DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

49 CFR Part 571

[Docket No. 1–11, Notice 11]

RIN 2127–AA43

Federal Motor Vehicle Safety Standards Rear Impact Guards; Rear Impact Protection

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

ACTION: Final rule.

SUMMARY: This final rule establishes two Federal Motor Vehicle Safety Standards (FMVSS) which will operate together to reduce the number of injuries and fatalities resulting from the collision of passenger vehicles with the rear end of heavy trailers and semitrailers. The first standard (FMVSS No. 223, Rear Impact Guards, or the ''equipment standard'') specifies performance requirements that rear impact guards (guards) must meet before they can be installed on new trailers and semitrailers. It specifies strength requirements, as well as test procedures that NHTSA will use to determine compliance with the standard. The guard may be tested for compliance while mounted to a non-vehicle ''test fixture'' or a complete vehicle. The equipment standard also requires the guard manufacturer to provide instructions on the proper installation of the guard. The final rule also specifies requirements to ensure energy absorption by the guards.

The second standard (FMVSS No. 224, Rear Impact Protection, or the ''vehicle standard'') requires that most new trailers and semitrailers with a Gross Vehicle Weight Rating of 4,536 kilograms (kg) (10,000 pounds (lbs)) or more be equipped with a rear impact guard meeting the equipment standard. Requirements for the location of the guard relative to the rear end of the trailer are also specified in the vehicle standard. The vehicle standard further requires that the guard be mounted on the trailer or semitrailer in accordance with the instructions of the guard manufacturer.

DATES: This rule will become effective on January 26, 1998. Petitions for reconsideration of this rule must be received no later than March 11, 1996.

ADDRESSES: Petitions for reconsideration should refer to the docket number and notice number and be submitted in writing to: Docket Section, National Highway Traffic Safety Administration, Room 5109, 400 Seventh Street, SW, Washington DC 20590. Telephone: (202) 366–5267.

FOR FURTHER INFORMATION CONTACT: Dr. Leon DeLarm, Dr. George Mouchahoir, or Mr. Sam Daniel, in the Office of Vehicle Safety Standards (Telephone: 202–366–4919), or Mr. Paul Atelsek, in the Office of the Chief Counsel (202–366–2992), National Highway Traffic Safety Administration, 400 Seventh Street, SW, Washington, DC 20590.

SUPPLEMENTARY INFORMATION:

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I. The Safety Problem

This rule addresses the problem of rear underride crashes, in which a passenger car, light truck, or multipurpose vehicle with a Gross Vehicle Weight Rating (GVWR) of 4,563 kg (10,000 lbs) or less (referred to collectively in this rule as passenger vehicles) collides with the rear end of a trailer or semitrailer (trailers and semitrailers are referred to collectively in this rule as trailers) and the front end of the passenger vehicle slides under (i.e., underrides) the rear end of the trailer. Underride occurs to some extent in most collisions in which a passenger vehicle crashes into the rear end of a large trailer because most trailer beds are higher than the hoods of passenger vehicles. In the worst cases, referred to as passenger compartment intrusion (PCI) or ''excessive underride'' crashes, the passenger vehicle underrides so far that the rear end of the trailer strikes and enters its passenger compartment. PCI collisions generally result in passenger vehicle occupant injuries and fatalities caused by occupant contact with the rear end of the trailer.

The solution to PCI is upgrading underride guards to make them stronger, but this introduces another concern. Even if guards succeed in preventing PCI, overly rigid guards may stop the passenger vehicle too suddenly, resulting in excessive occupant compartment deceleration forces and killing or injuring passenger vehicle occupants.

The agency estimates that about 11,551 rear-end crashes with trucks, trailers, and semitrailers occur annually. These crashes result in approximately 423 passenger vehicle occupant fatalities and about 5,030 non-fatal injuries.

II. Existing Regulations

The initial Federal regulation addressing the issue of heavy vehicle rear underride was issued in 1953 by the Bureau of Motor Carriers of the Interstate Commerce Commission (presently the Office of Motor Carriers of the Federal Highway Administration, DOT). This regulation (49 CFR 393.86), which is still in effect, requires heavy trucks, trailers, and semitrailers to be equipped with a rear-end device designed to help prevent underride. The rule requires that the ground clearance of the underride guard not exceed 760 mm (30 inches (in)) when the vehicle is empty. The rule also requires that the device be located not more than 610 mm (24 in) forward of the rear of the vehicle and that it extend laterally to within 460 mm (18 in) of each side. The regulation further requires that the ''[guards] shall be substantially constructed and firmly attached.''

The Research and Special Programs Administration (RSPA) of DOT has

specified configuration requirements for guards on tankers that carry hazardous materials (49 Part 178.345–8). The bottom of the guard must be at least 100 mm (4 in) below the lower surface of any part of the rear of the vehicle, and not more than 1,520 mm (60 in) from the ground when the tanker is empty. The guard must be very strong. It must deflect 150 mm (6 in) forward when subjected to a 20 m/s^2 (2 G) impact while loaded, without contacting the cargo tank. These requirements are designed primarily to protect the tank and piping, not the colliding vehicle, in the event of a rear end collision.

III. Past Proposals

From time to time, NHTSA has assessed the requirements of the Federal Highway Administration's (FHWA) regulation and considered whether NHTSA should issue a Federal Motor Vehicle Safety Standard (FMVSS) requiring heavy vehicles to be equipped with rear underride protection. The issues of particular concern have been the requirements for rear end guard ground clearance, guard strength, and the injury and fatality benefits of such a standard. The most recent of several NHTSA notices was a Supplemental Notice of Proposed Rulemaking (SNPRM) issued in 1992 (57 FR 252; January 3, 1992). Prior to the 1992 SNPRM, the agency issued a Notice of Proposed Rulemaking (NPRM) in 1981 (46 FR 2136; January 8, 1981.) The notices of proposed rulemaking issued by NHTSA and FHWA prior to the 1981 NPRM are cited and discussed in the 1981 NPRM (Docket 1–11; Notice 8).

IV. Summary of the 1981 NPRM

The 1981 NPRM proposed to adopt a FMVSS for all new trucks and trailers with a GVWR of 4536 kg (10,000 lbs) or more. This NPRM was issued after research and computer modeling studies indicated that it was feasible to manufacture light-weight guards that could prevent excessive underride and absorb crash energy. Guard energy absorption is important because overly rigid guards could result in passenger compartment forces that would increase the risk of occupant injuries even in the absence of underride.

The 1981 NPRM proposed that heavy trailers, semitrailers, and single unit (i.e., unarticulated) trucks be equipped with an underride guard that met certain requirements for strength and configuration. The NPRM proposed exclusions from this requirement for trailers with chassis that are low enough to the ground to meet the configuration requirements for the underride guard (low chassis vehicle), trailers that have the rear tires set back to within 305 mm (12 in) of the rear (wheels back vehicle), and trailers that have work-performing equipment in the lower rear whose function would be impaired by a guard (special purpose vehicle).

NHTSA tentatively concluded that the proposed standard was superior to the FHWA regulation in three major ways. First, NHTSA specified objective requirements for guard strength (FHWA requires that the guard be ''substantially constructed and firmly attached''). Second, the NPRM proposed a guard configuration that permitted less ground clearance 560 mm (22 in), less longitudinal distance between the guard and the trailer rear extremity 305 mm (12 in), and less lateral distance between the guard and the vehicle side extremities 100 mm (4 in), than the FHWA regulation. Third, the NPRM specified detailed procedures for testing the guards as installed on the vehicle for which they were intended by applying a specific force at certain points on the guard.

V. Summary of 1981 NPRM Comments

The agency received over 100 comments on the NPRM. Many of the comments were from vehicle manufacturers and operators who believed their vehicles should be excluded from the requirements because they were special purpose vehicles. Some commenters objected to the proposed requirements and suggested alternative means of reducing the injuries and deaths caused by rear underride crashes. The alternative approach most often cited involved reducing the incidence of underride crashes through improved heavy vehicle conspicuity.

The agency agreed that conspicuity was an important issue. The Fatal Accident Reporting System (FARS, a database containing a census of all vehicle fatalities in the U.S.) statistics had indicated that about 65 percent of the fatalities resulting from passenger vehicle collisions with the rear end of heavy vehicles occurred under non-daylight conditions. NHTSA conducted a fleet study between 1980 and 1985 of the effectiveness of improved conspicuity. As a result of this study, the agency determined that conspicuity improvement could reduce the incidence of the accidents by about 15 percent. Consequently, the agency published a NPRM on improved heavy vehicle conspicuity in December 1991, (56 FR 63474) and a final rule on conspicuity improvement in December 1992 (57 FR 58406).

The agency believes, however, that improved rear impact guards could mitigate some of the rear impact fatalities and serious injuries not addressed by the improved conspicuity rule. The rear impact guard is especially important in cases in which the passenger vehicle driver's abilities are impaired by alcohol or drowsiness. Accident data indicate that alcohol is a factor for passenger vehicle drivers in about 30–40 percent of fatal rear underride accidents.

Commenters on the 1981 NPRM also expressed concern that the proposed requirements would be a substantial financial burden on some truck and trailer manufacturers. Several commenters argued that the agency's cost estimate for rear underride guards was well below the actual cost of equipping the wide variety of single unit trucks with compliant guards. As to the trailer manufacturing industry, its members were said to be predominantly small firms that lack the engineering capabilities to meet the requirements of the proposed rule. In response to the comments and statistical data, the agency sought to determine if it could revise the proposed rule to reduce the financial burden on the manufacturers.

VI. Summary of the 1992 SNPRM

The 1992 SNPRM contained requirements that are similar to those in the 1981 NPRM in terms of the guard's strength and configuration. However, the SNPRM differed substantially from the NPRM in terms of its impact on the industry. In place of the 1981 proposal of a single vehicle standard specifying the testing of guards on a completed vehicle, the SNPRM proposed two standards: (1) An equipment standard providing for the testing of guards on a test fixture, and (2) a vehicle standard requiring installation of guards complying with the equipment standard.

The equipment standard proposed strength requirements and an objective test for determining compliance with these requirements. The guard manufacturer would conduct a test involving quasi-static loading of the guard with the guard mounted on a rigid test fixture rather than installed on a completed vehicle. Guards certified as passing the test could then be marketed to vehicle manufacturers for installation in accordance with the configuration requirements of the vehicle standard. Testing in this manner would relieve vehicle manufacturers, especially small ones, of the burden associated with compliance testing.

The other major difference from the NPRM is that the SNPRM proposed to exclude single unit trucks from the rulemaking. NHTSA added this

exclusion to those in the NPRM because single unit trucks are far less likely to be involved in fatal accidents than combination trucks (i.e., trailers and semitrailers). FARS and GES accident statistics indicate that only about 27 percent of the 423 average annual rear end fatalities and 18 percent of the 5,030 injuries involve single unit trucks, even though these vehicles represent 72 percent of the registered heavy vehicles. Thus, single unit trucks are significantly under-represented in rear end crashes. On the other hand, trailers are highly over-represented in rear end crashes, as they represent only 28 percent of the registered heavy vehicles, but account for 73 percent of the occupant fatalities and 82 percent of the injuries. Therefore, the agency believed that excluding single unit trucks from the proposed rule would result in a better rule in terms of the ratio of benefits to costs.

VII. Summary of 1992 SNPRM Comments

The agency received approximately 2,250 individual comments on the SNPRM. Industry-related comments were generally supportive of the proposal, while consumer interest organizations, local and State governments, and private citizens were generally critical.

Representing the industry were comments from automobile and truck manufacturers, trade associations, manufacturers of trailers and semitrailers, and manufacturers of specialized usage heavy duty vehicles. Most of these commenters supported Federal rulemaking in this area. The trade associations and manufacturers of trucks and trailers were generally in agreement with the proposed requirements. Manufacturers and operators of specialized vehicles suggested that the proposed rule be modified to better define the types of vehicles that would be excluded from the standard.

The vast majority of the critical comments were post cards or letters with multiple signatures from private citizens. These post cards and letters, as well as more detailed submittals from consumer interest organizations, expressed concern that the agency's proposal had three deficiencies. First, the commenters recommended that the rulemaking apply to single unit trucks as well as trailers and semitrailers. Second, the commenters recommended that the proposed maximum ground clearance, 560 mm (22 in), be reduced to a 405 to 455 mm (16 to 18 in) range. Third, these commenters expressed the opinion that the agency should mandate ''energy absorbing'' rear impact guards for heavy vehicles, i.e., guards with hydraulic pistons or shock absorbers designed to deflect or deform in a controlled manner upon impact and thereby lessen the deceleration experienced by passenger vehicles colliding with them. Several consumer interest organizations and private citizens also suggested that the proposed minimum guard strength requirements were insufficient.

The consumer interest organizations and some private citizens also expressed concern that the proposed equipment standard for the rear impact guard did not require guards to be tested while mounted on a vehicle. As a result, guards complying with the proposed strength requirements could be installed on vehicles in such a location or in a manner that the guard/vehicle combination would be ineffective. In addition, some of these commenters stated that the crash tests NHTSA relied on in formulating the SNPRM were inadequate because they were not conducted under representative conditions of guard height, car bumper height, and car speed. Specifically, they stated that car bumper height would be depressed if the driver were braking to avoid colliding with the trailer, thus increasing the likelihood that the car hood would underride a 560 mm (22 in) high guard without engaging any substantial body structure. The consumer interest organizations also questioned the validity of the FARS accident data that NHTSA used to determine the benefits of the SNPRM, contending that the agency had underestimated the benefits of the rule. The state and local governments that commented expressed concerns similar to those raised by private citizens and consumer interest organizations.

A summary of comments has been prepared and is available for inspection in Docket No. 1–11. Significant SNPRM issues raised by the commenters and NHTSA's response to the comments are discussed below. In response to the comments, the final rule includes several modifications to the rule proposed in the SNPRM, including clarified definitions, improved compliance test procedures, and a minimum guard energy absorption requirement.

VIII. Recent Testing by NHTSA

In responding to comments to the SNPRM and a congressional request for a report on several heavy truck underride issues, NHTSA conducted a research project on Heavy Truck Rear Underride Protection at the Vehicle Research and Testing Center (VRTC) between September 1992 and June 1993 to evaluate the effectiveness of an underride guard meeting the requirements of the SNPRM. A copy of the test report (VRTC–82–0267) was placed in the public docket (No. 01–11–N09–54. See also Publication No. DOT–HS–808–081).

For the purposes of the evaluation, NHTSA took the conservative approach of modifying the most common conventional guard design and developed a rear impact guard that was only slightly (10 percent) stronger than the minimum requirements of the SNPRM when tested at the vertical supports, which is the most significant location along the width of the guard's horizontal member. NHTSA arrived at this ''minimally complying'' design through an iterative process of fabrication and testing in accordance with the proposed compliance test procedures.

These minimally compliant guards were then evaluated in two series of full scale crash tests. The guards provided the proposed maximum ground clearance 560 mm (22 in). For the initial series of crash tests, the guards were mounted to a test fixture simulating the geometry of the rear end of heavy trailers. The guards were mounted on a late model production trailer for the other series. A total of seven crash tests were conducted with the minimally complying guard design. The tests were conducted at an impact speed of 48 kph (30 miles per hour (mph)) with late model compact and subcompact cars with mass between 1135 and 1590 kg (or weight between 2500–3200 lbs). In each category, vehicles were selected which had low hood profiles, and were therefore most likely to underride the 560 mm (22 in) guard height.

Four of the seven crash tests resulted in no PCI when the minimally compliant guard was mounted flush with the rear extremity of the trailer and simulated trailer. See Tables 6, 8, and 10 of the VRTC test report. The hood of one passenger car was driven through the windshield during one of these tests (Corsica 1, VRTC test report, page 26). The magnitude of the passenger compartment intrusion by the hood was marginal, however, and the test dummies were not contacted by the hood during the collision. Two cases of PCI were caused by guard system failure, one in a simulated trailer test and one in a production trailer test (respectively, Saturn 1 in Table 8 and Corsica (trailer) in Table 10 of VRTC test report). The guard system failure in the simulated trailer test was due to attachment hardware failure. The failure in the production trailer test was the

result of trailer structural failure at the guard attachment locations. In each case, the guard attachment hardware and the trailer structure were upgraded with simple, inexpensive materials for subsequent tests. Retests with the modified hardware and trailer frame showed adequate guard system performance.

All these crash tests included Hybrid III test dummies positioned in the driver and outboard front passenger seating locations for each crash test. The procedures used for frontal barrier crash test preparation under FMVSS No. 208, *Occupant Crash Protection*, were followed with respect to dummy positioning, restraint usage, and dummy instrumentation. Dummy instrumentation indicated very low potential for serious or fatal injury in all seven of the crash tests with the minimally compliant guard, even those in which there was PCI.

The VRTC research project also performed a crash test using a very strong, i.e., ''rigid,'' guard, to compare the amount of underride and deceleration forces generated with those generated by the minimally compliant guard. The 48 kph (30 mph) impact generated a peak force of about 415 kN (93,000 lbs) and the guard sustained an insignificant amount of permanent deformation. Although underride in this crash test was minimal, occupant compartment forces generated during the crash were significant, with on-board dummy readings indicating a potential for serious driver chest injuries (dummy chest acceleration was 61 G, slightly higher than the 60 G permitted in FMVSS No. 208, Occupant Crash Protection). A similar crash test with the minimally compliant guard was conducted with the same make and model passenger vehicle. The minimally compliant guard, with a force resistance capability of about 200 kN (45,000 lbs), allowed more underride than the rigid guard and marginal PCI. However, at 48 kph (30 mph), the minimally compliant guard test generated occupant compartment forces low enough that they posed essentially no potential for life-threatening occupant injuries. This test further demonstrated the adequacy of the proposed guard ground clearance requirement of 560 millimeters (mm) (22 in).

IX. Overview of the Final Rule

This rule establishes two Federal Motor Vehicle Safety Standards. The two standards are being announced in this single notice because they are complementary and because their substantive requirements both derive from a single standard proposed in an earlier NPRM (Docket No. 1–11, notice 8). The first standard will be referred to as the ''equipment standard'' because it sets forth requirements that a rear impact guard must meet as an item of motor vehicle equipment. The second standard will be referred to as the ''vehicle standard'' because it requires a new trailer or semitrailer to be equipped with a guard that meets the equipment standard.

The equipment standard specifies the procedures that the agency will use when testing a guard. The guard is first mounted to a rigid test fixture or a secured trailer, in accordance with the installation instructions which the guard manufacturer is required to provide. The standard describes how to select three test locations across the width of the guard. At these three locations, the testing procedure provides that force be slowly applied until the guard has been deflected by 125 mm (5 in). The standard specifies procedures for determining whether the tested guard has met the minimum requirements for strength and energy absorption. Guards that can pass the strength and energy absorption tests may be certified and labeled as complying with the equipment standard and sold to vehicle manufacturers if accompanied by the necessary attachment hardware and mounting instructions.

The guard mounting instructions are a crucial interface between the equipment standard and the vehicle standard. NHTSA has modified the equipment standard proposed in the SNPRM to require the guard manufacturer's instructions to include (1) a description of the types of structures to which attachment must be made, and (2) the manner in which attachment must be made, in order for the guard to perform in its designed fashion.

The vehicle standard requires that most new trailers and semitrailers be equipped with a rear impact guard certified to the equipment standard. The vehicle manufacturer can manufacture and certify the guards according to the equipment standard, or simply purchase and install certified guards from a guard manufacturer. The vehicle standard requires that the guards extend laterally to within 100 mm (4 in) of the sides of the trailer, that the guard have a ground clearance of no more than 560 mm (22 in), and that the guard be placed as close to the rear of the vehicle as possible. To ensure that the guard will perform properly, the vehicle standard further requires that the guard be mounted on the trailer or semitrailer in accordance with installation instructions provided by the guard manufacturer.

The vehicle standard lists and defines certain types of vehicles that are excluded from the requirement to have rear impact guards. Single unit (unarticulated) trucks, truck tractors, pole trailers, low chassis vehicles, special purpose vehicles, and wheels back vehicles do not have to have rear impact guards.

X. Summary of Changes From the 1992 SNPRM

The greatest change from the SNPRM is the addition to the equipment standard of a requirement for energy absorption. The SNPRM would have permitted fairly rigid guards because it did not require the guard to yield in response to force. Rigid guards may stop the passenger vehicle too quickly, causing occupant deaths and injuries from sudden deceleration. To ensure that the guards will yield, this rule adds a requirement that the guards absorb a certain amount of energy during the strength test. The new requirement does not necessitate the use of any additional new test equipment or the following of any additional test procedures. It does require more frequent measurements of the load during the strength test, and a few extra calculations after the test.

The test procedures in the equipment standard have been modified to allow velocity-sensitive rear impact guards. Velocity-sensitive guards would have failed the quasi-static strength test procedure proposed in the SNPRM because these guards are designed to provide resistance that is proportional to the displacement rate, and the test procedure displaces the guard very slowly. The final rule provides for modifying the guards to deactivate the energy absorbing components prior to the strength test. Because velocity sensitive guards typically have excellent energy absorption characteristics and because quasi-static testing does not test their energy absorbing capabilities, velocity-sensitive guards do not have to be tested for energy absorption. The only type of velocity-sensitive guards that the agency is aware of use hydraulic fluid properties to deform in a controlled manner. Therefore, these ''hydraulic guards'' are the only ones excluded from the energy absorption test.

The final rule requires greater specificity in statements regarding trailer structure in the installation instructions provided by the guard manufacturer. The SNPRM said only that the instructions had to specify the types of vehicles for which the guard was intended, state the necessity for

attaching the guard to the vehicle chassis, and explain how the attachment hardware was to be used. The regulatory text of the final rule makes it clear that the installation instructions must specify all aspects of the trailer that are necessary to the proper functioning of the guard. The test procedure has been modified to indirectly test the adequacy of the attachment.

NHTSA has changed some of the guard configuration requirements in the vehicle standard. The SNPRM proposed to require that the horizontal member of the guard extend to within 100 mm (4 in) of the side extremities of the vehicle and to within 305 mm (12 in) of the rear extremities. These requirements have been modified to allow rounded guard ends. The final rule allows an extra six inches in these dimensions only for the portion of a guard that is curved. Using rounded guard ends will diminish the hooking potential of the guards when the trailer is turning sharply. Guard ends that are rounded upward and attached to the vehicle may add strength to the horizontal member near the side extremity of the vehicle.

