DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

49 CFR Parts 571 and 585

[Docket No. NHTSA–2010–0162]

RIN 2127–AK43

Federal Motor Vehicle Safety Standard, Rearview Mirrors; Federal Motor Vehicle Safety Standard, Low-Speed Vehicles Phase-In Reporting Requirements

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

ACTION: Notice of proposed rulemaking (NPRM).

SUMMARY: The Cameron Gulbransen Kids Transportation Safety Act of 2007 directs NHTSA to issue a final rule amending the agency's Federal motor vehicle safety standard on rearview mirrors to improve the ability of a driver to detect pedestrians in the area immediately behind his or her vehicle and thereby minimize the likelihood of a vehicle's striking a pedestrian while its driver is backing the vehicle. Pursuant to this mandate, NHTSA is proposing to expand the required field of view for all passenger cars, trucks, multipurpose passenger vehicles, buses, and low-speed vehicles rated at 10,000 pounds or less, gross vehicle weight. Specifically, NHTSA is proposing to specify an area immediately behind each vehicle that the driver must be able to see when the vehicle's transmission is in reverse. It appears that, in the near term, the only technology available with the ability to comply with this proposal would be a rear visibility system that includes a rear-mounted video camera and an in-vehicle visual display. Adoption of this proposal would significantly reduce fatalities and injuries caused by backover crashes involving children, persons with disabilities, the elderly, and other pedestrians.

In light of the difficulty of effectively addressing of the backover safety problem through technologies other than camera systems and given the differences in the effectiveness and cost of the available technologies, we developed several alternatives that, compared to the proposal, offer less, but at least in one case still substantial, benefits and do so at reduced cost. We seek comment on those alternatives and on other possible ways to achieve the statutory objective and meet the statutory requirements at lower cost.

DATES: You should submit your comments early enough to ensure that the docket receives them not later than February 7, 2011.

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

- *Federal eRulemaking Portal:* Go to *http://www.regulations.gov.* Follow the online instructions for submitting comments.
- *Mail:* Docket Management Facility: U.S. Department of Transportation, 1200 New Jersey Avenue, SE., West Building Ground Floor, Room W12–140, Washington, DC 20590–0001.
- *Hand Delivery or Courier:* 1200 New Jersey Avenue, SE., West Building Ground Floor, Room W12–140, between 9 a.m. and 5 p.m. ET, Monday through Friday, except Federal holidays.
- *Fax:* 202–493–2251.

Instructions: For detailed instructions on submitting comments and additional information on the rulemaking process, see the Public Participation heading of the Supplementary Information section of this document. Note that all comments received will be posted without change to *http://www.regulations.gov,* including any personal information provided. Please see the "Privacy Act" heading below.

Privacy Act: Anyone is able to search the electronic form of all comments received into any of our dockets by the name of the individual submitting the comment (or signing the comment, if submitted on behalf of an association, business, labor union, *etc.*). You may review DOT's complete Privacy Act Statement in the **Federal Register** published on April 11, 2000 (65 FR 19477–78) or you may visit *http://DocketInfo.dot.gov.*

Docket: For access to the docket to read background documents or comments received, go to *http://www.regulations.gov* or the street address listed above. Follow the online instructions for accessing the dockets.

FOR FURTHER INFORMATION CONTACT: For technical issues, you may contact Mr. Markus Price, Office of Vehicle Rulemaking, Telephone: (202) 666–0098. Facsimile: (202) 666–7002. For legal issues, you may contact Mr. Steve Wood, Office of Chief Counsel, Telephone (202) 366–2992. Facsimile: (202) 366–3820. You may send mail to these officials at: The National Highway Traffic Safety Administration, Attention: NVS–010, 1200 New Jersey Avenue, SE., Washington DC 20590.

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I. Executive Summary

In this notice, the National Highway Traffic Safety Administration (NHTSA) is proposing to expand the current rear visibility requirements of all passenger cars, multipurpose passenger vehicles, trucks, buses, and low-speed vehicles with a gross vehicle weight rating (GVWR) of 10,000 pounds (lb) or less by specifying an area behind the vehicle that a driver must be able to see when the vehicle is in reverse gear. This rulemaking action is being undertaken in response to the Cameron Gulbransen Kids Transportation Safety Act of 2007 [1] (the "K.T. Safety Act," or the "Act"), which required that NHTSA undertake rulemaking to expand the required field of view to enable the driver of a motor vehicle to detect areas behind the vehicle to reduce death and injury resulting from backing incidents known as backover crashes. A backover crash is a specifically-defined type of incident in which a non-occupant of a vehicle (most commonly, a pedestrian, but it could also be a cyclist) is struck by a vehicle moving in reverse.

Our assessment of available safety data indicates that on average there are 292 fatalities and 18,000 injuries (3,000 of which we judge to be incapacitating [2]) resulting from backover crashes every year. Of those, 228 fatalities and 17,000 injuries were attributed to backover incidents involving light vehicles (passenger cars, multipurpose passenger vehicles, trucks, buses, and low-speed vehicles) with a gross vehicle weight rating (GVWR) of 10,000 pounds or less.

In analyzing the data, we made several tentative findings. First, many of these incidents occur off public roadways, in areas such as driveways and parking lots and involve parents (or caregivers) accidentally backing over children. Second, children under five years of age represent approximately 44 percent of the fatalities, which we believe to be a uniquely high percentage for a particular crash mode. Third and finally, when pickups and multipurpose passenger vehicles strike a pedestrian in a backover crash, the incident is four times more likely to result in a fatality than if the striking vehicle were a passenger car.

NHTSA believes that there are several potential reasons for these tentative findings, including, but not limited to, the attributes of the vehicle, vehicle exposure to pedestrians, and the driver's situational awareness while driving backward. However, due to difficulties in isolating each of those effects individually, we cannot at this time determine their relative contribution to the occurrence of these backover crashes.

In consideration of the areas that a driver cannot see either directly or using existing mirrors, the agency has tentatively concluded that providing the driver with additional visual information about what is directly behind the driver's vehicle is the only effective near-term solution at this time to reduce the number of fatalities and injuries associated with backover crashes.

Before reaching this tentative conclusion, NHTSA published an Advance Notice of Proposed Rulemaking (ANPRM) and considered the public comments received in response to that notice.[3] The ANPRM reiterated some previous tentative findings on backover crash statistics; outlined current technologies that may have the ability to improve rear visibility including: improved direct vision (*i.e.,* looking directly out the vehicle's rear window), indirect vision via rear-mounted convex mirrors or rearview video systems, and rear object detection sensors; [4] and presented research findings on the effectiveness of those technologies.

The ANPRM set forth three approaches to defining the potential scope of applicability of the proposed requirements for improving rearward visibility.[5] The approaches included requiring improvements on a) all light vehicles, b) those light vehicles that are trucks, multipurpose passenger vehicles, or vans, or c) those light vehicles whose rear blind zone area (*i.e.,* the area behind a vehicle in which obstacles are not visible to a driver)

[1] Cameron Gulbransen Kids Transportation Safety Act of 2007, (Pub. L. 110–189, 122 Stat. 639–642), § 4 (2007).

[2] The Manual on Classification of Motor Vehicle Traffic Accidents (ANSI D16.1) defines "incapacitating injury" as "any injury, other than a fatal injury, which prevents the injured person from walking, driving or normally continuing the activities the person was capable of performing before the injury occurred" (Section 2.3.4).

[3] 74 FR 9478, March 4, 2009.

[4] While object detection sensors do not technically improve visibility in terms of providing a visual image comparable to what a driver could see with his or her own eyes, the Act indicated that sensors should be examined as a candidate technology for improving rear visibility. Such sensors could be used in combination of some type of visual display to show the location of detected objects.

[5] 74 FR 9504.

exceeds a specified size. We also presented ideas on how and on what basis to define the areas behind a vehicle that should be visible to a driver and general performance characteristics for mirrors, sensors, and rearview video systems. Finally, the ANPRM sought responses to 43 specific questions covering all of the above mentioned areas.

Thirty-seven entities commented in response to the ANPRM, including industry associations, automotive and equipment manufacturers, safety advocacy organizations, and 14 individuals. Generally, the comments can be grouped into four main areas according to the organization of ANPRM sections. The areas are: approaches for improving vehicles' rear visibility, effectiveness of the technologies, cost of the technologies, and performance requirements suitable for each type technology.

With regard to the issue of which vehicles most warrant improved rear visibility, vehicle manufacturers generally wanted to focus any expansion of rear visibility on the particular types of vehicles (*i.e.,* trucks, vans, and multipurpose passenger vehicles within the specified weight limits) that they believed posed the highest risk of backover crash fatalities and injuries. Vehicle safety organizations and equipment manufacturers generally suggested that all vehicles need to have expanded rear fields of view.

With regard to the issue of what technology would be effective at expanding the rear field of view for a driver, commenters discussed additional mirrors, sensors, and rearview video combined with sensors. Some commenters provided input regarding test procedure development and rear visibility countermeasure characteristics, such as visual display size and brightness, and graphic overlays superimposed on a video image. Some also discussed whether it is appropriate to allow a small gap in coverage immediately behind the rear bumper.

Finally, with regard to the issue of costs, commenters generally agreed with the cost estimates provided by the agency. However, some did suggest that our estimates of the cost of individual technologies seemed high and that there would be larger cost reductions over time than the agency had indicated.

To assess the feasibility and benefits of covering different areas behind the vehicle, NHTSA considered the comments received, the available safety data, our review of special investigations of backover crashes, and computer simulation. For example, we examined the typical distances that backover-crash-involved vehicles traveled from the location at which they began moving rearward to the location at which they struck a pedestrian. We tentatively concluded that an area with a width of 10 feet (5 feet to either side of a rearward extension of the vehicle's centerline) and a length of 20 feet extending backward from a transverse vertical plane tangent to the rearmost point on the rear bumper encompasses the highest risk area for children and other pedestrians to be struck. Therefore, we are proposing that test objects of a particular size within that area must be visible to drivers when they are driving backward.

To develop estimates of the benefits from adopting such a requirement, NHTSA used a methodology that reviewed backover crash case reports to infer whether the crash could be avoided with the aid of some technology, evaluated the performance of various countermeasures in detecting an object behind the vehicle, and tested whether the driver used the countermeasure and avoided the crash. Our evaluation of currently available technologies (mirrors, sensors, and rearview video systems) that may allow a driver to determine if there was a pedestrian in a 10 feet by 20 feet zone behind a vehicle indicates that rearview video systems are the most effective technology available today.

However, we note that technology is rapidly evolving, and thus, we are not proposing to require that a specific technology be used to provide a driver with an image of the area behind the vehicle. Consistent with statutory requirements and Executive Order 12866, we are not prescribing requirements that would expressly require the use of a specific technology and are attempting to promote compliance flexibility through proposing more performance oriented requirements. We have tentatively concluded that, in order to maintain the level of effectiveness that we have seen in our testing of existing rearview video systems, we should propose a minimum set of such requirements. Accordingly, this proposal sets forth requirements for the performance of the visual display, the rearview image, and durability requirements for any exterior components. Under this proposal, manufacturers would have flexibility to meet the requirements as they see fit (perhaps through the development of new or less expensive technology). Since we believe that manufacturers, in the near term, would likely use current production rearview video systems to achieve the required level of improved rear visibility and that most, if not all, systems in production today already meet this minimum set of requirements, we do not believe that the adoption of these requirements would increase the cost of this technology. However, we seek comment later in this preamble on including in the final rule requirements relating to additional matters such as image quality and display location.

Section 2(c) of the K.T. Safety Act requires that the requirement for improved rear visibility be phased in and that the phase-in process be completed within "48 months" of the publication of the final rule. Because we anticipate publishing a final rule by the statutory deadline of February 28, 2011, the rule must require full compliance not later than February 28, 2015. We note, however, that model years begin on September 1 and end on August 31 for safety standard compliance purposes and that February 28 falls in the middle of the model year that begins September 1, 2014. The agency believes that vehicle manufacturers would need, as a practical matter, to begin full compliance at the beginning of that model year, *i.e.,* on September 1, 2014. They could not wait until the middle of the model year to reach 100% compliance. Accordingly, NHTSA is proposing the following phase-in schedule:

- 0% of the vehicles manufactured before September 1, 2012;
- 10% of the vehicles manufactured on or after September 1, 2012, and before September 1, 2013;
- 40% of the vehicles manufactured on or after September 1, 2013, and before September 1, 2014; and
- 100% of the vehicles manufactured on or after September 1, 2014.

The agency recognizes that taking the dates on which model years begin and end for safety purposes effectively reduces the overall phase-in duration by 6 months (from 48 months to 42 months).

We invite comment on how to provide as much leadtime as possible within the limits of the statute. Specifically, should the agency change the structure of the phase-in schedule to allow for more flexibility and ease of implementation? We note that the statute explicitly requires an expanded field of view for all light vehicles and that there are substantial differences in the effectiveness of available technologies. Accordingly, the agency is proposing performance requirements that would trigger the installation of expensive technologies such as video camera systems for these vehicles. In view of the need to expand the field of

view for all vehicles and the statutory requirements set forth by Congress regarding timing and manner of implementation of the proposed requirements, however, the agency is limited in its ability to reduce the cost of this rulemaking through adjusting the application of the proposed rule or the specific deadline for implementation.

In evaluating the benefits and costs of this rulemaking proposal, the agency has spent considerable effort trying to determine the scope of the safety problem and the overall effectiveness of these systems in reducing crashes, injuries and fatalities associated with backing crashes. We have also estimated the net property damage effects to consumers from using any technology to avoid backing into fixed objects, along with the additional cost incurred when a vehicle is struck in the rear and the technology is damaged or destroyed.

The most effective technology option that the agency has evaluated is the rearview video system. Using the effectiveness estimates that we have generated and assuming that all vehicles would be equipped with this technology, we believe the annual fatalities that are occurring in backing crashes can be reduced by 95 to 112. Similarly, injuries would be reduced by 7,072 to 8,374.

However, rearview video is also the most expensive single technology. When installed in a vehicle without any existing visual display screen, rearview video systems are currently estimated to cost consumers between $159 and $203 per vehicle, depending on the location of the display and the angular width of the lens. For a vehicle that already has a suitable visual display, such as one found in route navigation systems, the incremental cost of such a system is estimated to be $58–$88, depending on the angular width of the lens. (We note that the cost may well decrease over time, as discussed below.)

Based on the composition and size of the expected vehicle fleet, the total incremental cost, compared to the MY 2010 fleet, to equip a 16.6 million new vehicle fleet with rearview video systems is estimated to be $1.9 billion to $2.7 billion annually. These costs are admittedly substantial. Nonetheless, the following considerations (discussed briefly here and at great length below in section VII.D. of this preamble) lead us to conclude tentatively that our proposal to implement the statutory mandate is reasonable and necessary, and that the benefits justify the costs. We request comment on this conclusion and on the various considerations that support it.

Those considerations include the following—

■ 100 of the 228 annual victims of backover crashes are very young children with nearly their entire lives ahead of them. There are strong reasons, grounded in this consideration and in considerations of equity, to prevent these deaths.

■ While this rulemaking would have great cost, it would also have substantial benefits, reducing annual fatalities in backover crashes by 95 to 112 fatalities, and annual injuries by 7,072 to 8,374 injuries. (We attempt to quantify these benefits below.)

■ Some of the benefits of the proposed rule are hard to quantify, but are nonetheless real and significant. One such benefit is that of not being the direct cause of the death or injury of a person and particularly a small child at one's place of residence. In some of these cases, parents are responsible for the deaths of their own children; avoiding that horrible outcome is a significant benefit. Another hard-to-quantify benefit is the increased ease and convenience of driving, and especially parking, that extend beyond the prevention of crashes. While these benefits cannot be monetized at this time, they could be considerable.

■ There is evidence that many people value the lives of children more than the lives of adults.[6] In any event, there is special social solicitude for protection of children. This solicitude is based in part on a recognized general need to protect children given their greater vulnerability to injury and inability to protect themselves.

■ Given the very young age of most of the children fatally-injured in backover crashes, attempting to provide them with training or with an audible warning would not enable them to protect themselves.

■ Given the impossibility of reducing backover crashes through changing the behavior of very young children and given Congress' mandate, it is reasonable and necessary to rely on technology to address backover crashes.

■ Based on its extensive testing, the agency tentatively concluded that a camera-based system is the only effective type of technology currently available.

■ Requiring additional rearview mirrors or changes to existing review mirrors cannot significantly increase the view to the rear of a vehicle except by means that reduce and distort the reflected image of people or objects behind a vehicle.

■ The agency's testing indicated that currently available sensors often failed to detect a human being, particularly a small moving child, in tests in which the vehicle was not actually moving. In tests in which the vehicle was moving, and when the sensors did detect a manikin representing a child, the resulting warning did not induce drivers to pause more than briefly in backing.

■ In contrast, in the agency's tests of video camera-based systems, drivers not only saw a child-sized obstacle, but also stopped and remained stopped.

■ Consequently, the agency has tentatively concluded that the requirements must have the effect of ensuring that some type of image is provided to the driver.

■ The agency's estimates of current costs for video camera-based systems may be too high.

■ The agency has a contract in place for conducting tear down studies that could produce somewhat lower cost estimates.

■ In time, types of technology other than a video camera-based system may be able to provide a sufficiently clear visual image of the area behind the vehicle at lower cost. We believe that it is reasonable to project that the costs of the requirements proposed here may well decline significantly over time. While extrapolations are uncertain, technology has been advancing rapidly in this domain, and future costs may well be lower than currently expected.

■ In light of statutory requirements, the agency is limited in its ability to reduce the cost of this rulemaking through adjusting either the requirements or application of the proposed rule or the schedule for its implementation.

■ Congress has mandated the issuance of a final rule instead of allowing the agency to retain discretion to decide whether to issue a final rule based on its consideration of all the relevant factors and information.

■ Less expensive countermeasures, *i.e.,* mirrors and sensors, have thus far shown very limited effectiveness and thus would not satisfy Congress's mandate for improving safety.

■ As the most cost-effective alternative, a requirement for a system that provides an image of the area behind the vehicle would be consistent with the policy preference underlying the Unfunded Mandates Reform Act.

[6] J.K. Hammitt and K. Haninger, "Valuing Fatal Risks to Children and Adults: Effects of Disease, Latency, and Risk Aversion," *Journal of Risk and Uncertainty* 40(1): 57–83, 2010. This stated preference study finds that the willingness to pay to prevent fatality risks to one's child is uniformly larger than that to reduce risk to another adult or to oneself. Estimated values per statistical life are $6–10 million for adults and $12–15 million for children. We emphasize that the literature is in a state of development.

■ Were the agency able to provide more than the amount of lead time permitted by the statutory mandate, the additional leadtime might be sufficient to allow the development of cheaper cameras.

As noted, the agency requests comments on all of the foregoing points. And in view of the cost of our proposed option, the agency is seeking comment and suggestions on any alternative options that would lower costs, maintain all or most of the benefits of the proposal, and lower net costs or the cost per equivalent life saved. We carefully explored our ability under the Act to vary the population of vehicles subject to the proposal, vary the performance requirements, and extend the leadtime to implement the proposal and thereby develop alternative options that offer benefits similar to those of our proposal, but at reduced cost. Although our ability to make any of those types of adjustments appears constrained as a legal or practical matter, and although none of the alternative options that the agency has been able to identify would accomplish all three of those goals, we are seeking comment on them and on any others that commenters may suggest.

We seek comment especially on the alternative option under which passenger cars would be required to be equipped with either a rearview visibility (*e.g.,* camera) system or with a system that includes sensors that monitor a specified area behind the vehicle and an audible warning that sounds when the presence of an object is sensed. Under this option, other vehicles rated at 10,000 pounds or less, gross vehicle weight, would be required to be equipped with a visibility system.

This alternative would have substantially lower, but still significant, safety benefits, substantially lower installation costs, lower net costs, and higher cost per equivalent life saved. Cars not equipped under this option with a rearview visibility system would be required to provide an audible warning inside the vehicle of not less than 85 dBa between 500–3000 Hz when a test object is placed in one of the locations specified for test objects in the requirements for rearview image performance and the vehicle transmission is shifted into reverse gear. Given that current sensors have a shorter range than rearview visibility systems, the test objects might need to be placed somewhat closer to the vehicle than they are when used to test the performance of rearview visibility systems. Alternatively, the test objects could be placed in the same locations as for rearward visibility systems, thus requiring sensors to have stronger signals. A disadvantage of doing that would be the risk of increased "false" activations. This requirement to sense the presence of a test object would be required to be met for each of the test object locations. The other requirements would be similar to those for the proposed rearview systems.

II. Background

A. Cameron Gulbransen Kids Transportation Safety Act of 2007

Subsection (2)(b) of the K.T. Safety Act directed the Secretary of Transportation to initiate rulemaking by February 28, 2009 to amend Federal Motor Vehicle Safety Standard (FMVSS) No. 111, *Rearview Mirrors,* to expand the required field of view to enable the driver of a motor vehicle to detect areas behind the motor vehicle to reduce death and injury resulting from backing incidents.[7] The Secretary is required to publish a final rule within 36 months of the passage of the K.T. Safety Act (*i.e.,* by February 28, 2011).

Given that subsection (2)(b) requires the amendment of a Federal motor vehicle safety standard, this rulemaking is subject to both the requirements of subsection (b) and the requirements for such standards in the Vehicle Safety Act, 49 U.S.C. 30111.

Subsection (2)(b) contains the following requirements. Not later than 12 months after the date of the enactment of this Act, the Secretary shall initiate a rulemaking to revise Federal Motor Vehicle Safety Standard 111 (FMVSS 111) to expand the required field of view to enable the driver of a motor vehicle to detect areas behind the motor vehicle to reduce death and injury resulting from backing incidents, particularly incidents involving small children and disabled persons. The Secretary may prescribe different requirements for different types of motor vehicles to expand the required field of view to enable the driver of a motor vehicle to detect areas behind the motor vehicle to reduce death and injury resulting from backing incidents, particularly incidents involving small children and disabled persons. Such standard may be met by the provision of additional mirrors, sensors, cameras, or other technology to expand the driver's field of view.

Subsection (2)(e) of the K.T. Safety Act broadly defines the term "motor vehicle," as used in subsection (2)(b), as follows: As used in this Act and for purposes of the motor vehicle safety standards described in subsections (a) and (b), the term 'motor vehicle' has the meaning given such term in section 30102(a)(6) of title 49, United States Code, except that such term shall not include—a motorcycle or trailer; or any motor vehicle that is rated at more than 10,000 pounds gross vehicular weight.

Section 30102(a)(6) of the National Traffic and Motor Vehicle Safety Act defines "motor vehicle" even more broadly as a vehicle driven or drawn by mechanical power and manufactured primarily for use on public streets, roads, and highways, but does not include a vehicle operated only on a rail line.

The K.T. Safety Act also specifies the rule must be phased-in and that it must be fully implemented within four years after the publication date of the final rule. The statutory language, contained in subsection (c) of the K.T. Safety Act, sets out these requirements for the phase-in period: The safety standards prescribed pursuant to subsections (a) and (b) shall establish a phase-in period for compliance, as determined by the Secretary, and require full compliance with the safety standards not later than 48 months after the date on which the final rule is issued.

In establishing the phase-in period of the rearward visibility safety standards required under subsection (b), the Secretary shall consider whether to require the phase-in according to different types of motor vehicles based on data demonstrating the frequency by which various types of motor vehicles have been involved in backing incidents resulting in injury or death. If the Secretary determines that any type of motor vehicle should be given priority, the Secretary shall issue regulations that specify which type or types of motor vehicles shall be phased-in first; and the percentages by which such motor vehicles shall be phased-in.

Congress emphasized the protection of small children and disabled persons, and added that the revised standard may be met by the "provision of additional mirrors, sensors, cameras, or other technology to expand the driver's field of view." While NHTSA does not interpret the Congressional language to require that all of these technologies eventually be integrated into the final requirement, we have closely examined the merits of each of them, and present our analysis of their ability to address the backover safety problem.

We note that the inclusion of sensors as a "technology to expand the driver's field of view" suggests that the passage "expand the required field of view"

[7] As noted above, the agency first public step toward meeting this requirement was the issuance of an ANPRM. It was posted on the NHTSA Web site on February 27, 2009, and published in the **Federal Register** on March 3, 2009. 74 FR 9478.

should not be read in the literal way as meaning the driver must be able to *see* more of the area behind the vehicle. A literal reading would make the reference to sensors superfluous, violating a basic canon of statutory interpretation. Instead, it seems that language should be read as meaning the driver must be able to *monitor,* visually or otherwise, an expanded area.

Finally, section 4 of the K.T. Safety Act provides that if the Secretary determines that the deadlines applicable under the Act cannot be met, the Secretary shall establish new deadlines, and notify the Committee on Energy and Commerce of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate of the new deadlines describing the reasons the deadlines specified under the K.T. Safety Act could not be met.

The relevant provisions in the Vehicle Safety Act are those in section 30111 of title 49 of the United States Code. Section 3011 states that the Secretary of Transportation shall prescribe motor vehicle safety standards. Each standard shall be practicable, meet the need for motor vehicle safety, and be stated in objective terms. When prescribing a motor vehicle safety standard under this chapter, the Secretary shall consider relevant available motor vehicle safety information; consult with the agency established under the Act of August 20, 1958 (Pub. L. 85–684, 72 Stat. 635), and other appropriate State or interstate authorities (including legislative committees); consider whether a proposed standard is reasonable, practicable, and appropriate for the particular type of motor vehicle or motor vehicle equipment for which it is prescribed; and consider the extent to which the standard will carry out section 30101 of this title.

B. Applicability

With regard to the scope of vehicles covered by the mandate, the statute refers to all motor vehicles rated at not more than 10,000 pounds gross vehicle weight (GVW) (except motorcycles and trailers). Specifically, it states that the Secretary shall "revise [FMVSS No. 111] to expand the required field of view to enable the driver of a motor vehicle to detect areas behind the motor vehicle * * *," and defines a "motor vehicle" for purposes of the Act as any motor vehicle whose GVWR is 10,000 pounds or less, except trailers and motorcycles. This language means that the revised regulation could be applied to passenger cars, low-speed vehicles (LSVs), multipurpose passenger vehicles (MPVs),[8] buses (including small school buses and school vans), and trucks with a GVWR of 10,000 pounds or less. In this document, we are proposing that each of these types of vehicles would be subject to improved rear visibility requirements.

We note, however, that in our review of real-world crashes, NHTSA could not determine whether there were any backover incidents involving LSVs, small school buses, and school vans. Accordingly, we seek comment and data related to the issue of whether, if the agency remains unable to find such incidents, it could reasonably conclude that those vehicles pose no unreasonable risk of backover crashes and whether it would be permissible therefore it to exclude these vehicles from the application of the final rule. The agency invites comment on whether the absence of incidents might reflect operational conditions (school vehicles-operation in environments in which the vulnerable age groups are unlikely to be present or perhaps avoidance of backing maneuvers) or a possible absence of any blind spot behind the vehicle (some LSVs).

C. Backover Crash Safety Problem

i. Definitions and Summary

A backover crash is a specifically-defined type of incident, in which a non-occupant of a vehicle (*i.e.,* a pedestrian or cyclist) is struck by a vehicle moving in reverse. As stated in the ANPRM, using a variety of available data sources, NHTSA has identified a total population of 228 fatalities and 17,000 injuries due to light vehicle backover crashes.[9] Unlike other crashes, the overwhelming majority of backover crashes occur off of public roadways, in areas such as driveways and parking lots. Children and people over 70 are also far more likely than other groups to be victims of backover crashes. In the case of children, their short stature can make them extremely difficult for a driver to see using direct vision or existing mirrors.

Because many backover crashes occur off public roadways, NHTSA's traditional methodologies for collecting data as to the specific numbers and circumstances of backover incidents have not always given the agency a complete picture of the scope and circumstances of these types of incidents. The following sections detail NHTSA's attempts to both quantify the number of backover incidents and determine their nature.

In response to section 2012 of the "Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users" (SAFETEA–LU),[10] NHTSA developed the "Not-in-Traffic Surveillance" (NiTS) system to collect information about all nontraffic crashes, including nontraffic backing crashes. NiTS provided information on these backing crashes that occurred off the traffic way and which were not included in NHTSA's FARS database or NASS–GES. The subset of backing crashes that involve a pedestrian, bicyclist, or other person not in a vehicle, is referred to as "backover crashes." This is distinguished from the larger category of "backing crashes," which would include such non-backover events such as a vehicle going in reverse and colliding with another vehicle, or a vehicle backing off an embankment or into a stationary object. While the primary purpose of this rulemaking is to prevent backover crashes, any improvements to rear visibility should also have a positive effect on all types of backing crashes.

