Justice Reform

With respect to the review of the promulgation of a new regulation, section 3(b) of Executive Order 12988, "Civil Justice Reform" (61 FR 4729, February 7, 1996) requires that Executive agencies make every reasonable effort to ensure that the regulation: (1) Clearly specifies the preemptive effect; (2) clearly specifies the effect on existing Federal law or regulation; (3) provides a clear legal standard for affected conduct, while promoting simplification and burden reduction; (4) clearly specifies the retroactive effect, if any; (5) adequately defines key terms; and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. This document is consistent with that requirement.

Pursuant to this Order, NHTSA notes as follows. The preemptive effect of this proposed rule is discussed above. NHTSA notes further that there is no requirement that individuals submit a petition for reconsideration or pursue other administrative proceeding before they may file suit in court.

Paperwork Reduction Act (PRA)

Under the Paperwork Reduction Act of 1995**,** a person is not required to respond to a collection of information by a Federal agency unless the collection displays a valid OMB control number. Before seeking OMB approval, Federal agencies must provide a 60-day public comment period and otherwise consult with members of the public and affected agencies concerning each collection of information requirement. There are no Paperwork Reduction Act requirements associated with this proposed rule.

National Technology Transfer and Advancement Act

Under the National Technology Transfer and Advancement Act of 1995 (NTTAA)(Public Law 104-113), all Federal agencies and departments shall use technical standards that are developed or adopted by voluntary consensus standards bodies, using such technical standards as a means to carry out policy objectives or activities determined by the agencies and departments. Voluntary consensus standards are technical standards (e.g., material specifications, test methods, sampling procedures, and business practices) that are developed or adopted by voluntary consensus standards bodies, such as the International Organization for Standardization (ISO) and the Society of Automotive Engineers (SAE). The NTTAA directs us to provide Congress, through OMB, explanations when we decide not to use available and applicable voluntary consensus standards.

This NPRM proposes to adopt requirements of CMVSS No. 223, as discussed later in this section. NHTSA's consideration of CMVSS No. 223 accords with the principles of NTTAA, in that NHTSA is considering an established, proven standard, and has not had to expend significant agency resources on the same safety need addressed by CMVSS No. 223.

Unfunded Mandates Reform Act

Section 202 of the Unfunded Mandates Reform Act of 1995 (UMRA), Pub. L. 104-4, requires Federal agencies to prepare a written assessment of the costs, benefits, and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditure by State, local, or tribal governments, in the aggregate, or by the private sector, of more than $100 million annually (adjusted for inflation with base year of 1995). Adjusting this amount by the implicit gross domestic product price deflator for the year 2013 results in $142 million (106.733/75.324 = 1.42). This NPRM would not result in a cost of $142 million or more to

either State, local, or tribal governments, in the aggregate, or the private sector. Thus, this NPRM is not subject to the requirements of sections 202 of the UMRA.

Executive Order 13609 (Promoting International Regulatory Cooperation)

The policy statement in section 1 of E.O. 13609 provides, in part:

The regulatory approaches taken by foreign governments may differ from those taken by U.S. regulatory agencies to address similar issues. In some cases, the differences between the regulatory approaches of U.S. agencies and those of their foreign counterparts might not be necessary and might impair the ability of American businesses to export and compete internationally. In meeting shared challenges involving health, safety, labor, security, environmental, and other issues, international regulatory cooperation can identify approaches that are at least as protective as those that are or would be adopted in the absence of such cooperation. International regulatory cooperation can also reduce, eliminate, or prevent unnecessary differences in regulatory requirements.

This rulemaking is considering adopting requirements of CMVSS No. 223 to upgrade FMVSS Nos. 223 and 224. In 2005, Transport Canada issued upgraded rear impact protection requirements for trailers and semitrailers. Given that passenger car models manufactured in 2005 and later in Canada are required to provide adequate occupant protection to restrained occupants in 56 km/h (35 mph) full frontal rigid barrier crashes, Transport Canada requires rear impact guards to provide sufficient strength and energy absorption to prevent PCI of compact and subcompact passenger cars impacting the rear of trailers at 56 km/h (35 mph). FMVSS No. 208 has similar occupant protection requirements as those applicable in Canada. NHTSA believes that the FMVSS Nos. 223 and 224 requirements can be upgraded to that required by

CMVSS No. 223's upgraded requirements for the same principles underlying the CMVSS No. 223 upgrade.

CMVSS No. 223, "Rear impact guards," is applicable to trailers and semitrailers and has similar geometric specifications for rear impact guards as FMVSS No. 224. CMVSS No. 223 specifies quasi-static loading tests similar to those in FMVSS No. 223. However, CMVSS No. 223 replaced the 100,000 N quasi-static point load test at the P3 location in FMVSS No. 223 with a 350,000 N uniform distributed load test on the horizontal member.[65] The guard is required to withstand this load and absorb at least 20,000 J of energy within 125 mm of deflection, and have a ground clearance after the test not exceeding 560 mm (22 inches). Similar to FMVSS No. 223, CMVSS No. 223 permits testing the rear impact guard when attached, per manufacturer's instructions, to a rigid test fixture or to a complete trailer. These requirements ensure that compact and subcompact passenger cars would not have PCI when rear-ending a CMVSS No. 223 compliant trailer at 56 km/h (35 mph).

Table 13 presents a comparison of rear impact protection requirements for trailers in the U.S., Canada, and Europe.

Table 13: Comparison of rear impact protection requirements for trailers in U.S., Canada, and Europe.

Requirement	U.S.	Canada	Europe
Applicable standards	FMVSS No. 223/224	CMVSS No. 223	ECE R.58
Geometric requirements in unloaded condition			
Ground clearance	560 mm	560 mm	550 mm
Longitudinal distance from rear extremity	305 mm	305 mm	--
Lateral distance from side of vehicle	100 mm	100 mm	100 mm
Quasi-static load tests			
Point load at P1 (outer	50 kN	50 kN	25 kN

[65] The load is applied uniformly across the horizontal member by a uniform load application structure with length that exceeds the distance between the outside edges of the vertical support of the horizontal member and which is centered on the horizontal member of the guard.

edge of guard)			
Point load at P2 (center of guard)	50 kN	50 kN	25 kN
Point load at P3 (at the guard supports)	100 kN with no more than 125 mm displacement, 5,650 J energy absorption	--	100 kN with distance of rear impact guard from vehicle rear extremity of 400 mm after test.
Distributed load	--	350 kN with no more than 125mm displacement and 20,000 J energy absorption; guard ground clearance less than 560 mm after test.	--

The European standard, ECE R.58, "Rear underrun protective devices (RUPD); Vehicles with regard to the installation of an RUPD of an approved vehicle; Vehicles with regard to their rear underrun protection," specifies rear impact protection requirements for trailers weighing more than 3,500 kg (7,716 lb). The dimensional and strength requirements for rear impact guards in ECE R.58 are similar to but less stringent than those specified in FMVSS Nos. 223 and 224. ECE R.58 specifies that both during and after the quasi-static force application test, the horizontal distance between the rear of the rear impact guard and the rear extremity of the vehicle not be greater than 400 mm. However, ECE R.58 does not specify any energy absorption requirements.

NHTSA has decided to propose the strength requirements of CMVSS No. 223 rather than ECE R.58 because the rear impact protection requirements for trailers in Canada are more stringent than that in Europe, and more appropriate for the underride crashes experienced in the U.S. Passenger vehicles in the U.S. are required by FMVSS No. 208 to have frontal air bag protection and comply with a full frontal 56 km/h (35 mph) rigid barrier crash test by ensuring that the injury measures of crash test dummies restrained in front seating positions are within the

allowable limits. CMVSS No. 223 is designed to prevent PCI in full frontal 56 km/h (35 mph) crashes. Together, FMVSS No. 208 and FMVSS Nos. 223 and 224 would significantly reduce the harm resulting to occupants of passenger vehicles impacting the rear of trailers in crashes of up to 56 km/h (35 mph).

Regulation Identifier Number

The Department of Transportation assigns a regulation identifier number (RIN) to each regulatory action listed in the Unified Agenda of Federal Regulations. The Regulatory Information Service Center publishes the Unified Agenda in April and October of each year. You may use the RIN contained in the heading at the beginning of this document to find this action in the Unified Agenda.

Plain Language

Executive Order 12866 requires each agency to write all rules in plain language. Application of the principles of plain language includes consideration of the following questions:

- Have we organized the material to suit the public's needs?
- Are the requirements in the rule clearly stated?
- Does the rule contain technical language or jargon that isn't clear?
- Would a different format (grouping and order of sections, use of headings, paragraphing) make the rule easier to understand?
- Would more (but shorter) sections be better?
- Could we improve clarity by adding tables, lists, or diagrams?
- What else could we do to make the rule easier to understand?

If you have any responses to these questions, please write to us with your views.

Privacy Act

In accordance with 5 U.S.C. 553(c), DOT solicits comments from the public to better inform its rulemaking process. DOT posts these comments, without edit, including any personal information the commenter provides, to www.regulations.gov, as described in the system of records notice (DOT/ALL–14 FDMS), which can be reviewed at www.dot.gov/privacy.

X. Public Participation

In developing this proposal, we tried to address the concerns of all our stakeholders. Your comments will help us improve this proposed rule. We welcome your views on all aspects of this proposed rule, but request comments on specific issues throughout this document. Your comments will be most effective if you follow the suggestions below:

- Explain your views and reasoning as clearly as possible.
- Provide solid technical and cost data to support your views.
- If you estimate potential costs, explain how you arrived at the estimate.
- Tell us which parts of the proposal you support, as well as those with which you disagree.
- Provide specific examples to illustrate your concerns.
- Offer specific alternatives.
- Refer your comments to specific sections of the proposal, such as the units or page numbers of the preamble, or the regulatory sections.
- Be sure to include the name, date, and docket number with your comments.

Your comments must be written and in English. To ensure that your comments are correctly filed in the docket, please include the docket number of this document in your comments.

Your comments must not be more than 15 pages long (49 CFR §553.21). We established this limit to encourage you to write your primary comments in a concise fashion. However, you

may attach necessary additional documents to your comments. There is no limit on the length of the attachments.

Please submit your comments to the docket electronically by logging onto http://www.regulations.gov or by the means given in the ADDRESSES section at the beginning of this document.

Please note that pursuant to the Data Quality Act, in order for substantive data to be relied upon and used by the agency, it must meet the information quality standards set forth in the OMB and DOT Data Quality Act guidelines. Accordingly, we encourage you to consult the guidelines in preparing your comments. OMB's guidelines may be accessed at http://www.whitehouse.gov/omb/fedreg/reproducible.html.

How Do I Submit Confidential Business Information?

If you wish to submit any information under a claim of confidentiality, you should submit three copies of your complete submission, including the information you claim to be confidential business information, to the Chief Counsel, NHTSA, at the address given above under FOR FURTHER INFORMATION CONTACT. In addition, you should submit a copy from which you have deleted the claimed confidential business information to the docket. When you send a comment containing information claimed to be confidential business information, you should include a cover letter setting forth the information specified in our confidential business information regulation. (49 CFR Part 512.)

Will the Agency Consider Late Comments?

We will consider all comments that the docket receives before the close of business on the comment closing date indicated above under DATES. To the extent possible, we will also consider comments that the docket receives after that date. If the docket receives a comment too

late for us to consider it in developing a final rule (assuming that one is issued), we will consider that comment as an informal suggestion for future rulemaking action.

How Can I Read the Comments Submitted by Other People?