To account for high, overhanging rear protrusions on trailers, NHTSA changed the definition of the vertical zone to be considered when determining the trailer's ''rear extremity.'' Determination of the ''rear extremity'' is important because the location of the guard is based on the location of the rear extremity. The SNPRM defined ''rear extremity'' as the rearmost point above 560 mm (22 in) from the ground. Since high overhangs pose no risk to colliding passenger vehicles, NHTSA has set a maximum height of 1905 mm (75 in) from the ground on the zone. Higher protrusions will not be considered as the rear extremity.

Another change in the configuration requirements is that the final rule requires the guard to be mounted as close to the rear extremity as practical within the 305 mm (12 in) zone forward of the rear extremity. The SNPRM did not regulate where in the zone the guard had to be mounted.

XI. Analysis and Response to Comments on the 1992 SNPRM

A. Separate Equipment and Vehicle Standards

Companies such as Waltco and industry groups such as the National Truck Equipment Association supported the separate equipment and vehicle standards as a method to prevent undue testing burdens.

One of the concerns raised by consumer interest organizations is that allowing the guards to be tested on a ''non-vehicle'' rigid test fixture posed a problem if it is done in the expectation that the guards would necessarily perform in a similar manner once they are installed on vehicles. The Institute for Injury Reduction (IIR) commented that neither the equipment standard nor the vehicle standard specifies or regulates the interface between the guard and the vehicle. Therefore, IIR was concerned that there are no ''real-world'' tests performed on the guards as installed on the vehicle and suggested that it is unclear whether a failure of such a test would represent noncompliance by the guard manufacturer, the vehicle manufacturer, both, or neither.

NHTSA agrees that an underlying assumption of this regulatory scheme is that the guards would perform in the real world in a manner similar to the way they do in the tests. This assumption is supported by the results of the VRTC research project, which show that the maximum force measured in quasi-static tests is similar to the maximum force generated in dynamic crash tests. Moreover, this regulatory scheme has worked well for tires, which also have separate equipment (49 CFR 571.109) and vehicle (§ 571.110) standards.

NHTSA disagrees with IIR's argument that separate guard and vehicle standards leave the guard/vehicle interface unregulated. The vehicle standard specifies that the guard be attached in accordance with the guard manufacturer's installation instructions, the same instructions used to attach the guard to the test fixture during agency compliance testing under the equipment standard.

When writing installation instructions, the guard manufacturer must take into account the possibility of inadequate trailer structure to support the guard. Depending on the guard design, the guard manufacturer may want to specify in the instructions that the guard cannot be attached to certain structures (e.g., floorboards) and that it must be attached to other surfaces, for example, frame rails with a horizontal surface and specified wall thickness of a certain material (e.g., hardened steel). The guard manufacturer may have to specify local reinforcement if the trailer chassis is inadequate to pass the compliance test with the chassis surface mounted on the rigid test fixture.

The installation instructions must be appropriate to the trailer design, so that the vehicle manufacturer knows which guard to purchase and does not have to deviate from the instructions to install the guard. To help assure this, the regulatory text has been modified to make it clear that the guard manufacturer must either list appropriate trailers or specify in the installation instructions all attributes that make a trailer suitable for the proper installation and functioning of the guard. These include the types of trailer structures, design types with dimensions, materials thickness and tire track widths that are appropriate as an installation location.

NHTSA will install the guards during compliance testing based on these instructions. Therefore, it is essential that the attachment site and attachment method be adequately specified. This is especially important to avoid failure of the attachment itself during the test.

In a VRTC test of the minimally complying guard mounted on a typical trailer, the trailer frame rails worked with the guard by bending/deforming to absorb the colliding vehicle's crash energy. However, the attachment site on the frame rails had to be strengthened with an inexpensive local reinforcement.

IIR's argument that failure during compliance testing would leave the identity of the non-complying party in doubt is incorrect. The only testing procedures in NHTSA's rule are the compliance tests in the equipment standard. Therefore, the only party that can be responsible for a testing failure is the guard manufacturer. Noncompliance by the vehicle manufacturer may be established by inspecting the vehicle and observing improperly installed guards, such as during an FHWA heavy truck inspection. If the vehicle manufacturer manufactures the guard which it uses, as NHTSA believes will usually be the case, there will be no ambiguity as to the party responsible for testing failure or improper installation.

B. Standard for Equipment

1. Relationship of Strength, Energy Absorption, and PCI

In specifying performance standards for rear impact guards, the agency must balance various performance attributes. The vast majority of the commenters, including virtually all of the consumer safety groups, asserted that underride guards should be strong, yet energy absorbing. NHTSA agrees that these are both desirable properties in an underride guard, but emphasizes that an increase in strength may result in a decrease in the capability of the guard to absorb energy, and vice versa. An impact guard strong enough to restrain a large car travelling at high speeds would impart high deceleration forces to a small car crashing into it at the

same speed. Conversely, an impact guard that is optimized to restrain a small car without excessive deceleration forces might fail (i.e., deform so much that it allows PCI) if a large car crashes into it, or if a small car crashes into it at higher speeds.

Energy absorption must also be balanced against PCI prevention. Energy absorption may be maximized by allowing the guard to yield for a greater distance before bringing the passenger car to a stop. However, the more the guard yields, the farther the colliding vehicle travels and the greater the likelihood of PCI. This rulemaking has focussed on balancing the need for PCI-prevention against minimizing crash injuries. FARS data show a strong correlation between PCI and fatalities or serious injuries. Preventing PCI demands a guard that is strong enough to prevent the passenger vehicle from advancing very far after contact with the guard.

Compounding the difficulty of balancing the guard's performance attributes is the wide range of colliding passenger vehicle weight, speed, and size. The combination of weight and speed determines the level of kinetic energy to which the guard will be subjected. Passenger vehicle weight generally correlates with the hood height and length, which determines how far the vehicle can proceed after contact with the guard before PCI occurs. Fortunately, these factors offset one another for large cars (i.e., the greater weight promotes greater amounts of underride, while the higher hood profile results in better guard engagement and the longer hood allows for more underride before experiencing PCI).

Small pickups and vans have relatively high profiles but a relatively short distance from the front of the vehicle to the occupant compartment. A guard would have to yield only slightly, or have high strength to prevent minivans and some pickups (which typically have a mass more than 1810 kg or weigh more than 4,000 lbs and have short hoods) from experiencing PCI. Because the passenger compartment is so close to the front of a heavy standard van, no underride guard is likely to be very effective in preventing PCI for these vehicles. Nevertheless, some reduction in fatalities and non-fatal injuries can be expected due to the initial energy absorption of the guard. Fortunately, vans have only been involved in 0.5 percent of all underride fatalities from 1982 to 1992. Pickups have been involved in about 18 percent of the fatalities during this period.

It should be recognized, therefore, that impact guards cannot be optimized for all situations. The requirements in this rule should reduce the incidence of PCI, fatalities, and injuries for all passenger vehicles, but some more than others. A minimally compliant guard should protect all passenger vehicles from PCI and excessive deceleration forces up to some speed in the 40 kph (25 mph) to 56 kph (35 mph) range, although that speed will vary on a sliding scale depending on the vehicle weight and front end profile. For example, NHTSA analytically estimates that mid and full size cars and light trucks and vans with a mass greater than 1590 kg (3,500 lbs) will experience PCI at approximately 43 kph (27 mph), while mini-compacts of less than 1135 kg (2,500 lbs) will be able to collide with the required guard at about 61 kph (38 mph) without PCI. This estimate is obtained by equating the energy absorbed by a 48 kph (30 mph) collision of a 1590 kg (3,500 lb) vehicle rigid barrier crash to the energy absorbed by a different weight vehicle). For example, for a 907 kg (2000 lb) vehicle, the calculated impact speed without PCI is: (square root of (1,590 kg/907 kg))×48 kph=63.5 kph, or (square root of (3,500 lb/2,000 lb))×30 mph=39.7 mph.

2. Guard Strength

Several consumer interest organizations and private citizens criticized the 1992 SNPRM's proposed guard strength requirements. These commenters' objections are either that guards meeting the requirements would be too weak to prevent underride or that they would be so strong that the passenger vehicle would be subjected to excessive deceleration forces. As explained above, the issues of strength and energy absorption are closely related. However, issues relating primarily to energy absorption will be addressed in the next section.

The SNPRM, which was premised upon underride protection being provided by a horizontal member, proposed to require that the horizontal member resist a force of 50 kilonewtons (kN) (11,240 lbs) applied at the center (site P2) and near the outboard ends (sites P1), and a force of 100 kN (22,480 lbs) at an intermediate position (sites P3), in separate quasi-static strength tests. For these tests, guard resistance at the specified force level would have to occur at less than or equal to a 125 mm (5 in) displacement of the guard's horizontal member.

Several commenters stated that overly ''rigid'' or non-yielding guards would be permitted by the proposed rule. They expressed concern that those guards would be too stiff, citing the results of full-scale, heavy truck rear underride crash tests conducted in the late 1970's and early 1980's by the Texas Transportation Institute (TTI), Dynamic Sciences, Inc., and the Insurance Institute for Highway Safety (IIHS). These crash tests indicated occupant compartment forces generated in collisions with rigid guards at impact speeds above 48 kph (30 mph) could produce potentially fatal driver and front passenger head and chest injuries.

Advocates for Highway and Auto Safety (Advocates) stated that the proposed guard would not perform as well as the agency expects, and would be excessively deformed or fail in impacts not much above 40 to 48 kph (25 to 30 mph). Advocates further stated that NHTSA directed its contracted researcher in 1982 to reduce the impact speed of a dynamic crash test on a Chevrolet Impala from 48 kph (30 mph) to 40 kph (25 mph), specifically to ensure that excessive underride did not occur. The actual speed of the tested 1,840 kg (4,060 lb) Chevrolet Impala was 38.5 kph (23.9 mph). Advocates contends that the agency admitted in a memorandum from Mr. Tomassoni (who worked for NHTSA at the time) that the test would have resulted in PCI at 48 kph (30 mph). IIHS also included these criticisms in its comment.

Some commenters recommended that NHTSA require specific levels of strength higher than those proposed in the SNPRM. Advocates attached a 1991 technical paper by Mr. G. Rechnitzer, of Monash University in Australia, which reviewed European truck underride data. The example with the widest application, the Economic Commission for Europe's (ECE) Regulation No. 58 for heavy truck rear underride guards, currently requires a guard force resistance of 100 kN (22,480 lbs) at the point on the guard corresponding with this rule's P3 test point, 50 kN (11,240 lbs) at the center, and up to 25 kN (5,620 lbs) at the outboard test position corresponding with this rule's P1 position. Mr. Rechnitzer recommended that the rear impact guard strength requirements be upgraded to 150 kN (33,370 lbs) at the P3 location and 100 kN (22,480 lbs) at the center and P1 locations. Mr. Byron Bloch, of Auto Safety Design, suggested an even stronger guard. He thought the rule should require that the guard resist 222 kN (50,000 lbs) at the P3 test location, where the SNPRM requires that the guard resist a force of 100 kN (22,480 lbs).

The VRTC tests indicate that the strength of the 1992 SNPRM guard is adequate for preventing underride with

PCI in a collision with an impact speed of up to 48 kph (30 mph) for vehicles with a mass of about 1,450 kg (3,200 lbs). PCI resistance would be expected at higher impact speeds for lighter vehicles and lower impact speeds for heavier vehicles. The test data also indicate that rear impact guards having somewhat more strength than the proposed level of strength could resist PCI at higher impact speeds without generating life-threatening passenger compartment force levels. Although stronger guard strengths may be desirable, the agency cannot quantify the increased benefits that might be obtained without further testing.

Based on the VRTC tests, the agency believes that the guard strength requirements proposed in the 1992 SNPRM are of sufficient magnitude to prevent PCI for most late model passenger vehicles at impact speeds of about 45 kph (28 mph). This rule has an additional requirement that guards yield enough to maintain survivable levels of occupant compartment deceleration when impacted by passenger vehicles. Therefore, the agency has decided to retain the strength requirements of the SNPRM in the final rule.

The IIHS advocated a specific guard design, which it said was preferable for strength purposes. That organization believes a diagonal strut from the horizontal member of the guard to the trailer chassis could augment guard strength without a large increase in guard weight. NHTSA agrees with the IIHS that this type of design is quite efficient with respect to weight and strength, though not necessarily with respect to energy absorption. However, the agency does not believe that it is necessary or desirable to mandate a specific design, since similar crash performance may be achieved with other designs.

3. Guard Energy Absorption

Although all non-rigid guards absorb some of the kinetic energy of the striking vehicle, there was considerable concern that the SNPRM did not require energy absorbing guards. The consumer interest organizations and about 2,200 private citizens urged NHTSA to mandate ''energy absorbing'' guards. By deforming, rear impact guard structures absorb some of the kinetic energy of the striking vehicle. The more energy the guard absorbs, the less energy must be absorbed by deformation of the striking vehicle before it stops. Commenters were concerned that the SNPRM would have permitted rigid guard designs that would impart high levels of crash forces to the striking vehicle's occupants.

As used by the consumer interest groups, the term ''energy absorbing guards'' generally refers to guards whose vertical support members are designed to pivot about their attachment braces at the vehicle chassis. These guards absorb energy by means such as cylindrical, telescoping hydraulic or plastic struts, which are also attached to the guard's horizontal member and the vehicle chassis. When impacted, these energy absorbing units respond by compressing without substantial deformation until the units have reached their maximum deflection, or ''bottomed out.'' On the other hand, the primary energy absorbing mechanism of a fixed guard, such as the design used in the VRTC tests, is the flexing and bending of the guard's vertical supports. Keeping this in mind, the agency uses the term ''energy absorbing guards'' below in the same sense as used by the commenters, as a shorthand way of referring to guard designs with special energy absorbing design features.

Advocates recommended that guards be required to be energy absorbing so that 64 kph (40 mph) impacts of small cars with the rear of heavy vehicles are survivable through the combined energy absorption of the car and the guard. The National Association of Independent Insurers (NAII) suggested that the proposed rule be modified to require a more flexible, energy absorbing guard. Citizens for Reliable and Safe Highways (CRASH) stated that the agency fails to acknowledge the need for and potential benefits from improved, slightly more expensive, energy absorbing guards that are in use in Europe.

To ensure that the guard will provide the combination of strength and energy absorption necessary to prevent underride with PCI at a specified impact speed, as recommended by Advocates, a full-scale dynamic compliance test including a passenger vehicle would be necessary. VRTC conducted full-scale crash tests with guards that were also tested in accordance with the SNPRM compliance procedures. These tests demonstrated that the proposed quasi-static compliance test is adequate for determining guard strength. The peak forces generated by the guard in the quasi-static compliance tests and the full-scale crash tests were approximately the same. Guard strength or peak force capability is the primary factor in underride prevention. Guard energy absorption characteristics determine the guard's ability to maintain impact forces at survivable levels in the striking vehicle, as well as the guard's resistance to structural failure.

The agency has decided to retain the quasi-static compliance test for guard strength due to the greater complexity and cost of a dynamic compliance test procedure. Although the guard's ability to resist PCI at a specific impact speed will not be tested directly, the VRTC tests show that dynamic guard performance can be accurately estimated from the quasi-static compliance test results. Therefore, it is not necessary to conduct expensive full-scale dynamic tests to attain most of the benefits of dynamic testing.

Advocates also stated that British researchers assess the potential fatality reduction effectiveness of stronger, energy absorbing guards at 25 to 35 percent. This is about twice the current guard effectiveness in Europe, according to the document cited by Advocates, an opinion paper by P.F. Gloyns, et al., of Vehicle Safety Consultants, Ltd., entitled ''Legislative Implications of Accident Experience in the UK of Rear Under-Run Guards.'' The Gloyns paper does not quantify the increase in guard strength or the magnitude of guard energy absorption required to achieve the estimated increase in guard effectiveness. The agency acknowledges that various combinations of guard strength and energy absorption capability could increase the effectiveness of rear impact guards. However, without more quantitative information, NHTSA cannot address the guard effectiveness claims of Gloynes, et al.

It may be that energy absorbing rear underride guards, which were referred to by CRASH and which are currently in use on one to two percent of vehicles in Europe, are superior to a moderate strength, fixed guard meeting the minimum performance requirements specified in the rulemaking proposal. The agency notes that these European guards, or guards with similar energy absorbing characteristics and design features, would not be prohibited by NHTSA's proposed rule and will no doubt be considered by the industry as a possible means of compliance, just as they were in Europe.

The agency has tested one guard, the Quinton-Hazel rear impact guard, which utilized pivoting vertical support members along with telescoping hydraulic struts and coil springs. The guard demonstrated excellent overall performance in a crash test conducted in 1979 by the Texas Transportation Institute. The striking crash test vehicle was a 1,810 kg (4,000 lb) Chevrolet and the impact speed was 56 kph (35 mph). The collision did not result in PCI, and all measured occupant responses indicated that the potential for driver

and front passenger serious injuries was low. It is estimated that similar guards would weigh about 1.33 to 3 times more and cost 3 times more than a fixed, moderate strength guard designed to meet the requirements of the SNPRM. In other words, it would cost $300–$350 and have a mass of 136 kg (300 lbs) to 181 kg (400 lbs). Further, hydraulic energy absorbing guards would be considerably more complex than fixed guards that comply minimally with this rulemaking, and would require periodic maintenance. It is NHTSA's understanding that there are currently no guards in production in this country or in Europe that utilize hydraulic or plastic energy absorbing, telescoping units. A letter from one of the former manufacturers, Quinton-Hazel, indicates that the market probably rejected them as too costly.

Nevertheless, in response to the comments recommending energy absorbing guards, the agency has added a performance requirement for guard energy absorption to the rule. The requirement does not include design specifications such as pivoting vertical supports or telescoping energy absorbing units. The agency is requiring that each guard absorb a minimum amount of energy based on the forces and displacements specified in the 1992 SNPRM. The same quasi-static compliance test procedure proposed for strength testing will be used to determine compliance with this new specification. The test for guard energy absorption will be conducted only at the P3 location used for guard strength testing. The minimum magnitude of guard energy absorption will be 5,650 joules (4,170 foot-pounds), which is based on the force required to comply with the strength test at the P3 test location and the maximum displacement allowed for the guard to generate the force (125 mm, or 5 in). The energy absorption test will require that the guard's horizontal member undergo 125 mm (5 in) of displacement while the force generated by the guard is recorded at least ten times per 25 mm. The magnitude of guard energy absorption at the P3 location is sufficient to absorb about 12 percent of the total kinetic energy of a 48 kph (30 mph) centric collision with a 1,135 kg (2500 lb) vehicle. This magnitude of guard energy absorption capability is also similar to the amount recommended in several British research papers provided by Advocates.

Several commenters, including consumer interest organizations and trailer manufacturers, stated that the proposed rule would permit overly ''rigid'' or non-yielding guards that would absorb little or no crash energy. The commenters expressed concern that those guards would be too stiff and would result in fatal driver and front vehicle passenger head and chest injuries.

The agency has drafted the energy absorption requirement to address these concerns. NHTSA recognizes the potential trade-off between designs of underride guards that minimize occupant injury criteria responses and those that provide the most protection from PCI. The agency also recognizes that an increase in the level of rigidity from the minimally compliant guard used in the VRTC tests is desirable, but this should not be at the expense of energy absorption. On the other hand, the agency does not want to restrict or dictate guard design by specifying the rigidity of the guard. Therefore, to discourage overly rigid guards, this rule requires that a minimum amount of the energy be absorbed during the energy absorption test from permanent yielding, or plastic deformation, of the guard. After the guard has reached the full 125 mm (5 in) of deformation, the load is reduced and any elastic ''rebound'' of the guard is measured until the load is zero. The elastic component of the energy that is returned by the guard is not included in the calculation of total energy absorbed by the guard. This method gives guard designers flexibility to select guard material properties and frame member spatial configuration.

Some commenters observed that the test procedures proposed in the SNPRM precluded the use of hydraulic energy absorbing guards. Mr. John Tomassoni stated that the 125 mm (5 in) displacement maximum allowed in the strength test would allow only passive structures such as steel struts designed to bend on impact. This is because active energy absorbing struts that are hydraulic (analogous to a vehicle shock absorber) are velocity sensitive. With the slow application of force during the quasi-static test, the hydraulic fluid units would develop almost no resistance. He recommended adding a ''bottoming'' provision to allow static testing after hydraulic systems have reached full stroke.

NHTSA agrees that quasi-static test procedures are inappropriate for hydraulic guards, or any other type of velocity sensitive guard (although NHTSA is unaware of any non-hydraulic guards that are velocity sensitive). A dynamic test would be required to assess their energy-absorbing capabilities by supplying the sudden onset of force their energy absorbing units require to generate resistance. Because the agency does not want to discourage the use of these advanced guard designs by requiring expensive dynamic tests, and because these guards typically have excellent energy absorbing capabilities, the final rule excludes these guards from the energy absorption requirements.

There are also problems with subjecting velocity sensitive guards to the strength requirement. However, complete exclusion of those guards from the performance requirements would be inappropriate. Accordingly, the agency has modified the test procedures to allow velocity sensitive guards to be tested for compliance with the strength requirement. The agency is concerned that, if the hydraulic energy absorbing units do not operate properly, the guard will not generate significant resistance and energy absorption. NHTSA wants to assure that the guard has enough residual strength, even without the energy absorbing units, to meet the same strength requirements as other guards. Therefore, velocity sensitive energy absorbing guards will be tested by slowly compressing the energy absorbing units to the full extent of their designed travel or 610 mm (24 in), whichever occurs first. This will allow the frame of the guard itself to generate resistance, rather than having the piston simply compress the hydraulic shock absorbers.