The national estimates for fatalities and injuries presented in the ANPRM were developed using data from FARS, NASS–GES, and the NiTS. While there are newer estimates available for FARS and NASS–GES, there are not for the NiTS and therefore the estimates we provided in the ANPRM and in this document represent the most current data available. As such, based on the currently available data, NHTSA estimates that 463 fatalities and 48,000 injuries a year occur in traffic and nontraffic backing crashes.[11] Most of these injuries are minor, but an estimated 6,000 per year are incapacitating injuries. Overall, an estimated 65 percent (302) of the fatalities and 62 percent (29,000) of the injuries in backing crashes occurred in nontraffic situations.

Based on existing data, NHTSA estimates the following number of injuries and fatalities. Overall, backing crashes result in approximately 463 fatalities and 48,000 injuries. Of those, the subset of backover crashes comprises 292 fatalities (63 percent) and 18,000 injuries (38 percent). These figures are reflected in Table 1 below.

[8] Per 49 CFR 571.3, multipurpose passenger vehicle means a motor vehicle with motive power, except a low-speed vehicle or trailer, designed to carry 10 persons or less which is constructed either on a truck chassis or with special features for occasional off-road operation.

[9] 49 FR 9482.

[10] Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users, Public Law 109–59, August 10, 2005.

[11] Fatalities and Injuries in Motor Vehicle Backing Crashes, NHTSA Report to Congress (2008), DOT HS 811 144. *http://www-nrd.nhtsa.dot.gov/Pubs/811144.PDF.*

TABLE 1—ANNUAL ESTIMATED FATALITIES AND INJURIES IN ALL BACKING CRASHES FOR ALL VEHICLES [12]

Injury severity	Total	Backover crashes	Other backing crashes
	Estimated total	Estimated total	Estimated total
Fatalities	*463*	*292*	*171*
Incapacitating Injury	6,000	3,000	3,000
Non-incapacitating Injury	12,000	7,000	5,000
Possible Injury	27,000	7,000	20,000
Injured Severity Unknown	2,000	1,000	2,000
Total Injuries	*48,000*	*18,000*	*30,000*

Source: FARS 2002–2006, NASS–GES 2002–2006, NiTS 2007.
Note: Estimates may not add up to totals due to independent rounding. [Note to agency, unknowns will be updated prior OST approval to reflect optics that 2,000 + 1,000 does not equal 2.]

ii. Backover Crash Risk by Crash and Vehicle Type

Backovers account for an estimated 63 percent of all fatal backing crashes involving all vehicle types. As indicated in Table 2, an estimated 15 percent (68) of the backing crash fatalities occur in multivehicle crashes, and an estimated 13 percent (62) occur in single-vehicle non-collisions, such as occupants who fall out of and are struck by their own backing vehicles. About half of the backing crash injuries (20,000 per year) occur in multi-vehicle crashes involving backing vehicles.

TABLE 2—FATALITIES AND INJURIES BY BACKING CRASH TYPE [13]

Backing crash scenarios	All vehicles		Passenger vehicles	
	Fatalities	Injuries	Fatalities	Injuries
Backovers: Striking Non-occupant	292	18,000	228	17,000
Backing: Striking Fixed Object	33	2,000	33	2,000
Backing: Single-vehicle Non-collision	62	1,000	53	1,000
Backing: Striking/Struck by Other Vehicle (multi-vehicle)	68	24,000	39	20,000
Backing: Other	8	3,000	8	3,000
Total Backing	*463*	*48,000*	*361*	*43,000*

Source: FARS 2002–2006, NASS–GES 2002–2006, NiTS 2007.
Note: Estimates may not add up to totals due to independent rounding.

Most backover fatalities and injuries involve passenger vehicles. Tables 2 and 3 indicate that all major passenger vehicle types (cars, trucks, multipurpose passenger vehicles, and vans) with GVWR of 10,000 pounds or less are involved in backover fatalities and injuries. However, the data indicate that some vehicles show a greater involvement in backing crashes than other vehicles. Table 3 illustrates that pickup trucks and multipurpose passenger vehicles are statistically overrepresented in backover fatalities when compared to all non-backing traffic injury crashes and to their proportion to the passenger vehicle fleet. The agency's analysis revealed that while LTVs were statistically overrepresented in backover-related fatalities, they were not significantly overrepresented in backover crashes generally.

TABLE 3—PASSENGER VEHICLE BACKOVER FATALITIES AND INJURIES BY VEHICLE TYPE [14]

Backing vehicle type (GVWR 10,000 lb or less)	Fatalities	Percent of fatalities	Estimated injuries	Estimated percent of injuries	Percent of fleet
Car	59	26	9,000	54	58
Utility Vehicle	68	30	3,000	20	16
Van	29	13	1,000	6	8
Truck	72	31	3,000	18	17
Other Vehicles	0	0	*	2	<1
Passenger Vehicles	*228*	*100*	*17,000*	*100*	*100*

Source: FARS 2002–2006, NASS–GES 2002–2006, NiTS 2007.
Note: * Indicates estimate less than 500, estimates may not add up to totals due to independent rounding.

[12] Ibid.

[13] Ibid.

iii. Backover Crash Risk by Victim Age

NHTSA's data indicate that children and adults over 70 years old are disproportionately represented in passenger vehicle backover crashes. Table 4 details the ages for fatalities and injuries for backover crashes involving all vehicles as well as those involving passenger vehicles only. It also details the proportion of the U.S. population in each age category from the 2007 U.S. Census Bureau's Population Estimates Program for comparison. Similar to previous findings, backover fatalities disproportionately affect children under 5 years old and adults 70 or older. When restricted to backover fatalities involving passenger vehicles, children under 5 years old account for 44 percent of the fatalities, and adults 70 years of age and older account for 33 percent. The difference in the results between all backover crashes and passenger vehicle backover crashes occur because large truck backover crashes, which are excluded from the passenger vehicle calculations, tend to affect adults younger than 70 years of age.

TABLE 4—ALL BACKOVER CRASH FATALITIES AND INJURIES BY VICTIM AGE [15]

Age of victim	*Fatalities*	*Percent of fatalities*	*Estimated injuries*	*Estimated percent of injuries*	*Percent of population* **
All Vehicles					
Under 5	103	35	2,000	8	7
5–10	13	4	*	3	7
10–19	4	1	2,000	12	14
20–59	69	24	9,000	48	55
60–69	28	9	2,000	8	8
70+	76	26	3,000	18	9
Unknown	.....	.....	*	2	.....
Total	*292*	*100*	*18,000*	*100*	*100*
Passenger Vehicles					
Under 5	100	44	2,000	9	7
5–10	10	4	1,000	3	7
10–19	1	1	2,000	12	14
20–59	29	13	8,000	46	55
60–69	15	6	1,000	8	8
70+	74	33	3,000	19	9
Unknown	.....	.....	*	2	.....
Total	*228*	*100*	*17,000*	*100*	*100*

Note: * Indicates estimate less than 500, estimates may not add up to totals due to independent rounding.
Note: ** Source: U.S. Census Bureau, Population Estimates Program, 2007 Population Estimates; FARS 2002–2006, NASS–GES 2002–2006, NiTS 2007.

The proportion of backover injuries by age group is more similar to the proportion of the population than for backover fatalities. However, while children under 5 years old appear to be slightly statistically overrepresented in backover injuries compared to the population, adults 70 years of age and older appear to be greatly overrepresented.

Table 5 presents passenger vehicle backover fatalities by year of age for victims less than 5 years old. Out of all backover fatalities involving passenger vehicles, 26 percent (60 out of 228) of victims are 1 year of age and younger.

TABLE 5—BREAKDOWN OF BACKOVER CRASH FATALITIES INVOLVING PASSENGER VEHICLES FOR VICTIMS UNDER AGE 5 YEARS [16]

Age of victim (years)	*Number of fatalities*
0	< 1
1	59
2	23
3	14
4	3
Total	*100*

Note: Estimates may not add to totals due to independent rounding.
Source: US Census Bureau, Population Estimates Program, 2007 Population Estimates; FARS 2002–2006, NASS–GES 2002–2006, NiTS 2007.

iv. Special Crash Investigation of Backover Crashes

As reported in the ANPRM, NHTSA's efforts to collect data on police-reported backover crashes have included a Special Crash Investigation (SCI) program. The SCI program was created to examine the safety impact of rapidly changing technologies and to provide NHTSA with early detection of alleged or potential vehicle defects.

SCI began investigating cases related to backover crashes in October 2006.[17] SCI receives notification of potential backover cases from several different sources including media reports, police and rescue personnel, contacts within NHTSA, reports from the general public, as well as notifications from the NASS. As of August 2009, roughly 80 percent of 849 total "Not-in-Traffic Surveillance" system incident notifications that SCI had received regarded backover

[14] Ibid.
[15] Ibid.
[16] 74 FR 9478.
[17] Fatalities and Injuries in Motor Vehicle Backing Crashes, NHTSA Report to Congress (2008).

crashes.[18] For the purpose of the SCI cases, an eligible backover is defined as a crash in which a light passenger vehicle's back plane strikes or passes over a person who is either positioned to the rear of the vehicle or is approaching from the side. SCI primarily focuses on cases involving children; however, it investigates some cases involving adults. The majority of notifications received do not meet the criteria for case assignment. Typically, the reasons for not pursuing further include:

- The reported crash configuration is outside of the scope of the program,
- Minor incidents with no fatally or seriously injured persons, or
- Incidents where cooperation cannot be established with the involved parties.

As an example, many reported incidents are determined to be side or frontal impacts, which exclude them from the program. Cases involving adult victims were generally excluded from the study unless they were seriously injured or killed or if the backing vehicles were equipped with backing or parking aids.

The SCI effort to examine backover crashes includes an on-site inspection of the scene and vehicle, as well as interviews of the involved parties when possible. When an on-site investigation is not possible, backover cases are investigated remotely through an examination of police-provided reports and photos as well as interviews with the involved parties. For each backover case investigated, a case vehicle visibility study is also conducted to determine the size of the vehicle's blind zones and also to determine at what distance behind the vehicle the occupant may have become visible to the driver.

Thus far, NHTSA has completed special crash investigations of 58 backover cases. The 58 backing vehicles were comprised of 18 passenger cars, 22 multipurpose passenger vehicles, 5 vans (including minivans) and 13 pickup trucks. For cases in which an estimated speed for the backing vehicle was available, the average speed of the backing vehicle was approximately 3 mph. Of the 58 SCI backover cases, 95 percent (55) of the cases occurred in daylight conditions. Half (29) involved a non-occupant fatality.

Four of the 58 cases involved vehicles equipped with a parking aid system. All four systems were sensor-based parking aids. In two vehicles, the systems had been manually turned off for unknown reasons. In one backover case, the system did not detect an elderly female who had fallen behind a sensor-equipped vehicle, and presumably positioned at a height below the detection zone of the sensors. In the fourth case the system did detect the adult pedestrian victim and provided a warning that prompted the driver to stop the vehicle, but the driver looked rearward and did not see an obstacle so he began backing again and struck the victim.

One issue that was evident from the SCI cases is that very few instances involved victims that were easily visible from the driver's position. Instead, most of the victims were either children (who were too short to be seen behind the vehicle), or adults who had fallen or bent over and were also thus not in the driver's field of view. Eighty-eight percent of the backover crashes (51 of the 58) involved children, ranging in age from less than 8 months old up to 13 years old, who were struck by vehicles. The other 12 percent of the 58 cases involved adult victims aged 30 years or older. Of the 8 adult victims, 4 were in an upright posture either standing or walking and one of those 4, as noted in the prior paragraph, had been detected by a rear parking sensor system, but the driver only stopped briefly before continuing to back and then struck the person. Of the remaining four adult victims documented in the SCI cases, one was bending over behind a backing vehicle to pick up something from the ground, one was an elderly female who had fallen down in the path of the vehicle prior to being run over, and the postural orientation of the remaining two was unknown.

Based on NHTSA's analysis of the quantitative data and narrative descriptions of how the 58 SCI-documented backover incidents transpired, the breakdown of the victim's path of travel prior to being struck is as follows: 41 (71 percent) were approaching from the right or left of the vehicle, 12 were in the path of the backing vehicle, 4 were unknown, and one was "other".[19]

Subsequent to the ANPRM, NHTSA further analyzed these SCI backover cases to assess how far the vehicle traveled before striking the victim. Distances traveled for these cases ranged from 1 to 75 feet. Overall, as shown in Table 6 below, this analysis showed that in 77 percent of real-world, SCI backover cases, the vehicle traveled up to 20 feet. While the subset may or may not nationally representative of all backing crashes, we believe this information from the SCI cases could be used in the development of a required visible area and the associated development of a compliance test.

TABLE 6—AVERAGE DISTANCE TRAVELED BY BACKING VEHICLE FOR FIRST 58 SCI BACKOVER CASES AND PERCENT OF BACKOVER CRASHES THAT COULD BE AVOIDED

	Number of SCI cases	Average distance traveled prior to Strike (ft)	7ft (%)	15ft (%)	20ft (%)	35ft (%)
Car	18	13.7	39	56	78	89
SUV	22	13.4	27	68	82	100
Minivan	4	31.0	25	50	50	75
Van	1	54.5	0	0	0	0
Pickup	13	17.2	38	69	69	92
All Light Vehicles	58	26.0	33	63	77	93

[18] Since SCI investigates as many relevant cases that they are notified about as possible and not on a statistical sampling of incidents, results are not representative of the general population.

[19] Note that one or more cases examined involved multiple victims, causing the total of the path breakdown scenarios to be 53 rather than 52.

v. Analysis of Backover Crash Risk by Pedestrian Location Using Monte Carlo Simulation

As noted in the ANPRM, NHTSA also calculated backover crash risk as a function of pedestrian location using a Monte Carlo simulation.[20] Data from a recent NHTSA study of drivers' backing behavior,[21] such as average backing speed and average distance covered in a backing maneuver, were used to develop a backing speed distribution and a backing distance distribution that were used as inputs to the simulation. Similarly, published data [22] [23] [24] characterizing walking and running speeds of an average 1-year-old child were also used as inputs. A Monte Carlo simulation was performed that drew upon the noted vehicle and pedestrian motion data to calculate a probability-based risk weighting for a test area centered behind the vehicle. The probability-based risk weightings for each grid square were based on the number of pedestrian-vehicle backing crashes predicted by the simulation for trials for which the pedestrian was initially (*i.e.,* at the time that the vehicle began to back up) in the center of one square of the grid of 1-foot squares spanning 70 feet wide by 90 feet in range behind the vehicle. A total of 1,000,000 simulation trials were run with the pedestrian initially in the center of each square.

The output of this analysis calculated relative crash risk values for each grid square representing a location behind the vehicle. Analysis results showed that the probability of crash decreases rapidly as the pedestrian's initial location is moved rearward, away from the rear bumper of the vehicle. Areas located behind the vehicle and to the side were also shown to have moderately high risk, giving pedestrians some risk of being hit even though they were not initially directly behind the vehicle. The results suggest that an area 12 feet wide by 36 feet long centered behind the vehicle would address pedestrian locations having relative crash risks of 0.15 and higher (with a risk value of 1.0 being located directly aft of the rear bumper). To address crash risks of 0.20 and higher, an area 7 feet wide and 33 feet long centered behind the vehicle would need to be covered. The analysis showed that an area covering approximately the width of the vehicle out to a range of 19 feet would encompass risk values of 0.4 and higher.

D. Comparative Regulatory Requirements

As of today, no country has established a requirement for the minimum area directly behind a light vehicle that must be directly or indirectly visible. All countries do, however, have standards for side and interior rearview mirrors, although slight differences do exist in terms of mirror requirements.

i. Current FMVSS No. 111

FMVSS No. 111, *Rearview mirrors,* sets requirements for motor vehicles to be equipped with mirrors that improve rearward visibility.[25] This standard sets different requirements for various classes of vehicles, notably including passenger cars in paragraph S5, and multipurpose passenger vehicles (MPVs), trucks, and buses (including school buses and school vans) with a GVWR of 10,000 pounds or less in paragraph S6. The purpose of this standard is to reduce the number of deaths and injuries that occur when the driver of a motor vehicle does not have a clear and reasonably unobstructed view to the rear.

With respect to passenger cars, paragraph S5 of the standard sets requirements for both the rearward area to the sides of the vehicle, as well as the area directly behind the vehicle. With regard to the requirements for viewing the area directly behind the vehicle, paragraph S5 requires that the inside mirror must have a field of view at least 20 degrees wide and a sufficient vertical angle to provide a view of a level road surface extending to the horizon beginning not more than 200 feet (61 m) behind the vehicle. If this requirement is not met, the standard requires that a flat [26] or convex exterior mirror must be mounted on the passenger's side of the vehicle; although no specific field of view is required.

With regard to the rearward area to the side of the vehicle, paragraph S5 requires a driver's side rearview mirror to be mounted on the outside of the vehicle. This mirror is required to be a plane mirror that provides "the driver a view of a level road surface extending to the horizon from a line, perpendicular to a longitudinal plane tangent to the driver's side of the vehicle at the widest point, extending 2.4 m (7.9 ft) out from the tangent plane 10.7 m (35.1 ft) behind the driver's eyes, with the seat in the rearmost position."

Paragraph S6 sets mirror requirements for buses (including school buses and school vans), trucks, and MPVs, with a GVWR of 10,000 pounds or less. Unlike the requirement for passenger cars, paragraph S6 does not set a requirement for a rear field of view directly behind the vehicle, but only sets a requirement for the rearward area to the sides of the vehicle. Pursuant to paragraph S6, vehicles must have either mirrors that conform to paragraph S5 or outside mirrors of unit magnification with reflective surface area of not less than 126 square centimeters (19.5 square inches) on each side of the vehicle. We note that under S6, manufacturers are given the option to have mirrors that conform to S5, instead of the requirements listed in S6. As paragraph S6 does not establish minimum rear field of view requirements for the area directly behind the vehicle, existing state laws or regulations may regulate the vehicle's rear field of view for vehicles subject to the requirements of paragraph S6.

FMVSS No. 111 also includes requirements for school buses in paragraph S9. These requirements are substantially more robust than the mirror requirements for other vehicles. The standard also contains test procedures (paragraph S13) for determining the performance of school bus mirrors.

ii. Relevant European Regulations (Also United Kingdom and Australia)

In 1981, the United Nations Economic Commission for Europe enacted Regulation 46 (ECE R46), which details uniform provisions concerning the approval of devices for indirect vision.[27] ECE R46 defines devices for indirect vision as those that observe the area adjacent to the vehicle which cannot be observed by direct vision, including "conventional mirrors, camera-monitors or other devices able to present information about the indirect field of vision to the driver." ECE R46 permits either exterior planar or convex mirrors

[20] 49 FR 9484.

[21] Mazzae, E. N., Barickman, F. S., Baldwin, G. H. S., and Ranney, T. A. (2008). On-Road Study of Drivers' Use of Rearview Video Systems (ORSDURVS). National Highway Traffic Safety Administration, DOT HS 811 024.

[22] Manual on Uniform Traffic Control Devices for Streets and Highways, 2003 Edition. Washington, DC: FHWA, November 2003.

[23] Milazzo, J.S., Rouphail, J.E., and Alien, D.P. (1999). Quality of Service for Interrupted-Flow Pedestrian Facilities in Highway Capacity Manual 2000. Transportation Research Record, No. 1678 (1999): 25–31.

[24] Chou, P., Chou, Y., Su, F., Huang, W., Lin, T. (2003). Normal Gait of Children. Biomedical Engineering—Applications, Basis & Communications, Vol. 15 No. 4 August 2003.

[25] 49 CFR 571.111, Standard No. 111, Rearview mirrors.

[26] Flat mirrors are referred to as "planar" or "unit magnification" mirrors.

[27] ECE R46–02, Uniform Provisions Concerning the Approval of: Devices for Indirect Vision and of Motor Vehicles with Regard to the Installation of these Devices, (August 7, 2008).

on both sides of the vehicle, provided a minimum field of view is satisfied. Specifications are also provided to define the required minimum surface area of the interior rearview mirror.

The ECE R46 regulation previously outlined requirements for devices for indirect vision other than mirrors for vehicles with more than eight seating positions and those configured for refuse collection. However, in an August 7, 2008 amendment all performance requirements were removed and replaced with the statement, "Vehicles may be equipped with additional devices for indirect vision." [28] This change allows for indirect vision systems to be installed on European vehicles without meeting any performance requirements.

iii. Relevant Regulations in Japan and Korea

The Japanese regulation, Article 44, provides a performance based requirement for rearview mirrors.[29] For light vehicles, rearview mirrors must be present that enable drivers to check the traffic situation around the left-hand lane edge and behind the vehicle from the driver's seat.[30] The regulation requires that the driver be able to "visually confirm the presence of a cylindrical object 1 m high and 0.3 m in diameter (equivalent to a 6-year-old child) adjacent to the front or the left-hand side of the vehicle (or the right-hand side in the case of a left-hand drive vehicle), either directly or indirectly via mirrors, screens, or similar devices." Article 44 does not specify requirements for rear-mounted convex mirrors and rearview video systems. Rear-mounted convex mirrors are commonly found on multipurpose passenger vehicles and vans in Japan.

The Korean regulation on rearview mirrors, Article 50 outlines rearview mirror requirements for a range of vehicles. Article 50 requires a flat or convex exterior mirror mounted on the driver's side for passenger vehicles and buses with less than 10 passengers. For buses, cargo vehicles, and special motor vehicles, flat or convex rear-view mirrors are required on both sides of the vehicle. Article 50 does not address rear-mounted convex mirrors and rearview video systems, therefore these devices are allowed, but not required under the standard. Again, rear-mounted convex mirrors can be found on SUVs and vans in Korea.

iv. State Regulations

In the ANPRM, NHTSA requested comment on whether states or municipalities have regulations pertaining to rear visibility requirements.[31] NHTSA has found that two states, New York and New Jersey, have motor vehicle regulations that require some single-unit trucks to have a cross-view mirror or electronic backup device. Specifically, the regulations apply to vehicles with a "cube-style" or "walk-in type" cargo bay. We note that while the K.T. Safety Act applies primarily to passenger vehicles, the state regulations apply only to vehicles used for commercial purposes. However, we note that some commercial vehicles may be encompassed by the proposed regulations, and that issues of Federal preemption could apply. This is discussed in more detail in Section IX.

III. Advance Notice of Proposed Rulemaking

The ANPRM set forth the agency's analysis of the crash data and safety problem, our research progress, and ideas for possible proposals.[32] Specifically, the ANPRM reiterated some previous findings on backover statistics, presented research findings on the effectiveness of various countermeasures, and outlined options for improving rear visibility including: Improved direct vision (*i.e.,* looking directly out the vehicle's rear window) or indirect vision via rear-mounted convex mirrors, rearview video systems, and rear object detection sensors. The notice also set forth three approaches to defining the scope of the applicability of the enhancements to FMVSS No. 111 being contemplated by the agency. The approaches included requiring a rear visibility countermeasure on all light vehicles, only LTVs, or just a portion of the fleet as determined using a rear blind zone area threshold. Such a threshold would indicate what size of area behind the vehicle in which a driver cannot see obstacles is too large based on an associated high rate of backing or backover crashes. Several approaches for developing a threshold were provided, including a vehicle type approach and multiple implementations of a rear blind zone area threshold approach. Finally, the ANPRM sought responses to approximately forty-three specific questions addressing the feasibility and performance of various technologies, technology cost, and requesting feedback on NHTSA's ideas about possible approaches for countermeasure application throughout all or a portion of the fleet. Sections A through D of this section summarize the information presented and the subsequent sections summarize the comments received.

A. Technologies To Mitigate Backover Crashes

Systems to aid drivers in performing backing maneuvers have been available for nearly two decades. To date, original equipment systems have been marketed as a convenience feature or "parking aid" for which the vehicle owner's manual often contains language denoting sensor performance limitations with respect to detecting children or small moving objects. Aftermarket systems, however, are often marketed as safety devices for warning drivers of the presence of small children behind the vehicle.

Since the early 1990s, NHTSA has actively researched approaches to mitigate backing crashes with pedestrians for heavy and light vehicles by assessing the effectiveness of various backing aid technologies. In addition to sensor-based rear object detection systems, the agency has evaluated rear-mounted convex mirrors and rearview video systems. To date, our evaluation and testing results indicate that rearview video systems not only offer drivers the most comprehensive view behind a vehicle but drivers seem to use them more effectively in avoiding a conflict situation with a pedestrian when compared to additional mirrors and sensors. The following paragraphs provide a summary of the information presented in the ANPRM describing each of the system types assessed by NHTSA to date and our observations on how they could be used to improve the rear visibility of current vehicles.

i. Rear-Mounted Convex Mirrors

Rear-mounted convex mirrors are mirrors with a curved reflective surface that can be mounted internal or external to the vehicle. Their design is such that they compress a reflected image to provide a wider field of view than planar (*i.e.,* flat) mirrors. When used on vehicles, the mirrors may be mounted at the rear to allow a driver to see areas behind the vehicle. A single rear-mounted mirror can be mounted at the upper center of the rear window with the reflective surface pointing at the ground (commonly referred to as backing mirrors, under mirrors, or "look-down" mirrors) or at the driver's side on the upper corner of the vehicle

[28] Section 15.3.5 of ECE R46–02, Uniform Provisions Concerning the Approval of: Devices for Indirect Vision and of Motor Vehicles with Regard to the Installation of these Devices, (August 7, 2008).

[29] Japanese Safety Regulation Article 44 and attachments 79–81.

[30] Vehicles manufactured for the Japanese market are right-hand drive.

[31] 74 FR 9480.

[32] 74 FR 9478, [Docket No. NHTSA–2009–0041].

(commonly seen on delivery vans or mail delivery trucks and called "corner mirrors") to show the area behind the vehicle. Both look-down and corner convex mirrors are typically positioned to show a portion of the rear of the vehicle to give drivers a visual reference point. Alternatively, rear convex "cross-view" mirrors pairs can be integrated into the inside face of both rearmost pillars or attached to the rear glass to show objects approaching on a perpendicular path behind the vehicle to aid a driver when backing into a right-of-way. While cross-view mirrors are available for passenger cars and LTVs, rear convex look-down and corner mirrors can only be mounted on vehicles with a vertical rear window, such as vans and SUVs. Rear-mounted convex mirrors are primarily available as aftermarket products in the U.S., but are also available as original equipment on at least one multipurpose passenger vehicle.[33] In Korea and Japan, rear-mounted convex mirrors are used on small school buses, short delivery trucks, and some multipurpose vehicles (*e.g.,* SUVs) to allow drivers to view areas behind a vehicle.

Generally, drivers use rear-mounted convex look-down mirrors to view the area behind a vehicle by looking directly at the mirror or by viewing them indirectly through their reflection in the interior rearview mirror. Cross-view mirrors also may be viewed either directly or indirectly through the interior rearview mirror. For a rear convex corner mirror, which is not in the driver's direct line of sight, he or she must look into the driver's side rearview mirror to view the reflection of the rear convex corner mirror.

In the ANPRM, NHTSA outlined its observations about these mirrors based on our testing conducted in 2006 and 2007.[34] [35] The fields of view for look-down mirrors examined were found to extend from the rear bumper out approximately 6 feet radially from the mirror location, while the view provided by cross-view mirrors extended further due to the mirrors' vertical orientation. Overall, our testing generally indicated that convex mirrors compress and distort the image of reflected objects in their field of view, which makes objects and pedestrians appear very narrow and difficult for the driver to discern and identify in most locations within the reflected image. These aspects of image quality worsen as the length of the vehicle increases, since for longer vehicles the mirror is further from the driver. Our testing also has indicated that because rear cross-view mirrors are positioned to show an area to the side and rear of the vehicle, they do not provide a good view of the area directly behind the vehicle (the area bounded by two imaginary planes tangent to the sides of the vehicle). As such, it is possible that a pedestrian or object located directly behind the vehicle would not be visible to the driver. Rear cross-view mirrors can help drivers see objects approaching the rear of the vehicle along a perpendicular path.

ii. Rearview Video Systems

Rearview video systems are available as both original and aftermarket equipment and permit a driver to see the area directly behind the vehicle via a visual display (*i.e.,* video screen) showing the image from a video camera mounted on the rear of the vehicle. NHTSA has observed the placement of these visual displays in a number of locations. Sometimes these displays serve the added purpose of providing a visual display for a navigation system or satellite radio. As stand-alone units, these displays have also been incorporated into the dash or into the interior rearview mirror. The video cameras installed with rearview video systems vary in field of view performance from approximately 130 to 180 degrees behind the vehicle.