You may read the comments received by the docket at the address given above under ADDRESSES. You may also see the comments on the Internet (http://regulations.gov).

Please note that even after the comment closing date, we will continue to file relevant information in the docket as it becomes available. Further, some people may submit late comments. Accordingly, we recommend that you periodically check the docket for new material.

Anyone is able to search the electronic form of all comments received into any of our dockets by the name of the individual submitting the comment (or signing the comment, if submitted on behalf of an association, business, labor union, etc.). You may review DOT's complete Privacy Act Statement in the Federal Register published on April 11, 2000 (Volume 65, Number 70; Pages 19477-78). See Privacy Act heading above under Rulemaking Analyses and Notices.

List of Subjects in 49 CFR Part 571

Imports, Motor vehicle safety, Motor vehicles, Rubber and rubber products, and Tires.

In consideration of the foregoing, NHTSA proposes to amend 49 CFR Part 571 as set forth below.

PART 571—FEDERAL MOTOR VEHICLE SAFETY STANDARDS

1. The authority citation for Part 571 continues to read as follows:

Authority: 49 U.S.C. 322, 30111, 30115, 30117 and 30166; delegation of authority at 49 CFR 1.95.

2. Section 571.223 is amended by:

a. Revising S3;

b. Amending S4 by adding a definition of "ground clearance," in alphabetical order;

c. Revising S5.2; S5.5(c); the introductory text of S6; the last sentence of S6.1; S6.3; the introductory texts of S6.4, S6.4(a), and S6.4(b);

d. Removing S6.4(c);

e. Revising S6.5 and S6.6;

f. Adding S6.7 through S6.9; and,

g. Revising Figures 1 and 2, and adding Figures 3 and 4.

The added and amended text and figures read as follows:

§ 571.223 Standard No. 223; Rear impact guards.

*** * * * ***

S3. Application. This standard applies to rear impact guards for trailers and semitrailers subject to Federal Motor Vehicle Safety Standard No. 224, Rear Impact Protection (§ 571.224).

S4. * * * * *

Ground clearance means the vertical distance from the bottom edge of a horizontal member to the ground.

* * * * *

S5.2 Strength and Energy Absorption. When tested under the procedures of S6 of this section, each guard shall comply with the strength requirements of S5.2.1 of this section at each test location, and the energy absorption requirements of S5.2.2 of this section when a distributed

load is applied uniformly across the horizontal member as specified in S6.6 of this section. However, a particular guard (i.e., test specimen) need not be tested at more than one location.

S5.2.1 Guard Strength. The guard must resist the force levels specified in S5.2.1 (a) through (c) of this section without deflecting by more than 125 mm and without complete separation of any portion of the guard and guard attachments from its mounting structure.

(a) A force of 50,000 N applied in accordance with S6.8 at test location P1 on either the left or the right side of the guard, as defined in S6.4(a) of this section.

(b) A force of 50,000 N applied in accordance with S6.8 at test location P2, as defined in S6.4(b) of this section.

(c) A uniform distributed force of at least 350,000 N applied across the horizontal member, as specified in S6.6 and in accordance with S6.8.

S5.2.2 Guard Energy Absorption.

(a) A guard, other than a hydraulic guard or one installed on a tanker trailer, when subjected to a uniform distributed load applied in accordance with S6.8(c) of this section:

(1) shall absorb by plastic deformation at least 20,000 J of energy within the first 125 mm of deflection without complete separation of any portion of the guard and guard attachments from its mounting structure; and

(2) have a ground clearance not exceeding 560 mm, measured at each support to which the horizontal member is attached, as shown in Figure 4, after completion of the load application.

(b) A guard, other than a hydraulic guard or one installed on a tanker trailer, that demonstrates resistance to a uniform distributed load greater than 700,000 N applied in accordance with S6.8(b) of this section, need not meet the energy absorption requirements of

S5.2.2(a) but must have a ground clearance not exceeding 560 mm at each vertical support to which the horizontal member is attached after completion of the 700,000 N load application.

* * * * *

S5.5 * * * * *

(c) An explanation of the method of attaching the guard to the chassis of each vehicle make and model listed or to the design elements specified in the instructions or procedures. The principal aspects of vehicle chassis configuration that are necessary to the proper functioning of the guard shall be specified including the maximum allowable vertical distance between the bottom edge of the horizontal member of the guard and the ground to ensure post-test ground clearance requirements are met. If the chassis strength is inadequate for the guard design, the instructions or procedures shall specify methods for adequately reinforcing the vehicle chassis. Procedures for properly installing any guard attachment hardware shall be provided.

S6. Guard Test Procedures. The procedures for determining compliance with S5.2 of this section are specified in S6.1 through S6.9 of this section.

S6.1 * * * The hydraulic units are compressed before the application of force to the guard in accordance with S6.8 of this section and maintained in this condition throughout the testing under S6.8 of this section.

* * * * *

S6.3 Point Load Force Application Device. The force application device employed in S6.8 of this section consists of a rectangular solid made of rigid steel. The steel solid is 203 mm in height, 203 mm in width, and 25 mm in thickness. The 203 mm by 203 mm face of the block is used as the contact surface for application of the forces specified in S5.2.1 (a) and (b)

of this section. Each edge of the contact surface of the block has a radius of curvature of 5 mm plus or minus 1 mm.

S6.4 Point Load Test Locations. With the guard mounted to the rigid test fixture or to a complete trailer, determine the test locations P1 and P2 in accordance with the procedure set forth in S6.4 (a) and (b) of this section. See Figure 1 of this section.

(a) Point Load Test location P1 is the point on the rearmost surface of the horizontal member of the guard that:

* * * * *

(b) Point Load Test location P2 is the point on the rearmost surface of the horizontal member of the guard that:

* * * * *

S6.5 Uniform Distributed Load Force Application Device. The force application device to be employed in applying the uniform distributed load is to be unyielding, have a height of 203 mm, and have a width that exceeds the distance between the outside edges of the outermost supports to which the tested portion of the horizontal member is attached, as shown in Figure 2.

S6.6 Uniform Distributed Load Test Location. With the guard mounted to the rigid test fixture or to a complete trailer, determine the test location in accordance with the procedure set forth in S6.6 (a) of this section. See Figure 2 of this section.

(a) Distributed Force Test location is the plane on the rearmost surface of the horizontal member of the guard that:

(1) Is centered in the longitudinal vertical plane passing through the center of the guard's horizontal member; and

(2) Is centered 50 mm above the bottom of the guard.

S6.7 Positioning of Force Application Device. Before applying any force to the guard, locate the force application device specified in S6.3 for the point load test location and that specified in S6.5 for the uniform distributed load test location, such that:

(a) The center point of the contact surface of the force application device is aligned with and touching the guard test location, as defined by the specifications of S6.4 of this section for the point load test locations, and S6.6 of this section for the uniform distributed load test location.

(b) The longitudinal axis of the force application device passes through the test location and is perpendicular to the transverse vertical plane that is tangent to the rearmost surface of the guard's horizontal member.

(c) If the guard is tested on a rigid test fixture, the vertical distance from the bottom edge of the horizontal member to the ground at the location of each support to which the horizontal member is attached, shall be measured.

S6.8 Force Application. After the force application device has been positioned, according to S6.7 of this section, at the point load test locations specified in S6.4 of this section or the uniform distributed load test location specified in S6.6 of this section, apply the loads specified in S5.2 of this section. Load application procedures are specified in S6.8 (a) through (d) of this section.

(a) Using the force application device, apply force to the guard in a forward direction such that the displacement rate of the force application device is the rate, plus or minus 10 percent, designated by the guard manufacturer within the range of 2.0 cm per minute to 9.0 cm per minute. If the guard manufacturer does not designate a rate, any rate within that range may be chosen.

(b) If conducting a strength test to satisfy the requirement of S5.2.1 or S5.2.2(b) of this section, the force is applied until the forces specified in S5.2.1 or S5.2.2(b) of this section have been exceeded, or until the displacement of the force application device has reached at least 125 mm, whichever occurs first.

(c) If conducting a test to be used for the calculation of energy absorption levels to satisfy the requirement of S5.2.2(a) of this section, apply a uniform distributed force to the guard until displacement of the force application device, specified in S6.5 of this section, has reached 125 mm. For calculation of guard energy absorption, the value of force is recorded at least ten times per 25 mm of displacement of the contact surface of the loading device. Reduce the force until the guard no longer offers resistance to the force application device. Produce a force vs. deflection diagram of the type shown in Figure 3 of this section using this information. Determine the energy absorbed by the guard by calculating the shaded area bounded by the curve in the force vs. deflection diagram and the abscissa (X-axis).

(d) During each force application, the force application device is guided so that it does not rotate. At all times during the application of force, the location of the longitudinal axis of the force application device remains constant.

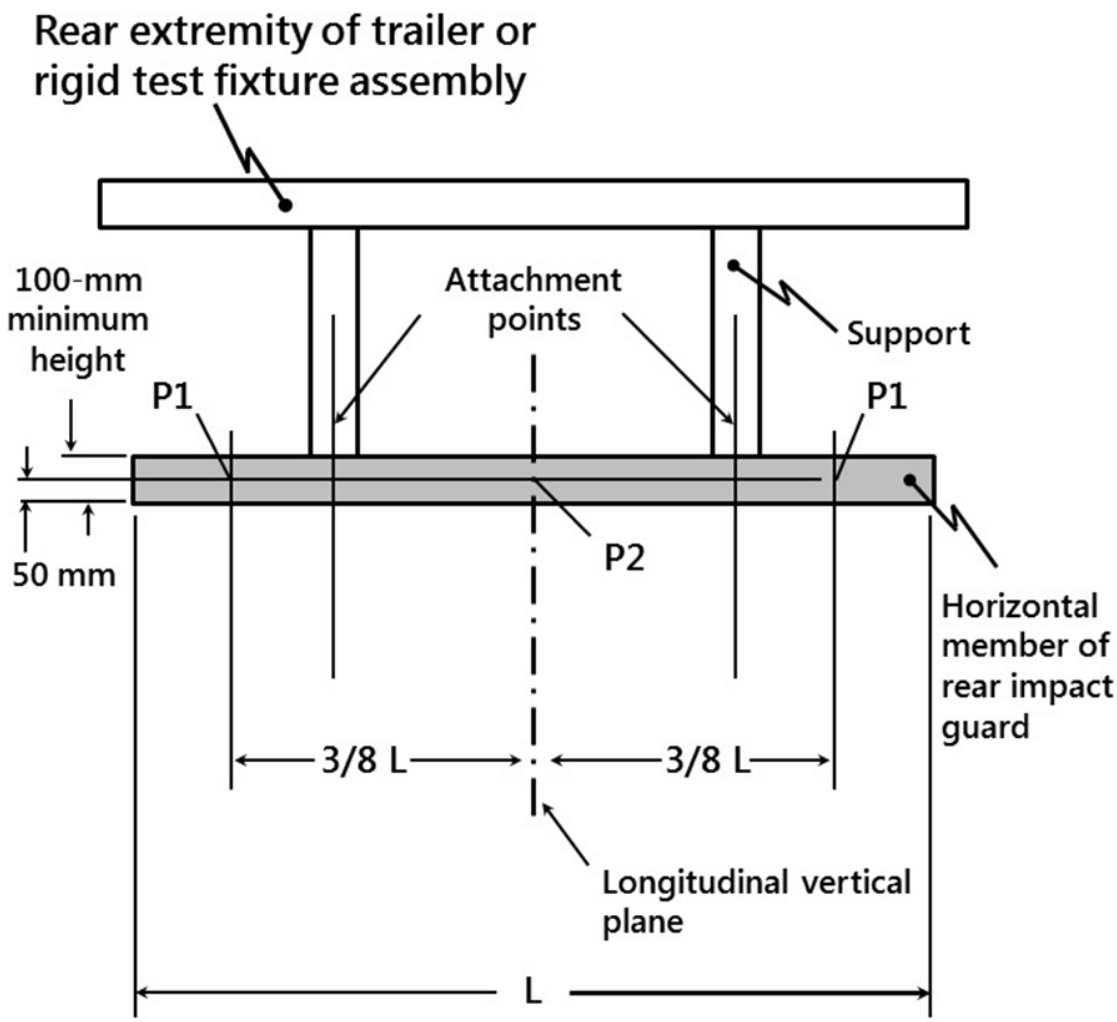
S6.9 Ground Clearance Measurement

(a) For the test device attached to a complete trailer as specified in S6.2, the ground clearance of the guard at the vertical supports to which the horizontal member is attached shall be measured after completion of the uniform distributed load test in accordance with S6.8(b) or S6.8(c) of this section.