4. Vertical Cross-sectional Height of Horizontal Cross-member

The SNPRM proposed a minimum vertical cross sectional height of 100 mm (4 in) across the entire width of the guard's horizontal cross-member. Advocates stated in its comment that the guard must be at least 205 mm (8 in), and preferably 305 mm (12 in), high to better manage the loading impact forces and assure full engagement of the vehicle front end. In contrast, the Truck Trailer Manufacturers Association (TTMA) suggested reducing the requirement, urging that the guard be only 50 mm (2 in) high because that is all that is required for adequate strength. It asserted that requiring greater vertical cross section height just adds unnecessary weight and cost to the guards.

NHTSA agrees with Advocates' position that a higher vertical cross section has the potential to better distribute the impact forces, but this does not mean that the proposed 100 mm (4 in) height is insufficient. The 100 mm (4 in) height would be inferior if it sheared or ''cut'' through the front of the striking vehicle, thus allowing forward vehicle motion without much energy absorption due to the low magnitude of

force generated by the guard. A guard should cause the vehicle to absorb energy by crushing, rather than shearing through, frontal vehicle structural components. Shearing through did not occur in the agency's testing with a 100 mm (4 in) high guard horizontal member. None of the crash tests conducted pursuant to this rulemaking resulted in significant shearing of the passenger vehicle's frontal structure (above the 560 mm (22 in) high guard). The crash tests show that the 100 mm (4 in) profile of the guard horizontal member resulted in adequate engagement of the car's front end and is harmonized with the guard specified in ECE Regulation 58. Moreover, a 205 mm (8 in) high profile may require heavier and more expensive guards. Finally, the agency notes that 100 mm (4 in) is only a minimum height, so guard manufacturers are free to manufacture the guards that Advocates recommends. Accordingly, the agency concludes that a higher vertical cross sectional height requirement is unnecessary.

NHTSA also disagrees with TTMA's position that a 50 mm (2 in) vertical cross sectional height would be appropriate. The TTMA did not provide any data to support its assertion that the strength should be adequate. Even if the 50 mm (2 in) height were sufficient for strength purposes, it would have a greater tendency to shear into the front of the passenger vehicle instead of crushing it. This would result in a reduction of energy absorption by the guard and an increase of the striking vehicle damage in low speed crashes of 16 to 24 kph (10 to 15 mph). Accordingly, the agency has decided to retain the 100 mm (4 in) cross sectional vertical height requirement in the final rule.

5. Shape of the Horizontal Cross-member

Some commenters stated that NHTSA should require the guards to have blunted or rounded ends. The Florida Department of Transportation, based on visual evaluations of the installed guard, stated that the requirement that the guard extend to within 100 mm (4 in) of the side of the vehicle would make it a dangerous ''hook'' for adjacent vehicles, especially during sharp turns of the trailer. It suggested requiring a ''U'' shaped guard, similar to one used by some carriers which is attached at either end to the underside or rear of the vehicle. It thought that the ends on these guards could be located further inboard. The TTMA had a similar suggestion, proposing that NHTSA allow (but not require) guards with rounded corners, to lessen the hooking potential when the sliding tandem is positioned forward. The TTMA suggested that the rule be modified to allow such guards to begin curving at a point 255 mm (10 in) inboard of the edges of the vehicle, while retaining the 100 mm (4 in) requirement for straight guards.

NHTSA agrees that there is some potential for hooking the guard on the fenders and wheel wells of adjacent passenger vehicles when the rear end of the trailer swings out laterally during a sharp turn. This phenomenon would be accentuated when the rear wheels on a sliding tandem are positioned forward. The rear wheels are generally positioned forward to give the trailer greater maneuverability, so it is likely that trailers in this configuration will be making sharp turns.

On the other hand, rounded or U-shaped guards would be more expensive to manufacture and would weigh more. Moreover, rounded corners offer very limited potential added value on roadways where sharp turns are infrequent, such as on the interstate highways, which are heavily traveled by trailers. Therefore, while the agency wants to allow guards with rounded ends for operations where they are desired, NHTSA does not think it is necessary or even appropriate to require them.

The commenters referred to rounded guard ends that curve upward, but a rounded end that curves forward could also be useful. It would serve the purpose of making hooking less likely because the guard end would sweep through a smaller arc and present a less pointed profile to adjacent passenger vehicles. Moreover, forward-curving guards could slightly enhance guard effectiveness if a passenger vehicle strikes the trailer in the rear corner at an angle. However, forward-curving guard ends might interfere with the rear wheels if a sliding tandem were moved to the rearmost position.

NHTSA notes that the SNPRM would not prohibit guards with rounded ends, but its configuration requirements would have restricted their curves to a 100 mm (4 in) radius of curvature. To minimize hooking potential and property damage in some applications, the final rule adopts the TTMA's suggestion and allows a guard with rounded ends to begin curving 255 mm (10 in) inboard of the side extremity of the trailer. This will allow a radius of curvature of 150 mm (6 in), or 255 mm (10 in) if the guard end extends all the way to the side extremities. To make the same allowances for forward-curving guards, should guard manufacturers want to produce them, NHTSA is allowing those guards to begin curving forward 255 mm (10 in) inboard of the side extremities, even if the guards are already mounted as far forward as possible—305 mm (12 in) forward of the rear extremity.

6. Guard Attachment

The SNPRM did not specify a particular guard attachment method. To assure an adequate interface between the guard and the trailer, the SNPRM proposed to require that the guard be attached to the trailer chassis in accordance with the instructions provided by the guard manufacturer.

Several commenters thought the SNPRM inadequately addressed the issue of guard attachment and discussed the merits of certain guard designs. Citing a study by Vehicle Safety Consultants (VSC) Ltd., Advocates stated that attaching the horizontal member of the guard to the vehicle with vertical members is not ideal because the guard tends to pivot forward and up if it is struck from the rear by a passenger vehicle and fails. It said that the vertical members then form an inverse ramp, thus aggravating any underride tendency by pushing the passenger vehicle down and the trailer up. To solve this problem, Advocates appears to recommend either guards with diagonal hydraulic struts or the use of hinged, pivoting energy absorbing guards that can fold up for rail or other intermodal transportation. IIHS also believed a diagonal strut would improve guard strength without adding weight and would make it more likely that the guard will move downward as it deforms, thus helping to stop the passenger vehicle.

The agency agrees with IIHS and Advocates that designs employing diagonal struts are strong yet light, but believes it would be inappropriate to require such designs. There is no evidence that only designs with diagonal struts perform adequately. To the contrary, the design used in the VRTC tests did not have diagonal struts and performed acceptably. Diagonal struts may also be impracticable in some cases, due to trailer construction and use.

Likewise, while the pivoting, fold-away design that Advocates recommended has obvious practical advantages in some circumstances, the agency does not believe that there is any necessity for mandating that all guards incorporate that design. Such designs would be unneeded by many trailer operators since most trailers do not travel by ship or train. If trailer operators need fold-away guards for intermodal transportation or other

operational environments, they may specify such guards when ordering new trailers.

NHTSA believes that specifying a particular attachment configuration, as suggested by Advocates and IIHS, would unnecessarily restrict design flexibility on the part of guard manufacturers. Adequate performance may be achieved by a variety of attachment methods. Moreover, it is impracticable for NHTSA to attempt to anticipate all the factors that may go into the choice of attachment method, given the variety of possible guard and trailer configurations. The agency's decision not to specify a particular attachment method leaves the guard manufacturers free to choose an appropriate design.

Some commenters had conflicting impressions that the SNPRM required a particular attachment method. Transamerica Leasing interprets the SNPRM's reference to ''attachment hardware'' as meaning that the proposed rule contemplates only bolt-on guards. It thinks that guards that are welded on should also be allowed. In contrast, Advocates suggested that the SNPRM requires guards with vertical supports for the horizontal member and welded steel construction.

No specific attachment method was proposed in the SNPRM. Nothing in the SNPRM nor in this final rule requires vertical supports or welded construction. Similarly, the agency did not intend its references to attachment hardware in the SNPRM to imply that only bolt-on guards are permitted. The agency's intent was to require that any necessary attachment hardware be included with the guard when a guard manufacturer sells the guard to a trailer manufacturer if the guard manufacturer's method of attachment involves attachment hardware, as in the case of bolt-on guards. Weld-on guards are also permitted. However, if the guard manufacturer's installation instructions do not adequately specify the welding procedures, welds of poor quality could break in NHTSA's compliance testing. Weld strength could probably be assured through incorporating by reference welding industry standard practices.

Some commenters believed that the guard-trailer interface was inadequately addressed by the SNPRM. IIHS noted that the SNPRM proposed no minimum strength for the chassis or the attachment method, and concluded that the attachment may fail before the guard. It stated that NHTSA's static tests showed that the trailer frame rails failed without a doubler plate and that, even with a doubler plate, the flange welds failed in dynamic tests. It also believed that NHTSA should require installation instructions that are specific to each make and model of trailer. IIHS reiterated these comments in a September 16, 1994 letter that pointed to failures of the guard attachment hardware and trailer structures resulting in PCI in two of the VRTC crash tests. IIHS urged NHTSA to either require minimum strength levels for the guard attachment hardware and frame rail or require that the guard be tested together with the type of trailer frame rail to which it would be attached.

Mr. John Tomassoni suggested that the preamble to this rule should encourage manufacturers to install guards with due care so that the attachment is as good as the guard. He said that the trailer frame is the ''weak link'' in crashes today, and that adding ''doubler plates'' to trailer frame members helps to maintain the integrity of the attachment in a crash.

NHTSA's test results show the importance of considering the strength of the attachment point when designing a guard. The agency does not at this time believe that it is necessary to define strength requirements for the chassis or the attachment hardware because the necessary strength is dependent on the design of the guard. For example, a guard that is attached to the rear of the frame rail with two vertical supports (i.e., the commonly used cantilever design used in the VRTC tests and on most trailers) would require a stronger attachment site and attachment hardware than a guard with many attachment points or with diagonal struts. Therefore, without knowing the design of the guard, NHTSA cannot readily specify minimum strengths for the trailer frame or the attachment hardware, as suggested by IIHS.

However, the guard manufacturer must consider frame and hardware strength in order to have a basis for certifying the guard for use on the types of vehicles specified in the installation instructions. NHTSA agrees with Mr. Tomassoni that, if a cantilever design is used, guard manufacturers should consider doubler plates or other appropriate frame reinforcement to prevent frame failure. NHTSA does not want to require such features, however, because a different attachment design or a sturdier trailer frame may eliminate the need for reinforcement. It is not a requirement of this rule that guard manufacturers specify frame strength or reinforcement procedures in the installation instructions. However, as a practical matter, to have a basis for certification, they must consider frame strength using testing, engineering analysis, or both, to be assured that the guard attachment is appropriate for the types of vehicles specified in those instructions.

The VRTC test experience illustrates why guard manufacturers should appropriately design the strength of the attachment. In one case, attachment bolts which were marginally weaker than those used in the quasi-static test sheared under the sudden onset of force in the dynamic test. In another case, the proximity of the guard to the rear edge of the frame rail resulted in tearing of the trailer frame rail webbing. In each case, the guard itself was not really exercised because the attachment failed. In each case, simple modifications solved the problem. The importance of careful attachment hardware material selection and attachment design cannot be overemphasized.

Although guard manufacturers are free to issue separate instructions for each specific make and model of trailer, as IIHS recommends, it is not necessary for NHTSA to require such instructions. An efficient way to specify trailer type would be to list specific make/model combinations. However, as long as the instructions are adequate to identify which vehicles are appropriate for the installation of the guard, specification of the make and model of the trailer may not be necessary. One reasonable alternative for a guard manufacturer with a very adaptable guard design is to show in its instructions the types of trailer, types of chassis configurations, and frame strengths that are necessary to the functioning of that particular guard. For example, the guard manufacturer might specify that any flatbed or van trailer with longitudinal frame rails extending to within 305 mm (12 in) of the rear, spaced between 760 mm and 1,270 mm (30 and 50 in) apart, and with the bottom of the frame rails configured as a horizontal surface at least 100 mm (4 in) wide, composed of steel that is at least 6 mm (1/4 of an inch) thick, would be an appropriate trailer for mounting the guard.

Some commenters believed that defining ''chassis'' as the ''load supporting structure of a motor vehicle'' was too restrictive or otherwise inadequate. NSWMA asked NHTSA to modify S5.3.2 of the vehicle standard to allow vehicle manufacturers with ''unique design considerations'' to attach the underride guard ''to a load supporting structure of the vehicle or body, or through other means that provide equivalent protection.'' It believed that this change is necessary to take into account body designs that do not use a conventional chassis frame.

Mr. John Tomassoni also suggested that NHTSA further define the term ''load supporting structure'' because the longitudinal frame members don't extend all the way to the rear end of some trailers.

Although NSWMA did not provide any specifics on its vehicles, NHTSA agrees that there may be some trailers that do not have adequate chassis structure, in terms of a frame structure, to support a conventionally designed rear impact guard. However, no change to the requirements is necessary. Although the frame components are the obvious attachment point in the case of most trailers, attachment to this chassis member is not required by this rule. In certain cases, an unconventional guard design that is attached to other parts of the chassis may be necessary. In rare cases, custom-designed guards or even extension of the trailer chassis may be necessary to mount the guard.

The TTMA suggested changing the installation requirements in S5.3 to apply to ''guards that are produced or modified and installed by a vehicle manufacturer * * *,'' so that a trailer manufacturer can modify stock guards to fit its particular trailers. It assumes that the guard manufacturer is unlikely to provide installation instructions for the wide variety of trailer configurations. It reasons that, since the trailer manufacturer has to certify that the trailer is in compliance with all Federal motor vehicle safety standards anyway, why not let it modify the guard?

Vehicle manufacturers are allowed to modify purchased guards to suit their own trailers. There may be minor modifications to widely available guard designs that will make them suitable for trailers for which they were not designed. However, if a vehicle manufacturer modifies the guard in a way not contemplated by the instructions provided by the guard manufacturer, that vehicle manufacturer becomes a guard manufacturer. The vehicle manufacturer may no longer rely on the certification of the original guard manufacturer, because the original manufacturer presumably did not intend its guards to be so modified. As a guard manufacturer, the vehicle manufacturer would have to certify that the guard, as modified, complies with the equipment standard. Also, the vehicle manufacturer would have to affix its own certification label and prepare modified installation procedures. The installation procedures are necessary both to ensure that the guards are modified and installed the same way each time, and to allow NHTSA to duplicate the modification when conducting compliance testing.

The original guard manufacturer's installation instructions may provide for some flexibility in the installation. For example, they may specify that a certain kind of spacer may be used to achieve a proper fit, or that a doubler plate be installed if the thickness of the chassis is below a certain amount. However, NHTSA may employ any of the installation options provided to the vehicle manufacturer when subjecting a guard to compliance testing. Any test failure of a properly installed guard will represent noncompliance by the guard manufacturer.

7. Compliance Test Requirements and Procedures

a. Dynamic Versus Static Testing. Several commenters, including Advocates, urged that NHTSA require that the guards be tested dynamically, that is, by crashing cars into the rear of trailers equipped with the rear impact guard. The agency agrees that dynamic testing more closely simulates the conditions in which underride crashes occur in the real world than the quasi-static testing does. However, dynamic testing is also far more expensive. To test one guard/trailer combination with a dynamic test for strength and energy absorption would entail total test costs of approximately $30,000.

Dynamic tests would be so expensive that specifying such testing of trailers could raise practicability concerns regarding those trailer manufacturers that are small businesses. A requirement based on such tests would place these small manufacturers, which are numerous, at a competitive disadvantage, relative to larger companies, and would represent a significant financial burden.

Quasi-static tests provide similar information far more economically than dynamic tests. The VRTC research project demonstrated that quasi-static testing generates similar forces to those generated in an actual crash test, albeit at a slower rate. The project also demonstrated that guards only ten percent stronger than the minimum level of strength necessary to pass quasi-static test requirements performed adequately in dynamic tests. The quasi-static compliance test for a single guard at VRTC cost only about $3,500. Based on the foregoing and the discussion in the section above on separate equipment and vehicle standards, the agency believes that dynamic testing of underride guards is unnecessary and overly expensive. NHTSA further believes that quasi-static testing is adequate to ensure the manufacture of safe and effective rear impact guards and that it will do so at a far lower cost. Therefore, the quasi-static testing procedure has been retained in the final rule.

Some commenters commented on the definition of ''rigid test fixture.'' The TTMA assumes that a trailer can be used as a rigid test fixture, and other commenters urged that testing be permitted on trailers. The Institute for Injury Reduction commented that the terms ''sufficiently large,'' ''appropriately configured,'' and ''no significant amount of energy'' in the definition of rigid test fixture are vague, imprecise, ambiguous and in no way ''stated in objective terms.''

NHTSA notes that a trailer may meet the equipment standard's definition of a rigid test fixture, but because of slight flexing of the vehicle structure, in other cases, they may not meet this definition. NHTSA is persuaded that the benefits of testing on trailers outweigh the possible effect on testing repeatability and does not want to discourage testing on trailers by conducting its compliance testing only on a rigid test fixture. The TTMA comment indicates that, although it is not required, some vehicle manufacturers will conduct quasi-static guard testing on trailers or trailer portions. NHTSA sees no reason why this should not serve as a basis for manufacturer certification even if the trailer is not a rigid test fixture. The use of a trailer would be desirable because there is nothing more ''appropriately configured'' for guard mounting than the actual trailer the guard will be installed on and because the structural integrity of the trailer chassis will also be tested. However, caution must be exercised to assure that the trailer is secured so that it does not move during the test. If the guard is mounted to a trailer, the trailer chassis will be secured so that there is no rotation or translation of the trailer tires during the tests for guard strength and energy absorption.

When conducting compliance testing, the agency will give the guard manufacturer the option of designating testing on a rigid test fixture or on a trailer. NHTSA notes that it may test on any trailer described as appropriate in the guard manufacturer's installation instructions, even if the guard manufacturer based its certification for that trailer not on actual testing but on engineering analysis.

NHTSA agrees with the Institute for Injury Reduction that the definition of ''rigid test fixture'' needs a slight modification. The reference to size has been eliminated because size is not really as important as rigidity. However, it is not necessary to define the amount

of energy the fixture can absorb, because, like the ''fixed collision barrier'' defined in 49 CFR 571.3, the guards will be expected to pass the test no matter how little energy is absorbed by the fixture. Also, the term ''appropriately configured'' has been clarified. There is no way to precisely define how the test fixture will have to be configured because that will depend on the design of the guard being tested. There may be a number of appropriate configurations. As long as the guard can be attached to the test fixture in the same way that the guard manufacturer's instructions specifies the guard is to be attached to the vehicle, without either modifying the guard or adding adaptive parts to obtain a better fit between the guard and the fixture in a way that is inconsistent with the instructions, the test fixture is appropriately configured.

The agency had modified the strength test procedures to promote ease of testing. Paragraph (b) of S6.5 now requires the application of the force to the loading device to achieve a constant deflection rate, rather than a constant increase in force, as proposed in the SNPRM. In other words, rather than increasing the force at a constant rate, the deflection rate is required to be held constant and the force will vary depending on the resistance offered by the guard. Specification of a deflection rate procedure is consistent with existing agency practice. For example, the quasi-static compliance tests in S4(d)–(e) of Standard No. 214, *Side Impact Protection* and S6.3 of Standard No. 216, *Roof Crush Resistance* utilize this technique for force application.

b. Test Sites. Several commenters recommended changes in the language ′specifying the test sites to be used during the compliance tests. Mr. John Tomassoni recommended defining the P1 test site such that the ''3/8 L'' lateral dimension (see Figure 1) is defined relative to the side extremities of the trailer, as opposed to the center of the guard. He suggested that this change would account for newer 2,600 mm (102 in) wide trailers which have a 1,270 mm (50 in) longitudinal frame rail span, or for any other width trailer. This approach, however, is inconsistent with a separate equipment standard because the exact width of the trailer may not be known at the time of testing. Moreover, the requirement that guards extend to within 100 mm (4 in) of the side of the trailer should assure that the P1 site will be sufficiently outboard on the trailer, because wider guards will be required for wider trailers, and the P1 location is dependent upon guard width.

Mr. Tomassoni also suggested that S5.2.2 and Figure 1 should be modified to specify that the vertical center of force should not be more than 560 mm (22 in) from the ground, rather than at ''the horizontal plane that passes through the vertical center of the horizontal member,'' as proposed in the SNPRM. Mr. Tomassoni indicates that a guard with a horizontal member of cross sectional vertical height greater than 100 mm (4 in) would result in higher test points. Higher test points would yield test results that are not indicative of the guard's effective impact strength near the bottom edge, where force is likely to be concentrated in real world crashes. Although it is not possible to define the test points relative to the ground because the guard is not required to be mounted on the vehicle during testing, NHTSA has modified the rule to define the test points relative to the bottom of the guard itself. This should assure adequate strength and energy absorption at the level of likely impact force.

Mr. John Kourik pointed out that the P1 test site was defined incorrectly in the SNPRM, although it was correctly portrayed in Figure 1. The text of S5.2.2(a) (redesignated S6.4(a) in this rule) read ''3/8 of the transverse horizontal distance * * * between the * * * vertical centerline of the guard [and] the outermost edge * * * of the guard.'' The P1 definition has been corrected to reflect that the point is located 3/8 of the total guard width outboard of the centerline. Mr. Kourik also suggested that the four asterisks showing the P3 test sites in Figure 1 be reduced to two asterisks. NHTSA has modified the figure to make it clearer that there is only one P3 test site on each side of the guard, but that the location of the site is within a range from the centerline.

The TTMA and other commenters suggested broadening the range of locations of the P3 test site to allow it to be ''any point selected by the manufacturer * * * between 14 and 25 [rather than 20] inches outboard'' of the guard centerline. Most new trailers are wider than in the past with a frame rail span of 127 cm (50 in), and the frame rail is a likely chassis structure for guard attachment. TTMA wanted NHTSA to conduct the more demanding 100 kN (22,480 lb) P3 test near the attachment point of the guard's supports. This was NHTSA's general objective in specifying the P3 test location, and this objective is furthered by accommodating TTMA's request in part. The rule has been modified to provide that P3 is located 355 to 635 mm (14 to 25 in) from the guard centerline. However, NHTSA will select any point within the range for compliance testing, rather than permit a manufacturer to specify a single test site within the 355 to 635 mm (14 to 25 in) range.

c. Labeling and Certification. The TTMA suggested that affixing a certification label is redundant in those instances in which the guard is manufactured by the vehicle manufacturer because the vehicle manufacturer has to certify compliance with all the safety standards anyway. Although this is true, allowing some guard manufacturers to omit the label would be impractical from an enforcement standpoint, because vehicle inspectors would not be able to tell whether the guard was certified by the guard/vehicle manufacturer as part of the vehicle or whether the vehicle manufacturer installed a guard purchased from a guard manufacturer who neglected to make a required certification. Moreover, NHTSA does not believe that affixing the label is a significant burden. Therefore, the final rule retains the requirement of a separate guard certification for all guards.