Drivers use rearview video systems as an additional source of visual information complementing the views provide by the interior and exterior rearview mirrors. In a 2008 report [36] that documented NHTSA's research on drivers' use of rearview video systems, the agency asserted that proper use of a rearview video system by a driver would entail drivers beginning to back only when the rearview video system display image becomes visible and the driver has looked at the image, and that drivers should look at the display as well as the vehicle's mirrors periodically during backing rather than just taking one glance at the display at the start of the maneuver.

In the ANPRM, NHTSA summarized its 2006 research that examined three rearview video systems: One in combination with original equipment rear parking sensors, one aftermarket system combining both rearview video and parking sensor technologies, and one original equipment rearview video system.[37] [38] This examination of rearview video systems included assessment of their fields of view and their potential to provide drivers with information about obstacles behind the vehicle. Through this study, the agency observed that the rearview video systems examined provided a clear image of the area behind the vehicle in daylight and indoor lighting conditions. Rearview video systems displayed images of pedestrians or obstacles behind the vehicle to a viewable range of 23 feet or more, except for an area within 8–12 inches of the rear bumper at ground level. Systems displayed an area as wide as the rear bumper at the immediate rear of the vehicle and the view increasingly widened further out from the rear of the vehicle as a function of the video camera's viewing angle.

iii. Sensor-Based Rear Object Detection Systems

Sensor-based object detection systems are also available as aftermarket products and as original equipment. These systems use electronic sensors that transmit a signal which, if an obstacle is present in a sensor's detection field, reflects the signal back to the sensor producing a positive "detection" of the obstacle. These sensors detect objects in the vicinity of a vehicle at varying ranges depending on the technology. To date, commercially-available object detection systems have utilized short-range ultrasonic technology or longer range radar technology, although advanced infrared sensors are under development as well. Ultrasonic sensors inherently have detection performance that varies as a function of the degree of sonic reflectivity of the obstacle surface. For example, objects with a smooth surface such as plastic or metal reflect well, whereas objects with a textured surface, such as clothing, do not reflect very well. Radar sensors, which among other things can detect the water in a human's body, are better able to detect pedestrians overall, but demonstrate inconsistent detection performance for small children.

In 2006, NHTSA evaluated the object detection performance of eight sensor-

[33] Rear-mounted convex mirrors have been available on the Toyota 4Runner base model vehicle since model year 2003.

[34] 74 FR 9486.

[35] The research studies and the observations are documented in "The Ability of Rear-Mounted Convex Mirrors to Improve Rear Visibility," Enhanced Safety of Vehicles Conference 2009, Paper Number 09–0558. Since the ANPRM, NHTSA has conducted additional testing on drivers' use of rear-mounted convex mirrors, the findings of which will be discussed later in this document.

[36] Mazzae, E. N., Barickman, F. S., Baldwin, G. H. S., and Ranney, T. A. (2008). On-Road Study of Drivers' Use of Rearview Video Systems (ORSDURVS). National Highway Traffic Safety Administration, DOT 811 024.

[37] 74 FR 9490.

[38] Mazzae, E.N. and Garrott, W.R., Experimental Evaluation of the Performance of Available Backover Prevention Technologies, NHTSA Technical Report No. DOT HS 810 634, September 2006.

based original equipment and aftermarket rear parking systems.[39] Measurements included static field of view (*i.e.,* both the vehicle and test objects were static), static field of view repeatability, and dynamic detection range for different laterally moving test objects, including adult and child pedestrians. Both ultrasonic and radar sensor-based systems tested were generally inconsistent and unreliable in detecting pedestrians, particularly children, located behind the vehicle. Testing showed that, in most cases, pedestrian size affected detection performance, as adults elicited better detection response than 1- or 3-year-old children. Specifically, each system could generally detect a moving adult pedestrian (or other objects) behind a stationary vehicle; however, each system exhibited difficulty in detecting moving children. The sensor-based systems tested exhibited some degree of variability in their detection performance and patterns. Five of eight systems tested were found to exhibit maximum system response times that exceeded the 0.35 second limit set forth by the performance requirements of the International Organization for Standards (ISO) International Standard 17386[40]. NHTSA is aware that the performance of current sensor based systems can be influenced by the algorithms that are used for detection and that these systems, to date, have likely not been optimized for the detection of small children.

iv. Multi-Technology (Sensor + Video Camera) Systems

Multi-technology systems, as the term is used here, refer to the situation of more than one backing aid technology being present on a vehicle. Historically, multi-technology backing aid systems have consisted of a rearview video and sensor-based technologies being both present on the vehicle, but functioning independently of each other. Recently, integrated systems have become commercially available that use data from rear object detection sensors to provide added convenience through presentation of obstacle warnings superimposed on the rearview video system image.

It would seem reasonable to posit that such a combination system should have improved effectiveness over either technology alone. With a combined system, the sensor-based alerts could compensate for the passive rearview video technology by stimulating the driver to apply the brakes and glance at the rearview video system display to confirm the presence of an obstacle behind the vehicle (and inform the driver that the warning was not a false alarm). The intervention of the sensor-based warning should draw the driver's attention to the presence of a rear obstacle, rather than relying on the driver to look at the rearview video system display at the right moment when the obstacle is apparent.

However, this hypothesis has not proven correct. NHTSA's research to date has shown that the combination of rearview video and sensor technologies to be less effective in aiding drivers to avoid a backing crash than rearview video alone.[41] In laboratory testing of multi-technology systems' ability to detect different types of objects without interaction from a driver,[42] NHTSA found the performance of the combined technologies in detecting or displaying rear obstacles to be no better than that observed in the testing of those technologies as single-technology systems. As was the case with sensor-only systems, the sensor function of multi-technology systems have been shown to perform poorly and sporadically in detecting small children, while the rearview video component accurately displays rear obstacles located within the video camera's field of view.

v. Other Technologies

NHTSA is aware of two additional sensor technologies currently under development by manufacturers that may, one day, be used to improve a vehicle's rear visibility. The technologies include infrared-based object detection systems and video-based object recognition systems. As with other sensor systems, infrared-based systems emit a signal, which if an object is within its detection range, will bounce back and be detected by a receiver. Rear object detection via video camera uses real-time processing of the video image to identify obstacles behind the vehicle and then alert the driver of their presence. While these technology applications may eventually prove viable, because of their early stages of development and current unavailability as a production product, it is not possible at this time to assess their ability to effectively expand the visible area behind a vehicle. Also, it is anticipated that systems using such advanced technologies will not be available on vehicles for some time and will likely be more expensive than today's systems.

In addition, NHTSA has recently completed cooperative research with the Virginia Tech Transportation Institute and General Motors (GM) on Advanced Collision Avoidance Technology relating to backing incidents. The research focused on assessing the ability of more advanced technologies to mitigate backing crashes and refining a tool to assess the potential safety benefit of these prototype technologies. NHTSA expects to publish the findings of this particular research effort by the end of 2010.

B. Approaches for Improving Vehicles' Rear Visibility

In the ANPRM, NHSTA outlined three approaches that could be used to determine which vehicles would need a rear visibility countermeasure application to meet the requirements of the K. T. Safety Act:[43]

- Require improved rear visibility for all vehicles weighing 10,000 pounds or less.
- Require improved rear visibility for LTVs weighing 10,000 pounds or less.
- Require improved rear visibility for some vehicles weighing 10,000 pounds or less that do not meet a minimum rear visibility performance threshold.

The first approach would require that all vehicles have improved rear visibility sufficient to allow the driver to see a pedestrian in a specified zone behind the vehicle. The size of the zone would have a direct impact on the likely means a manufacturer could use to meet the rear visibility requirements.

The second approach would specify that all LTVs, as a vehicle class, should be required to have improved rear visibility. Crash data show that while multiple types of passenger vehicles (cars, multipurpose utility vehicles, trucks, and vans, but not LSVs and small buses) are involved in backover crashes, LTVs are statistically overrepresented in backover crash fatalities. Therefore, this alternative approach would target the class of vehicles which are disproportionately

[39] Mazzae, E.N. and Garrott, W.R., Experimental Evaluation of the Performance of Available Backover Prevention Technologies, NHTSA Technical Report No. DOT HS 810 634, September 2006.

[40] ISO 17386:2004 Transport information and control systems—Manoeuvring Aids for Low Speed Operation (MALSO)—Performance requirements and test procedures. This standard applies to object detection devices that provide information to the driver regarding the distance to an obstacle during low-speed operation.

[41] Mazzae, E. N., Barickman, F. S., Baldwin, G. H. S., and Ranney, T. A. (2008). On-Road Study of Drivers' Use of Rearview Video Systems (ORSDURVS). National Highway Traffic Safety Administration, DOT 811 024.

[42] Mazzae, E.N. and Garrott, W.R., Experimental Evaluation of the Performance of Available Backover Prevention Technologies, NHTSA Technical Report No. DOT HS 810 634, September 2006.

[43] 74 FR 9504.

responsible for the largest portion of backover fatalities.

A third approach discussed in the ANPRM was to establish a maximum direct-view rear blind zone area limit based on size of blind zone and/or crash rate.[44] With this approach, any vehicle not meeting the minimum rear visibility threshold would be required to be equipped with a rear visibility countermeasure. Because vehicle styling engineers would have a target threshold giving them an idea of minimum "acceptable" direct rear visibility, such an approach would allow manufacturers the flexibility to modify exterior structural physical attributes of a vehicle that impact rear visibility to provide adequate rear visibility without the need for a technological countermeasure to enhance rear visibility. Based on direct-view blind zone area measurements of the current fleet, we could determine a threshold and require vehicles that do not meet the threshold to be equipped with a countermeasure. Thus, the agency suggested that it could focus application on improved rear visibility requirements for vehicles with the largest rear blind zone areas and those vehicles that are most involved in backing and backover crashes. The goal of either of these partial-fleet approaches would be to remove the unreasonable risk associated with vehicles that are highly involved in backover crashes.

C. Rear Visibility Measurement

The ANPRM also discussed a method for the measurement of a vehicle's rear blind zone area.[45] If a maximum direct-view rear blind zone area threshold were to be used to establish the need for a vehicle to have improved rear visibility, its rear visibility characteristics would need to be measured and that vehicle's direct-view rear visibility and rear blind zone areas would need to be calculated. Therefore, a rear visibility measurement procedure would need to be developed. In the ANPRM, the agency identified existing measurement procedures, such as those by the Society of Automotive Engineers[46] and Consumers Union[47] and addressed advantages and disadvantages of the different identified methods. The ANPRM summarized NHTSA's 2007 effort to measure rear visibility of a set of vehicles using drivers and outlined the potential for variability inherent in tests involving human subjects.[48] Lastly, the ANPRM introduced a new measurement procedure developed by NHTSA that replaced the human driver previously used in rear visibility measurements with a laser-based fixture.[49] The enhanced procedure approximated the direct rear visibility of a vehicle for a 50th percentile male driver using a fixture that incorporated two laser pointing devices to simulate a driver's line of sight. One laser pointing device was positioned at the midpoint of a 50th percentile male's eyes when looking rearward over his left shoulder and the other device was placed at the midpoint of a 50th percentile male's eyes when looking rearward over his right shoulder during backing. Data documenting the high degree of repeatability of this test procedure were provided, as well as sample results. Additional aspects of the measurement procedure were summarized including size of the field over which measurements were made, coarseness of the test grid, and test object height.

D. Possible Countermeasure Performance Specifications

The ANPRM also discussed possible countermeasure performance specifications.[50] This included possible areas of required countermeasure coverage behind the vehicle, as well as various characteristics of a visual display, and system performance criteria. Visual display characteristics noted as being important included display size and location, response time, and various aspects of image quality for a video image display. In addition, possible video camera requirements were also noted, such as low light performance specifications.

The ANPRM discussed one basis for assertion of an appropriate countermeasure coverage area that used the results of a Monte Carlo simulation that examined backover crash risk as a function of a pedestrian's location behind a vehicle, as discussed in Section II.C.iv.[51] The area of critical risk was then used to define an area behind a vehicle that must be visible to the driver during a backing maneuver. Based on the Monte Carlo simulation results, an area over which the test object should be visible could be defined to include an area 10 feet wide at the vehicle's rear bumper that widens symmetrically to width of 20 feet at a distance of approximately 6 feet aft of the rear bumper. The width of the area increased along diagonal lines of 45 degrees with respect to the vertical plane of the vehicle's rear bumper and extending outward from the vehicle's rear corners. The maximum longitudinal range of a possible required visible area noted in the ANPRM was 40 feet.

E. Summary of Comments Received

NHTSA received comments from a total of 37 entities in response to the ANPRM, as well as one comment specifically directed at the Preliminary Regulatory Impact Analysis. These comments came from industry associations, automotive and equipment manufacturers, safety advocacy organizations, and individuals. Industry associations submitting comments included the Alliance of Automotive Manufacturers (AAM), the Association of International Automobile Manufacturers (AIAM), the Automotive Occupant Restraints Council (AORC), and the Motor & Equipment Manufacturers Association (MEMA). Vehicle manufacturers submitting comments included Ford, General Motors (GM), Honda, Mercedes-Benz USA, and Nissan, as well as Blue Bird, a manufacturer of buses. Several equipment manufacturers also submitted comments, including Continental, Delphi, Gentex, Magna, Sony, and Takata. Several companies focused on backing aid products specifically, included Ackton, a manufacturer of automotive parking sensors; Echomaster Obstacle Detection Technologies; Rosco Vision Systems, a maker of vision enhancement systems; and Sense Technologies, a manufacturer of aftermarket automotive mirror and radar-based sensor systems. Organizations submitting comments included the Advocates for Highway and Auto Safety, Consumers Union, Insurance Institute for Highway Safety (IIHS), and Kids and Cars. Finally, 14 individuals commented on the ANPRM, and their points and suggestions are addressed as well.

Because the ANPRM had an extremely broad scope, the comments addressed an extremely wide variety of issues and provided a large amount of information. Therefore, we have attempted to organize the comments received along some of the main issues, such as a blind zone area basis for determination of countermeasure need, countermeasure application based on vehicle type, and the adoption of convex driver's-side mirrors. Additionally, the ANPRM contained 43

[44] 74 FR 9504.

[45] 74 FR 9506.

[46] Society of Automotive Engineers, Surface Vehicle Recommended Practice: Describing and Measuring the Driver's Field of View. SAE J1050, Jan. 2003.

[47] Consumer Reports (August, 2006). Blind-zone measurements. *http://www.consumerreports.org/cro/cars/car-safety/car-safety-reviews/mind-that-blind-spot-1005/overview/*. Accessed 9/2/2009.

[48] 74 FR 9496.

[49] 74 FR 9507.

[50] 74 FR 9512.

[51] 74 FR 9484.

distinct questions, to which some commenters added appendices addressing individual questions specifically, in addition to their general comments. Because of the breadth of those questions, they are addressed separately in Section F below.

i. Measurement of Rear Blind Zone Area and Its Use as a Basis for Determination of Countermeasure Need

Numerous commenters addressed the issue of direct visibility and the significance of a vehicle's blind zone.[52] As stated above, identifying, measuring, and limiting blind zones was one of the issues discussed in the ANPRM. The document solicited comments on several issues relating to blind zones, including their significance relative to backover crashes, areas of the blind zone that could be considered more or less important for safety, and how they should be measured. The following summarizes the comments received on these issues.

The first issue related to the area to be measured to determine a vehicle's blind zone. Delphi questioned the use of a 50-foot square blind zone area, stating that it combined high- and low-risk areas together. It also stated that mandating particular blind zones or direct visibility requirements could impose severe limitations on vehicle styling. Furthermore, the commenter suggested that a maximum blind zone area approach to rear visibility may not be as effective in reducing backover crashes as hoped under real-world conditions, as passengers, head restraints, cargo, *etc.,* would obstruct the driver's direct view to the rear of the visibility in any event.

AORC stated that it was against a "zero blind zone" requirement, arguing that it would create an extremely limiting requirement vehicle styling. To this end, the AORC recommended that a rear visibility countermeasure should be required to detect the presence of objects that are similar to standing children beginning 0.25 meters (0.82 ft) aft of the rear bumper and extending outward to a minimum of 3.0 meters (9.84 ft). IIHS strongly urged the agency to consider a requirement that would eliminate a vehicle's rear blind zone entirely. IIHS further suggested that it could be a good idea to augment an improved rear visibility requirement with a minimum requirement for direct visibility, stating that it is desirable to preclude vehicle design choices that result unnecessarily small directly viewable rear areas, to account for situations when video cameras are inoperative.

In its comments, the AAM recommended that NHTSA define the area directly behind the vehicle into two zones, called the "reaction subzone" and the "reverse obscuration subzone." The AAM defined the reaction subzone as extending from the rear of the vehicle to a point 4.1 meters rearward. According to the AAM, this distance is "the product of the average backing speed of 1.66 meters per second (5.49 feet per second) and the mean perception response time between detection by a driver of a pedestrian and brake application of 2.5 seconds." The reverse obscuration subzone, behind that, extends to the point at which a test object (representative of an 18-month old child) first becomes visible in the interior mirror, which would vary by vehicle. The AAM did not specifically recommend what to require with regard to these zones.

Several commenters provided suggestions as to how to measure the blind zone, specifically, the height of the test target, and the position of the driver's "eyepoint" from which the target must be seen. In order to determine the size of the target, GM analyzed the age and height of children involved in backover crashes, noting that of the 41 SCI cases available at that time that involving children under 5 years old, 33 involved children 18 months and older. Based on that information, GM suggested that a height of 32 inches for any rear visibility test target would be justified, which it stated was the 50th percentile height of an 18-month-old child. GM stated that all the victims in the first 56 SCI backover cases would have been visible if the vehicle had permitted the driver to see the area at this height.

Blue Bird stated that field of view mapping is a time and effort-consuming enterprise, and that the company does not believe that the magnitude of the differences measured at multiple eyepoints would justify that effort. Instead, it stated that a single eyepoint should be used.

Kids and Cars stated that eyepoints should be based on smaller statured persons or dummies, and that NHTSA should not use eyepoints based on a 95th percentile male. With similar concern for smaller-statured drivers, Advocates for Highway and Auto Safety indicated their concern that any attempt to expand rear visibility through improvements to direct visibility may not sufficiently accommodate 5th percentile females and other drivers of very small stature.

Sony stated that NHTSA cannot satisfy the requirements of the Act solely by mandating limits on vehicle rear blind zones, since such an approach would only mitigate a portion of the total area of blind zones, and would do little to mitigate the ultimate danger of backover crashes.

In addition, numerous commenters provided more detail in response to specific NHTSA questions, which are discussed in Section F below.

ii. Application of Countermeasures Among Vehicle Types

One significant issue discussed in the ANPRM was the concept that different types of vehicles could be subject to different countermeasure requirements. For example, noting the higher proportion of fatalities in backover crashes involving LTVs, the agency presented the option of requiring only those vehicles to have a rear visibility countermeasure. Many commenters offered their thoughts on which vehicles should be equipped with countermeasures.

Sony commented that the Act permits NHTSA to "prescribe different requirements for different types of motor vehicles," but does not permit a total or partial exemption of a particular class of vehicles, or a percentage of a particular class of vehicles, from rear visibility requirements. Sony further stated that limiting the rear blind zone visibility requirements to LTVs ignores the fact that passenger cars account for 26 percent of backover deaths and 54 percent of backover injuries, and that these percentages will likely increase given the relative decline of LTV sales across the market. They also pointed out that the line between passenger cars and LTVs has blurred to the point where the weight and/or height of a particular vehicle does not necessarily correspond to rear visibility.

Safety organizations generally commented against limiting countermeasures to certain vehicle types. Kids and Cars stated that all vehicles must be addressed in order to prevent backover injuries and fatalities, stating that even one car with a large blind zone should indicate the need for the regulation to cover all vehicle types. Similarly, IIHS and Consumers Union both supported uniform requirements across light vehicle classes.

Some equipment manufacturers of rear visibility enhancement products also submitted comments recommending that rear visibility countermeasures not be limited to certain vehicle types, but be applied to

[52] We note that this is different than what many informally call a "blind spot," a term used to describe an area to the side of the car where people may not be able to see a vehicle when changing lanes.

all vehicles. Delphi and Magna stated that it believes the backover problem is widespread enough that countermeasures should not be limited to any particular class of vehicles. Similarly, Ackton suggested that countermeasures should not be limited to a certain vehicle class and also raised the issue that trailers should be equipped with sensor systems as well.

Several automakers commented in favor of limiting any rear visibility improvement to LTVs. Mercedes suggested that if the agency believes that advanced countermeasures are required for the portion of the vehicle fleet that is statistically overrepresented in backover crashes (*i.e.,* LTVs), then NHTSA should require those countermeasures only for those types of vehicles. Mercedes stated that those advanced countermeasures are particularly well-suited for higher-belt-line vehicles, and that the limitation would make the requirement more cost-effective. Honda also commented that rear visibility performance requirements should be instituted for only those vehicles with the highest rates of backover incidents, although it also suggested that NHTSA should actively monitor the data for all vehicle types so that it can consider broader application of the requirements based on the safety need.

Automakers Nissan and GM both recommended that a maximum blind zone area approach be used to determine whether a vehicle warrants improved rear visibility rather than applying the new requirements by vehicle type.

NHTSA received one comment, from Blue Bird, asserting that buses should not be subject to improved rear visibility requirements. First, Blue Bird noted that the backover statistics presented by NHTSA did not show any apparent backover crashes caused by buses. Second, it stated that most drivers of buses are required to obtain commercial driver licenses (CDLs), and that these drivers are subjected to additional training, limiting the chances of backover crashes. The company also stated that mirrors, in any of several configurations, would not be able to provide an adequate field of view to the rear of a bus, and would present exceptional mounting difficulties. Additionally, because many buses (such as school buses) are not equipped with navigation screens, the costs for installing rearview video systems in these vehicles would be higher than the average for passenger vehicles.

iii. Use and Efficacy of Rear-Mounted Mirror Systems and Convex Driver's-Side Mirrors

In the ANPRM, NHTSA presented data on the ability of mirrors to display usable images of the area behind a vehicle.[53] Several commenters provided information and opinions regarding mirrors. Furthermore, several manufacturers suggested that, due to the geometry of a number of backover scenarios analyzed, convex driver's-side mirrors could be an effective way to prevent backover crashes. We have summarized these comments below.

Several commenters, including Consumers Union, Kids and Cars, IIHS, Blue Bird, Magna, and Nissan agreed with NHTSA's preliminary evaluation of rear-mounted mirror systems in Section V of the ANPRM, stating that they are generally not useful in aiding a driver of a backing vehicle to visually detect pedestrians, particularly children, located behind the vehicle. Based on the information presented in the ANPRM, the Advocates for Highway and Auto Safety concluded that the coverage provided by rear-mounted convex mirrors is inadequate for the purpose of providing drivers with a sufficient rearward field of view to identify pedestrians and avoid backover crashes.

According to the AAM and other commenters, rear-mounted convex mirrors are installed as backing/parking aids to help the driver locate fixed objects behind and near the rear bumper.

One commenter, Sense Technologies, which manufactures rear cross-view mirrors, suggested that NHTSA perform additional research into the types of backover crashes and backing crashes that could be prevented with rear-mounted cross-view mirrors, which would enable drivers of vehicles to see objects approaching from the sides of a vehicle, which are frequently obscured in parking lots. It also suggested that cross-view mirrors could be mounted on the rear of passenger cars (unlike "look down" mirrors, which are usually only mounted on LTVs).

One issue mentioned by multiple commenters concerned the European standard for mirror performance, ECE R46. Several commenters suggested that replacing the side mirror requirement currently in FMVSS No. 111 with the convex driver's-side mirror specifications in ECE R46 would help drivers be better able to detect pedestrians before they enter the path of the vehicle, if they are approaching from the sides. We note that ECE R46 allows either flat or convex driver's-side mirrors, provided they meet the minimum field of view requirements. It was unclear to the agency whether some commenters were suggesting mandating convex mirrors (and disallowing current flat mirrors) or simply allow convex mirrors as an option.

The AAM recommended adopting ECE R46 convex driver's-side mirror requirements as a means to prevent a substantial number of backover crashes. It pointed to a number of purported benefits, such as an increase in viewing coverage, reduced glare, and driver preference for non-planar mirrors. Like other commenters, the AAM also discussed NHTSA's data that showed that a number of backover crashes resulted from side incursions. They stated that convex side mirrors could help the driver see these pedestrians earlier than flat mirrors. The AAM also cited research indicating that these mirrors would provide a 22.9 percent reduction in lane change crashes.

Mercedes commented that, given that many SCI cases indicated the children struck by backing vehicles moved into the path of the vehicle from either the left or right, it supported AAM's recommendation to adopt ECE R46 requirements for convex driver's-side exterior mirrors, as they substantially increase the driver's field of view to the sides and rear of a given vehicle, thus increasing the time that a moving pedestrian will be visible in the mirror and providing greater opportunity for the driver to detect them.

Regarding convex mirrors, Advocates for Highway and Auto Safety agreed that they may provide a wider field of view than that available with current rearview mirrors. However, they pointed out that convex mirrors may require drivers, even those with experience using convex mirrors, to interpret the altered view in order to understand precisely what is being conveyed regarding pedestrians and other objects present in the vehicle path.

iv. Use of Monte Carlo Simulation of Backover Crash Risk for Development of a Required Countermeasure Coverage Area

GM raised some questions about the Monte Carlo simulation presented in the ANPRM, which calculated the backover risk for pedestrians as a function of their location relative to a backing vehicle. GM noted that while the Monte Carlo simulation calculated the risk of a backing vehicle striking a pedestrian at certain locations behind the vehicle, it did not factor in the probability that the pedestrian would actually be located in

[53] 74 FR 9486.

that spot (*e.g.,* even though a child six inches from the rear edge of the vehicle is almost certain to be hit, the chance of the child being actually located there is comparatively low). Considering that, according to GM's analysis, the areas indicated as high-risk in the Monte Carlo simulation may not correlate particularly well with the overall backover crash risk.

On the other hand, Consumers Union praised the Monte Carlo simulation, and suggested using it as the basis for determining what a rearview video system should be able to detect, recommending that it detect any area where the risk factor was 0.10 or higher in that analysis.

v. Use and Efficacy of Sensor-Based Systems

The issue of the use and efficacy of sensor systems, that is, how they are designed and how well they function to prevent backovers was discussed by many commenters. These comments addressed three main issues. The first was the purpose for which sensors are currently designed, which are as parking aids, rather than backover prevention aids. Commenters also discussed the capabilities of sensors to detect various obstacles, as well as the cost of production and implementation, and provided recommendations for test objects. We have summarized the comments below.

One major issue addressed by numerous commenters was the assertion that NHTSA's analysis relating to sensor system effectiveness was flawed. Commenters felt that by testing currently available sensors, we were testing systems that were designed to detect large, dense or highly reflective, stationary objects (such as parked cars, walls, *etc.*) rather than smaller, lighter, and mobile objects like pedestrians. Because of this discrepancy, commenters suggested that NHTSA's testing of sensors may have led to artificially low estimates of system effectiveness.

Delphi questioned whether NHTSA's effectiveness numbers were accurate. The company stated that NHTSA's analysis of sensor effectiveness, which showed that sensor systems had a 39 percent detection rate and that a combination sensor/video system had a 15 percent driver performance result, should be used carefully because the sensors were not designed to detect children. Instead, Delphi stated that current OEM sensor systems are designed to the ISO 17386 standard,[54] which asserts performance requirements for object detection devices that provide information to the driver regarding the distance to an obstacle during low-speed operation. This ISO standard specifies a PVC cylinder for use in measuring systems' detection performance, and does not require the detection of objects low to the ground so that systems are permitted to avoid detecting curbs.

Delphi also provided extensive comments regarding sensor-based systems in terms of their abilities and how they may best be used. It suggested that sensors are an important addition to rearview video systems, as drivers need prompting in order to glance at the screen when an obstruction appears. The company also suggested that a sensor system with varying warnings, dependent on the calculated time-to-collision, could provide drivers with additional information that could be used to prevent backover crashes. Delphi stated that radar sensors are more efficient at detecting children than ultrasonic sensors, and can detect targets at greater ranges. With regard to test targets for sensor systems, it commented that any test target should be chosen to provide a minimum reflectivity that is representative of the smallest required detectable object (*e.g.,* 1-year-old child).