(b) For the test device attached to a rigid test fixture as specified in S6.2, the vertical distance from the ground to the bottom edge of the horizontal member at the vertical supports

to which the horizontal member is attached shall be measured after completion of the uniform distributed load test in accordance with S6.8(b) or S6.8(c) of this section and subtracted from the corresponding ground clearance measured before the load application in accordance with S6.7(c). The difference in ground clearance before and after the load application is added to the allowable maximum vertical distance between the bottom edge of the horizontal member of the guard and the ground as specified in S5.5(c), to obtain the ground clearance after completion of the uniform distributed load test.

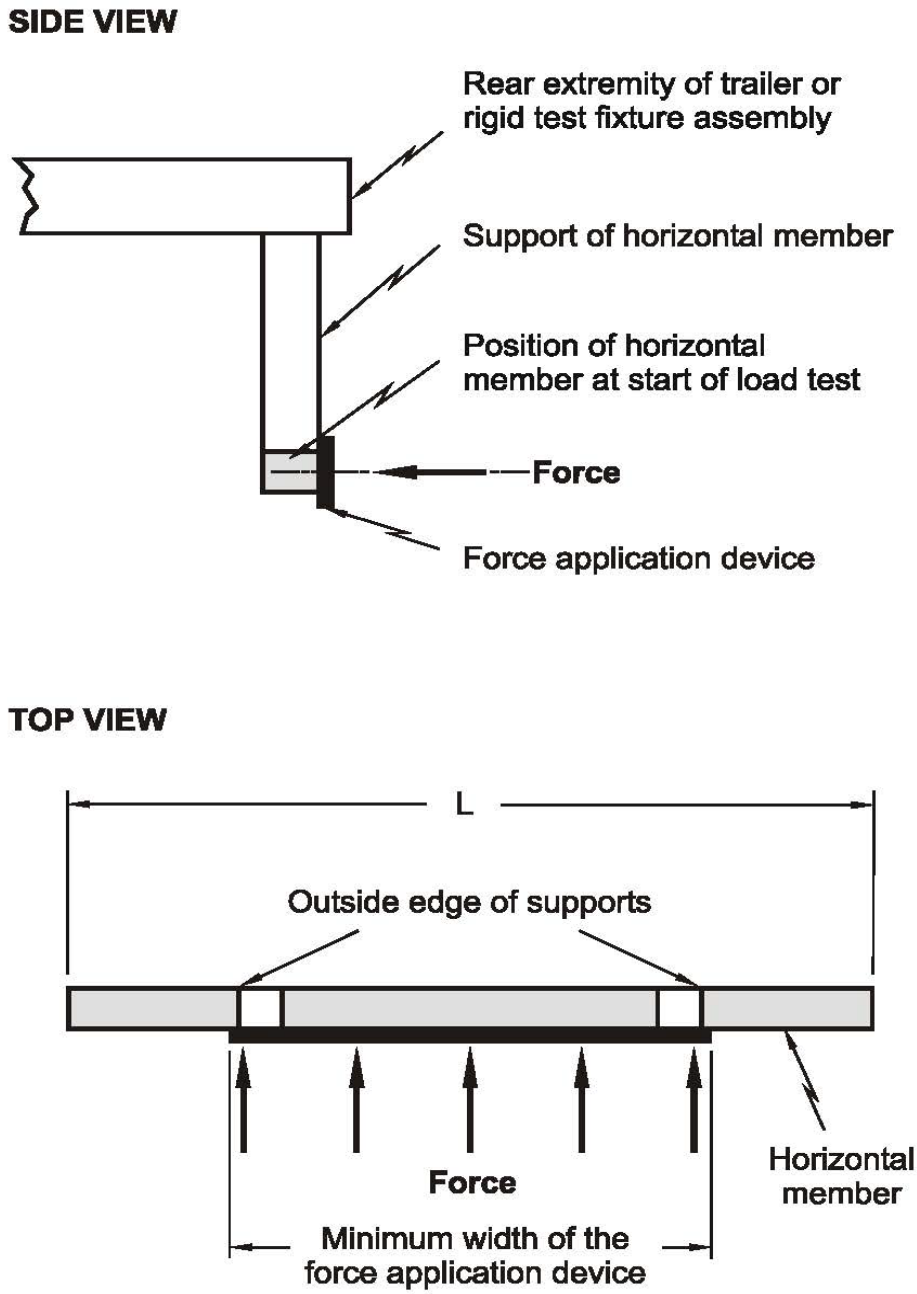
FIGURES TO § 571.223



Notes:
1. L means width of the horizontal member.
2. Drawing not to scale

Figure 1: Rear View of the Rear Impact Guard

FIGURE 2: UNIFORM DISTRIBUTED LOAD APPLICATION TEST



Notes:
1. L means width of the horizontal member.
2. Drawings not to scale

(Note: Drawings are not to scale)

FIGURE 3: TYPICAL FORCE DEFLECTION DIAGRAM

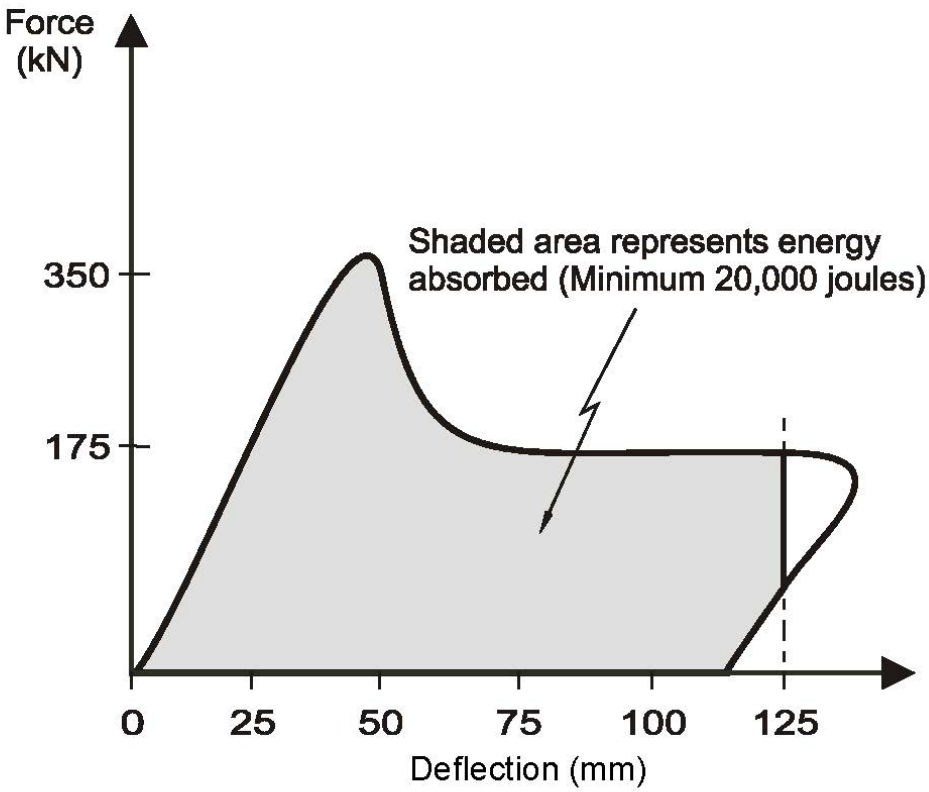
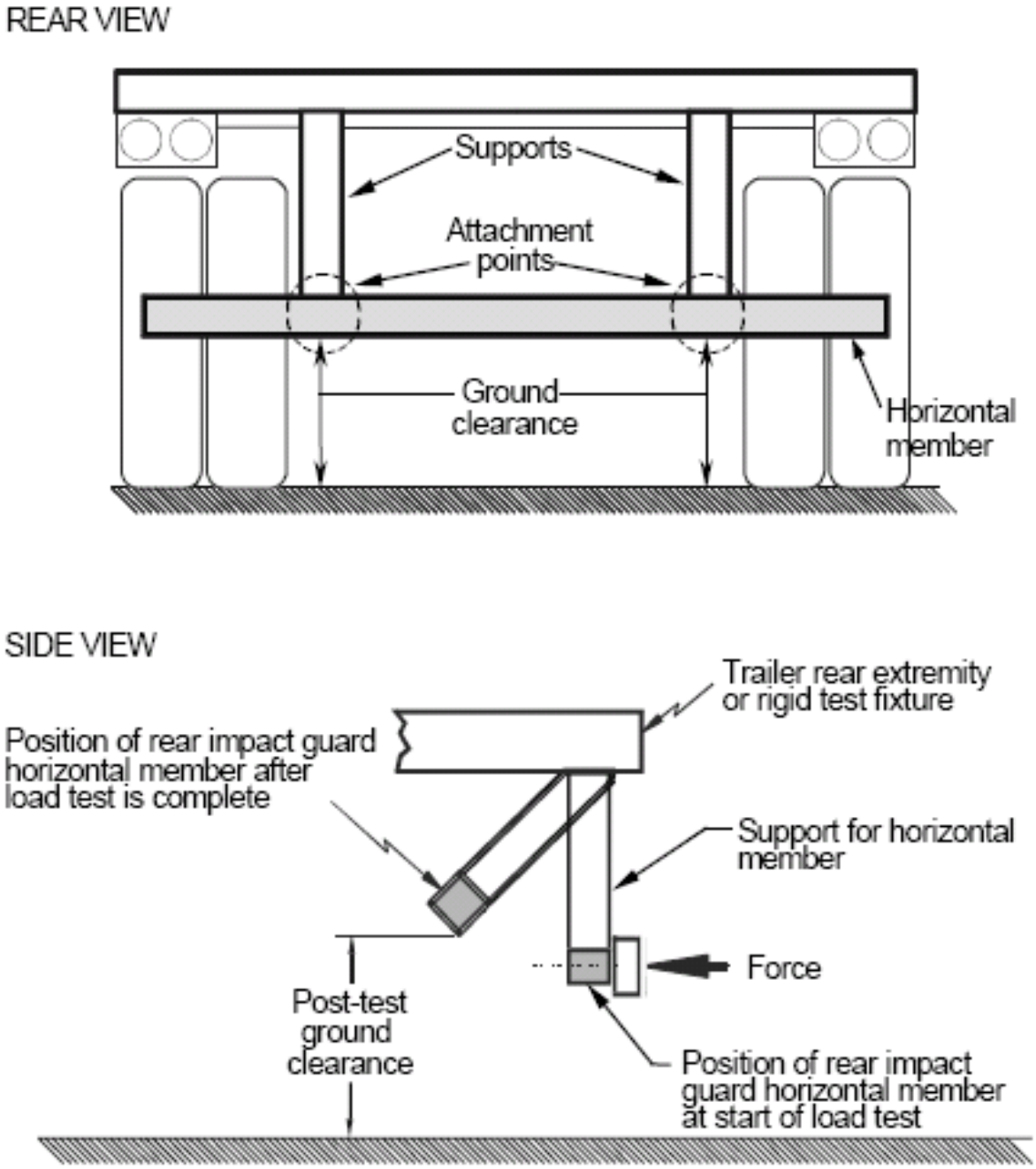


FIGURE 4: POST-TEST GROUND CLEARANCE MEASUREMENT



(Note: Drawings are not to scale)

3. Section 571.224 is amended by:

a. Revising the second sentence in S3; and;

b. Revising the definition of “Rear extremity” in S4.