The TTMA also recommended that the label be affixed to the roadside vertical supporting member of the guard, instead of the center of the horizontal guard member, to prevent damage and abuse. NHTSA believes that docking and other routine operations could damage the label if affixed in the proposed location. Therefore, the rule has been modified to require the label to be affixed in a less vulnerable location. The rule now requires the certification label to be placed on the forwardmost surface of the horizontal member of the guard at an offset location 305 mm (12 in) inboard of the right side end of the guard.

The TTMA also suggested changes in the label format. Specifically, it recommended that the letters and numbers should be 2.5 mm (3⁄32 of an inch) high, which is the same as the trailer certification label, rather than 13 mm (½ inch) high as proposed in the SNPRM. TTMA also asked that NHTSA require that the label be furnished to the vehicle manufacturer with a protective cover that can be removed after painting.

The agency believes that the smaller letters suggested by TTMA are sufficiently legible for inspection purposes, and has changed the rule to adopt this suggestion. However, market forces should determine whether protective covers are provided. Vehicle manufacturers will probably cover the labels themselves when painting to avoid having their guard confused with a noncomplying guard.

C. Standard for Vehicles

1. Configuration Issues

a. Maximum Guard Ground Clearance. One of the major issues addressed by nearly all the commenters was the maximum ground clearance of the horizontal member of the rear impact guard. The SNPRM proposed a maximum guard height of 560 mm (22 in). Consumer safety groups and private citizens generally favored lowering the guard to within 405 or 460 mm (16 or 18 in) of the ground in the belief that doing so would provide more complete protection for low profile vehicles such as sub-compact and mini-compact passenger cars. Since the real issue is not ground clearance, but guard height relative to the front structure of colliding passenger vehicles, some of these commenters addressed related issues such as the height of the engine block, hood, and cowl (windshield base) of those vehicles. Except for the consumer safety groups and a few private citizens, few provided a rationale or any data to support a lower guard height. The organizations and private companies related to the trucking industry generally supported a 560 mm (22 in) height, but offered a variety of reasons not to lower the guard further. Most of their concerns related to operational difficulties that would be caused by lower guard heights.

The consumer safety groups focussed their comments on guard effectiveness. Advocates advanced several reasons for reducing the guard height in order to achieve better engagement between the guard and the engine block, bumper, and tires of colliding passenger vehicles. Advocates stated that lower engine block heights on modern automobiles, combined with the lowering of the passenger vehicle's front end due to suspension compression during severe braking, will result in the rear impact guard passing over the engine and engaging only the hood and fenders of most cars. In addition to the front end lowering caused by braking, Advocates claim that additional frontal lowering will occur on downgrades due to forward weight transfer. Citing a random survey it made of subcompact cars and urging NHTSA to conduct a more thorough survey, it said that no engine block is higher than 560 mm (22 in) above the ground and bumpers are in the 430 to 535 mm (17 to 21 in) range. It stated that earlier NHTSA data using the average hood height above the ground was misleading because its ''casual'' survey of subcompact hood front edges showed none higher than 635 mm (25 in). It interprets these data to mean that only fender top and hood sheet metal would be engaged, and concluded that air bag sensors probably will not be triggered. Advocates also maintains that, even if the top of the engine were engaged, the underride guard will cause the blocks of transversely-mounted engines used in most subcompacts to rotate (roll) rearward, crushing the car occupant's legs. Based on British research, Advocates recommends a guard height of no more than 405 mm (16 in), and ideally 305 mm (12 in). Both Advocates and Mr. Byron Bloch, of Auto Safety Design, cited the 1980 study by Dynamic Science which concluded that the guard height should not exceed 510 mm (20 in). Mr. Bloch recommended a height of 405 to 460 mm (16 to 18 in). CRASH solicited many private citizens to send in petitions, letters, and pre-printed cards stating that the guard height should be set at 405 mm (16 in), but none provided supporting technical information.

The IIHS, citing the same studies as Advocates, urged NHTSA to adopt a maximum ground clearance of 460 mm (18 in). IIHS is primarily concerned that a 560 mm (22 in) high guard will override car bumpers, thus bypassing much of the potential front end energy absorption. Other concerns expressed by IIHS were late air bag activation, braking-induced bumper depression of two to 100 mm (4 in) or more, and possible lifting of the rear end of the trailer as the car wedges under the guard. IIHS implied that a 460 mm (18 in) requirement is practical, noting that one U.S. freight carrier reportedly sets its guards at 495 mm (19.5 in).

IIHS believes NHTSA's estimate that trailers probably sit 50 to 75 mm (2 to 3 in) lower when loaded is wrong. IIHS tests on 11 trailers showed the most heavily loaded trailers showed only 38 to 57 mm (1.5 to 2.25 in) of depression with an average of 28 mm (1.1 in). Four of the trailers even raised in the rear, indicating that load distribution is probably a factor in determining rear extremity compression height. IIHS believes that modern air suspensions compensate for loading depression. Even if loaded trailers are depressed, it believes that passenger vehicles should be protected from partially loaded or empty trailers, which it says are involved in 29 percent of fatal crashes. Therefore, IIHS urges NHTSA to assume no depression of the trailer bed due to loading.

Mr. John Tomassoni commented that a lower guard would be better because engine block resistance to a rigid guard doesn't start until 460 to 610 mm (18 to 24 in) behind the bumper. However, Mr. Tomassoni concluded that a 560 mm (22 in) requirement is a significant improvement over the existing 760 mm (30 in) height, and one that can be implemented with little or no difficulty. He notes that trailers 16 meters (m) (53 feet (ft)) or longer are currently being equipped with 560 mm (22 in) high guards.

Some municipalities sent comments in favor of lower guard heights. For example, the City of Durham, North Carolina sent an unsigned resolution that the height be set at no more than 460 mm (18 in). Its Transportation Advisory Committee submitted a similar comment. About 2,300 private citizens recommended a guard height of 405 mm (16 in).

The industry groups focussed their comments relating to guard height on operational restrictions that would result from the reduced ''angle of departure'' that lower ground clearance would cause. The angle of departure is basically the acute angle formed by the ground and a line connecting the point where the rear tires meet the ground with the bottom of the guard. The lower the guard, and the further forward the rear wheels are positioned relative to the guard, the smaller the departure angle is, and therefore the more likely the guard is to scrape or ''hang'' on the ground when the trailer mounts a steep incline. The problem is exacerbated for the longer 16 m (53 ft) trailers being used today, because they have correspondingly greater rear overhangs, and thus smaller departure angles. Many trailers have their rear wheels mounted on sliding tandems, or bogeys, that can be moved forward or rearward on the trailer's frame, depending on the load and the need for maneuverability. The further forward the wheels are, the more maneuverable the trailer is and the more the rear end of the trailer ''swings out'' in turns.

Changes in the industry since 1981 seem to have relieved the concerns of the rail industry that the proposed ground clearance of 560 mm (22 in) would interfere with rail car loading and unloading operations, in which trailers are driven up steep ''circus ramps'' onto flat cars. The Association of American Railroads (AAR) and TTX Company, a trailer-on-flat-car operator, opposed the 1981 NPRM, but now support the 560 mm (22 in) requirement because there are few ''circus'' ramps still operating. However, they caution that a significantly lower height would interfere with intermodal flatcar operations. TTX asserted that such a reduction in guard clearance could interfere with lift-on and lift-off operations for one type of railroad car (TTAX ''spin cars'') handling 16 m (53

ft) trailers. It added that there must be extra guard clearance to account for loading depression and bouncing. To illustrate the potential economic impact of lower guard clearance, TTX stated that there are 2,300 such cars costing $340 million, which are only 1.8 years old on average. TTX estimates that lowering the guard clearance could eliminate 75 percent of the capacity for 14 railroads.

In contrast, the 560 mm (22 in) guard height is still considered low by the portion of the industry that transports trailers in ships. Transamerica Leasing, Inc. recommends that NHTSA conduct further study before issuing this rule because a 560 mm (22 in) high guard would scrape loading ramps during roll-on/roll-off ship loading when the wheels are positioned forward to provide the maneuverability necessary in ships. The American Trucking Associations (ATA) supports the 560 mm (22 in) proposed ground clearance, but stated that any lower clearance would be unacceptable. It calculates that a loaded trailer driven onto a barge or vessel, which it says have departure angles as high as 15 degrees, would drag the guard if the rear axle is 190 cm (74.5 in) or more forward of the guard. It said that many states have restrictions on trailer kingpin-to-rear- axle distances that result in a 245 to 275 cm (96 to 108 in) rear-wheel-to-guard distance on 16 m (53 ft) trailers. It concludes that these trailers' guards would hang on such vessel loading ramps or on any 20 percent grade. It finds the 560 mm (22 in) clearance acceptable only because 16 m (53 ft) trailers are rarely used on vessels, and because 20 percent grades are rare. The Truck Maintenance Council of the ATA recommends a guard clearance of 560 mm (22 in) for general freight equipment. According to Mr. Robert Crail, a trailer designer and manufacturer, the proposed 560 mm (22 in) height is acceptable because, although many trailers are still driven into ships rather than being crane loaded, vessel owners can adjust their ramps, and because it is compatible with the dimensions established by the trucking industry and loading dock restraint device manufacturers. Ford Motor Company had no specific data, but is concerned that 560 mm (22 in) may be inadequate ground clearance for loading and unloading of long trailers in trains or ships. Ford also noted that some single unit trucks are equipped with kneel-down air suspensions to facilitate loading and unloading, which Ford says are incompatible with a 560 mm (22 in) high guard.

Even outside the context of intermodal loading and unloading operations, some commenters were concerned about the reduced departure angle that a 560 mm (22 in) high guard would create. The National Solid Waste Management Association (NSWMA) emphasized the importance of maneuverability for sanitation trucks in negotiating driveways and backing into tight places. It estimated that a 560 mm (22 in) guard mounted flush with the rear extremity of a sanitation truck would have a departure angle of only 9 degrees, which it says is typical of many driveway entrances. Although it appears that many of the trucks NSWMA is concerned with are single unit trucks that are excluded from the rule, NSWMA is also concerned about the guards getting hung up on the ground when the trailers are taken off-road onto the soft, unpaved, uneven roads at landfills and construction sites.

One additional industry concern is engagement of the guard with ''dock locks.'' When trailers back up to loading docks, these devices engage the underride guard to keep the trailer from moving away from the loading docks as forklifts repeatedly travel across the rear door sill. Transamerica Leasing believes that the 560 mm (22 in) high guards may interfere with ''dock lock'' engagement arms. Yellow Freight System states that thousands of dock locks have been installed according to the 560 mm (22 in) guard height recommended by the Maintenance Council of the ATA, and urges NHTSA not to change now. However, Rite Hite Corporation, a manufacturer of dock locks, submitted information indicating that dock locks can accommodate guard heights between 355 and 760 mm (14 and 30 in).

One industry group endorsed a lower guard height. The AFL-CIO Teamsters Union suggested that NHTSA could require a ground clearance lower than 560 mm (22 in) because auto carriers and UPS trailer fleets have reported no problems with lower guard heights. It also observed that 16 m (53 ft) trailers in many states have no problem using 560 mm (22 in) guards.

The question of proper guard ground clearance involves a balancing of the effectiveness of the guard in providing protection against PCI against the cost and operational restrictions that lower guard heights could impose on the industry.

The effectiveness of the guards is a primary consideration. Regarding Advocates' survey of bumper and hood heights on compact and subcompact cars, NHTSA conducted a similar survey of engine block height and front end profile of a sample of 40 vehicles. The results of this survey were summarized in the agency's Truck Underride Report to Congress, dated November, 1993. The NHTSA survey showed that the height of the top of the engine block was between 660 and 790 mm (26 and 31 in), with an average height of 840 mm (28 in). The hood leading edge in NHTSA's survey averaged about 685 mm (27 in) and the lower edge of the windshield frame averaged about 840 mm (33 in). The agency is not aware of the basis upon which Advocates selected the cars for its survey, but NHTSA's survey was targeted preferentially at cars with the lowest front end profile. Since NHTSA's average heights were higher than those obtained by Advocates, NHTSA has no explanation for the discrepancy, unless the survey methodologies were different. Hood heights have been getting lower over the past few years, but that trend may have stopped in the last two years. NHTSA believes that the average hood heights in its survey are representative of the anticipated dimensions for new passenger vehicles 5 to 10 years in the future. NHTSA concludes from the VRTC test results that a 255 to 305 mm (10 to 12 in) overlap between the guard bottom and the lower edge of the windshield will ensure adequate structural engagement with the guard for the vast majority of compact and subcompact cars.

NHTSA agrees with IIHS that a guard 560 mm (22 in) high will override most bumpers, but disagrees that bypassing the bumper sacrifices much of the potential front end energy absorption capability. The bumper is designed to prevent cosmetic damage in low speed crashes (less than 16 kph, or 10 mph) and provides only a small portion of the energy absorption by a car crashing at higher speeds. The bumper is mounted to the frontal crash energy management components which extend rearward and upward to the rearmost section of the engine compartment. These components will be adequately engaged by the rear impact guard during a collision. Regarding IIHS's contention that NHTSA should assume no loading-induced depression of the trailer bed, NHTSA has not made such an assumption. The final rule regulates the guard height only when the trailers are unloaded, and the 560 mm (22 in) guard height was adequate in NHTSA's VRTC tests.

The agency conducted seven full scale crash tests with the proposed guard in the course of the recent research project, using two types of subcompact and two types of compact cars. These vehicles were representative of average hood and engine heights for cars in those size classes. The minimally compliant rear

impact guard was set 560 mm (22 in) above the ground. During these tests, the cars had their front ends depressed to simulate the lowering that would be experienced during heavy braking, but the guard was not depressed to a level below the minimum clearance, as it might be if the trailer were loaded. In some sense, therefore, these tests represented a ''worst case scenario'' with regard to guard height. In each test, the air bags were fully deployed before dummy contact and the deceleration readings were much better than the minimum requirements in Standard No. 208, *Occupant Crash Protection*. When there was no guard attachment failure, they adequately engaged the structure of each car and prevented PCI. There was little movement of the engine and no contact between the engine and fire wall. The transversely mounted engines did not rotate substantially, and none of the dummies legs were crushed. Therefore, based on the docket comments, the recently completed crash tests, and the assessment of late model passenger vehicle frontal structure characteristics, NHTSA concludes that the 560 mm (22 in) maximum guard ground clearance is adequate to engage the frontal crash energy management structure of most subcompact and compact cars.

Although some small sectors of the industry may be affected, NHTSA does not believe that there will be any insurmountable problems with a 560 mm (22 in) guard height. Several states have required 560 mm (22 in) maximum guard ground clearances in conjunction with the passage of laws allowing 16 m (53 ft) trailers. NHTSA contacted several distributorships/dealerships that sell heavy trailers in excess of 15 m (50 ft) in length to the trucking industry and was unable to obtain information documenting substantial operational problems due to guard ground clearances of 560 mm (22 in) or less. The AFL-CIO Teamsters Union did not give NHTSA enough information about the operating environment of Carolina Freight Carriers Corporation, the trucking company that sets its guards at 495 mm (19.5 in), to determine why they have not experienced the problems that the other commenters expect with guards lower than 560 mm (22 in).

NHTSA does not believe that the number of trailers involved in ship roll-on/roll-off and trailer-on-flat-car circus ramp operations is significant. TTMA data indicate that less than 5 percent of trailers in the U.S. are ever transported by ship or barge, and that between one and less than ten percent of new trailers are produced for trailer-on-flat-car use. Modifications of may solve these problems. Most of the vehicles in the waste services fleet mentioned by NSWMA are single unit trucks excluded from the rule. However, in those few cases where there are still problems, movable or adjustable guards may be needed.

There is adequate evidence in the comments to conclude that requiring a guard height lower than 560 mm (22 in) would cause an undue burden on the industry. Of particular concern are the comments of ATA, TTX, AAR, and Transamerica Leasing, indicating that any height below 560 mm (22 in) will cause interference in intermodal operations. Moreover, a lower height will increase the probability that the guard will scrape or snag during normal vehicle operations and be damaged as a result. Therefore, because the 560 mm (22 in) maximum ground clearance proposed in the SNPRM appears to be the lowest height that provides adequate effectiveness without imposing an undue burden, it has been retained in the final rule. The agency notes that guards may be mounted with less than the maximum allowable ground clearance.

b. Guard Width. The SNPRM proposed that the horizontal member of the guard be required to extend across the width of the trailer to within 100 mm (4 in) of the side extremities, but not outboard of the side extremities. Advocates commented that the 100 mm (4 in) allowance appeared arbitrary, based on the rulemaking record, but did not actually suggest that the guard should extend fully to the side extremities of the trailer. The AFL–CIO Teamsters Union indicated that it fully supports the SNPRM's 100 mm (4 in) allowance, while noting much anecdotal information from drivers about the importance of a ''full width'' guard, especially for crashes that occur at an angle to the rear of the trailer.

NHTSA notes that there is no requirement of a 100 mm (4 in) inset. Vehicle manufacturers are permitted to install guards extending the full width of the trailer. However, the 100 mm (4 in) allowance gives trailer and guard manufacturers some flexibility in choosing and providing guards, without sacrificing safety or effectiveness. From the perspective of guard effectiveness, it is doubtful that the extra lateral coverage would significantly increase the strength of the guard at its extremities or its ability to protect passengers in an offset collision.

In fact, a 100 mm (4 in) inset would decrease the previously mentioned ''hooking'' potential during sharp turns of the trailer and provide more clearance in certain passing situations. The Florida Department of Transportation and the TTMA recommended allowing rounded guard ends to alleviate this potential problem, but NHTSA notes that a 100 mm (4 in) inset on an unrounded guard will partially accomplish the same goal. As discussed above in the section on shape of the horizontal cross member, pursuant to the TTMA's suggestion NHTSA has modified the rule to allow rounded corners on guards to begin curving at a point 255 mm (10 in) inboard of the edges of the vehicle, while retaining the 100 mm (4 in) requirement for straight guards. Curved guards still have to meet the other requirements of the vehicle standard (i.e., extend to within 100 mm, or 4 in, of the side extremity). This modification merely removes for the curved portion of the guard the requirement that the bottom of the horizontal member be within 560 mm (22 in) of the ground, in the case of upward curving guards, and the requirement that the rear surface of the horizontal member be within 305 mm (12 in) of the vehicle rear extremity, in the case of forward curving guards.

c. *Specification of the Rear Extremity.* Some commenters requested that NHTSA modify the proposed definition of ''rear extremity'' to take into account vehicles with high protrusions in the rear. The SNPRM defined the rear extremity as the rearmost point of the vehicle that is located 560 mm (22 in) or more above the ground. The specification of the rear extremity is important because the SNPRM also requires that the rear impact guard be located no more than 305 mm (12 in) forward of the rear extremity of the vehicle. Some trailers and semitrailers, such as hopper trailers with V-shaped bins and trailers with liftgates or refrigerator units in the upper rear, are shaped such that the rear extremity of the vehicle is located well above the road surface. These protrusions do not present a danger of PCI because they are located well above the roof line of most passenger vehicles. Yet, applying the rear extremity definition in the SNPRM, a rear impact guard would have to be mounted such that it extends rearward from the base of the trailer to a position within 305 mm (12 in) of the back of the high protrusion. Such an extended guard might pose a safety hazard as well as operational difficulties.

Several manufacturers of vehicles with high rear end overhang recommended alternative definitions of ''rear extremity'' that excluded portions of the trailer rear that were high enough to clear the roofs of passenger vehicles. The TTMA and the ATA recommended that vehicle structure with a ground

clearance of 1,680 mm (66 in) or more be excluded from the definition of rear extremity. NSWMA recommended excluding that portion of the rear of the vehicle located 1,520 mm (60 in) or more above the ground.

The agency acknowledges the potential problem with the proposed specifications and believes that redefining the rear extremity to accommodate these vehicles is possible without reducing rear impact guard effectiveness or creating new safety hazards. NHTSA contacted officials from TTMA and ATA to obtain more information about the current number and future production plans for vehicles of this type. According to TTMA, these are mostly highly specialized vehicles and the high overhang often consists of equipment such as cranes in addition to ''bubble door'' type container trailers. TTMA estimates that these vehicles constitute less than one percent of the annual trailer and semitrailer production and there is no trend toward increasing the numbers substantially. ATA also estimated that the number of vehicles produced annually with high rear overhanging structure represents less than 5 percent of the total annual production of trailers and semitrailers. ATA did not provide information on the future trend of production of these vehicles, but indicated that the number has been fairly constant in the recent past with new vehicles brought into service primarily to replace vehicles going out of service.

The NSWMA recommended that the rule specifically state that, for roll-off/hoist type trailers, the containers on the hoist frame be considered as part of the load and not as part of the vehicle for purposes of rear extremity specification. It suggests that the rearmost part of the hoist frame should be considered the rear extremity. Containers extend up to 1.5 m (5 ft) rearward from the end of the hoist frame.

The agency has decided to revise the SNPRM's definition of ''rear extremity'' to limit its ambit to the portion of the vehicle's rear located between a lower and upper height limit. The lower limit specification remains unchanged at 560 mm (22 in) (that is, guard ground clearance). An upper limit for the area in which the rear extremity is located has been specified at 1,900 mm (75 in) above the ground surface for purposes of the vehicle standard. The portion of the rear of the trailer that is located in the same horizontal planes as a passenger vehicle windshield is the critical area for rear underride protection. This is between 760 mm and 1,900 mm (30 and 75 in) above the ground for almost all passenger cars, vans, and light trucks.