Ackton was another company that noted that current sensors are designed to the ISO 17386 standard, and are not designed to detect children. It stated that until there is a pedestrian-detection standard, many systems will not be designed to pass it, and will therefore fail to detect pedestrians. Sony also stated that current sensors are designed as parking aids and are optimized to detect hard surface objects, but that technical advances may improve the ability of such systems to detect non-occupant pedestrians.

Ackton also commented that its "New-Gen" ultrasonic technology can detect a 36-inch child at a distance of 15 feet. Along similar lines, Magna commented on two future technologies discussed in the ANPRM, infrared and video-based object recognition systems. Magna stated that these systems were in active development, and would be ready for production by 2011.

Continental commented that in the future advanced systems may be developed that respond automatically with automatic braking to avoid a backing crash without any action from the driver. It stated that in the future, systems will be able to recognize pedestrians that are in danger of being struck and automatically intervene to prevent that from happening. Continental gave no indication of the timeframe for availability of such technology.

IIHS stated that the combination of sensors' unreliability and drivers' slow and inconsistent reactions to audible warnings suggest that requiring, or even allowing, sensors in lieu of a visual backover countermeasure systems is not advisable at this time, although sensors could augment other technologies. Kids and Cars and Magna also pointed to the audible signals from sensors as a source of annoyance to many drivers, especially given the prevalence of false positives, which caused many drivers to "tune out" the warnings. However, Magna stated that if the sensor warnings were provided visually (such as on a graphical overlay), drivers would be less prone to be irritated by them and therefore less likely to ignore them.

Advocates for Highway and Auto Safety suggested for sensor-based systems that the agency consider an interlock requirement that prohibits the vehicle from being able to be moved in reverse, even after the transmission has been placed in reverse gear, until a short period after the system becomes fully operational.

vi. Use and Efficacy of Rearview Video Systems

In the ANPRM, NHTSA presented its research on rearview video systems. Commenters discussed these systems at length. In summarizing these comments, we have divided them into two general groups. The first section describes the comments relating to the general effectiveness of rearview video systems in aiding drivers to avoid backing crashes. The subsequent section summarizes the comments relating to the specific possible requirements for rearview video systems, such as camera performance, visual display characteristics, *etc.*

Many commenters, including manufacturers of video cameras, safety organizations, and individual commenters, stated that rearview video systems would be the best system to prevent backover crashes. Commenters supporting this proposition included Consumers Union, Kids and Cars, IIHS, Magna, Nissan, and Sony.

Consumers Union also supported the application of rearview video systems, noting their potential to save lives, and also asserted that their efficacy would improve as users grew more accustomed to using them in their everyday driving.

[54] ISO 17386:2004 Transport information and control systems—Manoeuvring Aids for Low Speed Operation (MALSO)—Performance requirements and test procedures. This standard applies to object detection devices that provide information to the driver regarding the distance to an obstacle during low-speed operation.

It added that it believed a rearview video system coupled with a sensor system would be the overall best system. While Consumers Union referred to NHTSA's research study as involving drivers "trained" to use rearview video systems and the other systems tested, the agency notes that all drivers who participated in the study had owned and driven the system-equipped vehicle and had driven it as their primary vehicle for at least 6 months prior to study participation, but did not receive any specific training in the use of a rearview video system.

Advocates for Highway and Auto Safety pointed out that a video image of the area behind a vehicle immediately conveys information about rear obstacles and pedestrians within the system's field of view without any need for interpretation by the driver. This quality was noted as an advantage of rearview video systems over rear-mounted convex mirrors and sensor-based systems.

Magna stated that it believes camera technology has the potential to significantly enhance safety and that a rearview video system ranks highest by far, in regard to system performance and overall effectiveness estimates. In its responses to specific questions, Magna provided some additional research showing the overall effectiveness of rearview video systems in preventing backover crashes, which is discussed in Section F below.

Sony stated that it agrees with the majority of analysis provided and the preliminary conclusions reached observations made in the ANPRM. Specifically, Sony recommended that any amendment to FMVSS No. 111 should require backover prevention technologies to detect obstacles in areas other than immediately behind the vehicle. Sony stated that rearview video systems with 180-degree video cameras would be best able to address real-world backover crash scenarios, in which a majority of pedestrians enter the vehicle's path from the side.

Nissan provided some comments on its "Around View Monitor", which provides a birds-eye (*i.e.,* overhead) view of the area around the vehicle on all four sides. The company stated that their system was designed primarily as a parking aid, and that it will have significant limitations if used to protect children. Nissan stated that rearview video technology in general is a useful parking aid, but that its utility in preventing backover crashes may be limited, because drivers must be looking at the screen in order to see a pedestrian incur into their path. Nissan drew attention to the glance behavior cited in NHTSA's research, noting that on average drivers looked at the visual display twice, or about 8–12 percent of the time. It stated that this may not be enough to detect the pedestrian in time to react, even if the driver is using the rearview video system correctly, and that driver glance behavior has a significant effect on rearview video system effectiveness. Nissan also cautioned against excessive reliance on a video-based backing aid, cautioning that if a driver is relying excessively upon rearview enhancement technology, the operator can miss seeing a person or an object positioned just outside of that field of view. Nissan also stated that it is imperative that the operator always confirm clearance of the entire path of travel, and turn around and look during a backup maneuver.

The AAM made several comments similar to those of Nissan, stating that no safety countermeasure or safety technology is completely effective. AAM stated that regardless of the technology adopted to expand a driver's field of view, the driver is ultimately responsible for the safe operation of the vehicle. AAM characterized rear visibility enhancement systems as supplemental drivers with responsibility resting on drivers to use them properly.

GM stated that its analysis showed some limited benefits may be provided by rearview video technologies, but that potential solutions will continue to be limited by driver behavior. GM stated that it agrees with NHTSA that drivers' expectations influence behavior and system effectiveness, and that further improvements in the effectiveness of rearview video technologies may be achieved by improving feedback to the driver and improving driver behavior through education.

vii. Characteristics of Rearview Video Systems

NHTSA received numerous comments relating to the specific characteristics of rearview video systems. These related to issues of camera placement, durability, and performance, as well as visual display characteristics, such as location (*i.e.,* in the dashboard, or in the rearview mirror), brightness, and the functionality of the backing image. Commenters presented extensive comments on issues such as visual display size, whether digital graphical overlays should be used, and other characteristics related to these systems. IIHS noted that there was a wide range of performance by various current rearview video systems it examined and, based on this; expect that NHTSA will need to specify performance requirements to ensure a minimum level of performance for those systems.

Several commenters, including Consumers Union and Magna, recommended that NHTSA consider inclusion of graphic overlays as part of a video-based backover countermeasure, stating that this increases a driver's ability to detect obstacles, and makes the driver more likely to use the system.

NHTSA also requested comment regarding characteristics such as video camera angle, durability, and low-light performance, as well as contrast, image response and linger time, and display size and location. Commenters provided a wide array of suggestions.

IIHS stated that some rearview video systems are much more immune to weather and road dirt contamination than others, and recommended that NHTSA specify performance requirements to ensure that systems can withstand adverse conditions.

Sony offered an observation that while adverse weather conditions can affect rearview video system performance, cameras utilized in such applications are sealed in watertight housings and mounted at a downward angle, and therefore generally protected from the elements. Sony also commented on the number of backover incidents in which victims were struck after approaching from the side of the vehicle, stating that the incidence rate was 45 percent. It stated that this indicated that wide-angle rearview video systems would best prevent backover incidents.

Magna, on the other hand, commented that in order to assure overall system affordability across the widest possible range of vehicle types and models, NHTSA should not impose specific operational requirements on rearview video systems. It noted that "anti-wetting" and "anti-soiling" techniques are known and currently implemented despite the lack of a legislative mandate.

In its comments, Gentex stated that the interior rearview mirror is an ideal location for the rearview video system visual display. Gentex stated that that location is intuitive, logical, and ergonomic, and allows the driver to maintain a "head-up" position while viewing the display and the rearview mirror simultaneously. Furthermore, it noted that drivers are already trained to look in the interior rearview mirror when reversing. Magna also commented that the interior mirror is the best location for a rearview video system visual display, noting that the display in that location is much closer to the driver's eyes. However, Magna suggested that NHTSA not prescribe

specific requirements regarding display location, image size, or other requirements, as doing so may result in unintended restrictions on technology applications.

With regard to image size, commenters submitted a number of ideas for what a minimum visual display size should be. Gentex stated that it disagreed with NHTSA's suggestion that a minimum 3.25 inch screen size might be specified. Instead, they suggested a minimum viewable display height of 1.3 inches, based on its calculation of what the human visual system can generally resolve and the mean distance between the driver's eyes and the visual display. Ford also commented on NHTSA's minimum visual display size suggestion, stating that the GM research cited by NHTSA was not designed to assess system effectiveness as a function of visual display size since it only used one in-mirror display size, and in fact concluded that rear effectiveness was not affected by image size in the scenario used. Instead, Ford suggested that GM used a 3.5 inch screen in its study because it was offered as a regular production option, and that NHTSA's reliance on GM's research was inappropriate.

In lieu of the 3.5 inch minimum visual display size, Ford suggested that an Australian regulation on screen sizes for rear visibility systems (specifically, New South Wales' Technical Specification No. 149), could be used as a model. According to Ford's comment, this regulation states that when a 600 mm test cylinder is located five meters from the rear of the vehicle, the height on the screen should be no less than 0.5 percent of the distance between the driver's eye and the visual display. The company claimed that this technique has resulted in several iterations of a 2.4 inch screen size and that they have been readily accepted by consumers.

Magna, on the other hand, referred to studies by GM and the Virginia Tech Transportation Institute indicating that a 3.5 inch visual display, mounted in the interior rearview mirror, led to the highest crash avoidance rates.

Certain commenters focused on some of the other specifications of the visual display. Image response time, or the delay between when a vehicle is shifted into reverse and the rearview image from the video camera appears, was discussed extensively by Gentex. While NHTSA had suggested a maximum of 1.25 seconds for this value, Gentex recommended 3 seconds, based on its calculations of the time needed for signal transfer, powering the camera, and the complexity of the electronics. GM supported Gentex's comments on this matter.

Gentex made two additional recommendations with regard to visual displays in its comments. The company suggested a minimum brightness of 500 candelas per square meter (cd/m^2) for the screen, as well as a minimum contrast ratio of 10:1.

Consumers Union made a number of suggestions regarding displays for rearview video systems, including that there needs to be a minimum display size and that a maximum image response time of 1 second, and a maximum linger time between 4 and 8 seconds should be required. GM recommended a maximum linger time of 10 seconds or, as an alternative, a speed-based limit in which the rearview video display would turn off when the vehicle reach a speed of 5 mph (8 kph). Based on their observations of drivers making parking maneuvers, the AAM also recommended a maximum linger time of 10 seconds, but specified an alternative speed-based value of 20 kph (12.4 mph).

Ms. Susan Auriemma, of Kids and Cars, offered a personal testimony, stating that as a user of a rearview video system with an image response time of 2–3 seconds, there is a tendency to want to proceed to back the vehicle without waiting for the image to appear.

viii. Development of a Performance-Based or Technology-Neutral Standard

Numerous commenters suggested that any NHTSA standard be performance-based and technology-neutral. These commenters generally supported the idea that the blind zone must be limited to a certain size, or that certain areas behind the vehicle should be visible, but did not want NHTSA to prescribe how these areas should be detected. Instead, these commenters stated that allowing the manufacturer to determine the means by which the required area is detectable would promote styling flexibility, technological innovation, and help to contain costs.

MEMA stated that it supported a performance-based test, stating that "it is clear that there is no one solution to mitigating backover events." It also suggested that various countermeasures can be incorporated, whether complementary or separately, to promote increases in the rear field of view.

Delphi stated that there would be no reason to not grant compliance credits to vehicle manufacturers who choose any system, mirrors, sensors, or video, which detects the required areas behind a vehicle.

AIAM, in its comments, pointed out specific problems with all three countermeasure technologies, and then suggested that some of the issues would present a greater challenge for certain classes of vehicles. In light of that, it suggested that performance-based requirements would allow vehicle manufacturers to achieve the best match of technical approach for each of their vehicle models.

AORC stated that it believes that the regulation should allow for the enhancement of rear visibility via the implementation of rearview video systems or the use of sensor input. It stated that these systems should be subject to a pure performance requirement, and must able to detect children from a distance of 0.25–3.00 meters behind the vehicle.

Kids and Cars urged the agency to not only set the highest feasible rear visibility standard, but to also allow new innovative product designs that will evolve as technology matures.

ix. Other Issues Addressed in Comments

This section summarizes comments related to ancillary issues regarding rear visibility. For example, several commenters suggested that NHTSA design a performance rating system for rear visibility, issuing it in addition to, or in lieu of, a countermeasure performance requirement. Alternatively, suggestions for driver education proposals were made. Some commenters also discussed the rate at which any rear visibility standard be phased in.

Several commenters suggested that a performance rating system be developed, to provide consumers information about the rearward visibility characteristics of various vehicles. Delphi stated that a performance rating system would have the effect of giving consumers the necessary facts to purchase vehicles that offer the best choice of safety and value, and would encourage continued innovation in backover avoidance technology.

AORC suggested a performance rating system for rear visibility enhancement systems, similar to ones used in NHTSA's New Car Assessment Program, as it could give consumers information relating to vehicle purchase. This idea was also supported by Magna, which recommended a five-star Federal safety rating program.

The AAM recommended that NHTSA provide information to consumers about proper backing procedures, as well as the capabilities and limitations of rear visibility countermeasures.

Another remark by Kids and Cars member, Ms. Susan Auriemma, focused on "proper backing procedures." Specifically, the commenter stated that research is needed to define what proper use of a rearview video system is in terms of how often a driver should look at a rearview image, and whether a driver should also look directly behind the vehicle and at the mirrors. Ms. Auriemma also questioned whether the sample size used by NHTSA, 37 drivers, was large enough to make definitive conclusions regarding backing behavior and rearview video system use.

Several commenters requested that the phase-in period for rear visibility system requirements be extended beyond the four-year period mandated in the K.T. Safety Act. Honda stated that in addition to the cost of the systems, there could be considerable costs if major design changes are required before vehicles are scheduled for normal redesign. The company suggested that the costs could be substantially reduced if only one or two additional years are allowed for the phase-in schedule to coincide with existing redesign plans. AIAM also suggested a six-year phase-in schedule so that changes could be implemented in accordance with vehicle redesign schedules. It also stated that small volume and limited line manufacturers should be excluded from the visibility requirements until the end of the phase-in period is reached, due to reduced access to technologies and generally longer product life cycles compared to larger manufacturers.

One comment from Sony suggested that a mechanism to reduce costs would be to eliminate the U.S. import tariff on rearview video camera imports, which currently stand at 2.1 percent. Kids and Cars suggested that NHTSA also consider proposing a "forward visibility" standard to prevent "frontovers," stating that fatalities from such accidents have increased substantially in recent years.

Finally, NHTSA received several comments from individuals relating personal experiences involving backover crashes. One anonymous commenter, who had backed over their son, recommended that backup sensors and/or rearview video systems be put in all vehicles. Ms. Shannon Campbell described a personal backover experience with a "sport utility vehicle" (SUV), and stated that it is impossible for the driver to see behind the vehicle without a rearview video system. Similarly, Mr. Donald Hampton, whose granddaughter was involved in a backover with an SUV, recommended that every new vehicle have a rearview video system, stating that an add-on video camera kit costs around $100. Ms. Sharron DiMario, who son was involved in a backover with a minivan, recommended safety modifications to dramatically improve vehicle blind spots. Ms. Karena Caputo, who son was involved in a backover with a Hummer, stated that children cannot be seen behind vehicles, and that every vehicle should have some type of backup safety device. Ms. Andriann Raschdorf-Nelson, whose 16-month old son was involved in a backover with an SUV, simply applauded NHTSA's decision to make all vehicles safer for children. Ms. AnnMarie Bartlett-Pszybylski commented that she had installed a rearview video system on her vehicle after a backover incident involving her son. Mr. David Sarota requested that NHTSA promulgate a Federal regulation after witnessing a near-backover involving a small truck. Finally, Mr. Paul Faragher Anthony whose 23-month-old son was the victim of a near-fatal backover incident involving a van equipped with a rear-mounted convex mirror, which he stated "do nothing to improve the field of view downward, where a toddler is likely to be."

Kids and Cars discussed the specifics of backover crashes. It stated that parents and relatives have a greater vulnerability to backover crashes because they are involved in more backing situations when young children are present. Kids and Cars stated that in all the backover cases they documented, the parent or relative driving the vehicle was unaware the child was behind the vehicle.

x. Suggested Alternative Proposals

In their comments, several commenters laid out suggested proposals for addressing the problem of backover crashes. Suggestions were received from GM, AORC, Mr. Louis Martinez, and the AAM. We have summarized these alternative proposals below.

GM suggested a two-part alternative proposal. First, GM suggested that NHTSA expand the required field of view to the sides and rear of the vehicle, through establishing passenger side mirror requirements and expanding the existing driver side requirements. Second, GM suggested that all vehicles meet a maximum blind zone requirement, using an alternative "indirect" measurement of rear visibility. GM proposed an indirect threshold limit of 100 to 125 square feet, which it indicated would correspond to a direct-view blind zone area of approximately 400–500 square feet using the methods described by NHTSA in the ANPRM. Vehicles that did not meet this threshold indirect visibility requirement would need additional rear vision enhancements, such as video cameras, to meet the requirements.

The AAM suggested a three-part alternative proposal in its comments. First, it suggested that NHTSA adopt European mirror requirements (ECE R46) for both driver and passenger side convex mirrors, for reasons described above. Second, it suggested NHTSA develop performance-based criteria to identify vehicles that may require additional countermeasures. Third, it recommended that NHTSA increase consumer information about capabilities and available technology intended to enhance rear detection capability and enhance driver education.

AORC suggested dividing the area behind the vehicle into a "warning zone," extending three meters behind a vehicle, and an "observation zone," extending an indefinite distance behind the warning zone. Video cameras and sensors would be required to perform different warning and obstacle-avoidance tasks for objects within the two zones, and would be tested using a 0.75 meter (2.5 ft) tall object with human form approximation.

Mr. Louis Martinez submitted a description of a "three-piece interior rear view mirror assembly for vehicles." According to the commenter, this planar mirror assembly would enable driver to view more areas to the sides and rear of the vehicle without having to turn his or her head or adjust the mirrors.

xi. Costs and Benefits

Commenters also provided information which they stated could be used to develop the costs and benefits of the agency's rear visibility proposal.

Consumers Union stated that it believes the cost of rearview video systems, cited in the ANPRM, were too high, as they related to stand alone options. They suggested that the true cost to the OEM is less than $100. Consumers Union did not cite a source for this figure.

The Advocates for Highway and Auto Safety stated that the safety benefits noted in the ANPRM are in accord with project benefits for other NHTSA safety rules, such as the agency's recent upgrade of the roof crush resistance standard. The Advocates also posited that the benefits eventual savings in backover incidents may actually prove to be more effective than the roof crush rule.

Magna stated that it believed the costs of rearview video systems, as cited by NHTSA, were on the high end of the spectrum. It added that as the number of automotive video cameras increases,

their price will decline. Magna did not provide any indication of how low the price may get.

Ms. Susan Auriemma of Kids and Cars said that NHTSA should not be limited by monetary considerations in determining standards that may save children, stating that the value of the life of a child should not be equal to that of a 70-year old adult.

F. Questions Posed and Summary Response

NHTSA asked a series of 43 questions in the ANPRM on a wide variety of topics. In this section, we have reprinted the questions and grouped the significant responses by topic. Because of some of the information we received and further research we undertook subsequent to the ANPRM publication, some of the questions we asked no longer have significant bearing on the proposal (such as questions about methodologies for measuring blind zone size), but we have summarized the responses for the sake of completeness. Because several commenters separated their general comments from their specific responses to NHTSA's inquiries, we have summarized those responses separately. Note that this section contains only responses from those commenters who elected to explicitly respond to each or a subset of questions. Comments that related to questions asked, but were included in the body of the text, are addressed above.

i. Technologies for Improving Rear Visibility

The first series of questions was related to issues regarding the three main technological solutions—mirrors, sensors, and rearview video systems. NHTSA was interested in collecting information on the effectiveness, characteristics, and implementation of these technologies.

Question 1: While the objective to "expand the required field of view to enable the driver of a motor vehicle to detect areas behind" the vehicle implies enhancement of what a driver can visually see behind a vehicle, the language of the K.T. Safety Act also mentions that the "standard may be met by the provision of additional mirror, sensors, cameras, or other technology." NHTSA seeks comment with regard to the ability of object detection sensor technology to improve visibility and thereby comply with the requirements of the Act.

Responses: The commenters generally did not address the question of whether object detection sensor technology was literally capable of expanding the driver's view of the area immediately behind his or her vehicle, as opposed to increasing the driver's awareness of objects within that area.[55] They focused instead on the performance of that technology.

NHTSA received mixed views about its performance, with industry groups, GM, and equipment manufacturers including Ackton, Continental, Delphi, and Magna requesting that the agency make any requirements as technology-neutral as possible, so as to allow innovation and technological improvements, while others agreed with NHTSA's tentative thinking in the ANPRM that sensor technology may not function effectively in preventing backover crashes.

GM and Delphi said any technology is better than none, while Sony and Consumers Union recommended that rearview video may provide a better margin of safety with regard to backover crashes. GM and the AAM responded by saying that any technology that can provide a view of the rear of the vehicle should be permitted to comply with a rear visibility requirement. AAM added that given drivers' tendency to rely on mirrors once the backing maneuver starts, requirements should not preclude any technology.

Specifically in regard to sensor-based systems, Ackton stated that their product uses "New-Gen" ultrasonic technology that can detect another vehicle at a range of up to 30 feet and can detect a 36-inch-tall child at a range of up to 15 feet. On the other hand, Consumers Union and Nissan stated that they agreed with NHTSA's findings that sensor-based systems are inconsistent and unreliable in detection pedestrians, particularly small children, behind a vehicle. Nissan also commented that it generally agrees with NHTSA's evaluation of sensor-based systems and believes that they are generally unreliable in detecting pedestrians, particularly children. Nissan also stated that sensor-based "systems may not be able to detect children or detect them in time for the driver to react." Magna stated that it concurred with NHTSA's finding that sensor-based systems are inconsistent and unreliable in detecting children.

Ms. Susan Auriemma stated that false alarms occur frequently with sensors, and that they would be unhelpful in situations where the vehicle was near known obstructions, such as in garages, therefore recommending that sensors not be permitted to meet the requirement. Furthermore, she added that a malfunctioning sensor system could impart a false sense of security to a driver, who hearing no warning, might assume the path is clear.

Question 2: What specific customer feedback have OEMs received regarding vehicle equipped with rear parking sensor systems? Have any component reliability or maintenance issues arisen? Is sensor performance affected by any aspect of ambient weather conditions?

Responses: GM responded to this question by stating that the parking sensor systems have been generally reliable. AAM stated that weather, dirt, snow, harsh sunlight, intense cold, or high levels of ambient noise can reduce sensor performance. Mercedes also responded to this question, but with information it wished to keep confidential. Kids and Cars stated that it believes that people tend to "tune out" the sound of a sensor as they back out of a garage, as it can register a false positive from the garage walls, which would lessen its efficiency in preventing backover crashes.

Question 3: What specific customer feedback have OEMs received regarding vehicles equipped with rearview video systems? Have any rearview video system component or reliability issues arisen?

Responses: NHTSA received several responses to this question, indicating that most rearview video systems demonstrated good reliability. Other commenters pointed out that the systems have not been installed on vehicles for significant periods of time, so the data regarding their reliability are limited. GM stated that they have generally received favorable customer feedback regarding the performance and operation of their rearview video systems, but have had some negative comments regarding the camera lens needing to be periodically cleaned to remove contaminants. Magna stated that consumers gave positive feedback to the following features in rearview video systems: A wide-angle field of view, electronic image distortion reduction, graphical overlays, and interior mirror screen locations. Furthermore, Magna commented that it was not aware of component reliability problems in excess of what is normally seen in automotive systems. Rosco added that audio-enhanced video systems were positively received by customers. Sony

[55] As noted near the beginning of this document, the inclusion of sensors in this sentence as a "technology to expand the driver's field of view" suggests that "expand the required field of view" should not be read in the literal or natural way as meaning the driver must be able to *see* more of the area behind the vehicle. A literal or natural reading would make the reference to sensors superfluous, violating a basic canon of statutory interpretation. Instead, it seems that language could be read as meaning the driver must be able to *monitor,* visually or otherwise, an expanded area.

stated that video camera design for vehicles focuses on reliability, with particular attention to water resistance, vibration susceptibility, EMI sensitivity, and scratch resistance, and stated that the number of warranty returns for its video cameras were low.

Kids and Cars commented that 85 percent of individuals with these systems felt the systems were effective or very effective, and Ms. Auriemma noted a personal experience where a rearview video system had functioned for several years without malfunctioning.

Question 4: What are the performance and usability characteristics of rearview video systems and rear-mounted convex mirrors in low light (*e.g.,* nighttime) conditions?

Responses: In general, commenters including Nissan, GM, and Sony, seemed confident that, combined with backup lamps (required by FMVSS No. 108), rearview video systems and mirrors would provide a sufficiently visible image in low light conditions. Ms. Auriemma commented that her rearview video system works well under low light conditions. One commenter did point out that sensors, unlike those other systems, would not be affected by low ambient light conditions. Magna stated that performance depends, in part, on the luminous intensity of the tail lamps and backup lamps, but that low-light performance of current systems does improve rear visibility. Rosco stated that to improve nighttime performance, it incorporates infrared and audio technology into its rearview video systems.

Regarding specific performance information, GM stated that its rearview video system provide an image in 3 lux lighting conditions. While Sony indicated that their current video cameras operate in conditions as low as 1 lux, they recommended 5 lux with reverse gear and lamps engaged as an appropriate minimum light level for rearview video system compliance testing.

Question 5: Is there data available regarding consumers' and vehicle manufacturers' research regarding backing speed limitation, haptic feedback to the driver, or use of automatic braking?

Responses: Commenters, such as GM, indicated that these systems have not been applied to backing conditions. However, Magna indicated that some technologies have been applied in certain vehicles, and that haptic feedback alerts can be effective in capturing the driver's attention. The Alliance added that a review of the SCI cases indicates that excessive backing speed was not a primary risk factor in backover incidents, but Nissan stated that research is being conducted, and that it expects that performance of backover countermeasures will improve when used in combination with a reduction in backing speeds.

Question 6: What types of rear visibility countermeasures are anticipated to be implemented in the vehicle fleet through the 2012 timeframe?

Responses: Without giving specific numbers, commenters did indicate that they expect rearview video systems to be installed on an increasing percentage of their fleets. The AAM stated that the same technologies employed today will likely be used in 2012. Nissan stated that it will continue to offer as parking systems a rearview video system, as well as its Around View Monitor system. Honda commented that rearview video systems are currently on Honda and Acura SUVs, as well as the Ridgeline pickup, Odyssey minivan, and several sedans and coupes. Magna stated that it forecast around 500,000–750,000 vehicles produced in North America will be equipped with a rearview video system, and Rosco added that the evolution of technology has been moving towards rearview video systems.

Continental stated that in the future, systems will be able to recognize pedestrians that are in danger of being struck and automatically intervene to prevent that from happening. However, they gave no indication of the timeframe for availability of such technology.

Takata provided confidential comments on anticipated developments in rear detection technology, including the estimated detection capabilities of future products.

Question 7: Can rear-mounted convex mirrors be installed on light vehicles other than SUVs and vans? What is the rationale for U.S. manufacturers' choosing to install rear parking sensors and video cameras, rather than rear-mounted convex mirrors as are commonly installed on SUVs and minivans in Korea and Japan? NHTSA is particularly interested in any information on the effectiveness of rear-mounted convex mirrors in Korea and Japan.

Responses: NHTSA received a number of responses to this question. AAM, GM, and other stated that rear-mounted convex mirrors cannot feasibly be mounted on passenger cars with a sloping rear window surface. The commenters stated that these sorts of mirrors are generally considered unattractive and are not well-received by consumers. Kids and Cars also speculated that consumers may find them unappealing, or that they may strike people or objects in tight areas.