The revised text reads as follows:

§ 571.224 Standard No. 224; Rear impact protection.

*** * * * ***

S3. Application. * * * The standard does not apply to pole trailers, pulpwood trailers, low chassis vehicle, road construction controlled horizontal discharge trailers, special purpose vehicles, wheels back vehicles, or temporary living quarters as defined in 49 CFR 529.2.

* * * * *

Rear extremity means the rearmost point on a trailer that is above a horizontal plane located above the ground clearance and below a horizontal plane located 1,900 mm above the ground when the trailer is configured as specified in S5.1 and when the trailer’s cargo doors, tailgate and other permanent structures are positioned as they normally are when the trailer is in motion, with non-structural protrusions excluded from the determination of the rearmost point, such as:

(a) Tail lamps,

(b) Rubber bumpers,

(c) Hinges and latches, and

(d) Flexible aerodynamic devices capable of being folded to within 305 mm from the transverse vertical plane tangent to the rear most surface of the horizontal member for

vertical heights below 1,740 mm above ground and, while positioned as they normally are when the trailer is in motion, are located forward of the transverse plane that is tangent to the rear bottom edge of the horizontal member and intersecting a point located 1,210 mm rearward of the horizontal member and 1,740 mm above the ground.

* * * * *

XI. Appendix A to Preamble: 2013 NHTSA/UMTRI Study

In 2009, the agency initiated an in-depth field analysis to obtain a greater understanding of the characteristics of underride events and factors contributing to such crashes. NHTSA sought this information to assess the need for and impacts of possible amendments to the FMVSSs to reduce severe passenger vehicle underride in truck/trailer rear end impacts.

NHTSA published the first phase of the field analysis in 2012,[66] and published the final report in March 2013. The reports analyze 2008-2009 data collected as a supplement to UMTRI's TIFA survey.[67] The TIFA survey contains data for all the trucks with a GVWR greater than 4,536 kg (10,000 lb) ("medium and heavy trucks") that were involved in fatal traffic crashes in the 50 U.S. States and the District of Columbia. TIFA data contains additional detail beyond the information contained in NHTSA's FARS.

NHTSA contracted UMTRI to collect supplemental data for 2008 and 2009 as part of the TIFA survey. The supplemental data included the rear geometry of the SUTs and trailers; type of equipment at the rear of the trailer, if any; whether a rear impact guard was present; the type of rear impact guard; and, the standards the guard was manufactured to meet. For SUTs and trailers involved in fatal rear impact crashes, additional information was collected on: the extent of underride; damage to the rear impact guard; estimated impact speeds; and whether the collision was offset or had fully engaged the guard.

NHTSA derived average annual estimates from the 2008 and 2009 TIFA data files and the supplemental information collected in the 2013 UMTRI study. The agency's review of these files found that there are 3,762 SUTs and trailers involved in fatal accidents annually, among

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[66] Analysis of Rear Underride in Fatal Truck Crashes, DOT HS 811 652, August 2012. Also available at http://www.nhtsa.gov/Research/Crashworthiness/Truck%20Underride, last accessed on March 6, 2015.
[67] Heavy-Vehicle Crash Data Collection and Analysis to Characterize Rear and Side Underride and Front Override in Fatal Truck Crashes, DOT HS 811 725, March 2013. Also available at http://www.nhtsa.gov/Research/Crashworthiness/Truck%20Underride, last accessed on March 6, 2015.

which trailers accounted for 67 percent, SUTs for 29 percent, tractors alone for 1.5 percent, and unknown for the remaining 2.5 percent.[68] About 489 SUTs and trailers are struck in the rear in fatal crashes, constituting about 13 percent of all SUTs and trailers in fatal crashes. Among rear impacted SUTs and trailers in fatal crashes, 331 (68 percent) are trailers, 151 (31 percent) are SUTs, and 7 (1 percent) are tractors alone.

Presence of Rear Impact Guard on Trailers and SUTs

UMTRI evaluated 2008 and 2009 TIFA data regarding the rear geometry of all the trailers and SUTs involved in all fatal crashes (not just those rear-impacted) to assess whether the vehicle had to have a guard under FMVSS No. 224 (regarding trailers) or the Federal Motor Carrier Safety Administration's (FMCSA's) Federal Motor Carrier Safety Regulation (FMCSR) No. 393.86(b) (49 CFR 393.86(b), "FMCSA 393.86(b)") (regarding SUTs).[69] Based on this evaluation, UMTRI estimated that 65 percent of trailers had to have a rear impact guard per FMVSS No. 224 (Table A-1). Among the 35 percent of trailers that did not have a guard because they were excluded from FMVSS No. 224, 26 percent were wheels back trailers,[70] 2 percent were low chassis vehicles,[71] 1 percent had equipment in the rear, and 6 percent were excluded vehicles because of type of cargo or operation. UMTRI estimated that although 38 percent of the SUTs involved in fatal crashes were required to have rear impact guards (based on

[68] "Bobtail" and "tractor/other" configurations were combined into the "tractors" category and "tractor/trailer" and "straight trucks with trailer" were combined into the "trailers" category.
[69] UMTRI only evaluated the rear geometry to determine whether a SUT's configuration qualified the vehicle as subject to FMCSR 393.86(b). It did not determine how the truck was operated and whether it was used in interstate commerce.
[70] Wheels back trailers, defined in FMVSS No. 224, is a trailer or semitrailer whose rearmost axle is permanently fixed and is located such that the rearmost surface of tires is not more than 305 mm forward of the rear extremity of the vehicle.
[71] Low chassis trailers are defined in FMVSS No. 224, and are trailer or semitrailer having a chassis that extends behind the rearmost point of the rearmost tires and a lower rear surface that meets the configuration (width, height, and location) requirements for an underride guard.

the truck rear geometry according to FMCSR 393.86(b)), only 18 percent were equipped with them (Table A-1). It is likely that the remaining 20 percent of the SUTs that were configur888 ed such that they would be subject to FMCSR 393.86(b) based on vehicle design, but that did not have a guard, were not used in interstate commerce. Among the 62 percent of SUTs that were excluded from installing rear impact guards by the FMCSR, 27 percent were wheels back SUTs,[72] 9 percent were low chassis SUTs,[73] 2 percent were wheels back and low chassis SUTs, and 16 percent had equipment in the rear that interfered with rear impact guard installation (see Table A-1).

Table A-1: Percentage of trailers and SUTs by their rear geometry and whether a rear impact guard was required according to UMTRI's evaluation of SUTs and trailers involved in fatal crashes in the 2008-2009 TIFA data files.

Type of Rear Geometry	Percentage of Trailers	Percentage of SUTs
Rear Impact Guard Required		
Guard present	65%	18%
Guard not present	0%	20%
Rear Impact Guard Not Required		
Excluded vehicle	6%	8%
Wheels back vehicle	26%	27%
Low chassis vehicle	2%	9%
Wheels back and low chassis vehicle	0%	2%
Equipment	1%	16%

Since the data presented in Table A-1 takes into consideration all SUTs and trailers involved in all types of fatal crashes in 2008 and 2009 (total of 2,159 trucks and 5,231 trailers), we make the assumption that the percentage of SUTs and trailers with and without rear impact guards in Table A-1 is representative of that in the SUT and trailer fleet.

[72] Wheels back SUTs according to FMCSR 393.86(b) is where the rearmost axle is permanently fixed and is located such that the rearmost surface of the tires is not more than 610 mm forward of the rear extremity of the vehicle.
[73] Low chassis SUTs according FMCSR 393.86(b) is where the rearmost part of the vehicle includes the chassis and the vertical distance between the rear bottom edge of the chassis assembly and the ground is less than or equal to 762 mm (30 inches).

Light Vehicle Fatal Crashes into the Rear of Trailers and SUTs

Among the types of vehicles that impacted the rear of trailers and SUTs, 73 percent were light vehicles,[74] 18 percent were large trucks, 7.4 percent were motorcycles, and 1.7 percent were other/unknown vehicle types. Since we do not expect trucks and buses to underride other trucks in rear impacts, the data presented henceforth only apply to light vehicles impacting the rear of trailers and SUTs.

Underride Extent in Fatal Crashes of Light Vehicles into the Rear of Trailers and SUTs

In the UMTRI study of 2008 and 2009 TIFA data, survey respondents estimated the amount of underride in terms of the amount of the striking vehicle that went under the rear of the struck vehicle and/or the extent of deformation or intrusion of the vehicle. The categories were "no underride," "less than halfway up the hood," "more than halfway but short of the base of the windshield," and "at or beyond the base of the windshield." When the extent of underride is "at or beyond the base of the windshield," there is PCI that could result in serious injury to occupants in the vehicle. Rear impacts into trailers and SUTs could result in some level of underride without PCI when the rear impact guard prevents the impacting vehicle from traveling too far under the heavy vehicle during impact. Such impacts into the rear of heavy vehicles without PCI may not pose additional crash risk to light vehicle occupants than that in crashes with another light vehicle at similar crash speeds.

The data show that about 319 light vehicle fatal crashes into the rear of trailers and trucks occur annually. UMTRI determined that about 36 percent (121) of light vehicle impacts into the rear of trailers and trucks resulted in PCI. Among fatal light vehicle impacts, the frequency of PCI was greatest for passenger cars and sport utility vehicles (SUVs) (40 and 41.5 percent,

[74] UMTRI categorized passenger cars, compact and large sport utility vehicles, minivans, large vans (e.g. Econoline and E150-E350), compact pickups (e.g., S-10, Ranger), and large pickups (e.g Ford F100-350, Ram, Silverado) as light vehicles.

respectively) and lowest for large vans and large pickups (25 and 26 percent, respectively), as shown in Figure A-1 below. Since the extent of underride was also determined by the extent of deformation and intrusion of the vehicle, it was observed in a number of TIFA cases that large vans and large pickups did not actually underride the truck or trailer but sustained PCI because of the high speed of the crash and/or because of the very short front end of the vehicle.