With regard to roll-on/hoist type trailers, the agency agrees with NSWMA that there would be numerous regulatory problems involved in considering the containers to be part of the vehicle, rather than part of the load. Although the containers may extend beyond the end of the vehicle and are capable of causing PCI just like the rear end of a trailer, they are not part of a new vehicle as manufactured. Further, the boxes, tanks, and other specialty containers are manufactured, maintained, and in many cases owned separately from the vehicle. NHTSA has no authority to regulate vehicle loads under 49 U.S.C. Chapter 301.

While NHTSA cannot require guards on the container on roll-on/hoist type trailers, it can require guards on the rear of the trailer that carries it. If the vehicle is designed to carry containers that do not extend appreciably beyond the rear of the vehicles, the agency sees no basis for excluding it. Casual observations indicate that the containers do not usually extend beyond the rear of the vehicle, so these trailers are required to have guards. The rear extremity will be determined without the container.

d. *Distance between the Guard Rear Surface and the Vehicle Rear Extremity.* Several commenters urged NHTSA to change the requirement proposed in the SNPRM that the guard's horizontal member be mounted not more than 305 mm (12 in) forward of the rear extremity of the trailer and not rearward of the rear extremity. The distance between the guard and the trailer rear extremity is significant because the sooner the passenger vehicle engages the underride guard, the farther its occupant compartment will be from the rear of the trailer when the guard is engaged, and the better the chance that the passenger vehicle will stop short of PCI.

Some commenters thought that NHTSA should allow the guard's horizontal member to extend rearward of the rear extremity. Mr. John Tomassoni stated that he saw no good safety reason for restricting rear extension, since it is beneficial for preventing PCI. The TTMA also saw no reason why the guard should not be located rearward of the rear extremity. It also suggested a change in the language of S5.1.3 that makes it clear that, even above 560 mm (22 in) the guard cannot be more than 305 mm (12 in) from the rear extremity of the vehicle.

The Rite Hite Corporation stated that, for dock locks to function, there must be no more than 230 mm (9 in) between the rear extremity and the guard. It is concerned that the 305 mm (12 in) allowance will render the dock locks useless.

NHTSA notes that the 305 mm (12 in) allowance is not a minimum, but a maximum requirement. Casual observations by the agency indicate that nearly all trailers currently have their guards mounted flush with the rear extremity of the trailers. This practice is also specified as the recommended practice in the ATA Maintenance Council guidance (RP 707). It is also the configuration most compatible with dock locking mechanisms. Based upon the TTMA's comment relating to mounting rearward of the rear extremity, the industry appears to be in favor of mounting as far rearward as possible. Therefore, NHTSA believes that trailer manufacturers will continue to mount guards flush with the rear extremity of the vehicle.

The main incentive to change the prevailing practice relates to the smaller departure angle that will be created by lowering the maximum guard ground clearance from 760 mm to 560 mm (30 to 22 in). Moving the guard 305 mm (12 in) forward will slightly increase the departure angle. However, nothing in this rule increases that existing incentive. Therefore, the agency does not expect that a 305 mm (12 in) allowance would have any effect on prevailing practice. Further, NHTSA does not believe the benefit of moving the guard forward would be very significant. Nevertheless, the agency had modified the requirement in section 5.1.3. for guard rear surface location, or off-set, to state that the guard should be mounted as close as practical to the rear extremity of the vehicle. This will prevent vehicle manufacturers from mounting the guard with up to 305 mm (12 in) of forward off-set from the rear extremity of the vehicle unless the off-set is necessary and not merely convenient. It should be noted that the requirement to mount the guard as close to the rear extremity as practical is identical to the requirements of ECE Regulation 58.

NHTSA agrees that having the horizontal member of the guard positioned rearward of the rear extremity would be beneficial for preventing PCI in the event of a crash. Some meritorious guard designs, such as the Quinton-Hazel hydraulic energy absorbing guard and the Hope rearguard underrun device, utilize horizontal members that are hinged so that they are angled down and slightly rearward from the rear of the trailer. This rearward positioning enables the guard to engage a striking vehicle at a greater distance from the rear extremity and gives the guard a greater distance to swing

forward and ''ride down'' the energy of the striking vehicle before PCI occurs. If vehicle manufacturers want to provide this extra measure of safety, this agency will not discourage it, as long as vehicle manufacturers consider State laws governing overall combination truck length. However, NHTSA does not want to require rearward positioning because this configuration exacerbates the previously mentioned potential for ''hooking'' adjacent vehicles during sharp trailer turns and in other situations. Therefore, NHTSA has removed the SNPRM's prohibition on positioning the horizontal member rearward of the rear extremity. The new requirement that the member be as close to the rear extremity as practical is limited so that it does not prohibit mounting rearward of the rear extremity.

Advocates stated that NHTSA has no data to support the 305 mm (12 in) allowance because all crash tests were done with guards positioned at the very rear of the trailer, thus implying that testing in the forward-mounted position is required to support the allowance.

Even though the crash tests conducted by NHTSA had the rear impact guards mounted in the usual position, flush with the rear of the trailer, NHTSA has used a simple mathematical calculation to determine whether, and to what extent, PCI would have occurred if the guard had been mounted 305 mm (12 in) forward of the rear extremity (see VRTC report ''Heavy Truck Rear Underride Protection,'' June, 1993. DOT–HS–808–081). The agency assumed that if the guard had been mounted 305 mm (12 in) farther forward, the car's occupant compartment would have come to a rest 305 mm (12 in) closer to the rear of the trailer after the crash. There is no reason to expect that the guards would have performed more poorly if mounted further forward in the 305 mm (12 in) zone at the rear of the trailer. Therefore, there is no need, as Advocates suggests, to mount the guards at the ''worst case'' forwardmost point for testing purposes. In any case, the new requirement to mount the guards as close to the rear extremity as possible minimizes the number of trailers with guards mounted forward of the rear extremity.

Mr. Byron Bloch recommended that the guard should be located no more than 150 mm (6 in) forward of the rear extremity instead of 305 mm (12 in). He said that the 150 mm (6 in) gained could be used to make the guard more effective, by permitting the guard to absorb more energy by utilizing a 255 mm (10 in) stroke rather than the proposed 125 mm (5 in) stroke. He stated that this would allow the manufacturers greater flexibility in choosing an energy absorbing type of guard.

While it might be desirable to have guards that absorb an equivalent amount of energy over a greater distance, Mr. Bloch's suggestion could make PCI more likely. NHTSA does not want to reduce the vehicle manufacturer's flexibility to offset the guard up to 305 mm (12 in) forward of the rear of the trailer. If the agency permitted a greater stroke for guards designed to be mounted closer to the rear extremity, it would be difficult to control where these guards are actually mounted. If mounted too far forward within the permitted offset, they would allow excessive penetration under the trailer. NHTSA is also concerned that guards with a greater amount of stroke will pivot at the vehicle chassis, causing the horizontal member of the guard to rotate up until it no longer engages substantial striking vehicle structure of lower profile vehicles. This also would make PCI more likely.

2. Exclusions

The SNPRM excluded certain categories of vehicles from the requirement for rear impact guards. These categories were: Single unit trucks (also referred to as ''straight body'' because they are unarticulated); truck tractors; pole trailers; low chassis trailers; special purpose vehicles; and wheels-back vehicles.

Almost every comment addressed one or more of these exclusions. The consumer safety groups and most of the comments from the general public were especially opposed to the exclusion for single unit trucks. The consumer groups were also opposed to the exclusion for wheels back vehicles. There was little opposition from the consumer safety groups or the public to the exclusion for special purpose vehicles. Industry groups generally supported all the exclusions. Many industry groups and equipment manufacturers requested that their vehicles be explicitly included in the special purpose vehicle category. Industry groups also commented on the wheels back vehicle definition, generally requesting that it be expanded to cover more vehicles.

The comments on the excluded vehicles are discussed in more detail below. Since there was no substantive comment on the exclusions for pole trailers, low chassis trailers, and truck tractors, these exclusions are not discussed.

a. Single Unit (Straight body) Trucks. NHTSA expressly solicited comment on the issue of applicability of the proposed rule to single unit trucks. The majority of docket submissions, including comments from trade associations, safety and consumer interest groups, and private citizens, expressed the opinion that the proposed rule should apply to single unit trucks. Many of these commenters stated that the exclusion did not make sense because the underriding passenger vehicle would not be any less at risk in striking the rear end of a single unit truck than striking the rear of a trailer. Advocates said single unit trucks account for about 300,000 of the 500,000 heavy vehicles produced each year. IIHS and Advocates stated that medium and heavy duty single unit trucks account for 36 percent of all the vehicle miles traveled by heavy vehicles and 68 percent of all non-fatal (AIS 1–5) injuries associated with passenger vehicle impacts with the rear of heavy vehicles. CRASH's analysis indicated that the number of fatal accidents in which passenger vehicles collide with the rear of trailers has been increasing at a rate of about 6 percent per year. According to CRASH, rear impacts involving single unit trucks have been increasing at a rate of 11 percent annually in the recent past.

Mr. Robert Crail and Transamerica Leasing opposed the exclusion because single unit truck manufacturers would be able to obtain guards from the same places as trailer manufacturers. Mr. Byron Bloch recommended that single-unit trucks should be excluded only by exemption petition from individual manufacturers, and that if petitions are granted, NHTSA should require a warning sign on the truck. The State of New York Attorney General expressed the opinion that NHTSA is required by the 49 U.S.C. Chapter 301 requirement that a safety standard must meet the need for motor vehicle safety to include single unit trucks in this rule, based on the ''very modest costs involved.'' Mr. John Kourik could find no definition anywhere in NHTSA's regulations for the term ''single unit truck.''

Additional organizations recommending that the rule apply to single unit trucks include the International Brotherhood of Teamsters, the Owner-Operator Independent Drivers' Association, the Specialized Carriers and Rigging Association, and the American Insurance Services Group. About 2,200 private citizens also recommended that the rule apply to single unit trucks as well as trailers and semitrailers.

Mr. John Tomassoni commented that including vehicles with a gross vehicle weight rating (GVWR) of greater than 14,536 kg (10,000 lbs) in the statistical

cost benefit analysis made the trailers appear unfairly dangerous because most single unit trucks are in the low end of this weight range, yet the larger trucks can still cause underride fatalities. He suggested that cost effectiveness be reassessed on the basis of requiring guards on trucks and trailers weighing greater than 11,790 kg (26,000 lbs). He further recommended that even if the single unit exclusion were retained in the final rule, the rule should at least ''encourage'' manufacturers of single unit trucks above 9,070 kg (20,000 lbs) GVWR to install ''upgraded'' guards.

Manufacturers, owners, and operators of single unit trucks supported the agency proposal to exclude those vehicles from the rulemaking. Single unit trucks have many different configurations, according to Ford Motor Company (Ford), some of which would make installation of the rear impact protection guard impracticable. For example, school buses with a 3,810 mm (150 in) distance from the rear axle to the rear extremity of the vehicle would have their angle of departure severely limited by the proposed rear impact protection guard. Ford also indicated that there would be many questions concerning guard installation responsibility because many units are sold without bodies to secondary manufacturers.

The National Truck Equipment Association (NTEA) supported NHTSA's proposal to exclude single unit trucks from the guard requirements, citing the low rate of rear end impacts for trucks as compared to trailers. NTEA also stated that single unit truck rear impact guard installation cost would be considerably more (up to $3,000 where custom-made guards are required) than the installation cost for trailers because of the high number of special purpose single unit trucks. It also said that single unit trucks are often farm vehicles, dump trucks, and delivery trucks that travel short distances, at lower speeds, generally in the daytime.

NSWMA says the single unit truck exclusion is important because the safety benefits to passenger vehicles would be offset by the increased risk to the truck operator and waste service personnel resulting from the design restrictions that would be imposed by requiring guards on single unit trucks.

Agency accident data indicate that approximately 27 percent of the striking vehicle occupant fatalities and 15.8 percent the serious injuries (AIS 3-5) in rear end collisions with heavy vehicles involve single unit trucks, while 73 percent of striking vehicle occupant fatalities and 84.2 percent of serious injuries involve trailers and semitrailers. This relatively low involvement of single unit trucks contrasts sharply with their contrasts sharply with their predominance among heavy vehicles. Single unit trucks represent 72 percent of registered heavy vehicles. Also, there are 1.6 times as many single unit trucks produced as there are trailers and semitrailers that would be candidates (i.e., assuming they do not qualify for some other exclusion) for underride protection guards. Therefore, this rule covers about 28 percent of the total vehicles and would achieve about 73 percent of the fatality reduction benefits. The SNPRM estimated that collisions with single unit trucks account for approximately 68 percent of the total injuries based on 1986 NASS data. Based on a reevaluation of the data from the newer General Estimate System (GES) data set, NHTSA has revised this estimate to about 18 percent.

According to FARS data from 1982 through 1992, fatalities resulting from passenger vehicle collisions with the rear of single unit trucks have remained fairly constant, with a slight increasing trend. This shows that single unit trucks are not an increasing problem, as suggested by CRASH.

NHTSA has concluded that this category of vehicles should not be covered by the rule at this time. It may be desirable to cover at least some single unit trucks. However, the agency lacks sufficient information at this time to deal with single unit trucks as it has with trailers, i.e., by excluding from the larger group of single unit trucks those subgroups with special problems. The agency is concerned that the variety, complexity, and relatively low weight and chassis strength of many single unit trucks could require guards that are substantially more costly than the guards for trailers and semitrailers. This would prevent the industry from benefiting from the economies of scale that the separate equipment and vehicle standards were intended to promote. NHTSA is currently conducting a study of the single unit truck production to see if there are groups of single unit trucks that, like trailers, could be fitted with rear impact guards without excessive costs.

The vast majority of heavy truck striking vehicle occupant fatalities (73 percent) and injuries (84.2 percent) involve collisions with the rear ends of trailers and semitrailers. Therefore, NHTSA can capture most of the benefits from rear underride guards by requiring them at the outset for trailers and semitrailers. The agency may supplement this action by initiating a separate rulemaking action to consider rear impact guards for single unit trucks after completion of its study.

The agency does not see any merit in Mr. Tomassoni's suggestion. There would be little benefit in requiring or encouraging manufacturers to install guards on single unit trucks with a GVWR greater than 11,790 kg (26,000 lbs), because only 10 percent of single unit trucks are between 4,536 and 11,790 kg (10,000 and 26,000 lbs).

In response to Mr. Kourik's observation that there was no definition in the SNPRM or elsewhere for ''single unit truck,'' the regulatory text of the final rule does not use that term, thus such a definition is not necessary there. Single unit truck refers to trucks that do not have an articulated chassis.

b. Special Purpose Vehicles. Several manufacturers and operators of specialty vehicles such as vehicles with rear mounted liftgates, dump trailers, auto transporters, farm equipment, and recreational vehicles recommended that their vehicles be explicitly excluded from the rule. They recommended that the definition of ''special purpose vehicle'' in the 1992 SNPRM be revised to include these vehicles.

A number of liftgate manufacturers submitted comments. Thieman Tailgates, Waltco Truck Equipment Company (Waltco), and Leyman Manufacturing Company all recommended explicit exclusion of trailers equipped with liftgates. Most liftgates are installed after the trailer leaves the manufacturer. They also stated that it would be very burdensome on small businesses to design liftgates around the guard configuration requirements.

Waltco estimated that several thousand new vehicles are equipped with liftgates annually. If required, guards for trailers equipped with liftgates would be more expensive than NHTSA's cost estimate, according to Waltco. Some guards would have to be movable and compliance testing would be more complicated since some configurations would necessitate that the guard be mounted to the liftgate itself. Waltco provided diagrams to show that all of its liftgate designs are incompatible because they must either swing through the guard area or create dangerous shear/pinch zones between gate and guard.

Anthony Liftgates (Anthony) estimated that each year 3,000 new trailers and semitrailers are equipped with rear mounted liftgates, 500 of the liftgates being manufactured by Anthony. Anthony stated that rail-type liftgates are the most commonly used and their rail-type models would be compatible with the proposed guard.

Anthony requested that NHTSA give special consideration to vehicles equipped with liftgates since certain restrictions would be highly detrimental to the industry.

NTEA stated that vehicles equipped with liftgates comprise the largest group of special purpose vehicles. NTEA estimated that 2,500 of the 150,000 trailers built each year are equipped with liftgates at the rear, comprising only 1.7 percent of the market. The NTEA assured NHTSA that no trailer manufacturer would use the special purpose vehicle exclusion to evade the guard requirement because liftgates cost ($6,000) so much more than guards.

The Leyman Manufacturing Company stated that positioning the guard as specified in the proposal would eliminate the installation of liftgates. Leyman also pointed out that vehicles equipped with liftgates were excluded from the January 8, 1981 NPRM.

The agency concurs with the observations made by liftgate manufacturers regarding the complexities associated with the installation of rear impact protection guards on these vehicles. NHTSA acknowledges that vehicles equipped with liftgates were cited in the January 8, 1981 NPRM as vehicles that would fall within the special purpose vehicle exclusion. The agency also agrees that the rear impact protection guard would interfere with the operation of some rear liftgates. However, NHTSA does not think it is necessary to exclude all liftgate-equipped trailers explicitly. Instead, the agency has modified the definition of special purpose vehicle to make it clear that vehicles with rear mounted liftgates that operate by swinging through the area that is designated for the rear impact guard are excluded. Consequently, vehicles equipped with the rail type liftgates that Anthony Liftgates said would be compatible with a guard are not excluded, while vehicles equipped with tuckunder and other types of incompatible liftgates are excluded.

The Manufactured Housing Institute (MHI) stated that manufactured homes are generally moved once or twice over their lifetime on an integral, temporary chassis under strict oversize permits. MHI recommended that NHTSA exclude these trailers from the proposed rule, stating that the standard should not apply to manufactured homes, modular structures, and mobile homes. According to MHI, there are about 300,000 units transported annually in the United States, being hauled as trailers for an average distance of 160 to 200 kilometers (km) (100 to 125 miles (mi)). MHI also noted that mobile homes in transport have 305 to 560 mm (12 to 22 in) of ground clearance.

Mobile homes are not covered by the FMVSS. NHTSA has long interpreted the Mobile Home Construction and Safety Standards Act of 1974 (Pub.L. 93–383) as withdrawing NHTSA's authority to regulate mobile homes as motor vehicles and vesting this authority in the Department of Housing and Urban Development. Therefore, mobile homes are not covered by this rule. This conclusion does not, however, apply to motor homes.

The Recreational Vehicle Industry Association (RVIA) recommended that recreational trailers be excluded from the proposed regulation as special purpose vehicles. According to RVIA, recreational vehicles are probably involved in a small percentage of the rear end collisions due primarily to low mileage and little nighttime highway exposure. RV trailers often require high ground clearance for off-road use, according to RVIA.

The agency does not believe that recreational vehicles should be included in the definition of special purpose vehicle because they do not have work performing equipment in their lower rear extremity. However, NHTSA has concluded that certain recreational vehicles should be explicitly excluded under the applicability section of the rule. Most of these vehicles are believed to be low chassis vehicles, and even if they are not, their chassis will generally be too weak to support a guard. Therefore, vehicles with ''temporary living quarters,'' as defined in 49 CFR 523.2, are excluded from the rule.

The Specialized Carriers and Rigging Association (SC&RA) suggested that two types of heavy hauler trailers be listed in the final rule as examples of ''special purpose vehicles''. The vehicles cited have rear end configurations that vary based on use. According to SC&RA, rear underride guards would interfere with the function of these types of vehicles. The SC&RA asserts that design considerations prevent compliance with the proposed rule.

If SC&RA is correct in asserting that design considerations prevent the two vehicle types from having rear impact guards, these vehicles would clearly meet the special purpose vehicle definition. The illustrations provided indicate that they have work performing equipment or would qualify for the low chassis vehicle exclusion. Therefore, the agency sees no need to explicitly list these vehicles as examples of special purpose vehicles.

NSWMA recommended that the ''special purpose vehicle'' definition be modified to include vehicles with special equipment mounted at the rear that is not directly affected in an adverse manner by the rear impact protection guard. NSWMA believes that this exclusion is necessary because of the potential impairment of function in waste industry specialized hauling vehicles from factors such as reduced departure angle and off-road use.

NHTSA does not believe that the special purpose vehicle definition should be modified in response to NSWMA's recommendation. Vehicles with work performing equipment at the rear whose operation would not be adversely affected by the rear impact guard should be equipped with guards. All trailer users will have to deal with a reduced angle of departure. Further, exclusions of vehicles need to be made on the basis of physical attributes instead of anticipated functional restrictions. NSWMA has not alleged that these trailers are physically different from any other trailers, only that they are used in a demanding operational environment.

NHTSA believes that the use of adjustable guards will alleviate most operational restrictions where the work performing equipment does not qualify the vehicle for the special purpose vehicle exclusion, such as trailers that travel on uneven surfaces or that have beds that raise and lower at their rear ends. NSWMA acknowledged that most of the vehicles it refers to are excluded as single unit trucks.

The National Potato Council recommended that vehicles used primarily for harvesting be excluded from the rule. The Potato Council stated that rear-unload semitrailers have rear conveyors whose function would be significantly impaired if rear impact guards were required. It also requested that eighteen wheelers that travel no more than 240 km (150 mi) from their base farm should be excluded from the proposed rule. These vehicles are on road for very short periods, according to the Potato Council—one to two months in the spring to haul seeds, and a similar period in the fall to bring the crop to market.

Assuming the Potato Council is correct that underride guards would substantially impair the function of the rear-unload semitrailers, these vehicles would qualify as special purpose vehicles. A specific mention of them in the rule is therefore unnecessary. Regarding the eighteen wheelers, sporadic road use and short travel distances have been considered in the past as factors in determining whether vehicles are ''motor vehicles'' that are subject to NHTSA's safety standards. However, the fact that the vehicles are

used on the public roads only two to four months a year does not disqualify them as motor vehicles. The same may be true for many pickup trucks used on farms. Merely because a given trailer happens to be used on the farm most of the year does not mean it was not manufactured primarily for use on the public streets. Similarly, the shortness of the trips the vehicle takes is not dispositive, unless it is used only to cross from field to field or to travel between job sites. It appears that the trailers the Potato Council refers to are used primarily for transportation during the spring and fall. Therefore, the definition of special purpose vehicles has not been modified as recommended by the Potato Council.