Honda provided information that these mirrors, widely used in Asia, are being phased out in favor of rearview video systems. Furthermore, it noted that these mirrors are used as parking aids, and would not be effective for obstacle avoidance in non-parking backing maneuvers. GM indicated that their research has shown that rear-mounted convex mirrors do not demonstrate any effectiveness in reducing backover crashes in the situations they examined. Rosco stated that it provides these mirrors to customers such as the United States Postal Service and other commercial package delivery services.

Question 8: NHTSA seeks any available research data documenting the effectiveness of rear convex cross-view mirrors in specifically addressing backover crashes.

Responses: GM and the Alliance stated that they were not aware of research on this topic.

Question 9: NHTSA seeks comment and data on whether it is possible to provide an expanded field of view behind the vehicle using only rear-mounted convex mirrors.

Responses: Honda and GM both responded that the utility of rear-mounted convex mirrors was limited in this regard. Honda stated that this was due to "minification" (the small image size) and distortion problems. The AAM pointed to its responses to questions I–7, II–5, and III–10 as being relevant to this question.

Question 10: NHTSA is aware of research conducted by GM that suggests that drivers respond more appropriately to visual image-based confirmation of object presence than to non-visual image based visual or auditory warnings. Is there additional research on this topic?

Responses: GM responded to this question, and reiterated the results of its research, stating that while all people that saw the rear obstacle applied the brakes, most people who simply heard a warning looked for the object first, and did not stop if they did not get visual confirmation. Magna stated drivers have a higher tolerance for visual alerts than for auditory alerts, which drivers view to be intrusive (and hence, can get tuned out). Magna said that visual overlays are best tolerated by drivers, even when they discern that the object being highlighted is benign. The Alliance pointed to its answer to question I–1 as applying to this question.

Question 11: NHTSA requests input and data on whether the provision of

graphical image-based displays (*e.g.,* such as a simplified animation depicting rear obstacles), rather than true-color, photographic visual displays would elicit a similarly favorable crash avoidance response from the driver.

Responses: In response to the questions regarding whether graphical image-based visual displays may be as effective as photographic video displays, GM reiterated its response to question VI–2 (below).

Sony commented that graphical image-based displays offer inferior protection from backover crashes when compared to true-color, photographic visual images from a rearview video system. They indicated that rearview video images provide a wider and deeper viewable area. Sony also stated that a graphical image-based display would require the driver to exit the vehicle to confirm the presence of a rear obstacle, and that if false alarm rates were high, the driver might choose to ignore the warning and not check for an obstacle.

Magna responded by emphasizing the benefits of graphical overlays superimposed on a rearview video image and urged NHTSA to consider inclusion of graphic overlays as part of a video camera-based rear backup aid. Magna indicated that they view graphical image-based displays as a supplement to a true color photographic visual image rather than a substitute for such an image.

However, the Alliance responded by stating that these technologies are in their infancy, and requesting that regulations be crafted in such a way as to not impede their development.

Question 12: To date, rearview video systems examined by NHTSA have displayed to the driver a rear-looking perspective of the area behind the vehicle. Recently introduced systems which provide the driver with a near 360-degree view of the area around the entire vehicle do so using a "birds-eye" perspective using images from four video cameras around the vehicle. During backing, it appears that, by default, this birds-eye view image is presented simultaneously along with the traditional rear-facing video camera image. NHTSA requests data or input on whether this presentation method is likely to elicit a response from the driver that is at least as favorable as that attained using traditional, rear-view image perspective, or whether this presentation is more confusing for drivers.

Responses: Nissan, which uses this technology in some of its vehicles, stated that it has not received negative customer feedback about it. The AAM again stated that such systems have only recently been introduced into the marketplace.

ii. Drivers' Use and Associated Effectiveness of Available Technologies To Mitigate Backover Crashes

These questions were posed in order to help NHTSA gain a better understanding of how technologies were being deployed and used by drivers, and to fill in gaps in research. The agency was particularly interested in any market or research studies indicating customer satisfaction and adoption of specific technologies.

Question 1: NHTSA has not conducted research to estimate a drivers' ability to avoid crashes with a backing crash countermeasure system based only on sensor technology. We request any available data documenting the effectiveness of backing crash countermeasure systems based only on sensor technology in aiding drivers in mitigating backing crashes.

Responses: AAM commented by stating that these devices have only been recently introduced into the marketplace, and that more time would be needed before results would be detectable. GM's comment referred to the results of the McLaughlin and Llaneras studies, which provided some evidence that although warnings influenced driver behavior, warnings were unreliable in terms of their ability to induce drivers to immediately brake to a complete stop. GM stated that their research has shown no additional benefit of integrated (rearview video and sensor) systems over simple rearview video alone. Kids and Cars stated that there is a common reaction for drivers to "tune out" the sensor, such as in situations where a driver is backing out of a garage.

Question 2: NHTSA has not conducted research to estimate drivers' ability to avoid crashes with a backing crash countermeasure system based on multiple, integrated technologies (*e.g.,* rear parking sensors and rearview video functions in one integrated system). We request any available objective data documenting the effectiveness of multi-technology backing crash countermeasure systems in mitigating backing crashes. We also request comment on what types of technology combinations industry may consider feasible for use in improving rear visibility.

Responses: NHTSA received a variety of responses on this issue. While AAM indicated that the technology is too new to have good effectiveness data, both GM and Nissan stated that multi-technology systems were less effective than video alone. Kids and Cars, on the other hand, commented that graphic overlays based on sensor data could improve the user experience with rearview video systems. It also stated that a sensor can alert a driver to a problem, and that a rearview video system can verify that there is an obstacle behind the vehicle. Magna stated that graphic overlays, which include fusion of ranging sensing (*i.e.,* using infrared or radar technology), already exist, and can enhance the driver's ability to judge distance/depth and to assimilate what is being displayed on the video screen.

Question 3: NHTSA requests any available data documenting the image quality of rear-mounted convex mirrors and their effectiveness in aiding drivers in preventing backing crashes.

Responses: GM responded by stating that its research indicated rear-mounted convex mirrors offered no improvement in the prevention of backover crashes. The AAM stated that it does not have data documenting their performance in preventing backover crashes.

Question 4: NHTSA requests any available additional objective research data documenting the effectiveness of sensor-based, rearview video, mirror, or combination systems that may aid in mitigating backover incidents.

Responses: Magna pointed to a variety of research studies being performed by the Virginia Tech Transportation Institute and other entities. Some conclusions it summarizes include: That good image quality is important for customer acceptance; that a 3.5 inch in-mirror display led to the highest backover avoidance rates; and that in-mirror displays were preferred by a large majority of drivers. The AAM stated that it does not have any data on these systems, and given the uncertainty associated with them, recommends that NHTSA adopt a technology-neutral regulation. GM reiterated that it had already shared its relevant findings.

Question 5: NHTSA requests information regarding mounting limitations for rear-mounted convex mirrors.

Responses: Commenters stated that they are aware of no reasonable method for attaching effective rear-mounted mirrors to vehicles like sedans, where such mirrors could not be mounted on or near the roof and provide an image of the area directly behind the vehicle. The AAM cautioned that long bracket arms would be impractical and have a negative effect on component reliability. GM also reiterated that it had not found the mirrors effective even when mountable. Honda added that it believes it is impractical to apply a rear-mounted

convex mirror to vehicles with trunk lids.

iii. Approaches for Improving Vehicles' Rear Visibility

In this section, NHTSA was presenting the regulatory concepts it could use in developing a rear detection system that would best prevent backover crashes. These ideas included the specific areas that would need to be detected by a rear visibility system, the design and possible placements of mirrors or video screens, and the ramifications of requiring certain systems (*e.g.,* the maintenance costs of video cameras). This section also contained additional questions regarding the pricing and feasibility of a variety of potential systems.

Question 1: NHTSA seeks comment on the areas behind a vehicle that may be most important to consider when improving rear visibility. Furthermore, while the distribution of visible area behind the vehicle was not considered in the blind zone area metrics (*e.g.,* rear blind zone area) discussed in this document, it may be helpful to specify some specific areas behind the vehicle that must be visible.

Responses: Commenters generally fell into two categories. Honda stated simply that the area immediately behind the vehicle's rear bumper is significant and should be addressed as a priority. Other commenters, such as AAM and GM, stated that based on a review of the SCI data, the area to the sides of the vehicle is of significant importance, since most victims intruded into the path of the backing vehicle from the sides, rather than starting from directly behind the vehicle. Rosco responded, with respect to school buses, that the area behind the bus closest to the curbside rear wheels may be the most important in order to see a child running to catch the bus.

Advocates for Highway and Auto Safety encouraged the agency to make the coverage area behind the vehicle as large as possible to provide as much time as possible for the driver to determine that a pedestrian is behind the vehicle and to take measures to prevent a crash. The approach recommended by the Advocates was to eliminate vehicles' rear blind zones entirely. They indicated that allowing the degree of rear visibility improvement to be based on the size of the particular vehicle's rear blind zone would permit countermeasures that are tailored to produce the desired result for each vehicle model and type individually.

Question 2: NHTSA invites comment as to how an actual threshold based on vehicles' rear blind zone area could be defined.

Responses: This question was asked in relation to the considered rear visibility threshold, or how big the maximum permissible blind area could be before a countermeasure was needed. Commenters provided various responses. GM offered a method of measuring a vehicle's viewable area indirectly and noted an associated threshold value of 100–125 square feet measured using a 32-inch target plane, but stated that either the direct or indirect field of view methodology could be used to determine a threshold. AAM, on the other hand, offered a suggestion relating to calculating pedestrian speed of 6 kph (3.7 mph), vehicle speed of 6 kph or less, and estimated driver perception and response time 2.5 seconds. However, no data were provided by the AAM to support the specific values. Honda stated that any specified minimum rear visibility value should be based on conclusive data to indicate a direct safety benefit that has been found to be cost-effective in light of all of the related design trade-offs. Consumers Union recommended that a threshold be established based on NHTSA's Monte Carlo analysis in which all areas with risk of 0.1 or higher are required to be visible.

Question 3: NHTSA is considering specifying a minimum portion of a vehicle's rear visibility that must be provided via direct vision (*i.e.,* without the use of mirrors or other indirect vision device). NHTSA seeks comments on this approach, such as input regarding how a minimum threshold should be specified, and how much of a vehicle's rear area should be visible via direct vision?

Responses: Commenters were generally unsupportive of the idea of a direct visibility requirement. Honda stated that it would unduly restrict vehicle design and styling, and stated that it would be a design-restrictive standard that would not enhance vehicle safety. GM commented that while there are currently no field of view requirements, most vehicles provide them, and that market demand for direct field of view would continue for the foreseeable future. The Alliance stated that direct field of view should be incorporated into FMVSS No. 111 as well as indirect field of view. Rosco was concerned that it would be impossible for some vehicles, particularly larger vehicles, to meet any direct visibility requirements.

Question 4: NHTSA requests information regarding anticipated costs for rear visibility enhancement countermeasures.

Responses: Many specific responses to this question were provided on a confidential basis, which were taken into account in the agency's cost and benefit analysis. However, Kids and Cars did comment that the agency's estimated costs were too high, and that it did not take into consideration the amount of money saved by the reduction in minor parking accidents. Nissan urged NHTSA to consider the "total cost" of implementation of any countermeasure in its cost-benefit analysis. It stated that the total cost includes equipment, research and development, software redesign, wiring, electrical architecture, instrument panels, *etc.* It also stated that the costs can be especially significant for vehicles that do not already have an integrated liquid crystal display (LCD).

Question 5: Given the increasing popularity of LCD panel televisions and likely resulting price decline, what decline in price can be anticipated for LCD displays used with rearview video systems? Will similar price reduction trends be seen for video cameras for rearview video system application?

Responses: GM suggested that substantial changes in price were not likely in the foreseeable future, although not impossible. The company stated that while it is conceivable that cost reductions will be realized, the more severe requirements for automotive LCD displays than for home applications puts them in a different category, and that cost reductions may not be realized for some time.

Question 6: NHTSA requests information on the estimated price of rear visibility enhancement countermeasures at higher sales volumes, as well as the basis for such estimates.

Responses: In response to this question, GM stated that it did not estimate that there would be any significant cost reductions. It noted that ultrasonic technology and mirrors have existed for some time, and that cost reductions are unlikely.

Question 7: NHTSA requests any available data on rearview video system maintenance frequency rates and replacement costs. How often are rearview video cameras damaged in the field?

Responses: In general, commenters suggested that the number of warranty claims on rearview video systems was low. However, it was noted that the systems are still comparatively young. GM stated that its current warranty rate for rear video systems is approximately 0.1–2.3 incidents per thousand vehicles.

Nissan stated that it is unaware of any issues that have arisen with regard to the damage rate of its systems. Mercedes provided confidential comments on this subject, which were also considered by NHTSA.

Question 8: NHTSA requests comments on which types of possible rear visibility enhancement countermeasure technologies may be considered for use on which types of vehicles. This information is important for estimating the costs of countermeasure implementation in the fleet.

Responses: This question also generated a variety of responses. GM stated that market forces are driving larger vehicles, such as SUVs and vans, to adopt rearview video systems. Rosco also suggested that larger vehicles would benefit most from having a rearview video system installed. Honda, on the other hand, suggested that rearview video systems would be better than mirrors on sedans and coupes, but with pickups, durability and tailgate placement must be considered. Finally, AAM stated that as a reasonably priced baseline, the ECE R46 mirror standard would be a good addition, and that for certain vehicles, countermeasures could supplement the mirror system. It is not clear to NHTSA whether AAM was suggesting convex mirrors should be required (and disallow current flat mirrors) or simply that convex mirrors should be allowed as an option.

Question 9: NHTSA requests information regarding available studies or data indicating the effectiveness of dashboard display-based rearview video systems and rearview mirror based rearview video systems. What are the key areas that will impact the real-world effectiveness of these systems as they become more common in the fleet?

Responses: GM suggested that as drivers grow more familiar with in-mirror and in-dash video systems as backing aids, the effectiveness of these systems will increase, and pointed to a study presented at the May 2008 Society of Automotive Engineers (SAE) Government/Industry meeting, suggesting that the rearview mirror-based displays showed more benefits for inexperienced drivers, while more experienced drivers experienced about equal benefits from each type of system. The Alliance admitted it had no data, but said it believed the same thing. Rosco made several arguments for the "integration" of dashboard and rearview mirror-based systems, namely that integration will make the display more theft resistant and help propagate other technologies.

Question 10: NHTSA requests objective data on the use, effectiveness, and cost of rear-mounted convex mirrors.

Responses: Commenters provided little new data in response to this question. GM pointed to its earlier response regarding convex mirrors, where it stated that they did not show substantial safety benefits. Additionally, AAM stated that rear-mounted convex mirrors were essentially parking aids, and would not be effective in preventing backover crashes.

iv. Options for Measuring a Vehicle's Rear Visibility

In this section, NHTSA asked a series of extremely specific questions relating to methodologies for measuring the direct rear visibility of vehicles. These questions focused on various aspects of the test procedures outlined in the ANPRM, such as how to set up the machines, what size dummies to use, and how to adjust rear head restraints so as to balance concerns between rear passenger safety and rear visibility.

Question 1: NHTSA requests comment on the use of the 50th percentile male driver size as a midpoint in terms of driver height and whether using multiple driver heights for these tests [to determine direct visibility] would cause undue hardship relative to the safety value of assessing different driver heights. Specific information regarding additional cost, if any, that would be incurred by vehicle manufacturers due to the use of different driver sizes for these different portions of FMVSS No. 111 is requested.

Responses: Commenters suggested a range of testing alternatives that could be used to measure a vehicle's direct visibility characteristics. GM stated that the 95th percentile eye-ellipse is used by manufacturers as the tool for evaluating visibility and is recognized in FMVSS No. 111, and that it would be consistent to apply that tool to determine rear visibility under the standard as well. Similarly, Nissan also recommended NHTSA investigate use of an eye-ellipse method (in accordance with the Society of Automotive Engineers Recommended Practice J941), rather than using the 50th percentile male driver's eye locations. Alternatively, Sony suggested that NHTSA "should use a worst-case-scenario driver body size when conducting rear visibility measurements, such as the 25th percentile female, or at the least correlate size with the actual size of people involved" in real backover crashes. A third alternative was suggested by AAM, which stated that the eyepoints and other incidentals of ECE R46 should be used in developing the criteria for FMVSS No. 111 visibility requirements. Honda, in its comment, did not offer a specific suggestion, but rather noted that using a variety of driver heights and eyepoints might encourage manufacturers to enlarge the mirror or change the curvature, which would add cost to the development and implementation of the system. Consumers Union stated that it did not see the need for a 95th percentile male test, as taller drivers always have a better view behind the vehicle. The organization stated that it has tested using only the 50th percentile, although testing at the eyepoint of the 5th percentile female would also be worthwhile.

Question 2: NHTSA has been using seating position settings recommended by the vehicle manufacturers for agency crash tests. For most vehicles, the vertical seat position setting recommended for seats with vertical adjustability is the lowest position. NHTSA seeks comment on whether this setting is the most suitable position for a 50th percentile male, or if a midpoint setting would be more appropriate for measuring rear visibility. NHTSA also seeks comment on whether the specific crash test seating specifications used are the most appropriate for this context.

Responses: Nissan, GM, and AAM commented in response to this question. They indicated that their responses to the previous question also applied to this issue. Honda pointed out the driver's eyepoint used affects visibility performance with rear-mounted convex mirrors, but does not affect the area behind a vehicle that is displayed by a rearview video system. Honda suggested that if a rule were to require accommodation of different driver sizes that manufacturers may modify the mirror to enlarge its size of change the radius of curvature. While Honda noted that such consideration would result in increased costs, although it did not specifically discourage this if NHTSA could show related enhanced safety benefits. Additionally, Honda stated that while the driver eyepoint is extremely relevant for direct view measurements, it would have no effect on rearview video systems.

Question 3: NHTSA seeks comment on the placements of head restraints. For example, would our test procedure result in the elimination of rear head restraints or a reduction in their size? If so, please identify the affected vehicles and explain why the rear head restraints particularly impair visibility in those vehicles. Similarly, NHTSA seeks comment on the approach to setting the

longitudinal position of all adjustable head restraints for rear visibility measurements. While longitudinally adjustable head restraints positioned fully forward may minimize the chance of whiplash, a more reasonable option for this test may be to position the head restraint at the midpoint of the longitudinal adjustment range.

Responses: NHTSA received comments on this subject from GM, Honda, Sony, and AAM. GM and Sony suggested that head restraints should be accounted for, as they contribute substantially to vehicle safety. Honda stated that head restraints should be adjusted to their lowest or stored position for rear visibility measurement, and that a direct visibility requirement should take into consideration the existence of safety features such as the center high-mounted stop lamp and rear window wiper and defogger. Honda added that if NHTSA believes the required head restraints unduly affect rear visibility, the agency should re-evaluate the recent upgrade of FMVSS No. 202a, *Head Restraints,* for which applicability took effect on September 1, 2009, and take into account rear visibility considerations. The AAM commented that the recently-updated standard FMVSS No. 202a has the effect of reducing rear visibility, and that NHTSA should adjust the head restraints to their lowest position for direct visibility testing purposes, similar to the procedures in ECE R46.

Question 4: In our testing, we found that the laser beam is difficult to detect visually. Therefore, we used the laser detector. NHTSA invites comment on the availability of other options for detecting the laser beam as used in this test that does not involve the use of an electronic laser detector.

Responses: GM and the AAM both responded to this question by noting the difficulties in using laser-based methods. GM stated that while it did not know of any better alternative methods for detecting lasers than what NHTSA described, it would likely use a math-based alternative to certify compliance. Similarly, the AAM stated that the European experience with laser measurement has generally been found to be cumbersome and that CAD-based measurement might be a more desirable option.

Question 5: For locating the laser devices at the selected driver eyepoints, is there another device besides the H-point device which can be utilized for this purpose? For simplicity, should eyepoints be indicated in a similar fashion as is currently in FMVSS No. 111 for school bus testing in which a single eyepoint is located at a specified distance from the seat cushion/seat back intersection and within a 6-inch semi-circular area?

Responses: GM recommended an alternative in which the eye location would be specified from a body fiducial point on the vehicle, similar to methods used in evaluating mirrors under the current standard. AAM questioned whether any single eye location could be representative, and if the proposed measurement method was capturing what was important for rear visibility. AAM also stated that the view in mirrors, which was not contemplated as part of the direct visibility measurement, was an important aspect to consider, especially for older drivers whose range of movement may be limited. Honda stated that it did not consider the school bus measurement method appropriate for passenger vehicles, because that measurement method was designed by contemplating the movement of a bus driver's head.

v. Options for Assessing the Performance of Rear Visibility Countermeasures

In determining a rear visibility threshold, NHTSA would first need to define a test area, from which the vehicle's viewable area could be subtracted, thereby calculating the size of the blind zone. These questions were asked in order to solicit comment on what that test area should cover, as well as other issues related to testing countermeasure performance.

Question 1: NHTSA invites comments on the need for and adequacy of the described area which rear visibility countermeasure systems may be required to detect obstacles. NHTSA is particularly interested in any available data that may suggest an alternative area behind the vehicle over which a rear visibility enhancement countermeasure should be effective? Is the described area of coverage unrealistically large? Is it adequate to mimic real world angles at which children may approach vehicles?

Responses: Many commenters used this question to comment on the number of instances in the SCI cases where the victim entered the vehicle's path from the side of the vehicle. Sony and Kids and Cars both stated that consideration should be given to areas to the sides of the vehicle, with Kids and Cars stating that all of the areas not visible directly or through side mirrors should be taken into consideration. GM and the AAM both stated that driver's-side convex mirrors, which have a wider field of view than that required by FMVSS No. 111, would help to prevent many of these incidents. Nissan commented that the area visible in side mirrors permitted in ECE R46 should be factored into the measured field of view of a vehicle. Sony stated that limiting the test are to the edges of the vehicle would fail to account for obstacles that move into the rear blind zone from the outside of the immediate rear of the vehicle. Sony suggested that the test area should account for, at a minimum, vehicle backing speed, driver reaction time, and the speed of potential obstacles.

Question 2: Is it reasonable to define the limits of the test zone such that it begins immediately behind the rear bumper for the test object defined here or should a gap be permitted before the visibility zone begins? What additional factors should the agency consider in defining the zone?

Responses: Commenters generally split into two groups in responding to this question. Some supported the idea that the test area should begin at the edge of the bumper. Kids and Cars suggested that the test area should begin at the rear bumper because when children approach a vehicle from the side, they frequently intersect the path of the vehicle close to the bumper. Rosco stated that coverage should begin at a vertical plane tangent to the rearmost surface of the rear bumper. Consumers Union also stated that they believe no gap should exist in the test zone. Nissan stated that as long as the target area size is realistic, it would be appropriate to define the limits of the test zone such that it begins immediately behind the rear bumper. GM and Honda, however, supported the idea of a gap. GM stated that as most accidents either come from the sides or from the area 3–8 meters behind the vehicle, a gap in the area would not be unreasonable. Honda also supported a small gap of 0.3 meters (1 foot), noting that if no gap were permitted, video cameras might be placed in locations that could be subject to damage in low-speed collisions, thereby increasing the cost of ownership.

Question 3: NHTSA requests comments on potentially requiring only the perimeter of the specified area to be tested for rear visibility enhancement systems. For video-based rear visibility countermeasure systems, NHTSA assumes that confirming the visibility of the test object over the perimeter of the required area is sufficient, since a system able to display the object at the perimeter of the required area should also be able to display the object at all points in between the extremities. Is this a reasonable assumption?

Responses: We received two comments in response to this specific

question. GM stated that this was not an unreasonable suggestion for a single rearview video camera, but that it did not take into consideration a system made up of multiple sensors or cameras with limited lateral scope. Rosco also questioned this assumption, stating that this did not take into account the fact that an obstruction such as a marker light could block out some portion of the rearward view. The Alliance also referenced its earlier comments on threshold detection (regarding the need for detection zones behind the vehicle), as well as the zones of coverage provided by ECE R46-compliant side mirrors.

Question 4: Would vehicles with rearview video cameras mounted away from the vehicle centerline have the ability to detect the test object over the area under consideration? Is there flexibility to relocate such off-center cameras to meet the requirements under consideration, if necessary?

Responses: This question elicited several responses. Honda and Nissan suggested that it may be possible, but that moving the position of a video camera could be expensive. They recommended allowing as much design flexibility as possible. The AAM also stated that limiting video placement to the centerline would be overly restrictive. Rosco and Sony, two equipment manufacturers, stated that current technology did allow a video camera to be mounted off-center and still be able to see the entire test area, depending on the specifics of that area.

Question 5: NHTSA seeks comment as to the availability of any mirrors that may have a field of view that encompasses a range of 50 feet, as well as the quality of image that might be provided over such a range. How different is the image size and resolution, and how significant are the differences to the mirrors' potential effectiveness?

Responses: No commenters stated they believe that rear mirrors could have an effective field of view that extends 50 feet. Nissan stated that it is difficult to describe variation in image size and resolution, as it varies by the mirror's fixed location on the vehicle body. Rosco stated that image sizes for rear cross-view mirrors become diminished beyond 30 feet. Honda questioned whether mirrors could provide a field of view that extended 50 feet back, but also questioned whether this was necessary for a typical backing maneuver.

Question 6: If a gap is permitted behind the vehicle before the visibility zone begins, how will systems prevent children who may be immediately behind a vehicle from being backed over?

Responses: In response to this question, Sony and Rosco stated that it would not be possible to prevent these backover crashes if the area in which the child was located was not visible to the driver, and reiterated that no gap in the visible zone should be permissible. GM, while acknowledging that not all backover crashes can be prevented, stated in its comments that NHTSA should focus on mitigating specific risks by focusing on the crashes that happen most often—incursions and instances where the vehicle is turning; and by focusing on vehicles that are statistically overrepresented in backover crash fatalities.

Question 7: NHTSA seeks input on what level of ambient lighting would be appropriate to specify for conduct of this compliance test. What other environmental and ambient conditions, if any, should the agency include in the test procedure?

Responses: Several commenters agreed that rear detection systems should be able to function in low light conditions. Kids and Cars and Rosco both stated that the systems should be able to work in dark conditions, while Honda and GM suggested that the low light conditions be specified with respect to the photometric requirements of backup lamps, which would be illuminated during a backing maneuver. Sony suggested that rear detection devices should function in 5 lux luminosity, which is slightly higher than the 3 lux suggested by GM.

Question 8: NHTSA invites input regarding the composition of the countermeasure compliance test object and the types of technologies that are likely to be able to provide coverage of the related test area.

Responses: In response to this query, AAM stated that based on Centers for Disease Control (CDC) growth data charts, it recommended a test object that is cylindrical with a diameter of 15 cm and a height of 82 cm. Kids and Cars, alternatively, suggested a test object with a height of 28 inches, or approximately 71 cm. Honda did not provide a specific suggestion, but noted that the test object should reflect the age and height of the people at risk and not be made of materials that cause excessive reflection or have other characteristics that could interfere with the goals of a practical, reliable, and repeatable test. Similarly, Sony stated that the test object should simulate the size of a 1-year-old child. Finally, GM noted that it provided information on this topic as part of its involvement in NHTSA-sponsored cooperative research with the Virginia Tech Transportation Institute focused on advanced crash avoidance technologies relating to backover avoidance.

vi. Options for Characterizing Rear Visibility Countermeasures

In this section, NHTSA sought comments that would provide insight into what specifications, if any, the agency should mandate for rear visibility enhancements. In the ANPRM, NHTSA noted a general lack of relevant existing industry consensus standards which could be considered in establishing regulatory performance requirements. The agency also noted it appeared there was no ongoing development to establish such consensus standards in the United States. Of particular interest were any standards that were being applied to specific types of countermeasures (such as sensors or cameras) by manufacturers. The agency also wanted to solicit comment on other considerations, such as display characteristics, durability measurements, or test procedures that could assist it in drafting a comprehensive proposed requirement. Questions posed also sought assistance in the identification of any additional parameters which the agency may need to consider specifying in a regulatory amendment to FMVSS No. 111.

Question 1: Are there any existing industry consensus standards for rear visibility enhancement systems which address the parameters outlined in this section? Are there any ongoing efforts to develop such industry consensus standards? If so, when will the standards be published?

Responses: Commenters generally agreed with NHTSA that industry consensus standards do not exist. Some commenters, such as Rosco, and Ford, cited international standards for items such as sensor performance and display requirements. Honda stated that ISO is currently reviewing performance requirements and test procedures for "Extended Range Backing Aids (ERBA)" but that this document is not directly addressing backover incidents as NHTSA did in the ANPRM and that timing-wise, the document could be balloted by ISO and issued as soon as the end of 2009 or early 2010. Nissan noted that while there is a lack of existing industry consensus standards for rear visibility enhancement systems, there does not appear to be wide variation between systems offered by different automakers due to the small number of rearview video camera suppliers.