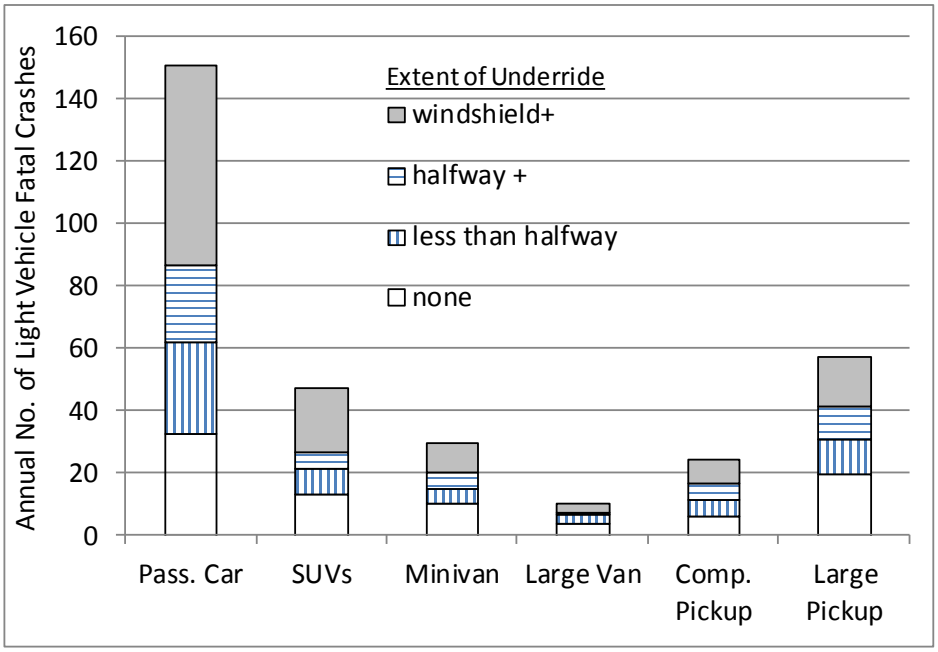


Figure A-1: Annual light vehicle fatal crashes into the rear of trailers and SUTs by type of light vehicle and extent of underride[75] (2008-2009 TIFA UMTRI study).

Fatal light vehicle crashes into the rear of trailers and trucks were further examined by the type of trailer and truck struck and whether a guard was required (according to FMVSS No. 224 for trailers and FMCSR 393.86(b) for SUTs) (Figure A-2 and Figure A-3).

Among the 319 annual fatal light vehicle crashes into the rear of trailers and SUTs, 23 (7 percent) are into SUTs with guards, 79 (25 percent) are into SUTs without guards, 115 (36

[75] The extent of underride in this and subsequent figures and tables means the following: None means "no underride"; less than halfway means "underride extent of less than halfway up the hood"; halfway+ means "underride extent at or more than halfway up the hood but short of the base of the windshield"; windshield+ means "extent of underride at or beyond the base of the windshield" or PCI.

percent) are into trailers with guards, 44 (14 percent) into wheels back trailers, 15 (5 percent) into exempt trailers (due to equipment in rear, type of operation, low bed), and 43 (13 percent) are other types of trucks (Figure A-2).

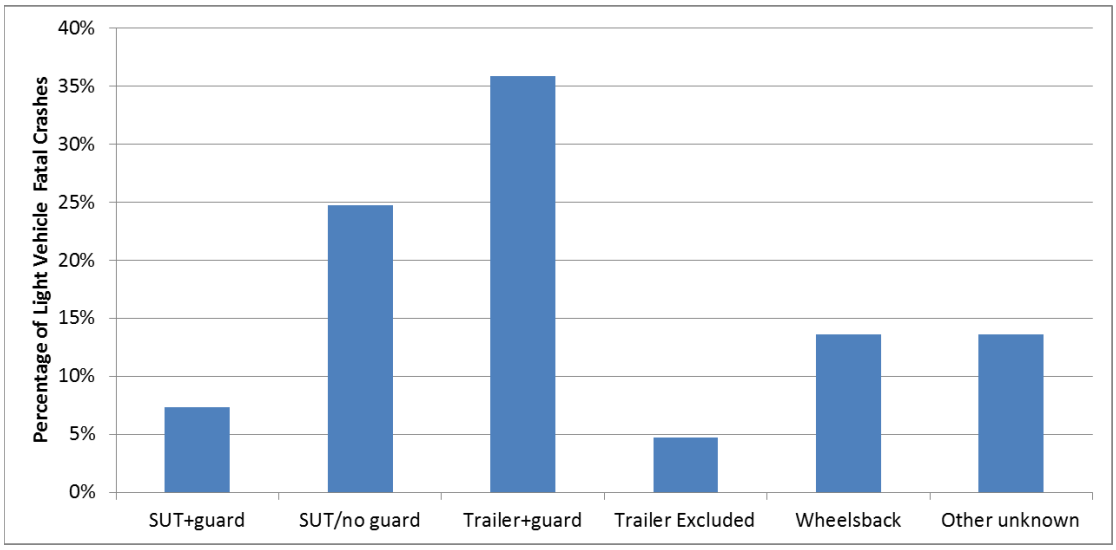
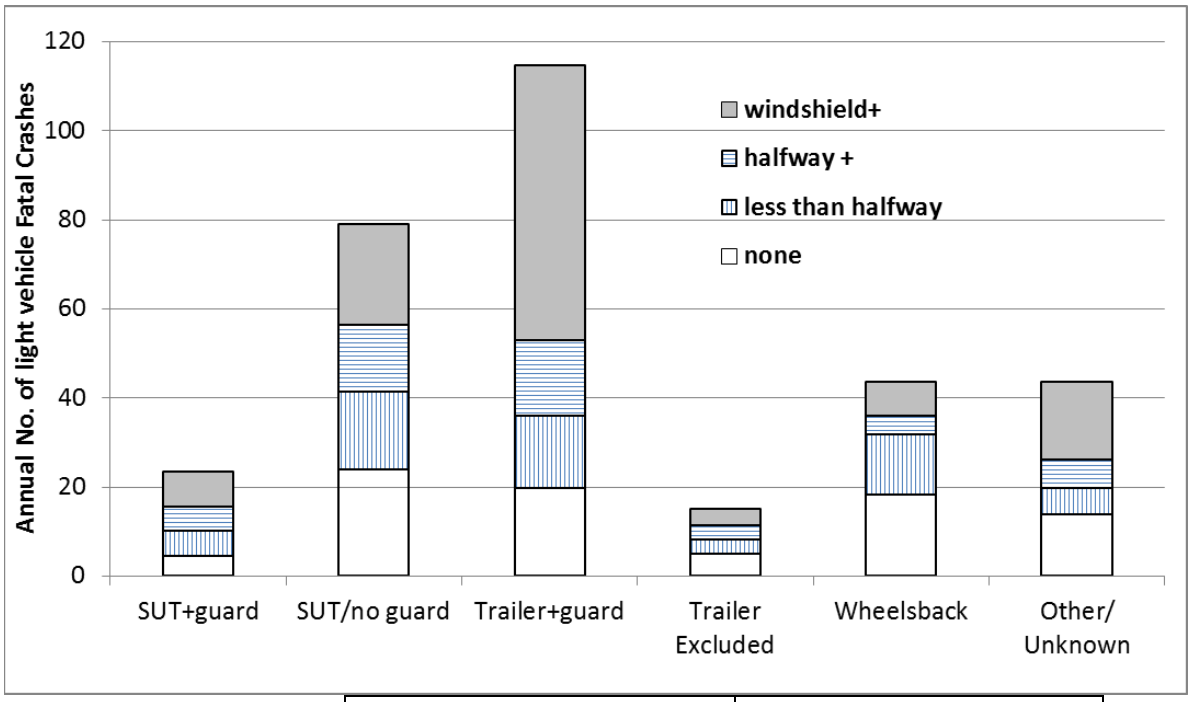


Figure A-2: Percentage of light vehicle fatal crashes into the rear of trailers and SUTs (2008-2009 TIFA UMTRI Study)

Among these light vehicle fatal crashes annually, 121 result in PCI, among which 62 (51 percent) occur in impacts with trailers with guards, 23 (19 percent) in impacts with SUTs without guards, 8 (7 percent) in impacts with SUTs with guards, 7 (6 percent) in impacts with wheels back trailers, 4 (3 percent) with excluded trailers (by type of cargo or operation), and 17 (14 percent) in impacts with other truck/trailer type (Figure A-3).[76]

[76] Underride extent was determined for 303 light vehicles, about 95 percent of the 319 light vehicle impacts into the rear of trailers and trucks. Unknown underride extent was distributed among known underride levels.



	Light vehicle fatal crashes into the rear of trailers & SUTs		Light vehicle fatal PCI crashes into the rear of trailers & SUTs	
	Annual #	Percentage	Annual #	Percentage
SUT+guard	23	7%	8	7%
SUT/no guard	79	25%	23	19%
Trailer+guard	115	36%	62	51%
Trailer Exempt	15	5%	4	3%
Wheelsback	44	14%	7	6%
Other/unknown	43	13%	17	14%
Total	319		121	

Figure A-3: Annual light vehicle fatal crashes into the rear of trailers and SUTs by type of truck/trailer and extent of underride.

It is noteworthy that trailers with guards represent 36 percent of annual light vehicle fatal rear impacts but represent 51 percent of annual light vehicle fatal rear impacts with PCI. On the other hand, SUTs (with and without guards) represent 32 percent of annual light vehicle fatal rear impacts but represent 26 percent of annual light vehicle fatal rear impacts with PCI. The field data suggest that there are more light vehicle fatal impacts into the rear of trailers than

SUTs and a higher percentage of fatal light vehicle impacts into the rear of trailers involve PCI than those into the rear of SUTs.

Relative Speed of Light Vehicle Fatal Crashes into the Rear of Trailers and SUTs

Using information derived by reviewing police crash reports,[77] UMTRI estimated the relative speed of fatal light vehicle crashes into the rear of SUTs and trailers. Relative velocity was computed as the resultant of the difference in the trailer (truck) velocity and the striking vehicle velocity and could only be estimated for about 30 percent of light vehicle fatal crashes into the rear of trailers and SUTs. Most of the crashes (with known relative velocity) were at a very high relative velocity and many were not survivable. The mean relative velocity at impact into the rear of trailers and SUTs was estimated at 44 mph. Among fatal light vehicle impacts into the rear of trailers that resulted in PCI, 74 percent were with relative velocity greater than 56 km/h (35 mph) (Figure A-4). Among the remaining 26 percent fatal light vehicle impacts into the rear of trailers, 21 percent were trailers with guards and 5 percent were trailers excluded from FMVSS No. 224 requirements. Among fatal light vehicle impacts into the rear of SUTs that resulted in PCI, 70 percent were with relative velocity greater than 56 km/h (35 mph). Among the remaining 30 percent fatal light vehicle impacts into the rear of SUTs, 3 percent of the SUTs had rear impact guards, 10 percent of the SUTs could be required to have a guard based on rear geometry but did not have a guard, 3 percent were excluded from requiring a guard (wheels back, low chassis vehicles), and 14 percent had equipment in the rear precluding rear impact guards.

[77] Information included police estimates of travel speed, crash narrative, crash diagram, and witness statements. The impact speed was estimated from the travel speed, skid distance, and an estimate of the coefficient of friction.