Mr. John Kourik suggested that the application section be expanded to show whether or not the rule covers the following kinds of vehicles: boat trailer, fire fighting vehicle (some have trailers), trailer converter dolly, agricultural commodity truck, auto transporter (a combination vehicle), container chassis trailer, pulpwood trailer, heavy hauler trailer, and straddle trailer. In the alternative, he suggests that some method for obtaining interpretations of configurations is needed, other than tedious petitions for exemptions.

NHTSA is not providing interpretations for each of the vehicles listed by Mr. Kourik. Applicability is based on the configuration of the vehicle, rather than vehicle function, as Mr. Kourik's list suggests. The agency is unsure about the physical attributes of some of the listed vehicles. In the absence of more detailed information, NHTSA cannot give definitive interpretations for the listed vehicles. NHTSA believes that the rule adequately defines those vehicles that are included and those that are excluded. NHTSA believes further that the applicability will be obvious in almost all cases to persons sufficiently familiar with details of the physical attributes of the vehicles in question. Given his knowledge about these vehicles, Mr. Kourik should be able to determine whether they fall within the agency's exclusions. The agency notes that the public is not required to petition for an exemption to obtain an interpretation of the rule's applicability to a particular vehicle configuration. The Office of the Chief Counsel issues such interpretations in response to letters of inquiry which provide sufficient background information.

FHWA initially indicated that the definition of a special purpose vehicle should include certain dimensions for the work performing equipment. The maximum ground clearance, minimum width, or maximum distance between any work performing equipment and the side of the vehicle were cited by FHWA as dimensions that should be included in the definition. According to FHWA, adding language to the rule that further defines the location of work performing equipment would provide better guidance to vehicle manufacturers and reduce potential enforcement problems for NHTSA and FHWA.

NHTSA believes that the relationship of the work performing equipment to the location in which the rear impact guard would have to be installed, and not the mere presence of the equipment, should be the criterion for determining exclusion. If the equipment needs to move through the area that could be occupied by the horizontal member of the guard, as defined in S5.1.1 through 5.1.3 of the vehicle standard, the presence of a guard would impair or eliminate the usefulness of the equipment. NHTSA has decided that it would be both impracticable and an undue burden to require rear impact guards on such vehicles. However, if the equipment is detached or stows out of the guard area while in the vehicle is in transit, a guard would not be an impediment to the equipment, and a guard is required. Although it is not required, NHTSA encourages vehicle manufacturers to move the guard within the limits of S5.1.1 through S5.1.3 to accommodate the work performing equipment.

It is neither practical nor necessary to specify location or dimensions for the work performing equipment. The ground clearance, width, and distance from the work performing equipment to the side of the vehicle are not relevant because the work performing equipment is not required to perform as a guard. NHTSA does not want to restrain innovation by giving direction to vehicle manufacturers on the configurations of their work performing equipment. Defining the dimensions or location of the work performing equipment is not necessary for an enforceable rule. All that is required to confirm the applicability of the exclusion is a demonstration that the work performing equipment, while the vehicle is in transit, resides in the area defined by S5.1.1 through S5.1.3 as the guard's horizontal member or passes through that area to perform its function. Therefore, the definition of special purpose vehicle in the rule has been revised to reflect that the foundation of the special purpose vehicle exclusion is the presence of work-performing equipment that resides in or, to perform its function, moves through the area designated for the underride guard while the vehicle is in transit.

The definition of special purpose vehicle has been modified to explicitly recognize the piping of hazardous materials tankers as work performing equipment. RSPA's rule for underride guards on hazardous materials tankers (49 CFR 178.345–8) is generally compatible with this rule, and this rule applies to hazardous materials tankers. However, to prevent any confusion as to the relationship between RSPA's rule and NHTSA's rule, this rule explicitly recognizes that piping that carries hazardous materials while in transit needs the special protection that is provided by RSPA's rule. Therefore, hazardous materials tankers with piping in front of the guard are excluded from the requirements of this rule.

c. Wheels Back Vehicle. A ''wheels back vehicle'' was defined in the SNPRM's vehicle standard as a vehicle which has a permanently fixed rear axle with tires whose rearmost surface is located not more than 305 mm (12 in) forward of a vertical transverse plane tangent to the rear extremity of the vehicle. Several commenters recommended that the wheels back vehicle definition be changed to include vehicles with rear tires located as much as 610 mm (24 in) from the rear extremity of the vehicle. Other commenters expressed concern that impacting the rear tires of a trailer or semitrailer is similar to impacting a rigid barrier and the agency should delete this category of exclusion.

Industry groups and some other commenters favored an expansion of the wheels back definition by allowing the wheels to be positioned more than 305 mm (12 in) forward of the rear extremity. The ATA and the TTMA noted that the proposed rule allowed guards to be mounted up to 305 mm (12 in) forward of the rear extremity while allowing an additional 125 mm (5 in) to meet the strength requirements of the 1992 SNPRM. TTMA recommended, therefore, that the distance between the rear tires and the rear extremity of the vehicle be increased from 305 to 430 mm (12 to 17 in). According to ATA, the spirit of the ''wheels back vehicle'' exclusion would not be violated by allowing the tires to be located as much as 560 mm (22 in) forward of the rear extremity. ATA reasons that guards mounted 305 mm (12 in) forward of the rear of the vehicle will allow some vehicles to underride more than 305 mm (12 in) prior to contact with the guard since the forward most area of the car may not be contacted.

TTMA's recommendation to add the 125 mm (5 in) of permitted test

deflection to the 305 mm (12 in) of permitted setback, resulting in 430 mm (17 in) of permitted setback, is not practical. It does not account for the fact that, in a crash, a portion of the impacting vehicle's initial energy and velocity will be absorbed after the guard has undergone 125 mm (5 in) of deflection or deformation. This is a very different situation from one in which the initial impact contact between the passenger car and the underride guard takes place 430 mm (17 in) forward of the trailer's rear extremity. With a 430 mm (17 in) setback, even if the rear impact guard were completely rigid, the striking vehicle would still advance closer to the rear of the trailer (and potential PCI) before coming to rest because the vehicle would be forced to absorb more energy (thus increasing the likelihood of occupant injury).

While some passenger vehicles may underride the impact protection guard prior to contact, as stated by ATA, this non-contact underride is not likely to be more than a few inches. If anything, this fact mitigates in favor of requiring the guards to be positioned farther to the rear. This final rule adds the requirement that the underride guard be positioned as far to the rear of the vehicle as practical.

Some commenters recommended allowing the wheels to be positioned even farther forward if there were a guard in between the rear wheels. The ATA encouraged NHTSA to allow vehicles to use the ''wheels back'' exclusion vehicles with tires up to 610 mm (24 in) forward of the rear extremity if a ''center'' guard were provided. This partial guard would be located no more than 305 mm (12 in) forward of the rear extremity and no more than 150 mm (6 in) inboard of the inside sidewalls of the tires. The center guard's placement between the wheels would complement the tires in resisting underride. Mr. Robert Crail suggested that a partial underride protection guard be specified for double trailers with the rear tires mounted between 430 and 610 mm (17 and 24 in) forward of the rear extremity, because the trailer wheels are as effective as a guard at full deflection. He said that the partial rear underride protection guard should extend to within 205 mm (8 in) of the inboard sidewalls of the rear tires.

The agency believes that the specification of a partial rear impact guard would not enhance safety because it is unlikely that a passenger vehicle would pass between the rear tires of the trailer. The spacing between the inside surfaces of the rear tires on a 2,600 mm (102 in) wide trailer was measured by the agency as 1,310 mm (51.5 in). There are almost no passenger vehicles produced with widths of less than 1600 mm (63 in). Therefore, even a centric collision between the widest trailers and the narrowest cars would probably result in considerable engagement of the tires with the frontal vehicle structure.

Other commenters, in addition to the ATA and Mr. Crail, believe that the 305 mm (12 in) maximum offset makes the exclusion too restrictive. Yellow Freight System suggested that the wheels back definition be changed to allow the wheels to be 560 mm (22 in) forward of the rear extremity. It states that most trailers cannot position the wheels closer than 460 to 560 mm (18 to 22 in) from the rear extremity because the combined effect of shorter distances and the Federal Bridge formula would be to restrict the weight of the load that can be carried. Strick Trailers stated that operators routinely position the rear axle at 915 and 1,065 mm (36 and 42 in) forward of the rear extremity of the vehicle, which would exclude them from the wheels back vehicle category.

The rationale for all these suggestions appears to be that most trailers with the axle in the rearmost position have the rear tire within a range of 405 to 610 mm (16 to 24 in) forward of the rear, and an expanded wheels-back definition would lower costs by allowing more trailers to qualify as wheels back. The agency notes that many of the commenters mentioned ''positioning'' of the rear wheels, which implies that they are referring to the vehicles that do not have fixed axles. Therefore, these vehicles would not be eligible for the wheels back exclusion anyway. NHTSA does not believe that carriers would change the wheel positioning of their fleets merely to avoid the small one-time incremental cost of installing an upgraded guard, as Yellow Freight suggests. Moreover, while NHTSA is concerned with the costs of the rule, the ultimate goal is to prevent PCI without imparting unacceptable deceleration forces to the impacting vehicle. Allowing vehicles to have their wheels farther forward would increase the likelihood of PCI. The agency does not believe, based on available information, that the definition of wheels back vehicle should be modified to increase the allowable distance between the rear extremity of the vehicle and the rear tires.

Advocates appeared to favor eliminating the wheels back exclusion altogether. Advocates stated that the agency has no test data on ''wheels back vehicles'' which support the conclusion that they should be excluded from the proposed rulemaking. Advocates further stated that the agency has contradicted the argument that impacting the rear wheels of trailers results in acceptable crash forces, because the Preliminary Regulatory Evaluation (PRE) likens a collision with the wheels to striking a ''rigid wall.'' Trailer tires will not provide an acceptable level of rear impact protection, according to Advocates. Advocates acknowledged that two crash tests with wheels back vehicles were conducted by the Texas Transportation Institute (TTI), but referenced a paper co-authored by John Tomassoni, a former NHTSA engineer, as evidence that the collision forces would be ''relatively high.'' Advocates also stated that the rule should define ''permanent'' settings for sliding bogeys by requiring that they be welded or bolted in place.

Vehicles meeting the wheels back requirements should be capable of preventing the trailer structure from penetrating a passenger vehicle occupant compartment during a rear end collision. Two full-scale crash tests involving ''wheels back vehicles'' were conducted by the TTI in 1979. For these wheels back vehicle tests, the rear tires were located about 100 to 205 mm (4 to 8 in) forward of the rear extremity of the trailer. In each test, in an offset crash in which a Chevrolet Impala struck the tires and in a centric crash in which a VW Rabbit struck the axle and other components between the tires, PCI was prevented at about 56 kph (35 mph). In the test with the VW Rabbit, post-crash photos indicate that, when dynamic underride reached the maximum, the body of the trailer was 305 to 355 mm (12 to 14 in) from the A-pillar and windshield area of the passenger vehicle. These crash tests indicate that a fixed rear axle with the tires mounted within 305 mm (12 in) of the vehicle's rear extremity constitutes an adequate substitute for a rear impact protection guard from the standpoint of preventing PCI.

The rear wheels of a trailer are adequate for managing the energy of an underride crash. The on-board dummy instrumentation during both crashes indicated a relatively low potential for serious injuries. In fact, the wheels back vehicle performed better in the offset crash than all other guards tested in the TTI research project except the Quinton-Hazel guard. Although the maximum vehicle deceleration of a VW Rabbit that was driven centrically into a wheels-back trailer at 33 mph was similar to the deceleration of the same make/model vehicle driven into a rigid wall (35 mph), partial guards for the sole purpose of energy absorption in centric crashes are not warranted from a cost-benefit standpoint.

NHTSA has decided to retain the wheels back exclusion for vehicles with the rear wheels within 305 mm (12 in) of the rear extremity of the vehicle. Vehicles with wheels set farther forward than that will have sufficient room between the guard and the trailer rear tires for the guard to deflect and absorb some of the passenger vehicle's energy before the guard contacts the rear wheels of the trailer. Vehicles with rear wheels within 305 mm (12 in) of the rear extremity will not have sufficient room for the guard to do much good before it contacts the wheels.

The wheels back vehicle exclusion is intended to apply exclusively to vehicles with the rear tires permanently located close to the rear extremity of the vehicle. The concept of ''permanent'' is clear enough and does not require elaboration, as Advocates suggests. The rear wheels must be either welded in place or designed so that they can occupy only one position. Vehicles with moveable bogeys cannot be wheels back vehicles even if their wheels are set in a wheels back position, as suggested by the comments of Yellow Freight and Strick Trailers.

D. Costs

Many of the commenters addressed the question of cost of the guard. The consumer safety groups thought that the agency's estimate of the cost of energy absorbing guards was too high. Conversely, the industry commenters generally thought the agency's estimate was either low or about right. Most of the private citizens who commented on guard cost said that energy absorbing guards were worth the price, without giving specifics.

Advocates stated that NHTSA had not taken into account the fact that economies of scale would lower the cost of hydraulic energy-absorbing guards to nearly that of the proposed guard. It said that the hydraulic guards are within the price range of the proposed guard. Advocates also commented that NHTSA provides no guidance information to carriers on effectiveness, cost/benefit ratio, mounting heights, or crashworthiness that would allow them to choose a superior (i.e., energy absorbing) guard.

The American Automobile Association (AAA), the New York Attorney General, and many private citizens expressed the view that the additional cost for energy absorbing guards (variously described by them as approximately $200 additional, or ''modest'') is reasonable. These commenters did not provide information on where such guards would be obtained or why a doubling to tripling of the cost represents a ''modest'' increase.

TTMA provided a table showing estimated costs to the customer over current ''bumper'' (NHTSA assumes TTMA means guard) prices for various kinds of vehicles. Estimated cost increases range from $130 to $200, except for tilt deck trailers. For those vehicles, the costs of the hydraulics to swivel the guard out of the way would cost $3000.

Based on the costs incurred during the fabrication of 15 minimally compliant guards for the VRTC research project, NHTSA estimates the incremental cost of the guard hardware is between $77 and $96 per unit. For a complete analysis of costs, see the Final Regulatory Evaluation (FRE). NHTSA agrees with Advocates that the economies of scale would lower the cost of hydraulic guards, or any guards, if they were to become widely accepted. However, Advocates submitted no data to show that the economies of scale would lower the cost of hydraulic guards close to the estimated price of the minimally compliant guard. NHTSA sees no basis for this assertion, especially since, to the best of this agency's knowledge, there are currently no hydraulic guards on the U.S. market. NHTSA has taken the economies of scale into account in its cost estimates in the FRE, as an offset to dealer mark-up, but notes that the amount cannot be quantified. TTMA's estimated incremental costs that were submitted to the agency on June 8, 1992 are 30 to 100 percent higher than NHTSA's if their list represents incremental increases. If, as NHTSA assumes, TTMA is referring to total guard equipment cost (excluding fuel penalty, maintenance, and payload loss), then NHTSA agrees.

As to Advocates' suggestion about providing information on hydraulic guards, the market place will sort out competing guard designs and technologies based on their effectiveness, cost/benefit ratio, mounting heights, and crashworthiness. Manufacturers of superior guards can be expected to provide carriers with information favorable to their products. If hydraulic energy absorbing guards are more advantageous than minimally compliant guards, vehicle manufacturers will undoubtedly install them. The commenters who stated that the benefits of energy absorbing guards were worth the modest costs will see this opinion tested in the marketplace.

Another aspect of costs addressed by the commenters was the revenue loss to the carriers due to the added mass of approximately 25 kg (55 lbs) of the upgraded guards displacing payload that they could otherwise carry. Advocates contended that NHTSA had eliminated hydraulic guards from consideration because of their extra weight, even though NHTSA's contracted researcher and agency staff had said that the payload displacement was exaggerated and the percentage of trailer fleet impacted is infinitesimal. Advocates concluded that the revenue loss is negligible because the majority of commercial carriers reach their maximum cubic cargo capacity before they reach permissible gross load limits. Advocates also believes that the agency based its conclusions on unrealistically high estimates of hydraulic guard mass (135 kg, or 300 lbs). Ford incorrectly asserted that NHTSA's calculated costs do not account for lost revenue from payload displacement. Transamerica Leasing stated that the 25 kg (55 lb) add-on in mass is a correct figure. Yellow Freight System considers the loss of productivity due to additional tare weight to be unquantifiable. However, it estimated the fuel cost penalties due to the additional weight of the guard at $29.53, and the maintenance of the upgraded guards at $13.33, over the lifetime of the trailers. Finally, Yellow Freight System estimated that this rule will cost it $2.2 million as their trailer fleet is retired and replaced.

The agency has reviewed its cost and weight data and concluded that the Quinton-Hazel guard is more costly (at $300) and heavier (135 kg, or 300 lbs). NHTSA does not believe that the McCafferty study, Advocates' basis for the contention that energy absorbing guards are weight-efficient, adequately supports that conclusion. A September 1980, Texas Transportation Institute report entitled ''Performance Upgrading of Commercial Vehicle Underride Guards'' states that the mass of the Quinton-Hazel energy absorbing guard ranges from about 60 to 143 kg (133 to 315 lbs). Yellow Freight System's estimates were based on the PRE, but NHTSA has updated these figures in the analysis in the FRE. The FRE now provides estimates of the payload displacement revenue loss of 33 cents over the life of the trailer, and estimates of lifetime fuel cost of $23.05.

Guard design and testing are other additional costs associated with this rule. Although some guards probably already meet the proposed requirements, NHTSA assumes in the FRE that all existing guards will need to be redesigned to meet the strength and energy absorption requirements. No commenters provided cost estimates for guard redesign. However, NHTSA notes that design and testing are one-time costs, and can be recovered over the

lifetime of the guard design. NHTSA further notes that the TTMA's Recommended Practice ''Rear Impact Guard and Protection'' appears to have been based on the SNPRM. This Recommended Practice is designated RP No. 92–94, and was originally issued in April of 1994 and revised in November of 1994. Apparently it has been adopted as an industry standard, so little reengineering should be necessary.

Testing of a guard design once it is produced is another expense related to this rule. IIHS commented that guard manufacturers must carefully consider the chassis in developing installation instructions. Therefore, IIHS concluded that testing with the guard attached to a part of the chassis (provided by the vehicle manufacturer) would result in little additional burden.

NHTSA agrees that there will generally be little additional burden in testing on a chassis part. However, the agency does not want to require such testing because there may be other valid bases for certification, such as engineering analysis, on certain models of trailers. Why should the guard manufacturer test on fifty different chassis parts when they are all nearly identical? NHTSA has adopted IIHS's suggestion to some extent by allowing testing on trailers, but it is an option, not a requirement.

Mr. John Kourik stated that there is no estimate given for the trailer manufacturer's costs for testing in situations in which the guard is incorporated or integrated into the chassis structure itself, rather than attached as a separate unit.

There is no estimate given for integrated guard designs because the agency considers it highly unlikely that manufacturers will produce integrated guards. Replacement or repair costs on such guards would be prohibitive. The FRE's estimates of testing costs are based on conventional designs that meet the performance requirements. Vehicle manufacturers can be expected to factor the increased testing costs into their decision whether to produce such an integrated design.

Four liftgate manufacturers commented on the responsibility for and burden of testing. Waltco Truck Equipment Company, Leyman Manufacturing Corporation, and Venco stated that not excluding vehicles with liftgates would put an undue burden on vehicle manufacturers of developing and testing guards compatible with the various liftgate designs. Leyman added that the SNPRM's estimated guard cost of $112 doesn't account for its removal and reinstallation when installing liftgates. Anthony Liftgates, Inc. stated that liftgate manufacturers cannot afford testing and that testing should be the responsibility of the trailer manufacturer or the last party to certify the trailer for highway use.

The agency recognizes the costs associated with designing, installing and testing underride guards. This is the reason NHTSA changed to separate equipment and vehicle standards. Testing is the responsibility of the guard manufacturer, not the trailer manufacturer. However, as with any piece of motor vehicle equipment required by a FMVSS, subsequent alterers may not render the guard inoperative. Moreover, trailers bearing liftgates in the lower rear have been excluded from the requirement to have rear impact guards.

NHTSA has also accounted for the incremental fuel and materials cost increase that will be expended in complying with the upgraded guard requirements. NHTSA estimates that an additional 25 kg (55 lbs) of steel will be required in a minimally compliant guard. This means that approximately 2,340 metric tons (2,580 tons) of additional steel will be required annually by the trailer industry. NHTSA estimates a lifetime additional fuel cost, due to the additional weight of the upgraded guards, of $23.05. Based on the weighted vehicle miles traveled, this translates to an additional 0.00007 liters of diesel fuel per kilometer (0.00003 gallons per mile). Since most tractor trailers now get about 2.3 kilometers per liter (5.5 miles per gallon), this seems insignificant.

E. Benefits

The main benefits of this rule will be the fatalities and injuries avoided by the upgraded guards. Commenters focussed solely on fatality and injury benefits. Advocates believes that the benefits of the rule could be much higher than NHTSA estimated. It believes that potential benefits are being foregone because a minority of newly manufactured trucks, only 15 percent of the American truck fleet, will be covered. Many other commenters also stated that a minority of trucks would be covered. Advocates says that NHTSA has not calculated the benefits lost through exclusion of special purpose vehicles and wheels back vehicles. Advocates also said that the agency's estimated benefit of 9 to 19 lives per year does not account for deaths due to unsurvivable deceleration forces from overly rigid guards permitted by the proposal. It believes that saving only 9 to 19 out of its claim of nearly 500 truck rear-end fatalities per year is inadequate. Advocates cannot reconcile the drop in the estimated number of lives saved (63 in the 1981 NPRM versus 9–19 in the 1992 SNPRM) with the SNPRM's statement that single unit trucks cause a minority of PCI deaths. It asserted that such a low benefits figure indicates that NHTSA has not revealed certain assumptions that it used in its cost benefit analysis. Advocates asserted that the benefits of the lower death/injury rate from energy absorbing guards make them worth requiring.