Ford cited the initiation of updates to ECE R46 for rearview video displays and stated that while it did not support the standard in its entirety, it believes the Australian state of New South Wales' Technical Standard No.149 [56] is instructive with regard to display image. Ford stated that this standard requires a cylinder test object located 5 meters from the rear of the vehicle to have a corresponding image height on the display of at least 0.5 percent of the distance between the driver's eye and the display. For example, for a driver's eye located 800 mm from the screen, the corresponding minimum height for the image on the display would be 4mm.

The most extensive comments received were in regard to ISO 17386:2004 Transport information and control systems, Manoeuvring Aids for Low Speed Operation (MALSO). This standard contains test specifications and requirements to establish the ability of a sensor-based system to detect stationary objects, primarily in the utilization as a parking aid. Delphi stated that tests used for system certification under this standard utilize an idealized target, a PVC pole, for uniform and repeatable performance. The tests were designed to ignore the area from 0 to 25 cm above the ground to prevent detection of parking curbs, presumably to limit the number of times the system alerted the driver to their presence so that drivers would not disable the system. As noted by the AAM, ISO 17386 pertains specifically to systems designed to assist drivers in maneuvering in tight spaces, such as in low-speed parking maneuvers. The AAM further noted that the parameters addressed in the ISO standard are not relevant for pedestrian impacts, nor are the systems designed for low-speed maneuvering optimized for pedestrian detection. Delphi identified the need for a more realistic target specification to be developed, compared to the ISO standard, for sensor-based systems to be able to detect small children. Ackton stated that up to this point, ISO's MALSO standard with the PVC target pole has been the benchmark for all equipment manufacturers. However, Ackton stated that many manufacturers have created systems that "go beyond" the requirements of the ISO standard and that its own "New-Gen" system utilizes technology that allows it to detect moving objects.

The AAM stated that ISO and SAE have several standards that pertain to human-machine interface (HMI) aspects including features employed by rearview video systems and sensor-based backing aids. It noted that these standards are recommendations, rather than specifications, due to the contingent nature of most HMI parameters, which are highly influenced by the specific context and implementation in question. The AAM concluded by stating that such standards do not lend themselves for incorporation into an FMVSS for rearward visibility.

Question 2: Are there additional parameters which should be specified to define a rear visibility enhancement system? What should the minimum specified performance be for each parameter?

Responses: Gentex suggested a minimum visual display brightness of 500 cd/m^2 for in-mirror displays, as measured at room temperature and in a dark room. Its rationale was that automaker research has confirmed this to be the minimally accepted value, presumably to account for a wide possible range of ambient conditions.

Magna suggested that instead of regulating operational areas of video camera performance that NHTSA instead leave implementation to the automakers and suppliers to address to ensure overall system affordability.

Question 3: Are future rear visibility systems anticipated which may have significantly different visual display types that may require other display specification parameters?

Responses: NHTSA did not receive comments in response to this question.

IV. Analysis of ANPRM Comments and NHTSA's Tentative Conclusions

Based upon the discussion in the ANPRM and the comments received, we have grouped the various ideas for mitigating backover crashes into five distinct threads. While there are numerous variations within each concept, we believe that these five concepts contain substantially all of the potential solutions discussed. The ideas are as follows: (1) The improvement of rear visibility for all vehicles within the scope of the K.T. Safety Act; (2) the improvement of rear visibility for certain high-risk vehicle types, namely those judged to be involved in a disproportionately high number of backover crashes; (3) the improvement of rear visibility for vehicles with blind zones that exceed a threshold or cannot view areas deemed to be critical; (4) the installation of driver's-side convex mirrors; and (5) the installation of advanced technology systems, such as combinations of sensors and video cameras, automatic braking systems, or other technology. We note that when referring to improved rear visibility via a "countermeasure," the term refers to any rearview video system, sensor, or mirror, although we discuss the specific differences between those technology types in the earlier ANPRM summary and in section V below. This section contains NHTSA's analysis of the various overall approaches that could be applied to backover prevention, as well as addresses comments germane to the discussion.

Following the discussion of comments relating to the possible means for improving rear visibility and mitigating backover crashes and comments received regarding these, a discussion of comments relating to possible rear visibility system characteristics and compliance test methods is presented.

A. Application of Rear Visibility Systems Across the Light Vehicle Fleet

One approach considered by NHTSA in the ANPRM was to require that all vehicles with a GVWR of 10,000 pounds or less be subjected to improved rear visibility requirements. Going forward with a requirement for improved rear visibility for all light vehicles was an idea supported by a variety of commenters. First and foremost, safety organizations and individuals whose families had been involved in backover incidents strongly favored this alternative. In general, these commenters supported the most comprehensive possible proposal in order to achieve the maximum possible benefits, pointing out the particular tragedy that many of these incidents involved a parent or other family member injuring or killing their own children. Kids and Cars stated that all vehicles must be addressed in order to prevent backover injuries and fatalities, stating that even one car with a large blind zone should indicate the need for the regulation to cover all vehicle types. Similarly, IIHS and Consumers Union both supported uniform requirements across light vehicle classes.

Several equipment manufacturers also were in support of requiring improved rear visibility on all light vehicles. Sony commented that the Act permits NHTSA to "prescribe different requirements for different types of motor vehicles," but does not permit a total or partial exemption of a particular class of vehicles, or a percentage of a particular class of vehicles, from rear visibility requirements. Sony further stated that limiting the rear blind zone visibility requirements to LTVs ignores the fact that passenger cars account for 26 percent of backover deaths and 54 percent of backover injuries, and that

[56] Australian Design Rule 14/02 Rear Vision Mirrors; 2006.

these percentages will likely increase given the relative decline of LTV sales across the market. Delphi and Magna stated their belief that the backover problem is widespread enough that improved rear visibility requirements should not be limited to any particular class of vehicles. Similarly, Ackton suggested that rear visibility countermeasures should not be limited to a certain vehicle class and also raised the issue that trailers could be equipped with sensor-based object detection systems.

In contrast to this broad approach, some automakers commented in favor of limiting any rear visibility improvement to just a portion of the fleet, such as LTVs, saying that, in terms of fatalities, they are statistically overrepresented in backover crashes. Nissan and GM both recommended that a maximum blind zone area approach be used to determine whether a particular model of vehicle warrants improved rear visibility, and recommended against the application of any new requirements by vehicle type. Mercedes suggested that if the agency believes that improved rear visibility should be required for the portion of the vehicle fleet that is statistically overrepresented in backover crashes (*i.e.,* LTVs), then NHTSA should apply the requirements to only those types of vehicles. Honda also commented that rear visibility performance requirements should be instituted for only those vehicles with the highest rates of backover incidents, although it also suggested that NHTSA should actively monitor the data for all vehicle types so that it can consider broader application of the requirements based on the safety need.

Lastly, some vehicle manufacturers generally supported alternative methods for preventing backovers. One manufacturer, Nissan, requested that the agency conduct more research before proposing to require any additional performance requirements for rear visibility. The AAM limited its support to the requirement for ECE R46-compliant convex side mirrors, instead of more advanced countermeasures. Mercedes echoed this approach, but allowed that if more advanced countermeasures were seen as essential, they be limited to LTVs, and not applied to passenger cars. The application of improved rear visibility requirements to LTVs only was also supported by Honda. GM was the lone manufacturer that recommended that NHTSA limit the requirement for improved rear visibility to vehicles with large blind zones only. We have addressed comments relating to those alternative proposals in the sections below.

While NHTSA agrees that requiring enhanced rear visibility for all light vehicles would be the most comprehensive approach to mitigate backover crashes, it would also entail the highest costs of any possible proposal. Commenters also suggested that NHTSA's projected costs were too high and that costs would likely decline once systems such as these were put into wider production. In response to these comments, NHTSA has more fully analyzed the costs and benefits of the proposal in the preliminary regulatory impact analysis (PRIA), which is presented in tandem with this document.

As described in Section II.B, NHTSA has tentatively decided to require improved rear visibility for all vehicles with a GVWR of 10,000 pounds or less. Having taken into account the intent of Congress in passing the K.T. Safety Act, the smaller, yet still-significant number of fatalities involving passenger cars, and the fact that the injury rate for all classes of vehicles is approximately proportional to their representation in the fleet, we do not at this time believe it is in the best interest of safety or otherwise appropriate or permissible under the K.T. Safety Act to exclude passenger cars from rigorous rear visibility performance requirements. Passenger cars account for slightly more than half of the injuries from backover incidents.

The rationale for proposing to require all light vehicles to have improved rear visibility is twofold. First, NHTSA, and Congress, are extremely concerned about the incidence of children being backed over by light vehicles. This is a phenomenon that is not limited to any particular vehicle type, and while the ANPRM did discuss blind zone area measurement, no driver of any type of vehicle could see the entire area behind the vehicle in which a pedestrian, especially a young child, might be located without the aid of an effective rear visibility countermeasure. Therefore, the obvious and most complete solution is to require an enhancement that enables drivers of all light vehicles to see children and other obstacles directly behind a vehicle.

Second, and as noted by some commenters, applying improved rear visibility requirements to just a portion of the fleet would cause an awkward safety disparity between vehicles equipped with a countermeasure, and those without. As NHTSA has noted in the ANPRM and this notice, driver education about and acceptance of rear visibility countermeasures is crucial in realizing their effectiveness. To require visibility improvements in only some vehicles may send a mixed message to drivers that would not achieve the intent of the law.

B. Limitation of Countermeasure Application to Certain Vehicle Types

A second concept explored in the ANPRM was the idea of limiting the requirement for improved rear visibility to certain vehicle types. The idea of having different rear visibility requirements for certain vehicle types was explicitly contemplated by Congress and articulated in the text of the K.T. Safety Act, which stated that "The Secretary may prescribe different requirements for different types of motor vehicles to expand the required field of view to enable the driver of a motor vehicle to detect areas behind the motor vehicle to reduce death and injury resulting from backing incidents, particularly incidents involving small children and disabled persons." Furthermore, we believe that in particular, vehicles like multipurpose passenger vehicles and pickup trucks were contemplated by Congress as potentially warranting more of an improvement in rear visibility than do passenger cars. In noting the need for rear visibility performance requirements, the legislative history stated that, "As larger vehicles, including SUVs, pickup trucks, and minivans, have become more popular, more drivers are confronted with larger blind spots." [57]

In the ANPRM, NHTSA considered whether it would be appropriate to take this idea further and limit the requirements for improved rear visibility to the vehicles known as "LTVs," which include multipurpose passenger vehicles, trucks, and minivans with a GVWR of 10,000 pounds or less. The agency reasoned that if a strong relationship between vehicle class and backover incidents existed, a targeted requirement for advanced rear visibility countermeasures could achieve a large percentage of the overall benefits of the technology at a fraction of the overall cost to the industry. Therefore, the agency conducted a statistical analysis and requested comment on the option.

The agency's analysis revealed that while LTVs were statistically overrepresented in backover-related fatalities, they were not significantly overrepresented in backover-related injuries or in backover crashes

[57] S. Rep. 110–275, S. Rep. No. 275, 110TH Cong., 2nd Sess. 2008.

generally. Table 7 below lays out a summary of the results.[58]

TABLE 7—BACKOVER CRASH FATALITIES AND INJURIES AND PERCENT OF FLEET BY VEHICLE TYPE

Vehicle type (GVWR of 10,000 lb or less)	Percent of fleet	Percent of injuries	Percent of fatalities
Passenger Car	58	54	26
Multipurpose Passenger Vehicle	16	20	30
Truck	17	18	31
Van (including minivans)	8	6	13

As shown by Table 7, LTVs represent a disproportionate share of the overall backover-related fatalities, being involved in almost twice as many fatalities as their portion of the fleet. Conversely, passenger cars are represented in only one half as many fatalities as their fleet percentage would indicate. We note that this discrepancy is spread relatively evenly across multipurpose passenger vehicles, trucks, and vans.

However, unlike fatalities, the relationship between backover crashes generally and vehicle type for injuries is proportional to a vehicle type's proportion of the fleet. The data show that passenger cars are just as likely to be involved in a backover incident as are other types of vehicles. The substantially similar numbers of total backovers (including injuries and fatalities) between vehicle types cast doubt on whether it would be in the best interest of safety to limit rear visibility improvement to just LTVs even if it were permissible to do so.

As indicated in the comment summary section above, commenters were split on the idea of imposing countermeasure requirements by vehicle class. Vehicle manufacturers in favor of a requirement that would affect only LTVs included Honda and Mercedes, while Nissan was against such a proposal. Mercedes suggested that if the agency believes that advanced countermeasures are required for the portion of the vehicle fleet that is statistically overrepresented in backover crashed (*i.e.,* LTVs), then NHTSA should require those countermeasures only for those types of vehicles. Nissan stated that it supported using a blind zone threshold, rather than vehicle class, to determine which vehicles require improved rear visibility. Honda also commented that rear visibility performance requirements should be instituted for only those vehicles with the highest rates of backover incidents, although it also suggested that NHTSA should actively monitor the data for all vehicle types so that it can consider broader application of the requirements based on the safety need. Consumers Union made statements that they did not support improving rear visibility for only a portion of the light vehicle fleet, but they did not provide any data or rationale to support the statements.

GM commented that the data provided in the ANPRM indicate that LTVs have a larger blind zone than most passenger cars, and that it can be extrapolated that the increased rate of LTVs in backing crashes could be the result of larger blind zones. Based on this idea, GM stated that this suggests the focus of the rulemaking should be on vehicle blind zone, not vehicle class. However, while NHTSA had considered this correlation, as described above, the agency has found that the relationship between rear visibility and backover crashes appears to involve too many factors to permit isolation of only the impact of rear visibility. This preliminary information suggests that the statistical overrepresentation of LTVs in backover crash incidence is not solely an effect of a vehicle's rear visibility characteristics.

Blue Bird submitted a comment requesting that smaller buses not be subject to any new rear visibility requirements. As it noted, the language of the K.T. Safety Act would include small buses as part of the class of vehicles potentially affected by the regulation. However, Blue Bird offered several reasons why it believes that it would be a better policy decision to exclude buses from the rear visibility requirement. First, it pointed to the fatality and injury data presented in NHTSA's ANPRM, which indicated that buses, which were included in the "Other Light Vehicle" category, were involved in no fatalities and few injuries. Second, Blue Bird stated that many small buses (including small school buses), are not equipped with navigation or multifunction screens. The commenter added that the increased costs could deter some school districts from purchasing new school buses, which could lead to safety disbenefits. Third, Blue Bird noted that most drivers of buses must have commercial driver's licenses, and many are subject to far more training than drivers of passenger vehicles.

We note that another commenter, Rosco, stated conversely that small buses should be subject to improved rear visibility requirements. It argued that small buses, frequently used for special needs children, are frequently used in situations around children. Rosco stated that because these vehicles have limited rearward visibility, they should be equipped with rearview video systems. However, Rosco also notes that operational guidelines (buses, in particular school buses, are driven by professional drivers) advise against traveling in reverse in normal operations. Furthermore, the statistics indicate that despite their proximity to children, the guidelines are effective, as our data indicates relatively few backover incidents involving school buses.

We received no comments regarding LSVs.

While sensitive to the issues cited by Blue Bird regarding school buses, we are proposing that school buses and low-speed vehicles also be included. We believe that it is apparent from the legislative history that Congress intended for this statute to address the problem of backover crashes involving all vehicles with a GVWR of 10,000 pounds or less. Therefore, we are proposing to include all passenger vehicles among the vehicles subject to the enhanced rear visibility requirements without exception.

C. Using Blind Zone Area as a Basis for Countermeasure Requirement

One option presented in the ANPRM was to limit the requirement for improved rear visibility using a vehicle's blind zone area (the area

[58] This table is presented in more detail in section III of the PRIA.

behind a vehicle that cannot be seen directly through the vehicle's rear windows) threshold. This option was based on the preliminary indication that certain vehicles with larger rear blind zones may be more prone to backover incidents.

In their comments, some vehicle manufacturers commented in favor of using a rear blind zone area threshold to determine which vehicles would need improved rear visibility. GM recommended that a maximum blind zone area approach should be used to determine whether a vehicle should be equipped with a countermeasure, and recommended against the application of countermeasures by vehicle type. GM offered a method of measuring a vehicle's viewable area indirectly and noted an associated threshold value of 100–125 square feet measured using a 32-inch target plane, but stated that either the direct or indirect field of view methodology could be used to determine a threshold. While GM commented extensively on how its indirect field of view measurement method correlated with and had some advantages over NHTSA's direct visibility method, it did not provide any additional information to aid in correlating measured direct rear visibility with backover incidents.

AAM, on the other hand, offered a suggestion relating to calculating minimum required field of view using a pedestrian speed of 6 kph (3.7 mph), vehicle speed of 6 kph or less, and estimated driver perception and response time 2.5 seconds. However, no data were provided by the AAM to support the specific values offered.

Nissan also supported a maximum blind zone area approach to identifying which vehicles most warranted improved rear visibility. However, it did not provide any data or specific recommended value and associated justification for its use as a blind zone area threshold.

Consumers Union recommended that a threshold be established based on NHTSA's Monte Carlo analysis in which all areas with risk of 0.1 or higher are required to be visible. However, no justification was provided for choosing 0.1 as a risk threshold as opposed to some other value.

While several commenters stated that they supported use of a blind zone area threshold approach to determine which vehicles should have a countermeasure, those comments did not provide any data in addition to what NHTSA presented that might support such a proposal.

As described in the ANPRM, to determine a suitable blind zone area threshold value at which vehicles with larger blind zones would be required to have a improved rear visibility, NHTSA plotted the average ratios of backing crashes to non-backing crashes and backover crashes to non-backing crashes versus the direct-view rear blind zone areas for 28 vehicles, as shown in Figure 1. These 28 vehicles were selected because they were the ones for which NHTSA had measured direct rear visibility and for which sufficient state crash data were available.

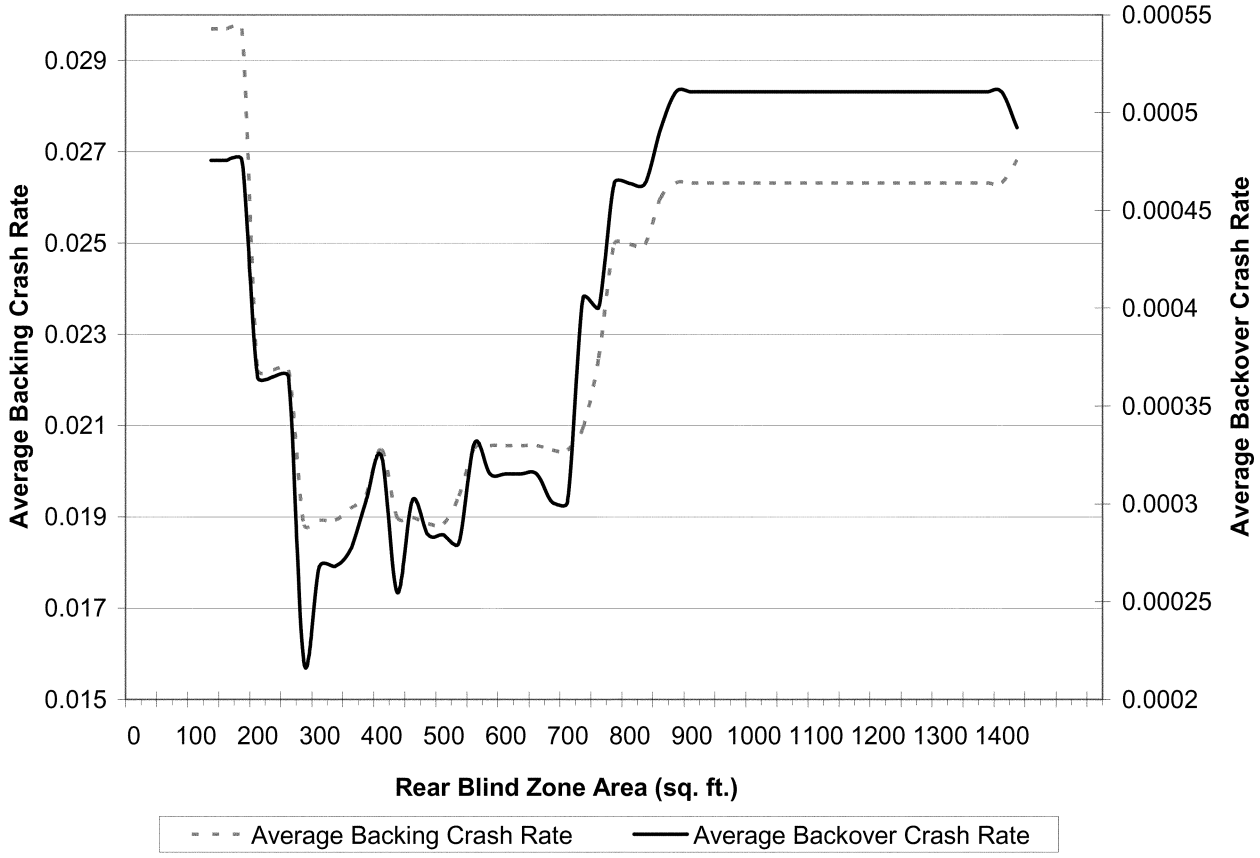

Figure 1. Backing and Backover Crash Rates as a Function of Vehicle Rear Blind Zone Area

Upon further examination, NHTSA has determined that using rear blind zone area to develop a threshold is not feasible at this time. We believe that the 28 vehicles we used to develop Figure 1 do not depict an obvious cutoff point where the risk of a backing crash dramatically increased with increasing blind zone area and that some vehicles with small blind zone areas (*e.g.,* less than 300 square feet) have fairly high backing and backover crash rates. Also, while we found that direct rear blind zone area measured in a 50-foot square centered behind the vehicle was correlated with *backing* crashes to a mildly statistically significant degree, the relationship between size of the rear blind zone area directly behind vehicles and backover crash risk, was not correlated to a statistically significant degree.[59] [60] 60 Finally, during our SCI review, we determined that a majority of the victims in backover crashes were directly behind the vehicle and within a range of 20 feet from the rear bumper, an area that is not visible to the driver in many vehicles of all types.[61] Therefore, any requirement for a maximum rear blind zone area that permitted the area within 20-foot aft of the rear bumper to not be visible to the driver would fail to address a large portion of backover crashes.

D. Use of Convex Driver's-Side Mirrors

Several commenters recommended that NHTSA make modifications to the existing mirror requirements of FMVSS No. 111 in order to realize the goal of the K.T. Safety Act. Among other requirements, FMVSS No. 111 currently requires a flat mirror on the driver's side, and permits, although does not require, a convex mirror on the passenger side (nearly all vehicles are equipped with such a mirror, however). NHTSA notes that FMVSS No. 111 does allow exterior rearview mirrors which incorporate an outer curved portion, as long as the required flat portion is also present. In the ANPRM, NHTSA did not consider modification of the existing side mirror provisions of FMVSS No. 111 since we believed it to be an ancillary issue with regard to the rear visibility activity currently being pursued.

In their comments on the ANPRM, the AAM, along with several vehicle manufacturers, recommended that NHTSA adopt European (ECE R46) mirror specifications to require non-planar side mirrors on both the driver and passenger sides of light vehicles. They stated that this would enable drivers to detect a majority of pedestrians involved in reported backover incidents, as most victims do not begin directly behind the vehicle, but rather enter the area directly behind the vehicle from one side or the other. Specifically, the AAM stated that its analysis of the agency's SCI cases indicated this expanded field of view (from non-planar mirrors) would cover approximately 80 percent of the cases investigated for which the pre-crash movement of the pedestrian was recorded. Furthermore, the commenters stated that the increased field of view of convex driver's-side mirrors would give drivers a greater window of time in which they could see an incurring pedestrian in the side mirror. The AAM stated that using the ECE specification would result in an increase in the lateral angular field of view up to 286 percent in expanded field of view over that required by FMVSS No. 111 for vehicles meeting passenger car requirements. In addition, the AAM cited findings from a study which concluded that non-planar mirrors can increase angular viewing coverage by over 300 percent when compared to flat mirrors and that spherical and aspheric mirrors with spherical portions can provide a substantial reduction in glare for drivers under normal conditions and improvements in lane change situations.

GM said it agrees with the AAM that 80 percent of the SCI cases are incursions from the side and could be addressed by modifying existing mirror requirements to the side and rear of the vehicle, and agreed with AAM on adopting ECE R46 requirements.

Mercedes said it supports the AAM's recommendation to adopt ECE R46 requirements for convex exterior mirrors, which it said would substantially expand the required field of view for all light vehicles and thereby improve the ability of drivers to detect pedestrians and pedal cyclists moving into the rearward pathway of the vehicle.

Conversely, Advocates for Highway and Auto Safety stated that simple changes in the current requirements for side and interior rearview mirrors will not fully address the problem of blind zones, enable drivers to see the entire area immediately behind the vehicle, or comply with the statutory mandate to "expand the required field of view * * *"

After careful consideration of the comments received, NHTSA believes that modifications to the side mirror requirements in FMVSS No. 111 are best handled in a separate rulemaking. We have come to this conclusion for two reasons. First, given that only marginal gains could be made in field of view to the sides of the vehicle, we do not believe that those gains would result in a reduction of backovers. NHTSA's rear visibility measurements show that rearview mirrors in current vehicles typically show a much wider area that exceeds the minimum requirements set forth in FMVSS No. 111, as illustrated in Figure 2 below. As a result, a fairly wide field of view provided by side rearview mirrors has already been present in the backover incidents that have occurred to date. At the extreme lateral distances from the vehicle, in the area in which an ECE-compliant convex mirror would display but a standard side-view mirror would not, pedestrians are sufficiently far from a vehicle that a driver (if the driver was using the mirror) would likely not perceive a risk that the individual would intersect the vehicle's path as the vehicle moved rearward.

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[59] The correlation between direct rear blind zone area and backing crashes was correlated to a statistically significant degree. However, this correlation was not sufficiently strong to use as a basis for determining a specific threshold.

[60] Partyka, S., Direct-View Rear Visibility and Backing Risk for Light Passenger Vehicles (2008).

[61] See analysis of SCI data, section V.B.i.