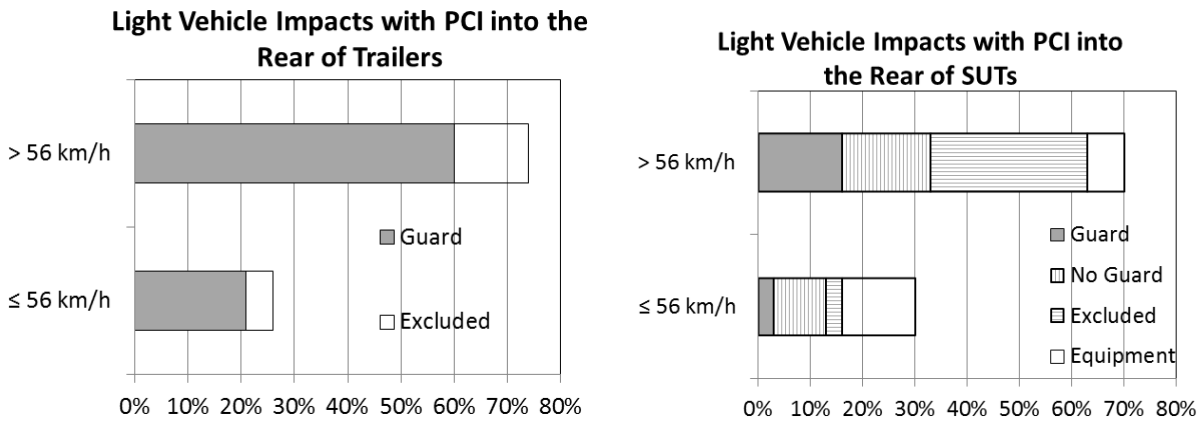


Figure A-4: Percentage of fatal light vehicle crashes into the rear of trailers and SUTs that resulted in passenger compartment intrusion - categorized by the relative speed of the crash, presence of rear impact guard, exclusion, and equipment in rear of vehicle.

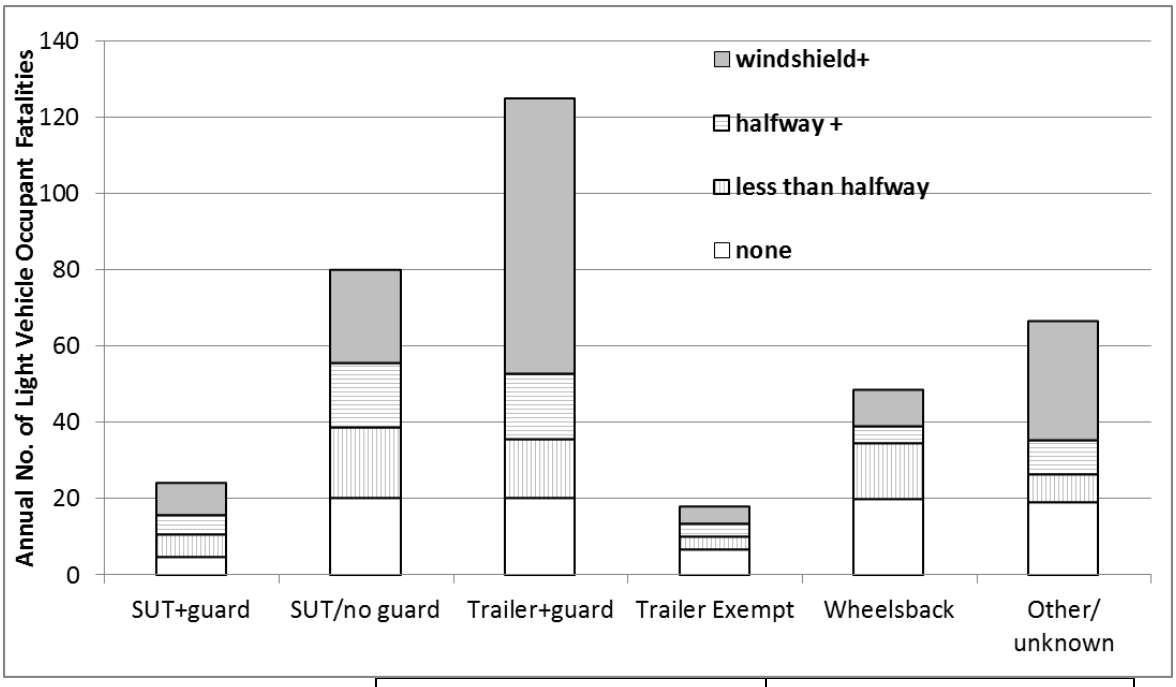
Fatalities Associated with Light Vehicle Crashes into the Rear of Trailers and SUTs

There are about 362 light vehicle occupant fatalities annually due to impacts into the rear of trailers and SUTs. Of these fatalities, 191 (53 percent) are in impacts with trailers, 104 (29 percent) are in impacts with SUTs, and 67 (18 percent) are impacts with an unknown truck type (Figure 5).

Among the 191 light vehicle occupant fatalities resulting from impacts with the rear of trailers, 125 occurred in impacts with trailers with rear impact guards while the remaining 66 were in impacts to trailers without guards (trailers excluded from a requirement to have a rear impact guard). PCI was associated with 86 annual light vehicle occupant fatalities resulting from impacts into the rear of trailers; 72 of these fatalities were in impacts with trailers with rear impact guards and 14 with trailers without guards (see Figure A-5).

Among the 104 light vehicle occupant fatalities resulting from impacts with the rear of SUTs, 80 occurred in impacts with SUTs without rear impact guards while the remaining 24 were in impacts to SUTs with guards. PCI was associated with 33 annual light vehicle occupant

fatalities resulting from impacts into the rear of SUTs; 25 of these fatalities were in impacts with SUTs without rear impact guards and 8 with SUTs with guards (see Figure A-5).



	Light vehicle fatalities in crashes into the rear of trailers & SUTs		Light vehicle fatalities in PCI crashes into the rear of trailers & SUTs	
	Annual #	Percentage	Annual #	Percentage
SUT+guard	24	7%	8	5%
SUT/no guard	80	22%	25	17%
Trailer+guard	125	35%	72	48%
Trailer Exempt	18	5%	5	3%
Wheels back	48	13%	9	6%
Other/unknown	67	19%	31	21%
Total	362		150	

Figure A-5: Annual light vehicle occupant fatalities in impacts into the rear of trailers and SUTs categorized by the geometry of the rear of the impacted vehicle and the extent of underride.

Among light vehicle occupant fatalities in impacts into the rear of trailers and SUTs, approximately 60 percent were in vehicles with no underride, underride less than halfway or

underride up to the hood without PCI. The agency found that in a number of TIFA cases reviewed, fatalities in non-PCI crashes into the rear of trailers and SUTs occurred due to occupants being unrestrained, other occupant characteristics (e.g. age), and other crash circumstances. Additionally, as shown in Figure A-4, 26 percent and 30 percent of light vehicle impacts with PCI into the rear of trailers and SUTs, respectively, had a relative velocity less than or equal to 56 km/h (35 mph). Since currently manufactured light vehicles are subject to FMVSS No. 208 requirements that ensure adequate occupant crash protection to restrained occupants in a 56 km/h (35 mph) rigid barrier frontal crash test, some light vehicle occupant fatalities in impacts into the rear of SUTs and trailers at speeds less than or equal to 56 km/h (35 mph) that resulted in PCI may be preventable if intrusion into the passenger compartment were mitigated.[78]

[78] Some of the fatalities associated with PCI may also be due to unrestrained status of the occupant.

XII. Appendix B to Preamble: Summary of IIHS's Evaluation of Rear Impact Guards

In 2010, IIHS completed a review of the Large Truck Crash Causation Study (LTCCS)[79] database to evaluate fatal crashes of vehicles into the rear of heavy vehicles.[80] IIHS reviewed 115 LTCCS cases of vehicle underride into the rear of heavy vehicles and documented the presence and type of underride guard and performance of the guard in mitigating underride. Among the 115 cases reviewed, nearly half of the passenger vehicles had underride classified as severe or catastrophic. IIHS noted that for the cases involving trailers with rear impact guards, guard deformation or complete failure of the guard was frequent and commonly due to weak attachments, buckling of the trailer chassis, and bending of the lateral end of the guard under low overlap loading. IIHS stated that 57 percent of the heavy vehicles in the 115 LTCCS cases were excluded from FMVSS No. 224 requirements by the standard, among which a large proportion were wheels back vehicles and single unit trucks (SUTs) such as dump trucks. IIHS was not able to estimate the crash speeds in its review of the LTCCS cases.

Following the review, in 2011, IIHS conducted an initial round of crash tests in which the front of a model year (MY) 2010 Chevrolet Malibu (a midsize sedan) impacted the rear of trailers equipped with an underride guard.[81] A 50th percentile male Hybrid III dummy (HIII 50M) was in each of the front outboard seating positions of the Malibu. Three trailer/guard designs (2007 Hyundai, 2007 Vanguard, and 2011 Wabash trailers) were evaluated in various conditions. Each guard design was certified to FMVSS No. 223 requirements, and two

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[79] Supra.
[80] Brumbelow, M.L., Blanar, L., "Evaluation of US Rear Underride Guard Regulation for Large Trucks Using Real World Crashes." Proceedings of the 54th Stapp Car Crash Conference, 119-31, 2010. Warrendale, PA, SAE International.
[81] Brumbelow, M. L., "Crash Test Performance of Large Truck Rear Impact Guards," 22nd International Conference on the Enhanced Safety of Vehicles (ESV), 2011. http://www-nrd.nhtsa.dot.gov/pdf/esv/esv22/22ESV-000074.pdf. Last accessed on April 2, 2015.

(Vanguard and Wabash) also met the more stringent CMVSS No. 223 requirements. A 2010 Chevrolet Malibu was first crashed into a trailer at 56 km/h (35 mph) with full overlap (the overlap refers to the portion of the Malibu's width overlapping the underride guard). If the rear impact guard of a trailer model was successful in preventing passenger compartment intrusion in the full overlap crash test, a new Malibu was crashed into a new trailer of the same model with 50 percent overlap of the Malibu. If the rear impact guard was successful in preventing PCI in this case as well, a third test was performed with only 30 percent overlap of the Malibu.

The test results showed that the full overlap 56 km/h (35 mph) crash test of the Malibu with the guard of the Hyundai trailer (built to only FMVSS No. 223 requirements) resulted in catastrophic underride with PCI of the Chevrolet Malibu. The guard on the Vanguard trailer that complied with the upgraded CMVSS No. 223 rear impact guard requirements could not prevent PCI in a 56 km/h (35 mph) crash test with 50 percent overlap of the Malibu because the attachments of the guard to the trailer failed. The rear impact guard on the Wabash trailer, also certified to meet CMVSS No. 223 requirements, prevented PCI in 35 mph crash tests with full and 50 percent overlap of the Malibu, but could not prevent PCI in the crash test with 30 percent overlap.

Quasi-Static Load Testing of Rear Impact Guards

To compare the static performance of the guards, IIHS conducted quasi-static load tests using a 203 mm square force application device (similar to that specified in FMVSS No. 223) at P1 and P3 locations of the horizontal member of the rear impact guards on the Hyundai, Vanguard and Wabash trailers. The load was applied at a rate of 1.3 mm/sec until the force application device displaced 125 mm. Figure B-1 below shows the force-displacement curves for all three guards in the quasi-static test at the P3 location.

Deformation patterns of the underride guards varied substantially in the quasi-static tests. In the test at P3 location on the Hyundai guard, a peak force of 163,000 N was achieved and then the vertical support member of the Hyundai guard was pulled slowly from some of the bolts attaching it to the fixture, whereas the vertical member itself deformed only minimally. In the test at P3 of the Vanguard guard, the vertical member flexed for the first 50 mm of loading achieving a peak load of 257,000 N and then the attachment bolts began to shear, causing the measured force to drop below that measured for the Hyundai later in the test. The Wabash guard reached its peak force of 287,000 N earliest, and then the vertical member began buckling near its attachment to the horizontal member. As the buckling continued, the rear surface of the guard eventually bottomed out against the diagonal gusset, causing the load to increase again late in the test. The Hyundai rear impact guard absorbed 13,900 J of energy, the Vanguard guard absorbed 14,000 J of energy, and the Wabash guard absorbed 22,100 J of energy in the P3 point-load tests.