CRASH and IIHS asserted that the data NHTSA relied on in its calculations were inadequate. CRASH argued that NHTSA improperly arrived at a 4:1 combination/single unit ratio by using 26 ''hard copy'' FARS reports, while dismissing as ''unrepresentative'' other state, national, and international studies. It cited estimates of 28 percent, 44 percent, and most recently 66 percent of rear end truck fatalities caused by underride. Using the 66 percent number and NHTSA's upper range (27 percent) of guard effectiveness, CRASH concluded that a rule including single unit trucks would save 122 lives in 1995, six times the highest NHTSA projection. CRASH accuses NHTSA of defining underride as only involving full PCI as a pretext for discarding the much higher figures from other studies.

IIHS thinks that NHTSA's estimate of 72 fatalities per year is understated by between 46 and 96 fatalities because the crashes were not properly coded in the FARS. It based this conclusion on IIHS calculations of parked truck underrides and other underrides that were not so coded in the FARS, extrapolating from California data. CRASH also stated that parked trucks were not properly treated in the analysis, even though they cause 20 percent of underride deaths. IIHS cited studies concluding that the European standard is only saving half of the lives that it could because its guard, at about 560 mm (22 in), is set too high. IIHS also sent a September 16, 1994 letter to the agency detailing inconsistencies between FARS and NASS data on underride. The letter concluded that the FARS analysts failed approximately 50 percent of the time to identify whether underride was involved because of inadequate information on the PARs and because FARS analysts are not familiar with typical indicators of underride.

CRASH also faulted NHTSA's benefit calculation methods, and says that the agency systematically chose the lowest possible figures to calculate potential benefits in the Preliminary Regulatory Evaluation (PRE). It thinks that NHTSA is falsely showing the underride fatality statistics as static by using only the

FARS data on combination trucks, and only during the period from 1985 to 1989. Its analysis of the data show that the single unit truck underride fatalities are growing most rapidly (80 percent between 1982 to 1989, claiming 145 persons in 1989). Extrapolating these data to the rule's 1995 effective date, CRASH calculates that single unit trucks account for 229 out of 685 total underride fatalities, an increase of 90 percent over NHTSA's static total.

Regarding Advocates' comment on the limited applicability of the SNPRM, the benefits of requiring guards on single unit trucks are far less than those for requiring guards on trailers because single unit trucks cause a proportionally smaller number of underride fatalities. Also, single unit trucks come in a much wider variety of configurations, making it much more difficult to attach standardized guards. Even if it would be cost beneficial to require some subsets of the single unit truck fleet to use underride guards, NHTSA does not now have the information necessary to define those subsets that should not be excluded. The FRE has a more complete analysis of the benefits. For these reasons, NHTSA may address underride guards for single unit trucks in a separate rulemaking. NHTSA has determined that there will be essentially no benefits lost by excluding wheels-back vehicles, since the rear tires of the trailer represent an adequate underride guard from the standpoint of PCI prevention. A similar argument can be made for low-chassis vehicles. PCI will be avoided due to trailer design, but the rear of the trailer may have other impact hazards that reduce effectiveness as a rear impact guard. The agency does not know how many trailers have work performing equipment that would qualify for the special purpose vehicle exclusion, but believes this number to be very small. Any benefits lost to it would likely be partially compensated for by the work performing equipment, such as liftgates, acting as a guard.

The energy absorption requirement in the final rule will adequately prevent deaths and injuries from overly rigid guards. Therefore, the agency believes that its estimate of the fatalities prevented by this rule is realistic, and will not be degraded by overly rigid guards, as Advocates claims. NHTSA cannot respond to Advocates comment about the benefits of the hydraulic energy absorbing guards because the agency has not been provided with sufficient information. Inquiries with the Quinton-Hazel Company revealed that they no longer produce the guard, and the basis for the study concluding that the guard was cost effective is unclear.

Regarding Advocate's comment that a rule that would save only 9 to 19 fatalities is inadequate because it should save more lives, the agency notes that two key factors resulted in the low benefits calculations: (1) The low annual underride fatality rate, and (2) guard effectiveness estimates. Based on 8 years of FARS data and 79 detailed police accident reports, NHTSA's preliminary estimate (PRE) determined that the national underride rate with PCI was 14–23.5 percent. This translates to an annual average of only 59 fatalities per year attributable to rear underride with PCI, or about one per state per year. Based on the 1979 Michigan data, NHTSA estimates that about one-third of these fatalities occur at speeds below 40 kph (25 mph), which is the maximum design speed of the minimally compliant guard for most vehicles. The low number of potentially affected fatalities was reflected in the guard effectiveness range (18–27 percent) used in the agency's preliminary benefit calculations. This effectiveness range is similar to that suggested for the comparable European guard by the British researchers cited by Advocates.

The drop in estimated benefits from the earlier notices is a result of improved calculation methods and data. The 1981 NPRM's estimate of 63 fatalities was based on an assumed average PCI rate of 35 percent and an assumed guard effectiveness of 50 percent. The 9–19 fatalities estimated in the SNPRM were based on a PCI underride fatality rate of 14 to 23.4 percent and a guard effectiveness of 18 to 27 percent. NHTSA subsequently has decided that a more appropriate methodology is to rely only on the FARS database, which is now well established. Therefore, based on better data (13 years of FARS plus inspection of 139 police accident reports) NHTSA now believes that the PCI rate is 11 to 17 percent. The 10 to 25 percent guard effectiveness estimate is consistent with experience with the European guard, modeling studies, and accident investigations, which are detailed in the FRE. Based on these parameters, the anticipated annual benefits of this rule, including the effects of conspicuity, are estimated to be 4 to 15 lives saved by preventing PCI and 29 serious injuries (AIS 2–5) prevented. An unknown number of non-PCI related lives will also be saved, as well as 145 minor injuries (AIS 1) prevented.

Advocates' suggestion that NHTSA is using unstated assumptions in the calculation of benefits is baseless. The regulatory evaluations explicitly state all of the important factors and assumptions used in the benefits calculation.

NHTSA acknowledges that the FARS data are not perfect. However, the agency disagrees with CRASH and IIHS that the FARS is an inadequate basis for making estimates of benefits and drawing conclusions for the purpose of this rulemaking. In fact, the FARS and NASS databases are the best available. The FARS represents a census of all fatal accidents occurring in the United States. Therefore, NHTSA considers the FARS to be a better basis for decisionmaking than the regional studies and casual surveys cited by some of the consumer safety groups. Based on NHTSA's survey of 113 police accident reports from across the country, NHTSA concludes that fatalities coded as underride are properly coded and that virtually all of them involve PCI. It is possible that some fatal accidents where some degree of underride occurred should have been coded as PCI in the police accident reports or the FARS, but were not. However, the FARS are the best data available.

The NASS, HSRI, and VSC (IIHS-sponsored) studies are inappropriate indicators of the percentage of underride fatalities with PCI. The use of non-census data such as NASS, which is based on a sample of tow-away crashes, has the potential to build sampling error into the conclusions. Problems with using these various studies are explained in more detail in the FRE. The FRE also explains why it is inappropriate to extrapolate the underride statistics from the atypical State of California to the rest of the nation, as IIHS urges.

The agency believes that CRASH's comment that a rule including single unit trucks would save 122 lives in 1995 is based on highly optimistic assumptions. Their estimate is based on unrealistic projections of the number of fatalities (685, compared to 423 in 1992), a high underride rate from a United Kingdom study which may not be applicable to the United States, and the 27 percent upper bound of guard effectiveness range estimated in the Preliminary Regulatory Evaluation.

NHTSA has expanded the scope of data considered in its FRE benefits analysis, as suggested by CRASH and other consumer safety groups, but the augmented data do not support their characterization of the underride problem. NHTSA included the FARS data for the eleven years from 1982 through 1992. In response to the comments from the consumer safety

groups, NHTSA has taken parked trailers into account in the analysis of benefits in the FRE. NHTSA has also expanded the number of police accident reports it inspected to determine the ratio of single unit trucks to trailers involved in parked underride accidents. NHTSA looked at 60 selected police accident reports over a three year period to determine this ratio. Figure IV–1A in the FRE demonstrates that the underride problem for single unit trucks is not increasing, as CRASH suggests, but is relatively static, as stated in the PRE. Therefore, NHTSA believes that CRASH's extrapolations of average annual fatalities to the rule's effective date are invalid. For reasons explained in the FRE, the agency remains unpersuaded by the estimates of underride percentage and the corresponding benefits suggested in CRASH's comments.

Ford also questioned NHTSA's estimated level of benefits. Ford stated that enhanced conspicuity, seat belt usage, and the reduction in the number of alcohol-related crashes will also reduce the incidence of underride-type crashes. Therefore, Ford doubts that reductions of fatalities and injuries in the magnitude estimated by the agency could be achieved solely by this rule. Ford also said that over the last ten years private trailer fleets that do not depend on public docks have lowered designs to increase productivity through use of small diameter, low profile tires and low ride suspensions. Therefore, a 1,000 to 1,250 mm (40 to 50 in) high trailer chassis may no longer be typical, and therefore the future benefits of rule may be inaccurate.

NHTSA agrees that all the factors cited by Ford will contribute to the reduction in fatalities from underride. However, NHTSA has accounted for the effects of the conspicuity rule in its FRE. Moreover, the effectiveness of the new automatic restraint systems depends on the prevention of PCI, because air bags need space to deploy. There may be some reduction in underride crashes due to increased seat belt usage and alcohol awareness, but such synergistic factors cannot be separated out at this point because projections of seat belt and alcohol use are difficult. NHTSA will assess analytically the effectiveness of this standard in the future and will normalize these factors in the analysis. Although lower chassis heights may now be more common in private fleets, NHTSA disagrees with Ford's suggestion that the standard trailer heights are no longer ''typical.'' NHTSA's data indicate that the vast majority of trailer chassis are still set at the 1,000 to 1,250 mm (40 to 50 in) height to provide access to public loading docks. The 1990/92 TTMA van trailer data indicate that 98 percent of floor heights range from 1,219 to 1,320 mm (48 to 52 in). The agency considers it unlikely that loading dock heights will change dramatically in the near future because standardization is very important to the trucking industry and a large investment would be required to change heights.

Volkswagen enclosed three studies of European accident statistics showing reductions in fatalities of between 5 and 17 percent for the European guards, and recommended harmonization with the European standards.

NHTSA does not dispute the studies cited by Volkswagen on the effectiveness of the European guard. However, NHTSA is not bound to follow the European standard. NHTSA's rule should be about 10 to 25 percent effective and the requirements of this rule are slightly more stringent than the European standard.

Yellow Freight System conducted a review of their 1991 accidents and concluded that there was no safety benefit from the use of the guards. It does not believe that any of its fatal accidents would have been prevented by the upgraded guards.

Yellow Freight System provided no evidence to show that upgraded guards on their trailers would not have prevented any fatalities during 1991. Even if it had, the particular experience of a single carrier over a single year period would not be indicative of the extent of the need for underride guards in the industry generally.

F. Lead Time

Most of the commenters supported the agency's proposal of a 24 month lead time. No commenter said that two years was insufficient. The American Truck Dealers Division of the National Automobile Dealers Association approved of the proposed lead time, stating that it will minimize the impact of the rule on the industry. Mr. Robert Crail, a trailer designer and manufacturer, indicated that two years would be adequate. The TTMA also supported the two year lead time, based on the requirements proposed in the SNPRM.

One commenter suggested that the proposed lead time was too long. Mr. John Tomassoni recommended that the lead time be lowered to 1 year, because only ''marginally more effort'' would be required to design, produce, and install the required guards. According to Mr. Tomassoni, this is because vehicle manufacturers are already producing and installing ''geometrically compliant'' guards, or guards that meet the configuration requirements of this rule, on 16 m (53 ft) trailers in order to meet State requirements. Since the basic design shown in the SNPRM has been available for some time, he believes that upgrading the current guards to meet the strength requirements should not be difficult.

While this may be a valid point for those manufacturers currently producing geometrically compliant guards, establishing too short a lead time period might create a competitive disadvantage for those manufacturers who are not. Also, the agency wants to allow enough lead time to permit engineers to produce innovative, highly efficient guard designs, rather than forcing them to rush to market with an upgraded version of the current design. Further, the agency notes that an energy absorption requirement has been added in the final rule that Mr. Tomassoni did not consider in suggesting that a year would be sufficient lead time.

Therefore, NHTSA does not believe that a shorter lead time than two years would be appropriate. Engineers will have to design guards and rigid test fixtures, and the guards will have to be manufactured, tested, and in some cases marketed. There is currently no industry in the business of manufacturing underride guards for third parties, although NHTSA anticipates that one may emerge to meet the demand created by this rule. Smaller trailer manufacturers wishing to acquire manufactured guards need time to work with the emerging guard designers/manufacturers regarding their frame and chassis configurations and appropriate attachment hardware. Because a relatively low level of technology is needed, NHTSA believes that two years will be sufficient time. Therefore, the two year lead time is being retained in the final rule. Compliance will be required 24 months from the date of publication of this rule in the Federal Register.

G. Miscellaneous Issues

1. Metric System Units

Section 5164 of the Omnibus Trade and Competitiveness Act (Pub. L. 100–418) and Executive Order 12770 direct Federal agencies to use the metric system (SI, the International System of Units) where possible in rulemakings. Therefore, the values that were proposed in English system units in the SNPRM are adopted using SI units. To facilitate cross-reference to the preceding notices, approximate English system equivalent measurements follow the SI measurements in the preamble.

2. Federal Highway Administration Rulemaking on Underride Guards

Many commenters, mostly private citizens, requested that NHTSA make this rule apply to existing trailers, thus requiring that the owners of those trailers remove the FHWA-required guards and retrofit the trailers with improved underride guards. The law firm of Lipman and Katz, Mr. Byron Bloch, and many others requested that NHTSA mandate retrofit of existing trucks.

NHTSA has no authority to issue such requirements. Authority to regulate existing trucks rests with the Federal Highway Administration. Some commenters realized this. The New York Attorney General said there is no excuse for not coordinating with FHWA and arranging for a parallel and simultaneous rulemaking by that agency for existing trucks. The American Truck Dealers Division of the National Automobile Dealers Association requested that NHTSA encourage FHWA to require retrofit.

FHWA has worked with NHTSA to ensure that its standards are compatible with the Federal Motor Vehicle Safety Standards whenever possible. As part of this effort, FHWA will continue to adopt appropriate sections of NHTSA's standards into the Federal Motor Carrier Safety Regulations (FMCSR). FHWA is considering a rulemaking to amend the FMCSR at 49 CFR 393.86, *Parts and Accessories Necessary for Safe Operation*, to require vehicles which are subject to NHTSA's rear impact guard requirements to maintain the devices. As part of that rulemaking, FHWA will determine if retrofitting of existing vehicles with rear impact guards should be required.

XII. Rulemaking Analyses and Notices

A. Executive Order 12866 (Federal Regulation) and Regulatory Policies and Procedures

This rulemaking action was reviewed under Executive Order 12866. The action has been determined to be ''significant'' under Executive Order 12866 and under the Department of Transportation regulatory policies and procedures because it concerns a matter in which there is substantial public interest. The FRE for this rule describes the economic and other effects of this rulemaking action in detail. A copy of the FRE has been placed in the docket for public inspection.

The cost and benefit information for this rule can be summarized as set forth below. Rear impact guards meeting the requirements of this rule would cost approximately $128 to $148 per trailer or semitrailer. This cost includes an incremental increase (above the cost of current rear impact guards) of between $77 and $96 per guard to satisfy the rear impact guard and rear impact protection requirements. An additional estimated cost of $7.00 per trailer may be needed to reinforce the frame of the trailer, depending on guard design. To repair the horizontal member of the guard when damaged, NHTSA estimates an incremental increase in lifetime maintenance/repair costs of $16.44. An added lifetime present value fuel cost of approximately $23.05 is estimated, based on the added mass of the guard (an incremental increase of approximately 25 kg or 55 lbs). The added weight will also cause a revenue loss due to payload displacement of $0.33 over the life of the trailer. There will be an additional cost for compliance testing of the guard (excluding the cost of the test fixture), which is estimated to be between $1.16 and $1.46 per vehicle. The incremental cost increase of the guard will be less than two percent of the trailer retail cost. NHTSA estimates that the total consumer cost of the rule will be about $11.9 to 13.7 million annually.

The agency estimates that 4 to 15 PCI fatalities will be eliminated annually by this rule when it is in full effect and all vehicles to which it is applicable are in compliance. The estimate of fatality reduction is based on the number of passenger vehicle occupants killed in PCI collisions. It is also based on an estimate that the rear impact guard is 10 to 25 percent effective in reducing PCI fatalities. There will also be non-PCI underride fatalities prevented but the agency was unable to quantify them. NHTSA further estimates that 29 non-minor injuries (AIS 2–5) and 145 minor injuries (AIS 1) would be prevented in both PCI and non-PCI collisions.

B. Regulatory Flexibility Act

NHTSA has analyzed the potential impacts of this rule on small entities under the Regulatory Flexibility Act and certifies that this rule will have a significant economic impact on a substantial number of small entities. NHTSA has described those possible impacts in the FRE, which is, in part, a regulatory flexibility analysis.

The agency seeks to reduce the severity of underride crashes by improving the design of the affected vehicle, the trailer or semitrailer. Accordingly, trailer and semitrailer manufacturers will be affected by the rule. Based on the 1994 AAMA Motor Vehicle Facts and Figures, there were approximately 327 trailer and semitrailer manufacturers in the U.S. in 1991, most of which are small manufacturers (less than 500 employees). These manufacturers will be required to produce each of their vehicles with a rear impact guard and ensure that the guard is positioned within the specified distances from the ground, the vehicle's sides, and the vehicle's rear extremity. If the vehicle manufacturers obtain a guard from a supplier, they will only have to install the guard in accordance with the installation instructions provided with the guard. If the vehicle manufacturers produce their own guards, they will have to ensure that the guards meet the rear impact requirements for guards.

The agency has designed this rule to minimize the impact on small businesses by issuing separate equipment and vehicle standards. This issuance of two separate standards relieves small trailers manufacturers of the necessity for testing their completed trailers. Rear impact guard suppliers as well as vehicle manufacturers which manufacture their own guards may test mount guards on a test fixture to assess for compliance with the strength and energy absorption requirements of the equipment standard. This compliance test option minimizes the cost impact on small entities in a manner consistent with the purposes of 49 U.S.C. Chapter 301.

C. Executive Order 12612 (Federalism)

Based on available information, the agency believes the federalism implications of this rulemaking are minimal. Nearly all states require underride protection guards for heavy trailers and semitrailers. Further, most states require that the guards meet certain configuration requirements, or that they be positioned in a certain location relative to the rear and sides of the vehicle. The rule will preempt State requirements for rear impact protection. However, the agency believes that federalism implications will be minor because the guards required by this rulemaking are not fundamentally different from those required by State law. Several States including Michigan, North Carolina, New York, and New Jersey require longer trailers 15 m (50 ft) to have guards with the configuration required by this rulemaking. For practical purposes, the only effect that this rulemaking would have in these States is to require the guards to be tested and certified for strength and energy absorption.

The agency has determined that this rulemaking does not have sufficient federalism implications to warrant the preparation of a Federalism Assessment. NHTSA believes that effective rear

impact protection measures can be implemented only at the national level. Only vehicle manufacturers can produce trailers and semitrailers with improved rear impact protection. The improvements required by this rulemaking will cause vehicle manufacturers and operators to incur costs that could affect their competitive position if compliance is voluntarily implemented by some, but not all manufacturers. This Federal rulemaking applies uniformly to all manufacturers and will ensure that the competitive position of the manufacturers will not be significantly affected by these safety improvements.

D. Preemptive Effect and Judicial Review

This final rule does not have any retroactive effect. Under 49 U.S.C. 30103(b), whenever a Federal motor vehicle safety standard is in effect, a state may not adopt or maintain a safety standard applicable to the same aspect of performance which is not identical to the Federal standard. 49 U.S.C. 30161 sets forth a procedure for judicial review of final rulemaking establishing, amending, or revoking Federal motor vehicle safety standards. That section does not require submission of a petition for reconsideration or other administrative proceeding before parties may file suit in court.

E. Paperwork Reduction Act

The labeling and installation instructions requirements associated with this rule have been submitted to the Office of Management and Budget (OMB) for approval in accordance with 44 USC chapter 35.

Administration: National Highway Traffic Safety Administration.

Title: Labeling and Installation Instructions Requirements for Rear Impact Guards.

Need for Information: Labeling—Identification of guards as meeting equipment standard for strength and energy absorption; Installation Instructions—Ensure that obtained guards are properly installed.

Anticipated Use of information: Labeling—Routine trailer inspection by FHWA; Installation Instructions—Installation of obtained guards by vehicle manufacturers.

Frequency: Labeling—On occasion; Installation Instructions—On occasion.

Burden Estimate: Labeling—7,500 hrs.; Installation Instructions—2,000 hrs.

Average Burden Hours per Respondent: Labeling—25; Installation Instructions—10.

For Further Information Contact: The Information Requirements Division, M–34, Office of the Secretary of Transportation, 400 Seventh St. SW, Washington DC 20590, (202) 366–4735.

List of Subjects in 49 CFR Part 571

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

In consideration of the foregoing, 49 CFR Part 571 is amended as follows:

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 1.50.

2. A new § 571.223 is added to read as follows:

§ 571.223 Standard No. 223; rear impact guards.

S1. *Scope*. This standard specifies requirements for rear impact guards for trailers and semitrailers.

S2. *Purpose*. The purpose of this standard is to reduce the number of deaths and serious injuries that occur when light duty vehicles collide with the rear end of trailers and semitrailers.

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

S4. *Definitions*.

In this standard, directional terms such as *bottom, center, height, horizontal, longitudinal, transverse,* and *rear* refer to directions relative to the vehicle orientation when the guard is oriented as if it were installed on a vehicle according to the installation instructions in S5.5 of this section.

Chassis means the load supporting frame structure of a motor vehicle.