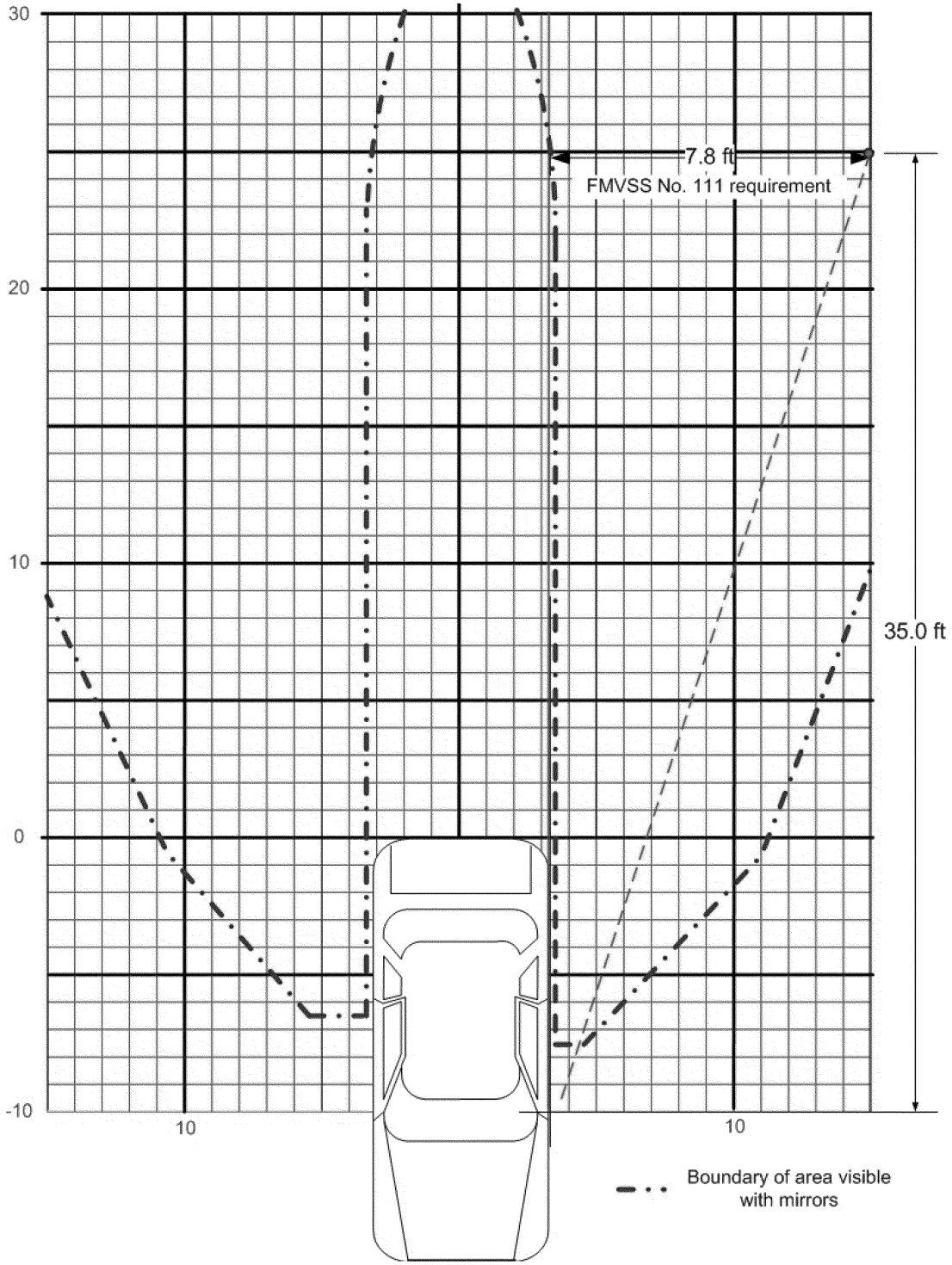

Figure 2. Comparison of FMVSS No. 111 Driver-Side Mirror Coverage Requirements versus Approximate Typical Mirror Coverage for Current Vehicles for 28-inch Tall Object

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Second, ECE R46 compliant mirrors would not provide a field of view that includes what the agency has determined, through Monte Carlo simulation, to be the highest risk areas for backover crashes, which are the areas directly behind the vehicle. Any areas of crash risk for a pedestrian behind the vehicle that would fall within the field of view of a convex side mirror are already well within the field of view of an existing FMVSS No. 111-compliant side mirror. Thus, we anticipate that little or no net

improvement in backover rates would occur if there were a switch to ECE R46-compliant mirrors.

Notwithstanding these observations, NHTSA plans to reexamine the side mirror requirements in FMVSS No. 111 in upcoming rulemaking actions. The suggestions of AAM and other commenters that these mirrors may provide safety benefits such as glare reduction and lane-change assistance will be considered in the context of those actions.

E. Advanced Systems and Combination Sensor/Rearview Video Systems

NHTSA's analyses are based on currently available technology. However, it is known that additional technologies are under development, but the quality of their performance is not known at this time. Two additional sensor technologies are being developed by manufacturers that could be used to improve a vehicle's rear visibility: an infrared-based object detection and video-based real-time image processing for object detection. Infrared-based systems operate by sensing the infrared radiation emitted by objects located in their detection range and can produce non-photographic images that portray the shapes and locations of objects detected. Rear object detection via video camera uses real-time image processing capability to identify obstacles behind the vehicle and then alert the driver of their presence. While these technology applications may eventually prove viable, because of their early stages of development, it is not possible at this time to assess their ability to effectively expand the visible area behind a vehicle.

NHTSA is currently engaged in cooperative research with the Virginia Tech Transportation Institute and GM on Advanced Collision Avoidance Technology relating to backing incidents. The research is focused on assessing the ability of more advanced technologies to reduce the occurrence of backing crashes, and refining a tool to assess the potential safety benefit of technologies, such as an advanced object detection system with integrated automatic braking capability. The completion of NHTSA's advanced technology research effort is not expected until calendar year 2011.

Commenters including Continental, Magna, and Takata indicated that they are either developing or anticipate development of advanced systems with pedestrian detection capability in the future. Nissan indicated that they are studying some potential future applications which could limit backing speed, apply automatic braking, or provide the driver with a haptic (*i.e.,* tactile, *e.g.,* vibration) response [62] to indicate the presence of a rear obstacle. While future advanced safety systems may be developed to reduce backover crashes, no systems are currently ready for market. Therefore, the proposed improved rear visibility requirements specified in this notice, while not precluding use of promising advanced technology, cannot be based on the possible benefits that may be attainable with such future systems.

F. Rear Field of View

In the ANPRM, NHTSA invited comment on what area behind the vehicle would need to be made visible to the driver in order to best improve safety. A wide area of up to 50 feet wide by 50 feet long was suggested as a possible coverage area option. NHTSA inquired about the feasibility of coverage such a large area and sought comments on which areas behind the vehicle may be most critical for backover mitigation.

Multiple commenters discussed the average area that any countermeasure would be expected to "see" and, in particular, noted the number of SCI cases in which the victim entered the vehicle's path from the side of the vehicle. Sony and Kids and Cars both stated that consideration should be given to areas to the sides of the vehicle, with Kids and Cars stating that all of the areas not visible directly or through side mirrors should be taken into consideration. Sony stated that limiting the rear test area to the area within the edges of the vehicle would fail to account for obstacles that move into the rear blind zone from outside of the immediate rear of the vehicle. Sony suggested that the test area should account for, at a minimum, vehicle backing speed, driver reaction time, and the speed of potential obstacles. Advocates for Highway and Auto Safety indicated that they believe that if the area immediately behind a motor vehicle is visible to a driver, substantial safety benefits will result for pedestrians, especially very young children.

Many commenters expressed a desire to minimize or eliminate any "gap" between the area that is required to be visible and the rear bumper. However, the rationale for allowing a gap seemed based to the difficulty of rear visibility systems might have in detecting areas directly behind the bumper. Kids and Cars suggested that the area of required coverage should begin at the rear bumper because when children approach a vehicle from the side, they frequently intersect the path of the vehicle close to the bumper. Advocates for Highway and Auto Safety stated that the countermeasure needs to provide the driver with a field of view that eliminates the entire blind zone immediately behind the rear of the vehicle, suggesting that no gap should be allowed. Consumers Union also stated that they believe no gap should exist in the test zone. Nissan stated that as long as the target area size is realistic, it would be appropriate to define the limits of the test zone such that it begins immediately behind the rear bumper. Rosco stated that coverage should begin at a vertical plane tangent to the rearmost surface of the rear bumper. Sony indicated that NHTSA need not and should not permit any significant gap behind a vehicle before the visibility zone begins.

On the other hand, some commenters supported the idea of a gap. The AORC stated that young children should be visible using a rearview video system beginning at a distance of 0.25 meters (0.82 ft) from the rear bumper and extending outward to a minimum distance of 3 meters (9.84 ft). GM stated that, as most of the documented SCI backover cases involved pedestrians entering the vehicle's path from the sides of the vehicle, a gap in the area immediately aft of the rear bumper would not be unreasonable. Honda also supported a small gap of 0.3 meters (1 foot), noting that if no gap were permitted, video cameras might be placed in locations that could be subject to damage in low-speed collisions, thereby increasing the cost of ownership.

In regard to the size of the visible area behind a vehicle may be needed to adequately mitigate backover crashes, Advocates for Highway and Auto safety stated that "there is no reason why a rearview video system could not provide an optimal coverage area that is unlimited when the vehicle is on a flat surface or extends at least 20 feet behind the vehicle." Multiple commenters noted that rear-mounted convex mirrors could not be modified to attain such a range as was indicated in the ANPRM. NHTSA's test results for rear-mounted convex look-down and cross-view mirrors agree with this comment. Manufacturers' descriptions of current sensor-based systems included in their comments also did not indicate that sensors could meet this range requirement. While no comments were received regarding the ability of rearview video systems to cover this

[62] Providing a driver with a haptic response means providing tactile feedback such as by causing the steering wheel to vibrate.

range, NHTSA's testing has shown that while the systems may display such a range, image quality decreases as areas further out from the vehicle are displayed.

In response to the ANPRM description of NHTSA's Monte Carlo analysis of backover risk as a function of pedestrian initial location, GM commented that NHTSA's analysis did not factor in the probability that a pedestrian would have actually been located at any specific point on the test grid. While NHTSA agrees with GM's comment, we note that the only available data for use in asserting such a probability of pedestrian location would be SCI case data, which is not nationally representative.

As will be explained later in this document, based on the above comments and some new analysis, NHTSA has determined that a coverage area of 20 feet in length and 10 feet in width (5 feet to either side of the vehicles centerline) is the most feasible and effective range for mitigating backover crashes.

G. Rear Visibility System Characteristics

In the ANPRM, NHTSA noted several possible system characteristics that may be important to require in order to ensure that the maximum possible effectiveness of a rear visibility system may be achieved. Our general approach in establishing performance requirements was to identify key areas that we believe are pertinent to overall system effectiveness. In the absence of existing consensus industry standards, we reviewed existing systems and made determinations regarding performance areas to specify. These areas include visual display characteristics and aspects of rearview image presentation. The following paragraphs summarize comments relating to system characteristics and describe NHTSA's analysis regarding those possible specifications.

i. Rearview Image Response Time

Image response time is the time delay between the moment the vehicle is put into reverse gear, and the moment which an image to the rear of the vehicle is displayed by a rear visibility system. The importance of response time to safety is illustrated by a comment from Ms. Susan Auriemma, in which she describes having to wait several seconds for the image to appear and notes that drivers may proceed to back without waiting for the image to appear. NHTSA agrees with her concern that if the display takes too long to appear, drivers may be likely to begin a backing maneuver before the image behind the vehicle is displayed, rendering the system less effective. In the ANPRM, we suggested a maximum value of 1.25 seconds for the maximum allowable time for a rearview video image to be displayed to the driver, or image response time.

Commenters generally concurred with NHTSA's concerns regarding image response time; however, manufacturers identified several technical issues which merit consideration. While GM and Gentex agreed that rearview video systems are able to display an image within 1.25 seconds, they noted that based on the complexity of the system and the need for tolerances, systems can typically take longer to produce images in some situations due in part to electronic image quality control checks that are a precursor to the full display of an image. Therefore, NHTA's suggested maximum value of 1.25 seconds could unnecessarily restrict the operation of some systems and in theory impact the electronic quality control approach of manufacturers. GM and Gentex noted that a maximum image response time value of 2.0 seconds would allow for timely activation of the system based on a reverse signal and provide a reasonable tolerance for system variation while ensuring the availability of an image at the beginning of backing maneuvers. Specifically, Gentex stated "In total, a typical application requires a nominal 1.20 seconds to display a rearview video image. With tolerance, as much as 2.00 seconds may be required—not including the time between the gear change * * *" Gentex went on to recommend that a maximum image response time of 3.0 seconds allows the rearview video system enough time to ensure the driver is presented with a quality video image. However, no data justifying the need for the additional 1 second was provided by Gentex. While NHTSA understands that allowing time for system checks may result in a higher quality image, we also believe that providing an image soon after the vehicle is shifted into reverse may substantially increase the likelihood that a driver could detect a rear obstacle, if present.

AAM recommended that maximum image response time be specified with reference to the time "when the vehicle driveline is engaged in reverse". NHTSA agrees that the point in time in which the vehicle's transmission is engaged in reverse gear is the most logical point in time from which to orient the image response time criterion.

Also in regard to image response time, NHTSA acknowledges that liquid crystal displays require some warm-up time before an image can be displayed clearly. In-dash LCD displays that are used for multiple functions are typically already active before the driver shifts into reverse gear and therefore are already warm and able to display a rearview video image immediately upon shifting into reverse. However, in-mirror LCD displays remain off until reverse gear is selected and, therefore, require some warm-up time before a clear rearview video image can be displayed. Therefore, some requirement for additional image response time is inherent in the use of in-mirror LCD displays, but is avoided with in-dash displays. Conversely, given that the buildup of heat can also be an issue with in-mirror LCD displays due to the limited area within the mirror in which heat may dissipate, providing power to these displays at all times as a means of avoiding longer image response times is not feasible. Therefore, providing some allowance of time for an in-mirror LCD display to warm-up may be reasonable.

Somewhat related to system the issue of system response time was a comment from the Advocates for Highway and Auto Safety that suggested vehicles be equipped with an interlock feature that prohibits it from being able to move in reverse, even after the transmission has been placed in reverse gear, until a short period after the countermeasure system becomes fully operational. This sort of measure would ensure that drivers had all available information about the presence of any rear obstacles at the moment that backing began. While this idea appears to have merit, NHTSA is concerned that drivers that are parking or hitching a trailer may be annoyed by such a feature. NHTSA seeks comment on whether this feature might be acceptable to consumers and whether any substantial advantage of this feature over the use of a maximum response time specification exists. Based on the comments, the agency will consider whether to include this feature in the final rule.

ii. Rearview Image Linger Time

Image linger time is another issue that was raised in the ANPRM. Linger time refers to the period in which a rearview image continues to be displayed after the vehicle's transmission has been shifted out of reverse gear. As noted by some commenters, a period of linger time may be desirable for situations where frequent transitions from reverse to forward gear are needed to adjust a vehicle's position (*e.g.,* parallel parking and hitching). In the ANPRM, NHTSA indicated that a minimum of 4 seconds but not more than 8 seconds of linger time may be appropriate after the vehicle is shifted from the reverse

position. NHTSA is concerned that excessive linger time may provide a source of distraction to the driver by a video image that is displayed longer than is needed. Consumers Union concurred with NHTSA's recommendation of 4–8 seconds for linger time. Nissan stated that its systems currently exhibit a linger time of approximately 200 milliseconds and that it does not see value in allowing a longer linger time. GM recommended a maximum linger time of 10 seconds or, as an alternative, a speed-based limit in which the rearview video display would turn off when the vehicle reaches a speed of 5 mph (8 kph). GM noted that a time-based linger time would be less costly to implement than a speed-based linger time would. Based on their observations of drivers making parking maneuvers, the AAM also recommended a maximum linger time of 10 seconds, but specified an alternative speed-based value of 20 kph (12.4 mph).

Because an excessive image linger time could result in adverse safety consequences associated with potential driver distraction when the vehicle is moving forward, NHTSA believes that linger time should be limited. On the other hand, NHTSA agrees with commenters who noted that allowing a reasonable linger time would provide a benefit to drivers who are parallel parking or hitching a trailer. Therefore, we believe there is a need to specify a maximum, but not a minimum, image linger time value for presentation of a rearview image.

iii. Rear Visibility System Visual Display Brightness

In the ANPRM, NHTSA suggested that it is appropriate to adopt a minimum visual display luminance to ensure that a rearview image is displayed with sufficient brightness to be adequately visible in varying conditions, such as bright sunlight or low levels of ambient light. Adequately visible, in this case, would mean that a driver can discern the presence of obstacles in the rearview video image. We note that in the SCI sample, 95 percent of backovers took place in daylight hours. Therefore a rearview image should be bright enough to be visible in daylight conditions. Commenters noted that a minimum of 500 cd/m^2 is appropriate based upon research performed by vehicle manufacturers and that internal specifications routinely require a luminance of at least this value. During the agency's review of existing rearview video systems, we found the display brightness of the existing systems to be adequate such that visual information was discernible under varying ambient conditions, such as background light level. While we do not currently have reason to believe that vehicle manufacturers are installing rearview video systems with displays having brightness values less than 500 cd/m^2, we believe it is necessary to propose an appropriate minimum brightness so that drivers can see the image under varying ambient lighting conditions.

iv. Rear Visibility System Malfunction Indicator

In the ANPRM, NHTSA indicated our belief that no malfunction indicator would be necessary for a system that presents a visual image of the area behind the vehicle since the absence of an image would clearly indicate a malfunction condition. Multiple commenters agreed with NHTSA's suggestion that such a malfunction indicator is not necessary for a system presenting a rearview image. We agree with these comments.

H. Rear Visibility System Compliance Test

A majority of comments regarding a rear visibility system compliance test related to ambient lighting conditions during test and the specific test object used. Comments regarding these issues and NHTSA's analysis of them follow.

i. Compliance Test Ambient Light Level

Given that ambient lighting conditions can affect how well a driver is able to see an in-vehicle visual display, the ANPRM solicited input regarding what ambient lighting conditions may be most appropriate for rear visibility system compliance testing. GM recommended that testing be conducted in 3 lux conditions, or the level provided in dark ambient conditions with the reverse lights operating. Sony suggested that the external ambient light level for testing should be 5 lux with reverse gear and lamps engaged. The AORC stated that tests should be conducted in a "min/max illumination condition which best simulates daytime conditions since the field data indicates this is the accident condition present and will allow the best value solution to be used." Given that 55 of the 58 SCI backover cases occurred in daylight conditions, NHTSA tends to concur with the AORC's comment on this matter. We believe that for the purpose of preventing backover crashes a worst case, "nighttime" ambient lighting condition for system compliance testing may be an unnecessarily challenging requirement.

ii. Compliance Test Object

NHTSA received many comments regarding specifications for a compliance test object. Certain features of the test object, most significantly the height, could have substantial ramifications on the burdens of compliance. Similarly, the shape and material composition of the test object would have had significant ramifications for manufacturers using sensors as a means of compliance. However, given that NHTSA is proposing a performance requirement that would most likely be met through the use of rearview video systems, the specific characteristics of the test object may not have as great of an impact on countermeasure performance (with the possible exception of the height and width of the test object). Nonetheless, we have summarized and addressed the comments on this subject below.

The ANPRM indicated NHTSA's belief, based on real world data, that the test object should simulate the physical characteristics of a toddler. Specifically in the ANPRM and again in this document, we have stated that 26 percent of victims in passenger vehicle backover crashes are 1 year old or younger. To date, NHTSA has generally used the average height of a 12-month-old child to represent a "1-year-old child" size to evaluate technologies that could be used to mitigate backover crashes. However, looking at the first 58 SCI cases shows that the average age of the 21 victims aged 1 year or younger was 15 months.[63] In their comments in response to the ANPRM, the AAM and GM recommended that the target dimensions be based on an 18-month-old child to best represent the victims involved in the first 56 documented SCI backover crash cases. Anthropometric data published by the CDC shows that the height difference between an average 15-month-old child and an average 18-month-old child is approximately 1 inch.[64] The difference in shoulder breadth for these two ages is approximately 0.2 inches. Upon further consideration of the SCI data regarding the age of victims, the fact that the small difference in size between a 15-month-old and 18-month-old child,

[63] This apparent disparity is explained by the fact that the category "1-year-old child" encompassed all children under age 2. Therefore, the average age of those children, some of whom were almost 2, and some younger than 12 months comes out to 15 months.

[64] CDC, Clinical Growth Charts. Birth to 36 months: Boys; Length-for-age and Weight-for-age percentiles. Published May 30, 2000 (modified 4/20/2001) CDC, Clinical Growth Charts. Birth to 36 months: Girls; Length-for-age and Weight-for-age percentiles. Published May 30, 2000 (modified 4/20/2001).

and the rationale provided by commenters, NHTSA agrees with the idea of basing the test object dimensions representing an average 12- to 23-month-old child using a midpoint age value of 18 months.

In the ANPRM, NHTSA suggested specific test object dimensions that correspond to a 12-month-old child. In regard to the height of the test object, NHTSA suggested in the ANPRM some specific test object dimensions that correspond to a 12-month-old child, including a height of 30 inches (0.762 meters). As stated earlier, the average height of a "1-year-old" child was used in NHTSA testing since SCI data have indicated that 26 percent of victims are 1 year of age or younger. In response to the height value suggested in the ANPRM, the AAM and GM recommended alternative heights. Specifically, GM recommended a test object height of 32 inches (81 cm). The AAM recommended specific test object dimensions of 82 cm (32.28 in) height based on 2000 CDC data for an 18-month-old child.[65] NHTSA believes that the difference between 30, 32, and 32.28 to be minimal for this purpose and in the proposal offers a compromise amongst these values.

In regard to test object width, NHTSA suggested a value of 5 inches to represent the breadth of an average child's head. In response to the suggested value, the AAM recommended an alternative test object width of 15 cm (5.9 in.) based on 2000 CDC data for an 18-month-old child.[66] NHTSA agrees and has reconsidered the size of test object needed to adequately assess system performance.

NHTSA's test data to date demonstrate that, except at the edges of the image and immediately aft of the rear bumper (*i.e.,* within 1 foot), a rearview video system generally displays the entire body of the child when present within the video camera's field of view. Since the entire body of a child standing behind the vehicle is visible with a rearview video system, the agency now believes that the test object's width should represent the width of the child's entire body, rather than just the child's head. While the average shoulder breadth of a standing 18-month-old child with their arms at their sides is approximately 8.5 inches, the absolute, overall width of an 18-month-old child standing with arms relaxed approaches 12 inches. A 12-inch test object width is currently used to represent a small child in the school bus mirror test defined under paragraph S13 of FMVSS No. 111. Furthermore, in order to perform compliance testing in regard to visual display image quality, the test object must be large enough that when displayed at substantial longitudinal range behind the vehicle the object is still large enough to be measured across its smallest dimension with some accuracy and minimal obscuration due to image graininess (for an electronic display).

V. NHTSA Research Subsequent to the ANPRM

As detailed in the ANPRM, NHTSA had conducted research to assess drivers' ability to avoid backing crashes in a controlled test involving presentation of an unexpected obstacle behind the vehicle while the driver backed out of a garage. Possible countermeasure technologies assessed in this research included a rearview video system with a 7.8-inch (measured diagonally) visual display in the center console, rearview video with a 7.8-inch in-dash visual display augmented by a separate rear parking system, and a baseline (or control group) condition in which no system was present.

The results of this research, which were presented in detail in the ANPRM, showed that drivers avoided 42 percent of crashes when a rearview video system was present and only 15 percent of crashes when both rearview video and rear object detection sensors were present on the vehicle. Without a system, all participants crashed.

While the results provided useful information regarding the potential of available technologies to aid drivers in avoiding backing crashes with unexpected obstacles, the study did not address the additional technologies being considered as a means of improving rear visibility per the Act. As a result, additional research was undertaken after publication of the ANPRM to assess drivers' ability to use a rear parking sensor system (alone), a rear-mounted convex "look-down" mirror, and rear-mounted cross-view mirrors. In addition, to assess whether display location for a rearview video system may affect drivers' performance in avoiding backing crashes using the system, drivers were also tested using rearview video systems with two sizes of in-mirror visual displays (2.4 inch and 3.5 inch). Finally, research aimed at investigating the effect of test location on results was also completed. All the research results that NHTSA has collected to date are available on the NHTSA Web site and in Docket No. NHTSA–2009–0041. A complete summary of NHTSA's research on rear visibility countermeasure technologies is presented in Section VI.

A. Rearview Video Systems With In-Mirror Visual Displays

Two rearview video system conditions were assessed: one having a 2.4-inch visual display and another with a 3.5-inch visual display. These tests used the same 2007 Honda Odyssey that was used in the previous rearview video system test, and the drivers in the tests were all drivers who personally owned a 2008 Honda Odyssey with a rearview video system with visual display (original equipment, 2.4 inch) integrated in the interior rearview mirror, to make sure that unfamiliarity with such a system was not a factor. The numbers of test participants run were 12 for the 2.4-inch display and 10 for the 3.5-inch display. The test results showed very different results between the two visual display sizes. Thirty-three percent of subjects driving vehicles equipped with a rearview video system with 2.4-inch visual display avoided crashing into the obstacle. However, 70 percent of subjects driving vehicles equipped with a rearview video system with 3.5-inch visual display avoided a crash. However, despite the observed 37 percent more crashes avoided with the larger in-mirror display, the result was not found to be statistically significant due to the relatively small sample size of subjects tested.[67] Across all system conditions tested, the rearview video system with 3.5-inch visual display proved to be the one with which drivers avoided the most crashes.

B. Rear-Mounted Convex Mirrors

A similar test was conducted with rear-mounted convex "look down" mirrors and rear cross-view mirrors. These tests also used the 2007 Honda Odyssey and were conducted using owners of this type of vehicle. Since no vehicle sold in the U.S. is known to offer rear convex look-down mirrors as original equipment, an aftermarket mirror was used. To provide the test participants in this system condition with some experience using the mirror (before they were presented with the

[65] CDC, Clinical Growth Charts. Birth to 36 months: Boys; Length-for-age and Weight-for-age percentiles. Published May 30, 2000 (modified 4/20/2001) CDC, Clinical Growth Charts. Birth to 36 months: Girls; Length-for-age and Weight-for-age percentiles. Published May 30, 2000 (modified 4/20/2001).

[66] CDC, Clinical Growth Charts. Birth to 36 months: Boys; Length-for-age and Weight-for-age percentiles. Published May 30, 2000 (modified 4/20/2001) CDC, Clinical Growth Charts. Birth to 36 months: Girls; Length-for-age and Weight-for-age percentiles. Published May 30, 2000 (modified 4/20/2001)

[67] In2010, NHTSA intends to conduct additional trials of this experiment to obtain more data in an effort to attain statistical significance.

unexpected obstacle event), the mirrors were installed on their vehicles for 4 weeks prior to the test event.[68] During the test procedure, none of the thirteen participants that participated in the study successfully avoided the unexpected obstacle, giving a driver performance factor of zero.

A similar test was conducted with rear cross-view mirrors. This test condition involved use of a 2003 Toyota 4Runner, which is the only vehicle sold in the U.S. known to offer rear convex cross-view mirrors as original equipment. Test subjects were owners of a 2003–2007 Toyota 4Runner who had owned and driven the vehicle for at least 6 months. During the test procedure, none of the seven participants that participated in the study successfully avoided the unexpected obstacle, giving the rear cross-view mirror system a driver performance factor of zero.

C. Rear Sensor Systems

Using the same unexpected obstacle event scenario, NHTSA tested fourteen drivers of vehicles equipped with a rear parking sensor system. This system involved use of a 2009 Ford Flex with an original equipment rear parking aid system using ultrasonic sensors. As with the testing of the other system types, drivers of the Ford Flex with sensor-based rear parking aid system were persons who owned the vehicle and had driven it as their primary vehicle for at least 6 months, so that they would be familiar with the system. During the test, the parking aid system on this vehicle detected the plastic obstacle and produced an auditory warning in 100 percent of trials. This detection rate was significantly better than the 39 percent detection rate observed in the NHTSA's prior testing that used an identical scenario but a different test vehicle.[69] Despite the consistent rate of object detection demonstrated by the Ford Flex rear parking sensors, only one test subject in this system condition successfully avoided crashing into the obstacle, resulting in only 7 percent of crashes avoided. However, we note that all of the participants braked slightly, and four came to a momentary, complete stop before resuming rearward motion and crashing into the obstacle.

D. Ability of Currently Available Sensor Technology To Detect Small Child Pedestrians

NHTSA's 2009 continuation of research to examine drivers' ability to avoid backing crashes used a 2009 Ford Flex equipped with a rear parking system. As noted in Section C above, this vehicle exhibited a 100-percent detection rate for the plastic obstacle used in the final conflict scenario. Given the improved detection performance seen with this ultrasonic-based sensor system over prior testing results using other ultrasonic systems, NHTSA thought it appropriate to assess this system's ability to detect small children.

Using a protocol developed previously and documented,[70] NHTSA conducted static and dynamic tests using young children and recorded the sensor system's ability to detect the children. Testing was conducted with two 1-year-old children and four children aged approximately 3 years. Tests with 1-year-old children included standing, walking laterally, and riding a wheeled toy that was towed (by test staff) laterally behind the vehicle. Tests with the 3-year-old children included standing, walking laterally, running laterally, and riding a wheeled ride-on toy behind the vehicle.

Testing showed that the 1-year-old children were detected in 100 percent of trials at a range of 1, 2, or 3 feet behind the vehicle when walking or riding on the wheeled toy. At a range of 4 feet, the 1-year-old children were detected in 4 of 6 trials (67 percent) when walking, but were not detecting at 4-foot range when riding the wheeled toy.

The 3-year-old children were found to be detected out to a range of 6 feet. Table 8 below summarizes the results for these tests and shows strong detection performance out to a range of 3 feet, as was seen for the younger children. However, detection performance appears to decline significantly at the 4-foot range.