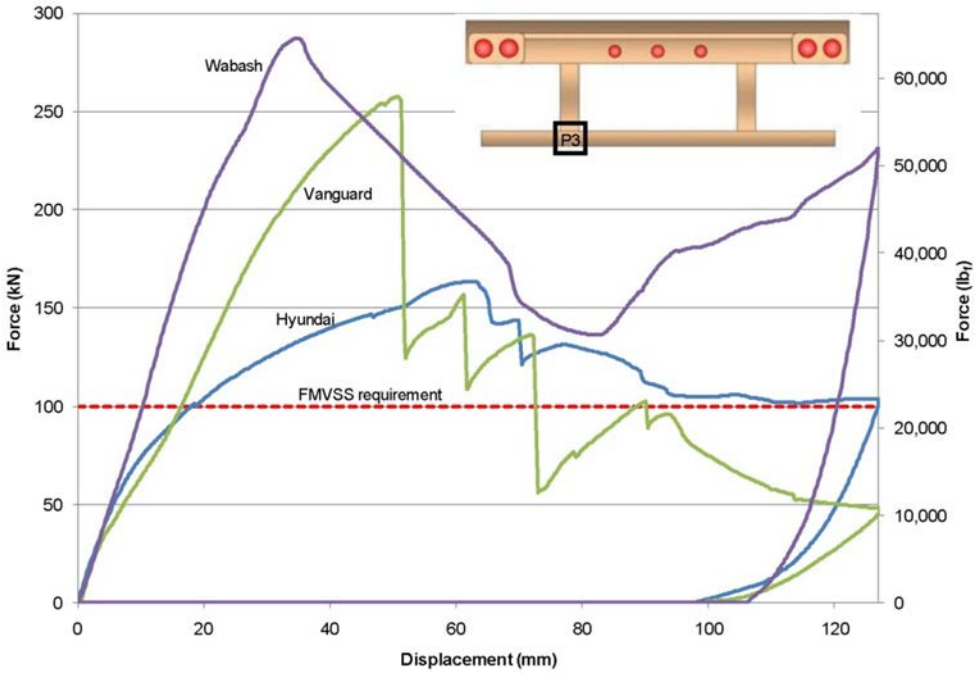

Figure B-1: IIHS quasi-static test at P3 of the 2007 Hyundai, 2007 Vanguard, and 2011 Wabash trailer rear impact guards.

Table B-1 summarizes the results of the initial five IIHS 56 km/h (35 mph) crash tests. In the first test, the 2007 Hyundai guard was ripped from the trailer's rear cross member early in the crash, allowing the Malibu to underride the trailer almost to the B-pillar. The heads of both dummies were struck by the hood of the Malibu as it deformed against the rear surface of the trailer. Under the same test conditions, the main horizontal member of the 2011 Wabash guard bent forward in the center but remained attached to the vertical support members, which showed no signs of separating from the trailer chassis.

Table B-1: Results of IIHS initial round of 56 km/h crash tests of the 2010 Chevrolet Malibu into the rear of trailers.

Conditions	Trailer	Guard performance	Underride	Max. longitudinal A-pillar deformation (cm)
100% overlap	2007 Hyundai	Attachments failed	Catastrophic	80
	2011 Wabash	Good	None	0
50% overlap	2007 Vanguard	Attachments failed	Severe	27
	2011 Wabash	End bent forward	None	6
30% overlap	2011 Wabash	End bent forward	Catastrophic	87

Table B-2 summarizes the peak injury measures[82] of the HIII 50M dummies in the front seating positions of the Malibu. For comparison purposes, Table B-2 also presents the HIII 50M dummy injury measures in the full frontal 56 km/h rigid barrier crash test of the 2010 Chevrolet Malibu conducted as part of NHTSA's New Car Assessment Program (NCAP). Head injury measures recorded by the dummies in the tests with severe underride were much higher than those reported for the Malibu's NCAP rigid wall test at the same speed. Chest acceleration and deflection measures were generally higher in tests without PCI than those with PCI.[83] The frontal air bag deployed in the 100, 50, and 30 percent overlap crash tests of the Malibu into the

[82] HIII 50M dummy injury measures are those applicable to current model passenger vehicles as specified in FMVSS No. 208, see http://www.ecfr.gov/cgi-bin/text-idx?SID=77e2aab5d088f2e9b46d15606090f9b0&node=se49.6.571_1208&rgn=div8.

[83] When PCI was prevented by the rear impact guard, the accelerations on the vehicle are higher which results in higher chest injury measures.

rear of the Wabash trailer. The driver and passenger injury measures in the Malibu full width crash test with the Wabash trailer (where the guard prevented PCI) was similar to the injury measures in the Malibu NCAP frontal crash test.

Table B-2: IIHS initial round of testing – Injury measures of dummies in front seating positions of the Malibu

Test			Head Resultant acceleration (g)	Head Injury Criterion (15 ms)	Chest Resultant Acceleration (3 ms clip, g)	Chest Displacement (mm)	Left Femur Force (kN)	Right Femur Force (kN)
Injury Assessment Reference Values				**700**	**60 g**	**63 mm**	**10 kN**	**10 kN**
Full-width	Hyundai	*Driver*	128	754	21	19	0.3	0.3
		Passenger	107	557	14	20	0.1	0.1
	Wabash	*Driver*	54	328	36	38	2.2	1.2
		Passenger	50	319	36	37	2.3	1.8
	NCAP (rigid wall)	*Driver*	49	330	43	40	2.0	1.2
		Passenger	55	389	42	32	0.5	0.8
50% overlap	Vanguard	*Driver*	109	254	14	20	2.2	0
	Wabash	*Driver*	36	160	25	33	3.7	0.9
30% overlap	Wabash	*Driver*	130	880	37	16	0.6	0.1

Following the preliminary crash tests in 2011, IIHS conducted similar crash tests of a 2010 Chevrolet Malibu sedan with eight additional 2012 and 2013 model year trailers from various manufacturers, including newly redesigned Hyundai and Vanguard models. All guards in this round of testing were not only certified as complying with FMVSS No. 223 but were also certified as complying with CMVSS No. 223.

Table B-3 presents certification data from trailer manufacturers showing compliance with CMVSS No. 223. Only one trailer manufacturer utilized an option in CMVSS No. 223 to test using half the guard with a point load force application of 175,000 N at P3, while the other rear impact guards were certified with the uniform distributed quasi-static load application of 350,000 N on the full guard. All the rear impact guards tested also complied with the CMVSS requirement that the ground clearance of the guard after the test not exceed 560 mm.

Table B-3: Trailer manufacturers' certification data (CMVSS No. 223) of rear impact guards

	P1	P2	Uniform Distributed Load	Uniform (1/2 of guard)
Requirement :	**50 kN**	**50 kN**	**350 kN / 20 kJ**	**175 kN / 10 kJ**
Strick	50.7	50.5		233.4 kN / 18.9 kJ
Vanguard	*50	*50	370.1 kN / 25.3 kJ	
Hyundai/ Translead	51.6	53.6	367.5 kN / 37.5 kJ	
Stoughton	53.7	56	404.6 kN @ 101.6mm/ 31.2 kJ	
Great Dane	*50	*50	386.7 kN @ 125mm / 28.8 kJ	
Manac	55.1	55.8	37.5 kN / 25.0 kJ	

* Loaded until 50 kN reached

The ground clearance of the bumper (vertical distance of the bottom of the bumper from the ground) of the 2010 Chevrolet Malibu is 403 mm and the vertical height of the bumper is 124 mm. Therefore, the Malibu bumper is located at a vertical height between 403 mm and 527 mm above the ground with its centerline located 465 mm above ground. The vertical height of the top of the engine block from the ground is 835 mm. The ground clearance of the horizontal member of each rear impact guard ranged between 400 mm and 498 mm (Table B-4).

Table B-4: Trailer guard ground clearance

Trailer	Guard Ground Clearance (mm)
2011 Wabash	445
2012 Manac	498
2012 Stoughton	477
2013 Great Dane	400
2012-2013 Hyundai	409
2013 Strick	413
2013 Utility	455
2013 Vanguard	452

Table B-5, Table B-6, and Table B-7 present the extent of underride, deformation of the Malibu, performance of the guard, and whether there was PCI in the 56 km/h (35 mph) frontal

impact crash tests of the Malibu into the rear of trailers with full overlap, 50 percent overlap, and 30 percent overlap of the Malibu, respectively.

All the rear impact guards on the trailers that were compliant with CMVSS No. 223 were able to prevent passenger compartment intrusion in full overlap crashes. In the tests with 50 percent overlap of the Malibu, all the guards except the 2013 Vanguard was able to prevent PCI. The Vanguard rear impact guard failed at the attachments where the bolts sheared off during the crash resulting in PCI of the Malibu. All the rear impact guards tested except the 2012 Manac guard were not able to prevent PCI in the 30 percent offset crash tests of the Malibu.

Table B-5: Rear impact guard performance in frontal impact crash tests of a 2010 Chevrolet Malibu into the rear of trailers with full overlap with the guard

2010 Chevrolet Malibu Into Trailer - Crash Test Results (100% Overlap @ 56 km/h)								
Trailer	**Guard Performance**			**PCI (due to underride)**	**Max. longitudinal deformation (cm)**		**Underride* (cm)**	**Peak Impulse (g at ms)**
	Overall	**Fastener Breakage**	**Material Failure**		**A-Pilar**	**Roof**		
2011 Wabash	Good	None	None	None	0	0	99	30g at 82ms
2012 Manac	Good	Some	None	None**	0	0	135	18g at 101ms
2012 Stoughton	Good	None	None	None	0	0	117	25g at 85ms
2013 Great Dane	Good	None	None	None	0	0	96	21g at 109ms
2012 Hyundai	Good	None	None	None	0	0	92	23g at 49ms
2013 Strick	Good	None	None	None**	0	0	121	26g at 93ms
2013 Utility	Good	None	None	None	0	0	99	30g at 47ms
2013 Vanguard	Good	Some	Some Tearing	None**	0	0	94	34g at 80ms
**Calculated by relative center of mass positions collected at initial impact and maximum displacement.*								
*** Windshield shattered*								

Table B-6: Rear impact guard performance in frontal impact crash tests of a 2010 Chevrolet Malibu into the rear of trailers with 50 percent overlap with the guard

2010 Chevrolet Malibu Into Trailer - Crash Test Results (50% Overlap @ 56 km/h)								
Trailer	**Guard Performance**			**PCI (due to underride)**	**Max. longitudinal deformation (cm)**		**Underride* (cm)**	**Peak Impulse (g at ms)**
	Overall	**Fastener Breakage**	**Material Failure**		**A-Pilar**	**Roof**		
2011 Wabash	Good	None	None	None**	6	None	135	19g at 95ms
2012 Manac	Good	None	None	None**	0	None	129	19g at 50ms
2012 Stoughton	Good	None	None	None**	11	None	147	14g at 66ms
2013 Great Dane	Good	Some	None	None**	0	None	152	14g at 97ms
2013 Hyundai	Good	None	None	None**	0	None	116	16g at 49ms
2013 Strick	Good	None	None	None**	15	None	146	15g at 80ms
2013 Utility	Good	None	None	None**	5	None	139	18g at 58ms
2013 Vanguard	Fail (fully detached)	Extensive	Extensive	Trailer rear sill directly contacted dummy head	146	Extensive	205	17g at 48ms