Guard width means the maximum horizontal guard dimension that is perpendicular to the longitudinal vertical plane passing through the longitudinal centerline of the vehicle when the guard is installed on the vehicle according to the installation instructions in S5.5 of this section.

Horizontal member means the structural member of the guard that meets the configuration requirements of S5.1.1 through 5.1.3 of § 571.224, Rear Impact Protection, when the guard is installed on a vehicle according to the guard manufacturer's installation instructions.

Hydraulic guard means a guard designed to use fluid properties to provide resistance force to deformation.

Rear impact guard means a device installed on or near the rear of a vehicle so that when the vehicle is struck from the rear, the device limits the distance that the striking vehicle's front end slides under the rear end of the impacted vehicle.

Rigid test fixture means a supporting structure on which a rear impact guard can be mounted in the same manner it is mounted to a vehicle. The rigid text fixture is designed to resist the forces applied to the rear impact guard without significant deformation, such that a performance requirement of this standard must be met no matter how small an amount of energy is absorbed by the rigid test fixture.

S5. Requirements.

S5.1 *Cross-Sectional Vertical Height.* The horizontal member of each guard shall have a cross sectional vertical height of at least 100 mm at any point across the guard width. See Figure 1 of this section.

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 at test location P3, as specified in S6.4 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.

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

(c) A force of 100,000 N at test location P3 on either the left or the right side of the guard as defined in S6.4(c) of this section.

S5.2.2 *Guard Energy Absorption.* A guard, other than a hydraulic guard, shall absorb by plastic deformation within the first 125 mm of deflection at least 5,650 J of energy at each test location P3. See Figure 2 of this section.

S5.3 *Labeling.* Each guard shall be permanently labeled with the information specified in S5.3 (a) through (c) of this section. The information shall be in English and in letters that are at least 2.5 mm high. The label shall be placed on the forward-facing surface of the horizontal member of the guard, 305 mm inboard of the right end of the guard.

(a) The guard manufacturer's name and address.

(b) The statement: ''Manufactured in _____'' (inserting the month and year of guard manufacture).

(c) The letters ''DOT'', constituting a certification by the guard manufacturer that the guard conforms to all requirements of this standard.

S5.4 *Guard Attachment Hardware.* Each guard, other than a guard that is to be installed on a vehicle manufactured by the manufacturer of the guard, shall be accompanied by all attachment hardware necessary for installation of the guard on the chassis of the motor vehicle for which it is intended.

S5.5 *Installation Instructions.* The manufacturer of rear impact guards for sale to vehicle manufacturers shall include with each guard printed instructions in English for installing the guard, as well as a diagram or schematic depicting proper guard installation. The manufacturer of a rear impact guard for one of its own vehicles shall prepare and keep a copy of installation procedures applicable to each vehicle/guard combination for a period of one year from the date of vehicle manufacture and provide them to NHTSA on request. The instructions or procedures shall specify:

(a) Vehicles on which the guard can be installed. Vehicles may be designated by listing the make and model of the vehicles for which the guard is suitable, or by specifying the design elements that would make any vehicle an appropriate host for the particular guard (e.g., vehicles with frame rails of certain spacing and gauge of steel).

(b) A description of the chassis surface to which the guard will be attached, including frame design types with dimensions, material thickness, and tire track width. This description shall be detailed enough to permit the agency to locate and duplicate the chassis surface during compliance testing.

(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. 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 S6.6 of this section.

S6.1 *Preparation of Hydraulic Guards.* For hydraulic guards, the horizontal member of the guard is deflected in a forward direction until the hydraulic unit(s) have reached the full extent of their designed travel or 610 mm, whichever occurs first. The hydraulic units are compressed before the application of force to the guard in accordance with S6.6 of this section and maintained in this condition throughout the testing under S6.6 of this section.

S6.2 *Guard Installation for Strength and Energy Absorption Tests.*

(a) The rear impact guard is attached to a test device.

(b) The test device for the compliance test will be whichever of the following devices, if either was used, the manufacturer used as a basis for its certification of the guard in S5.3(c) of this section. If the manufacturer did not use one of these devices or does not specify a device when asked by the agency, the agency may choose either of the following devices—

(1) A rigid test fixture. In the case of testing on a rigid test fixture NHTSA will consult the installation instructions or procedures to determine the surface or structure that the guard is supposed to be mounted to and mount it to the rigid test fixture in the same way.

(2) A complete trailer for which installation of the guard is suitable, as provided in the manufacturer's installation instructions or procedures required by S5.5 of this section. The trailer chassis is secured so that it behaves essentially as a fixed object during the test, such that the test must be passed no matter how little it moves during the test.

(c) The guard is attached in accordance with the instructions or procedures for guard attachment provided by the guard manufacturer for that guard as required by S5.5 of this section.

S6.3 *Force Application Device.* The force application device employed in S6.6 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) through (c) 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 *Test Locations.* With the guard mounted to the rigid test fixture or to a complete trailer, determine the test locations P1, P2, and P3 in accordance with the procedure set forth in S6.4 (a) through (c) of this section. See Figure 1 of this section.

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

(1) Is located at a distance of 3/8 of the guard width from the vertical longitudinal plane passing through center of the guard;

(2) Lies on either side of the center of the guard's horizontal member; and

(3) Is 50 mm above the bottom of the guard.

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

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

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

(c) Test location P3 is any point on the rearmost surface of the horizontal member of the guard that:

(1) Is not less than 355 mm and not more than 635 mm from the vertical longitudinal plane passing through center of the guard;

(2) Lies on either the right or left side of the horizontal member of the guard; and

(3) Is 50 mm above the bottom of the guard.

S6.5 *Positioning of Force Application Device.* Before applying any force to the guard, locate the force application device 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.

(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.

S6.6 *Force Application.* After the force application device has been positioned according to S6.5 of this section, apply the loads specified in S5.2.1 of this section. Load application procedures are specified in the S6.6 (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 constant and not less than 1 mm and not more than 1.5 mm per second.

(b) If conducting a strength test to satisfy the requirement of S5.2.1 of this section, the force is applied until the forces specified in S5.2.1 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 of this section, apply the force to the guard until displacement of the force application device 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 2 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.

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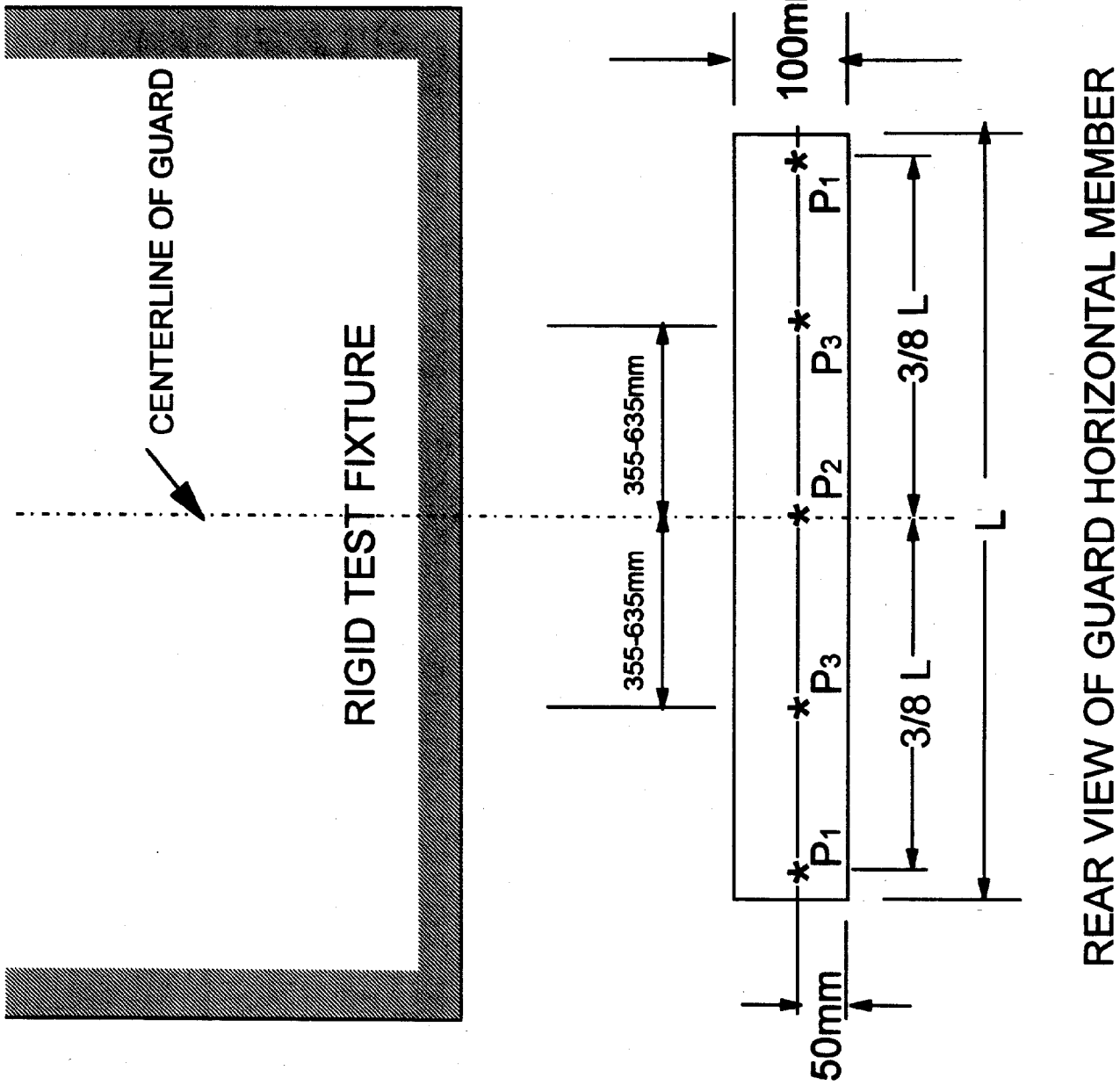
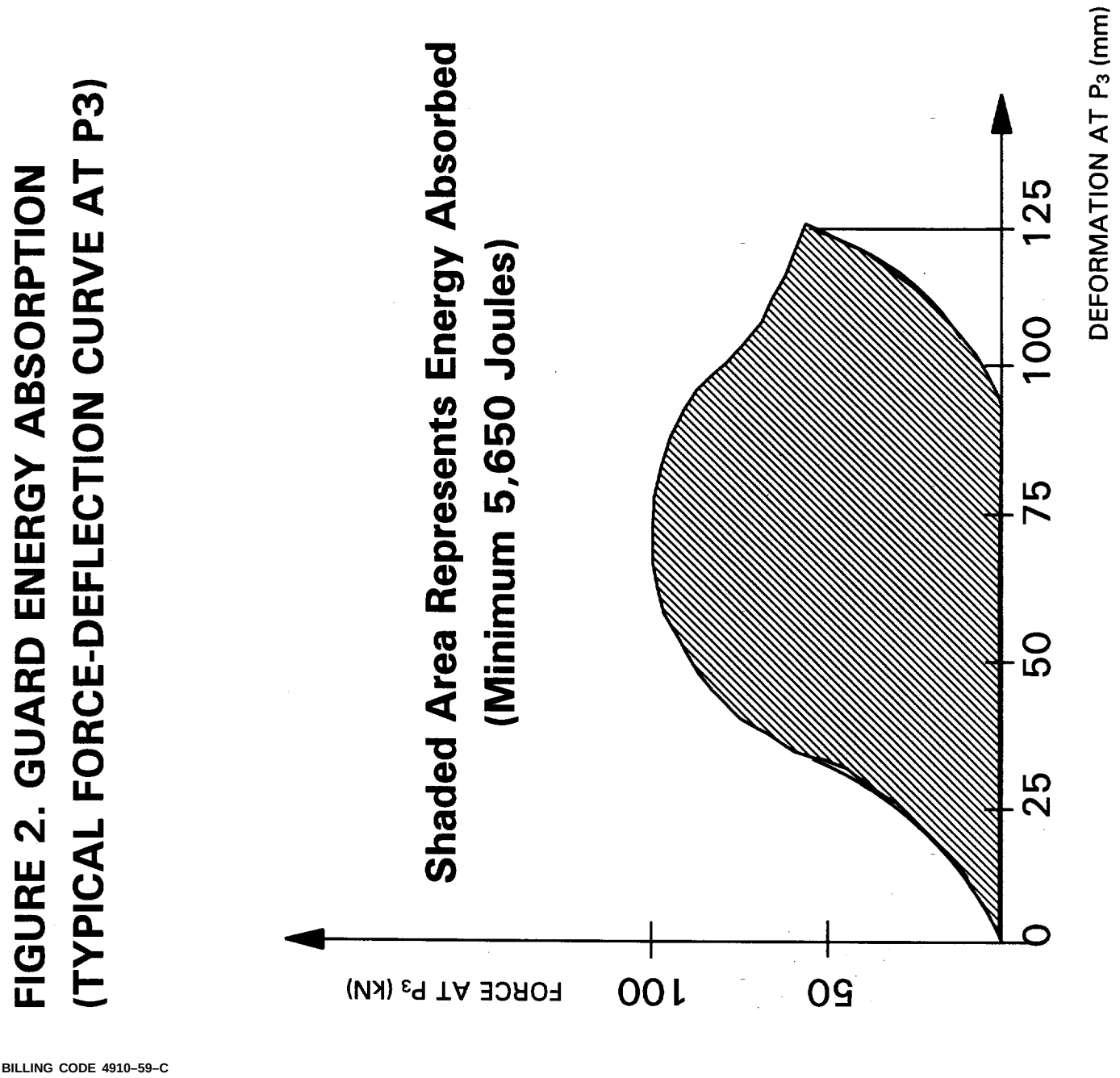
FIGURE 1. PERFORMANCE REQUIREMENTS





BILLING CODE 4910–59–C

3. A new § 571.224 is added to read as follows:

§ 571.224 Standard No. 224; rear impact protection.

S1. *Scope.* This standard establishes requirements for the installation of rear impact guards on trailers and semitrailers with a gross vehicle weight rating (GVWR) of 4,536 kg or more.

S2. *Purpose.* The purpose of this standard is to reduce the number of deaths and serious injuries occurring when light duty vehicles impact the rear of trailers and semitrailers with a GVWR of 4,536 kg or more.

S3. *Application.* This standard applies to trailers and semitrailers with a GVWR of 4,536 kg or more. The standard does not apply to pole trailers, low chassis vehicles, special purpose vehicles, wheels back vehicles, or temporary living quarters as defined in 49 CFR 529.2

S4. *Definitions.*

Chassis means the load supporting frame structure of a motor vehicle.

Horizontal member means the structural member of the guard that meets the configuration requirements of S5.1 of this section when the guard is installed on the vehicle according to the installation instructions or procedures required by S5.5 of § 571.223, Rear Impact Guards.

Low chassis vehicle means a 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 requirements of S5.1.1 through 5.1.3 of this section.

Outer or *Outboard* means away from the trailer centerline and toward the side extremities of the trailer.

Rear extremity means the rearmost point on a vehicle that is above a horizontal plane located 560 mm above the ground and below a horizontal plane located 1,900 mm above the ground when the vehicle is configured as specified in S5.1 of this section and when the vehicle's cargo doors, tailgate, or other permanent structures are positioned as they normally are when the vehicle is in motion. Nonstructural protrusions such as taillights, rubber bumpers, hinges and latches are excluded from the determination of the rearmost point.

Rounded corner means a guard's outermost end that curves upward or forward toward the front of the vehicle, or both.

Side extremity means the outermost point on a vehicle's side that is located above a horizontal plane 560 mm above the ground, below a horizontal plane located 190 cm above the ground, and between a transverse vertical plane tangent to the rear extremity of the vehicle and a transverse vertical plane located 305 mm forward of that plane when the vehicle is configured as specified in S5.1 of this section. Non-structural protrusions such as taillights, hinges, rubber bumpers, and latches are excluded from the determination of the outermost point.

Special purpose vehicle means a trailer or semitrailer having work-performing equipment (including any pipe equipment that would hold hazardous materials in transit and require rear-end protection under 49 CFR 178.345–8(d)) that, while the vehicle is in transit, resides in or moves through the area that could be occupied by the horizontal member of the rear underride guard, as defined by S5.1.1 through S5.1.3 of this section.

Wheels back vehicle means a trailer or semitrailer whose rearmost axle is permanently fixed and is located such that the rearmost surface of tires of the size recommended by the vehicle manufacturer for the vehicle on that axle is not more than 305 mm forward of the transverse vertical plane tangent to the rear extremity of the vehicle.

S5. *Requirements.*

S5.1 *Installation; vehicle configuration.* Each vehicle shall be equipped with a rear impact guard certified as meeting Federal Motor Vehicle Safety Standard No. 223, Rear Impact Guards (§ 571.223). When the vehicle to which the guard is attached is resting on level ground, unloaded, with its full capacity of fuel, and with its tires inflated and air suspension, if so equipped, pressurized in accordance with the manufacturer's recommendations, the guard shall comply with the requirements of S5.1.1 through S5.1.3 of this section. See Figure 1 of this section.

S5.1.1 *Guard width.* The outermost surfaces of the horizontal member of the guard shall extend outboard to within 100 mm of the longitudinal vertical planes that are tangent to the side extremities of the vehicle, but shall not extend outboard of those planes. See Figure 1 of this section.

S5.1.2 *Guard height.* The vertical distance between the bottom edge of the horizontal member of the guard and the ground shall not exceed 560 mm at any point across the full width of the member. Notwithstanding this requirement, guards with rounded corners may curve upward within 255 mm of the longitudinal vertical planes that are tangent to the side extremities of the vehicle. See Figure 1 of this section.

S5.1.3 *Guard rear surface.* At any height 560 mm or more above the ground, the rearmost surface of the horizontal member of the guard shall be located as close as practical to a transverse vertical plane tangent to the rear extremity of the vehicle, but no more than 305 mm forward of that plane. Notwithstanding this requirement, the horizontal member may extend rearward of the plane, and guards with rounded corners may curve forward within 255 mm of the longitudinal vertical planes that are tangent to the side extremities of the vehicle.

S5.2 *Installation Requirements.* Guards shall be attached to the vehicle's chassis by the vehicle manufacturer in accordance with the installation instructions or procedures provided pursuant to S5.5 of Standard No. 223, *Rear Impact Guards* (§ 571.223). The vehicle must be of a type identified in the installation instructions as appropriate for the guard.

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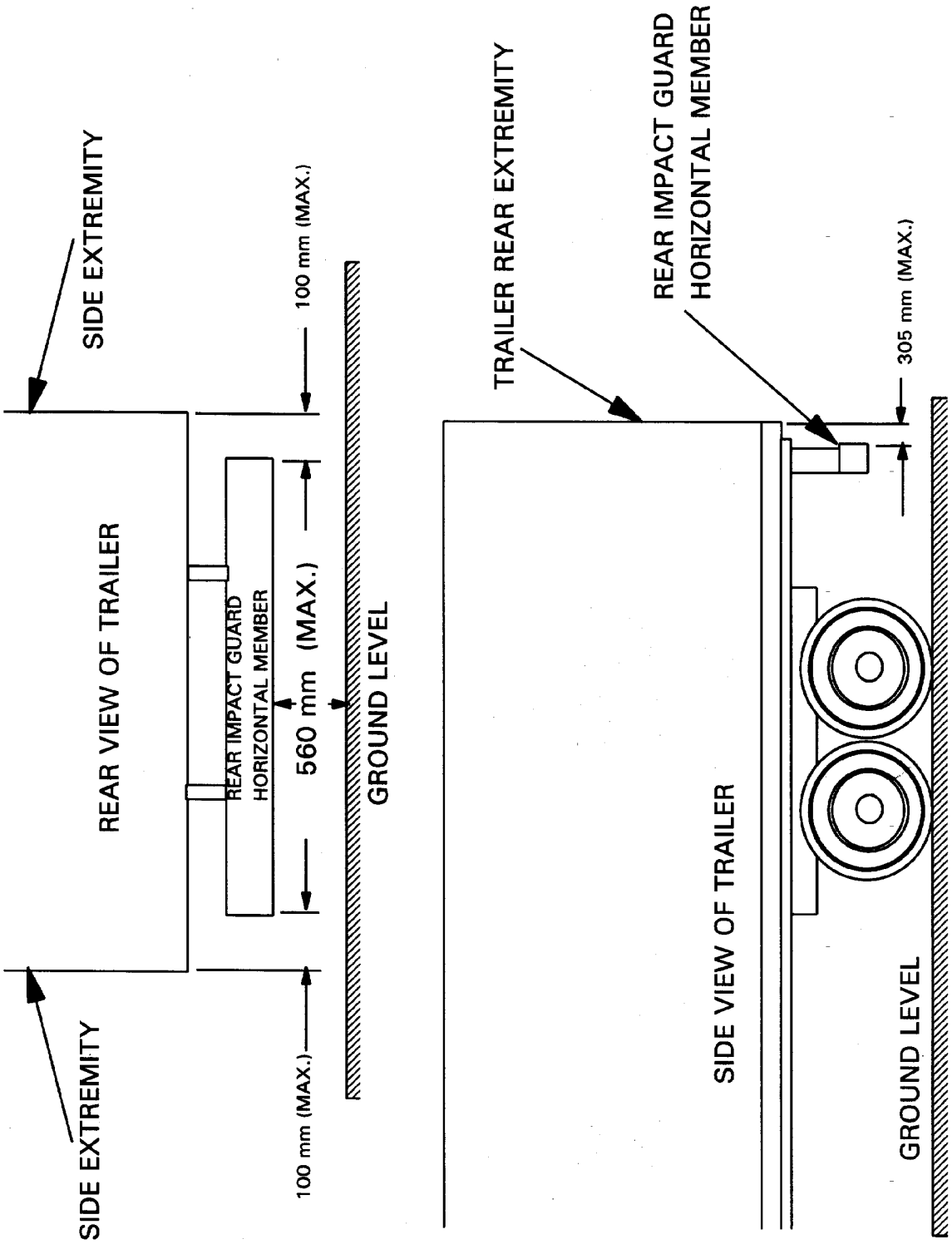
FIGURE 1. CONFIGURATION REQUIREMENTS



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Ricardo Martinez,

Administrator.

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