**Calculated by relative center of mass positions collected at initial impact and maximum displacement.*

***Windshield shattered*

Table B-7: Rear impact guard performance in frontal impact crash tests of a 2010 Chevrolet Malibu into the rear of trailers with 30 percent overlap with the guard

2010 Chevrolet Malibu Into Trailer - Crash Test Results (30% Overlap @ 56 km/h)								
Trailer	**Guard Performance**			**PCI (due to underride)**	**Max. longitudinal deformation (cm)**		**Underride* (cm)**	**Peak Impulse (g at ms)**
	Overall	**Fastener Breakage**	**Material Failure**		**A-Pilar**	**Roof**		
2011 Wabash	Fail	None	None	Extensive***	87	33	242	Not Reported
2012 Manac	Good	Some	None	None**	5	None	160	17g at 66ms
2012 Stoughton	Fail	None	None	Extensive***	89	Extensive	218	12g at 144ms
2013 Great Dan	Fail	None	None	Extensive***	111	Extensive	244	18g at 151ms
2013 Hyundai	Fail	None	None	Extensive***	112	Extensive	242	18g at 200ms
2013 Strick	Fail	None	None	Extensive***	117	Extensive	245	16g at 202ms
2013 Utility	Fail	None	None	Extensive***	123	Extensive	237	10g at 225ms
2013 Vanguard	*Not tested due to failure of 50% overlap test at 56kph*							

**Calculated by relative center of mass positions collected at initial impact and maximum displacement.*

***Windshield shattered*

****Trailer rear sill directly contacted dummy head*

Table Table B-8 presents the injury measures of crash test dummies (HIII-50M) in the driver and front passenger seating positions in 56 km/h (35 mph) crash tests conducted by IIHS with 100 percent overlap of the 2010 Malibu with rear impact guard.

Table B-9 and Table B-10 present the injury measures for the HIII-50M in the driver position in 56 km/h (35 mph) crash tests with 50 percent and 30 percent overlap of the 2010 Malibu with the rear impact guard, respectively.

The frontal air bags deployed in all the 100 percent and 50 percent overlap crash tests of the Malibu into the rear of 2011-2013 model year trailers. The air bag deployed in the 30 percent overlap crash tests of the Malibu into the rear of 2011-2013 model year trailers except for the tests into the rear of the 2012 Hyundai, 2013 Great Dane, and 2013 Strick trailer. When the Malibu experienced PCI in a crash test, the dummy injury measures, specifically the head injury criterion (HIC) and the neck injury criterion (Nij) generally exceeded the allowable Injury Assessment Reference Values (IARV) of 700 and 1.0 set forth in FMVSS No. 208, respectively, regardless of whether the air bag deployed.[84] When PCI was prevented by the rear impact guard, the accelerations on the vehicle are higher which results in higher chest deflection measures, although well within the allowable level, indicating higher acceleration loads on the dummy.

[84] Except in the neck injury measure (Nij = 0.65) in the 50 percent overlap crash with the Vanguard trailer.

Table B-8: Dummy injury measures in frontal impact crash tests of a 2010 Chevrolet Malibu into the rear of trailers with full overlap with the rear impact guard

2010 Chevrolet Malibu Into Trailer - Driver HIII 50M Injury Measures (100% overlap @ 56 km/h)								
Trailer	**Driver**				**Passenger**			
	HIC-15 (700)	**Max N_{ij} (1.00)**		**Rib Compression (63mm)**	**HIC-15 (700)**	**Max N_{ij} (1.00)**		**Rib Compression (63mm)**
2011 Wabash	328	0.33	Tension-Flexion	38	319	0.35	Compression-Extension	37
2012 Manac	206	0.28	Tension-Flexion	35	143	0.38	Tension-Flexion	37
2012 Stoughton	267	0.37	Tension-Flexion	40	265	0.37	Tension-Flexion	37
2013 Great Dane	49	0.22	Tension-Extension	32	65	0.16	Compression-Extension	35
2012 Hyundai	54	0.22	Tension-Flexion	39	110	0.20	Tension-Flexion	35
2013 Strick	107	0.26	Tension-Flexion	39	125	0.32	Tension-Flexion	37
2013 Utility	130	0.25	Tension-Flexion	37	173	0.33	Tension-Flexion	33
2013 Vanguard	212	0.31	Tension-Flexion	35	237	0.40	Tension-Flexion	31

Table B-9: Dummy injury measures in frontal impact crash tests of a 2010 Chevrolet Malibu into the rear of trailers with 50 percent overlap with the rear impact guard

2010 Chevrolet Malibu Into Trailer - Driver HIII 50M Injury Measures (50% overlap @ 56 km/h)				
Trailer	**HIC-15 (700)**	**Max N_{ij} (1.00)**		**Rib Compression (63mm)**
2011 Wabash	101	0.23	Tension-Flexion	33
2012 Manac	38	0.13	Tension-Flexion	29
2012 Stoughton	65	0.17	Tension-Flexion	25
2013 Great Dane	78	0.24	Tension-Flexion	28
2013 Hyundai	155	0.35	Compression-Extension	32
2013 Strick	163	0.18	Tension-Flexion	27
2013 Utility	37	0.17	Tension-Flexion	30
2013 Vanguard	1954	0.35	Compression-Flexsion	21

Table B-10: Dummy injury measures in frontal impact crash tests of a 2010 Chevrolet Malibu into the rear of trailers with 30 percent overlap with the rear impact guard

2010 Chevrolet Malibu Into Trailer - Driver HIII 50M Injury Measures (30% overlap @ 56 km/h)				
Trailer	**HIC-15 (700)**	**Max N_{ij} (1.00)**		**Rib Compression (63mm)**
2011 Wabash	880	1.16	Tension-Extension	16
2012 Manac	58	0.28	Tension-Flexion	31
2012 Stoughton	9069	1.23	Tension-Extension	14
2013 Great Dane	8708	2.45	Tension-Extension	16
2013 Hyundai	7346	1.94	Tension-Extension	19
2013 Strick	7742	2.38	Compression-Flexsion	19
2013 Utility	7415	2.55	Tension-Extension	17
2013 Vanguard	*Not tested due to failure of 50% overlap test at 56 km/h*			

Summary of the IIHS Test Data

The test data, summarized in Table B-11 and Table B-12 below, show that trailer guards compliant with FMVSS No. 223 were unable to withstand an impact of the Malibu at 56 km/h (35 mph), which resulted in PCI. The tests also demonstrated that trailers that comply with the Canadian standard, CMVSS No. 223, were generally able to prevent PCI in 56 km/h (35 mph) impacts of the Malibu with full and 50 percent overlap with the rear impact guard. However,

seven of the eight rear impact guards compliant with the Canadian standard could not prevent PCI when only 30 percent of the Malibu front end engaged the rear impact guard.

In a quasi-static test at P3 location of the Vanguard rear impact guard, the attachments bolts sheared but still enabled the vehicle to meet the load and energy absorption requirements of CMVSS No. 223. However, in the 56 km/h (35 mph) crash test with 50 percent overlap of the 2010 Malibu with the Vanguard trailer, the guard bolts sheared resulting in PCI of the Malibu.

In the tests where there was no PCI of the Malibu, the injury measures of the restrained test dummies in the Malibu were below the injury threshold levels used by the FMVSSs. When PCI was prevented by the rear impact guard, generally higher chest injury measures resulted compared to when PCI occurred, but the values were well within the allowable limits.

When the Malibu sustained PCI, the head and neck injury measures were generally greater than the allowable threshold levels indicating high risk of serious head and neck injuries, regardless of whether the air bag deployed. The IIHS tests showed that when PCI occurs, air bag deployment does not improve injury outcome.

Table B-11: Occurrence of PCI in 35 mph crash tests (conducted by IIHS) of the 2010 Chevrolet Malibu into the rear of trailers.

Trailer Model	Designed to	Full Width	50% overlap	30% overlap
2011 Wabash	CMVSS No. 223	None	None	Yes
2012 Manac	CMVSS No. 223	None	None	None
2012 Stoughton	CMVSS No. 223	None	None	Yes
2013 Great Dane	CMVSS No. 223	None	None	Yes
2012 - 2013 Hyundai	CMVSS No. 223	None	None	Yes

2013 Strick	CMVSS No. 223	None	None	Yes
2013 Utility	CMVSS No. 223	None	None	Yes
2013 Vanguard	CMVSS No. 223	None	Yes*	N/A
2007 Hyundai	FMVSS No. 224	Yes	N/A**	N/A

* The attachment of the guard to the trailer failed during impact.
** Since the guard was unable to withstand the loads in the first test, the second and third tests were not conducted.

Table B-12: Summary of IIHS's frontal impact crash tests of a 2010 Chevrolet Malibu into the rear of trailers

Trailer	Compliance	Overlap/Underride		Injury			
	P_3 Peak Force (kN) Energy Absorbed (kJ)	**Overlap**	**Underride* (cm)**	**HIC-15 (700)**	**Max N_{ij}** (1.00)**		**Rib Compression (63mm)**
2011 Wabash	287 kN / 22.1 kJ (point load)	100%	99	328	0.35	Compression-Extension	37
		50%	135	101	0.23	Tension-Flexion	33
		30%	242	880	1.16	Tension-Extension	16
2012 Manac	361.8 kN / 25.0 kJ (distributed load)	100%	135	206	0.38	Tension-Flexion	37
		50%	129	38	0.13	Tension-Flexion	29
		30%	160	58	0.28	Tension-Flexion	31
2012 Stoughton	404.6 kN / 31.2 kJ (distributed load)	100%	117	267	0.37	Tension-Flexion	37
		50%	147	65	0.17	Tension-Flexion	25
		30%	218	9069	1.23	Tension-Extension	14
2013 Great Dane	386.7 kN / 28.8 kJ (distributed load)	100%	96	49	0.16	Compression-Extension	35
		50%	152	78	0.24	Tension-Flexion	28
		30%	244	8708	2.45	Tension-Extension	16
2012 - 2013 Hyundai	367.5 kN / 37.5 kJ (distributed load)	100%	92	54	0.2	Tension-Flexion	35
		50%	116	155	0.35	Compression-Extension	32
		30%	242	7346	1.94	Tension-Extension	19
2013 Strick	233.4 kN / 18.9 kJ (½ guard)	100%	121	107	0.32	Tension-Flexion	37
		50%	146	163	0.18	Tension-Flexion	27
		30%	245	7742	2.38	Compression-Flexsion	19
2013 Utility	Not Available	100%	99	130	0.33	Tension-Flexion	33
		50%	139	37	0.17	Tension-Flexion	30
		30%	237	7415	2.55	Tension-Extension	17
2013 Vanguard	370.1 kN / 25.3 kJ (distributed load)	100%	94	212	0.4	Tension-Flexion	31
		50%	205	1954	0.65	Compression-Flexsion	21
		30%	*Not tested due to failure of 50% overlap test at 56 km/h*				
2007 Hyundai	163 kN / 13.9 kJ Point Load	100%	catastrophic	754		NA	19
		50%	*Not tested due to failure of 100% overlap test at 56 km/h*				
		30%	*Not tested due to failure of 100% overlap test at 56 km/h*				

*Calculated by relative center of mass positions collected at initial impact and maximum displacement.
**For 100% overlap only the driver dummy is presented for comparison to 50% and 30% overlap scenarios.

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For Rulemaking

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