TABLE 8—2009 FORD FLEX REAR SENSOR SYSTEM DETECTION PERFORMANCE WITH 3-YEAR-OLD CHILDREN

Longitudinal range from rear bumper face	Walking (%)	Running (%)	Ride-on toy (%)
1 ft	100	100	100
2 ft	100	100	100
3 ft	100	67	87
4 ft	40	13	47
5 ft	20	0	0
6 ft	20	0	0

These tests demonstrated improved consistency of detection over results from past NHTSA testing of ultrasonic-based sensor systems. However, the short detection range for young children is insufficient for the purposes of backover mitigation. NHTSA notes, however, that as with research results described in the ANPRM, all systems tested were designed as parking aids and were not intended to be used for the purpose of detecting children.

VI. Countermeasure Effectiveness Estimation Based on NHTSA Research Data

Three conditions must be met for a rear visibility technology to provide a benefit to the driver. First, the crash must be one that is "avoidable" through use of the device; *i.e.,* the pedestrian must be within the target range for the sensor, or the viewable area of the camera or mirror. Second, once the pedestrian is within the system's range, the device must "sense" that fact, *i.e.,* provide the driver with information about the presence and location of the pedestrian. Third, there must be sufficient "driver response," *i.e.,* before impact with the pedestrian, the driver must receive this information and respond appropriately by confirming whether someone is or is not behind the vehicle before proceeding. These factors are denoted as f_A, f_S, and f_{DR}, respectively, in this analysis. Their product is the final system effectiveness.

This three-phase concept is depicted in Figure 3 below for both sensor-based systems and visual systems (*i.e.,* rearview video systems, mirrors).

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[68] In order to conceal the fact that this was an experiment in rear obstacle detection, participants were told that recording devices were installed in the rear mirror.

[69] Mazzae, E.N., Barickman, F.S., Baldwin, G. H.S., and Ranney, T.A. (2008). On-Road Study of Drivers' Use of Rearview Video Systems (ORSDURVS). National Highway Traffic Safety Administration, DOT 811 024.

[70] Mazzae, E.N. and Garrott, W.R., Experimental Evaluation of the Performance of Available Backover Prevention Technologies, NHTSA Technical Report No. DOT HS 810 634, September 2006, and Vehicle Backover Avoidance Technology Study, Report to Congress, November 2006.

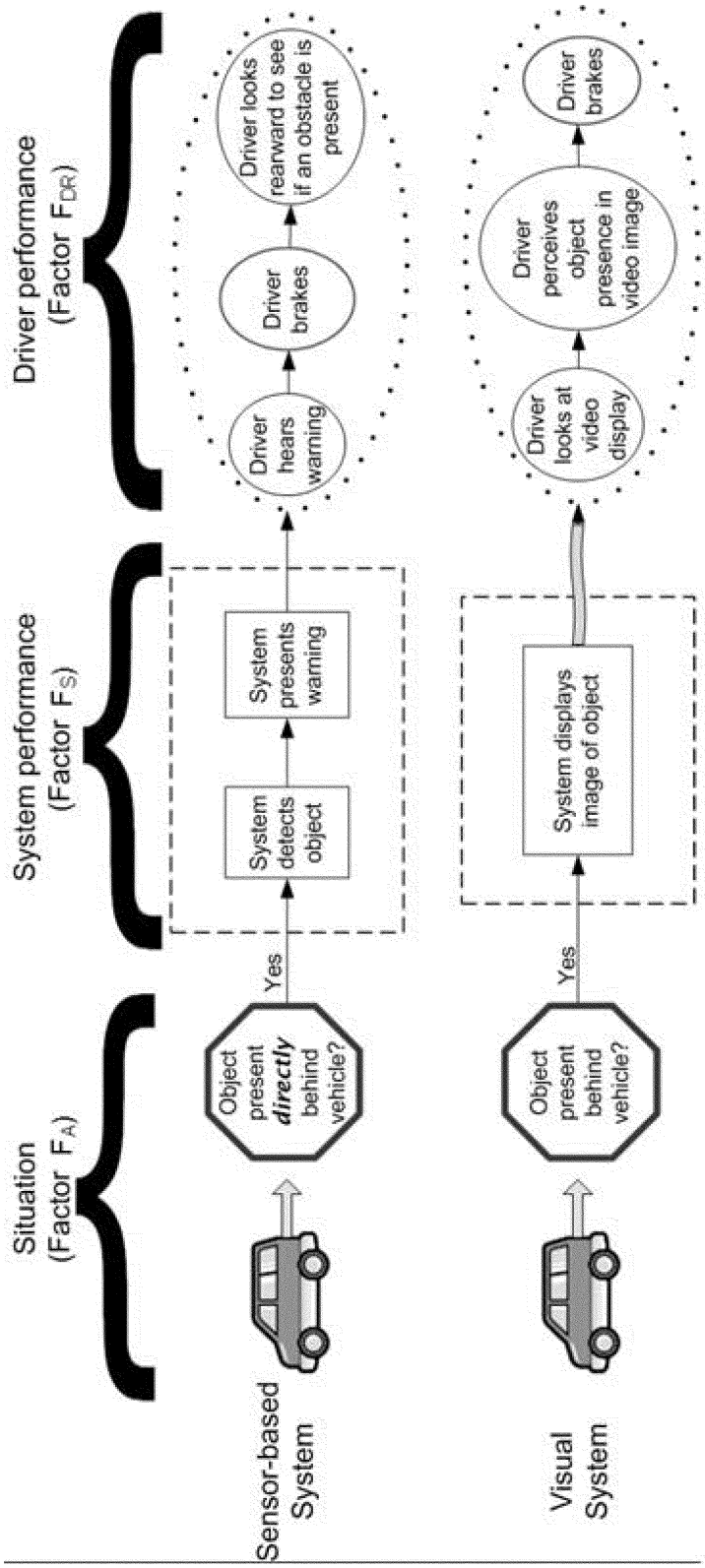

Figure 3. Overall Effectiveness Methodology Illustration

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Based on this general description of the process of avoiding a backing crash, NHTSA has developed overall effectiveness of various backover countermeasure technologies using three individual factors. First, SCI backover incident reports were examined to characterize the geometry of the specific situations in which a backing vehicle struck a pedestrian or cyclist to determine if the backover

crash was conceivably avoidable using a given technology and standard vehicle equipment (*i.e.,* required rearview mirrors). We call this the "avoidability" of the backing conflict situation, or factor "F_A" depicted in the figure above. Second, we estimated the probability that a countermeasure could sense and warn the driver of the rear obstacle, which we call "system performance," or factor "F_S" in the figure above. Finally, we determined the likelihood of a driver responding appropriately to information provided by the system to successfully avoid a backing crash. We call this "driver reaction," depicted above as factor "F_{DR}." If an obstruction in the path of a backing vehicle is avoidable, detectable, and a driver reacts appropriately, a backover crash will be avoided. Therefore, the "overall effectiveness" of the system is calculated by multiplying F_A, F_S, and F_{DR} together. The derivation of these three factors is described below.

A. Situation Avoidability

Factor "F_A" was derived by determining the "avoidability" of a backover crash. In order to better understand how avoidable these situations are, NHTSA closely reviewed the SCI backover case reports. By qualitatively analyzing the case reports, NHTSA assessed a variety of factors concerning the case and how they contributed to "avoidability", including:

- Original and final position of the vehicle.
- Vehicle speed.
- If the victim was conceivably visible through direct vision or indirectly using the vehicle's mirrors given the visual aspects of the environment surrounding the vehicle during the backing maneuver (*i.e.,* was the area clear of visual obstructions?).
- Position of the victim with respect to the vehicle.
- Size, orientation (*i.e.,* standing, sitting), and movement of the victim.
- If the victim was detectable given the detection characteristics of a given technology.
- If the vehicle could have stopped in time given typical system performance for that technology (based on results of NHTSA testing of system capabilities).

NHTSA used a general process to determine if a crash was avoidable. We examined the system detection zone, vehicle blind zone area, and visible areas surrounding the vehicle. If the pedestrian or cyclist was detectable either visually or by a sensor-based system, then what followed was a cataloguing of all the impediments to a typical, reasonable driver reacting in time after receiving a warning or recognizing a pedestrian or cyclist seen on a rearview video system display.

While many backover crashes are theoretically avoidable, certain characteristics render some incidents impossible to prevent using rear object detection technology, even if the technology and the person using it act appropriately. Consider, for example, a situation where a vehicle is backing along a wall. If a child walks through a gap in the wall and enters the vehicle's path less than 2 feet from the vehicle, the backover would be judged "unavoidable." This is because no known technology could have detected the child through the wall, and no car could brake fast enough to stop in time to avoid the child, once he became visible.

Some backover crashes are avoidable for certain technologies, but not for others, a function that generally corresponds to the detection range of the rear visibility countermeasure. For example, an ultrasonic sensor might have an effective range of only 6 feet, while a rearview video system might be able to effectively display a child positioned 20 feet behind a vehicle. If a vehicle were backing at a relatively high speed toward a child, it might take 10 feet once the brakes were applied to stop the vehicle. In that case, the backover crash would be unavoidable for the vehicle equipped with the sensor system, because it could have only detected the child at 6 feet. On the other hand, the same backover situation would be considered an "avoidable" incident for a vehicle equipped with the rearview video system. This is why the "F_A" factor differs for different technologies.

We note, of course, that merely because a backover crash is avoidable does not mean it will be avoided. Furthermore, drivers differ in their tendencies to check rearview mirrors and rearview video system displays, and may not always react perfectly and with sufficiently fast reaction time. However, those factors are addressed in the two sections below. The avoidability of a situation merely describes whether backover avoidance technology could have had any effect at all on the outcome of the conflict situation.

Based on our analysis of the SCI data, we have derived the following values for the percent of backover crashes that are avoidable using various technologies. Rear-mounted mirrors could prevent up to 49 percent of backover crashes. Sensor technology, on average, could have prevented up to 52 percent of backover crashes. For a rearview video system, NHTSA's analysis concluded that up to 76 percent of backover crashes were avoidance with a 130-degree camera lens and 90 percent of backover crashes were avoidable with a 180-degree camera lens, through which more pedestrians could be seen approaching from the sides of the vehicle.

B. System Performance

Factor "F_S" was derived by determining the ability of the system to detect or display a rear obstacle based on the results of comprehensive NHTSA testing of systems' ability to detect various objects in a laboratory setting. Since mirrors and rearview video systems have the ability to display anything within their field of view, we used a figure of 100 percent effectiveness.[71] Sensors, however, may not always detect an obstacle behind the vehicle, even when the object is within their specified detection zone. This may be the result of the reflectivity of the obstacle, such as if a child's clothing is textured and therefore absorbs the ultrasonic signal. Our specific value for sensor system performance is based on research described at length in the ANPRM. In NHTSA's 2007 study of drivers' ability to avoid a backing crash with an unexpected obstacle while driving a vehicle equipped with a rearview video system either alone or in conjunction with a rear parking system, the sensor-based system detected the rear obstacle in 39 percent of test trials.[72] This value represents the system performance of sensor-based systems in the calculation of overall effectiveness presented in this notice.

C. Driver Performance

Factor F_{DR} represents the degree to which drivers may use the various possible backover avoidance countermeasures to successfully avoid a crash. Unlike many other safety technologies, these countermeasures are only effective at preventing vehicle crashes if they are understood, trusted, and used by drivers. This is a particularly important issue considered in this rulemaking. Currently, drivers are most familiar with the interior and side rearview mirrors required or permitted by FMVSS No. 111. Signals from sensor-based rear object detection systems and images from new mirrors and rearview video system visual

[71] While we realize a component of a rearview video system could malfunction or break or a mirror could break or be misaligned, for purposes of our analysis, we assume they, and sensors, are functioning properly.

[72] Mazzae, E.N., Barickman, F.S., Baldwin, G.H. S., and Ranney, T.A. (2008). On-Road Study of Drivers' Use of Rearview Video Systems (ORSDURVS). National Highway Traffic Safety Administration, DOT 811 024.

displays must be noticed, understood, and reacted to by the driver in order to avoid a crash. A system merely detecting or displaying the obstacle in the path of the vehicle is not enough to avoid a crash.

NHTSA has differing concerns related to all three types of technologies currently available for informing a driver of the presence of an obstacle behind a vehicle. With regard to rear-mounted convex mirrors, the primary concern is that the images they provide are too distorted to permit the driver to discern an obstacle within the image. In addition, the range that mirrors display behind the vehicle may be insufficient to allow a driver time to brake to a stop once the driver sees the rear obstacle. With all sensors, drivers may tend to not trust the warnings provided because they may not be able to visually confirm that an obstacle is present in the vehicle's rear blind zone. In addition, if a system is prone to frequent false positive signals, this may cause drivers to ignore, or even turn off, the system, a concern echoed by several commenters. Finally, we are concerned that drivers may have difficulty integrating glances at a rearview video system visual display into their normal glance patterns while backing, focusing more on direct view (glancing rearward over their shoulder) or existing mirrors. In this section, we present the driver performance research that NHTSA has conducted and continues to conduct on currently available system types that are relevant to backover avoidance.

As described in the ANPRM and in Section V of this notice, NHTSA conducted research [73] to assess drivers' ability to avoid backing crashes in a controlled test involving presentation of an unexpected obstacle behind the vehicle while the driver backed out of a garage. The tests were designed so that the crash was always preventable (*i.e.,* an "F_A" factor of 100%) for drivers of vehicles equipped with a countermeasure system. Drivers in the baseline condition whose vehicles were only equipped with standard rearview mirrors could not see the rear obstacle and therefore it was nearly impossible for them to avoid a crash (and none did). The tests were also designed such that the obstruction was detectable by the countermeasure [74] in every trial (*i.e.,* a "F_S" factor of 100%). Therefore, any failure of the driver to avoid crashing into the obstacle should be attributable solely to the driver performance factor.[75] Therefore, NHTSA believes that these experiments isolated, to the extent possible, the effects of driver performance in avoiding a backing crash.

Table 9 summarizes the comparative driver effectiveness results for each of the seven systems assessed. This is how the various "F_{DR}" factor figures were derived, which are used in the overall effectiveness calculations, described below.

TABLE 9—SUMMARY OF CRASH RESULTS IN UNEXPECTED OBSTACLE EVENT BY SYSTEM TYPE

Technology	N	Number of crashes	Driver performance ("F_{DR}" factor) (%)
No system	12	12	0
Rear-mounted convex mirrors	13	13	0
Rear cross-view mirrors	7	7	0
Sensors (ultrasonic and radar) [76]	14	13	7
Rearview video, in-dash, combined with ultrasonic sensors	13	11	15
Rearview video, in-mirror, 2.4-inch display	12	8	33
Rearview video, in-mirror, 3.5-inch display	10	3	70
Rearview video, in-dash	12	7	42

NHTSA[76] has recently completed the third in a series of three studies that examined drivers' use of backing aid systems to avoid crashes while backing. Backing aid systems examined in the studies included rearview video (RV) systems with different display sizes and locations, rear sensor-based systems (RPS), and a combination system having both rearview video and rear sensors. For the five "system" conditions examined in both laboratory (studies 1 and 2) and non-laboratory (study 3, daycare parking lot) settings, the relative crash rates were consistent. Given this observation, once our reduction of the data is complete, we will place these results in the docket and incorporate them for the final rule.

D. Determining Overall Effectiveness

Based on the above strategy of defining the components of effectiveness, we can estimate the overall effectiveness of each of the possible backover avoidance countermeasures examined. Overall, NHTSA's research showed that out of all technologies tested, rearview video systems were the most effective in aiding drivers to avoid backing crashes. With rear-mounted convex mirrors, the research showed that drivers were not inclined to use them in backing situations, presumably due to image distortion and limited range. While sensors may have the potential to show benefits, the research demonstrated that without visual confirmation, drivers tended not to believe the warnings provided by the sensor system, and continued the backing maneuver in spite of the warning. The agency requests comments on what steps could be taken and at what cost and with what consequences to improve the range and sampling rate of sensors, to address problems with detecting pedestrians wearing low reflectivity clothing and to improve driver response to sensor provided warnings. What sort of performance requirement would be needed to ensure that sampling frequency would be increased sufficiently? However, rearview video systems examined were able to consistently display the rear obstacles to the drivers, as well as enable and induce

[73] Mazzae, E.N., Barickman, F.S., Baldwin, G.H.S., and Ranney, T.A. (2008). On-Road Study of Drivers' Use of Rearview Video Systems (ORSDURVS). National Highway Traffic Safety Administration, DOT 811 024.

[74] This means that the obstacle's image either appeared on the mirror surface, was visible on a rearview video system visual display. For sensors, the obstacle as positioned at the centerline of the vehicle was assumed to be detectable by the system.

[75] However, the ultrasonic sensor-based system used in this testing was found to only detect the centered obstacle in 39 percent of trials.

[76] A radar-based sensor system was not assessed in this test, however, for the purposes of assessing driver performance, sensor technology was deemed not critical in this research.

drivers to avoid them. Table 10 below summarizes these results.

TABLE 10—SUMMARY OF OVERALL EFFECTIVENESS VALUES BY SYSTEM TYPE

System	F_A(%)	F_S(%)	F_{DR}(%)	Final effectiveness (%) $F_A \times F_S \times F_{DR}$ = FE
180° Camera	90	100	55	49
130° Camera	76	100	55	42
Ultrasonic	49	70	7	2.5
Radar	54	70	7	2.7
Mirrors	*33	100	**0	0

* F_A for mirrors is taken from separate source due to lack of inclusion in the SCI case review that generated F_A for cameras and sensors.
** F_{DR} for mirrors is taken from a small sample size of 20 tests. It is 0% because throughout testing, drivers did not take advantage of either cross-view or lookdown mirrors to avoid the obstacle in the test.

VII. Proposal To Mandate Improved Rear Visibility

Based on the comments on the ANPRM and NHTSA's research on the various means available to mitigate backover crashes, NHTSA has developed the following proposal to improve light vehicle rear visibility. The proposal is based in part on our tentative conclusion that drivers need to be able to see a visual image of a 32-inch tall cylinder with 12-inch diameter behind the vehicle over an area 5 feet to either side of the vehicle centerline by 20 feet in longitudinal range from the vehicle's rear bumper face. We are also proposing to specify certain performance criteria for visual display performance, such as luminance and rearview image response time, which are detailed below, as well as durability requirements. We believe that these specifications are necessary to ensure robust and effective performance.

These proposed improvements would apply to all passenger cars, MPVs, trucks, buses, and low-speed vehicles with a GVWR of 10,000 pounds or less. Based on the substantial numbers of fatalities and injuries involving light vehicles other than LTVs, we are not proposing to limit these more stringent rear visibility performance requirements to LTVs only. Further, despite NHTSA's decision to propose a requirement for improved rear visibility for nearly all light vehicles, we have included in the preliminary regulatory impact analysis an economic analysis of an alternative in which only LTVs are subjected to these requirements. We invite comments on this additional analysis.

In the near term, we believe that existing rearview video systems can be used to meet the requirements with minimal or no modifications. While we recognize that there are significant costs involved in addressing the safety problem at issue using rearview video systems, we believe that our research shows that rearview video systems currently represent the most effective technology to address the problem of backover crashes. This is because rear-mounted convex mirrors and sensor-based object detection systems offer few benefits compared to rearview video systems due to system performance and driver use issues. As we have previously said, use of a blind zone area threshold to focus the improve visibility requirements on vehicles with large rear blind zone areas, and presumably high backover crash rates, from these enhanced rear visibility requirements lacks a sufficient statistical basis while adding problematic issues. Some vehicles with comparatively small blind zones had high rates of backover incidents. Similarly, limiting countermeasures to LTVs, such as vans, multipurpose passenger vehicles, and trucks with a GVWR of 10,000 pounds or less, would leave large gaps in safety protection as well as a disparity in quality of rear visibility between these vehicles and passenger cars.

In response to the suggestion of many commenters that, regardless of how broadly or narrowly the performance requirements are applied within the population of light vehicles, the requirements be technology-neutral, we believe we need to consider the practical consequences that adopting a technology neutral approach would have not only for the first phase of a backover crash, but also for each of the later phases. Adequate performance at the initial phase does not necessarily assure adequate performance at a later phase. The ultimate safety test of a technology in the context of this rulemaking is whether the technology enables the driver to detect the presence of a pedestrian in or near the path of the driver's backing vehicle *and* whether drivers use the technology and succeed in avoiding backover crashes.

Under our proposal, current rear object detection sensors and rear-mounted convex mirrors would not be sufficient as stand-alone technologies to meet the proposed rear visibility requirement. This is because sensors and mirrors, while able to detect pedestrians to some degree, simply do not induce the driver response needed to prevent backover crashes. NHTSA research indicates that the presence of a system consisting of rear-mounted convex mirrors was statistically equivalent to the absence of any system at all for seeing pedestrians behind a driver's vehicle. Therefore, we do not believe that any benefits would accrue from installation of rear-mounted convex mirrors.

With regard to sensors, our research shows [77] that, in the vast majority of cases, a sensor-activated warning of the presence of an obstacle will not lead to a successful (*i.e.,* timely and sufficient) crash avoidance response from the driver unless the driver is also provided with visual confirmation of obstacle presence. Because of this apparent need for visual confirmation and that the fact that sensors induced a successful driver reaction only 7 percent of the time in NHTSA testing, we do not believe it is in the best interest of safety to propose allowing systems that rely on sensors alone.

However, we note that we are not proposing to disallow sensor systems as a supplement to rearview video systems. While NHTSA research[78] showed 27 percent worse driver crash avoidance performance in a vehicle equipped with both a rearview video system and rear sensors than in a vehicle with only rearview video, deficiencies in the performance of the sensor system may have confounded the isolation of driver performance. It is thus unclear to what extent the presence of sensors may

[77] Research by GM also showed this apparent tendency of drivers to want visual confirmation of obstacle presence.

[78] Mazzae, E.N., Barickman, F.S., Baldwin, G.H.S., and Ranney, T.A. (2008). On-Road Study of Drivers' Use of Rearview Video Systems (ORSDURVS). National Highway Traffic Safety Administration, DOT 811 024.

induce some drivers to rely on the sensors to some extent instead of relying exclusively on close and uninterrupted monitoring of the video display. To the extent that drivers rely on sensors and to the extent that the sensors fail to detect objects, driver crash avoidance performance will worsen. We seek comment on this issue. Furthermore, the cost of a combined rearview video and sensor system would be higher than that of a rearview video system alone.

Finally, while NHTSA is not at this time proposing to mandate advanced multi-technology countermeasure systems, we note that research continues. These systems may include video-based systems with real-time image processing for object detection and combinations of sensors and video cameras, some of which (detailed by commenters) include sensor-based graphic overlays superimposed over visual images from rearview video systems. Advances like infrared detection, automated braking, and backing speed limitation were all concepts raised either by commenters or NHTSA analysis.

A. Proposed Specifications

Our general approach in developing performance requirements was to consider the various phases of backover crashes and identify key areas of performance pertinent to overall system effectiveness. In the absence of existing consensus industry standards, we reviewed existing systems and determined which aspects of performance should be addressed in the regulatory text of this proposal. Based on the systems we have tested and comments on the ANPRM, we believe that existing systems generally meet our proposed specifications and in cases in which they do not, changes could be made with minimal cost impact. For example, it is likely that existing systems would meet our durability requirements because they are typically subjected to vehicle level tests involving harsher conditions than we are proposing. Both vehicle and equipment manufacturers cited low warranty claim rates for rearview video systems in their comments. This indicates to us that today's systems are proving durable in typical driving conditions. Similarly, while some current systems would not satisfy our maximum image response time requirement, a change to the vehicle to prioritize display of the rearview video image over navigation software would significantly improve image response time with minimal cost.

i. Improved Rear Field of View

To determine the appropriate minimum width of the required visible area, NHTSA reviewed both available SCI backover case data and our Monte Carlo analysis of backover crash risk as a function of pedestrian initial location. While some small risk exists as far as 9 feet laterally to the left and right of a rearward extension of a vehicle's longitudinal centerline, the vast majority of the risk is concentrated within a 10-foot wide area that extends symmetrically only 5 feet laterally to either side from the extended centerline. Accordingly, NHTSA proposes that the required area of improved visibility be this 10-foot wide area that is centered on the vehicle's centerline.

To determine the appropriate minimum longitudinal range (*i.e.,* length) of the area that should be specified to maximize the feasibility and effectiveness of the proposal in reducing backover crashes, NHTSA considered comments on the ANPRM, SCI backover case data, and the results of our Monte Carlo analysis. Using the 58 SCI backover cases, NHTSA examined the distance the vehicle traveled prior to striking the pedestrian. Figure 4 shows the percent of cases encompassed by various ranges of longitudinal distance. These data show that in 77 percent of SCI backover cases the vehicle traveled 20 feet or less before striking the victim. The Monte Carlo analysis of backover crash risk as a function of the pedestrian's initial location used a distribution of actual backing maneuver travel distances based on those observed in naturalistic backing maneuvers made by test participants in NHTSA's research study that examined drivers' use of rearview video systems.[79] The Monte Carlo analysis, which was outlined in Section II.C.v, indicated based on computer simulation that the highest risk for pedestrians being struck is within a range of 33 feet aft of the rear bumper. Given that actual backover SCI case data are available, NHTSA proposes a longitudinal range for rear visibility coverage of 20 feet extending backward from the rearmost point of the rear bumper based on those rear-world data.

[79] Mazzae, E.N., Barickman, F.S., Baldwin, G.H.S., and Ranney, T.A. (2008). On-Road Study of Drivers' Use of Rearview Video Systems (ORSDURVS). National Highway Traffic Safety Administration, DOT 811 024.

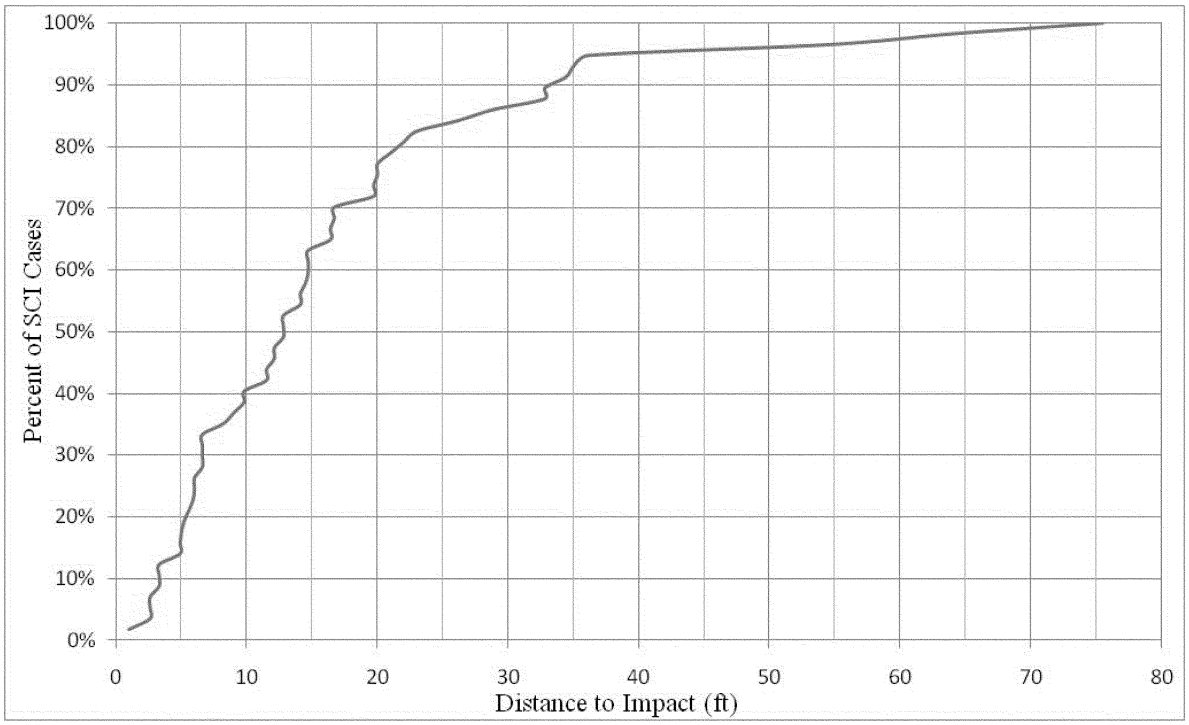

Figure 4. Percent of SCI Backover Cases as a Function of Distance to Impact

To ensure adequate visibility of this area, the agency is specifying the placement of seven test objects (cylinders) within the area. Given the size of the area and the locations of the cylinders within the area, we believe that a view of the entire area can be captured through the installation of a single video camera that has a minimum 130-degree horizontal angle and is located at or near the centerline of the vehicle. For that reason, NHTSA's analysis has used the estimated costs and benefits of a rearview video system with a 130-degree video camera.

ii. Visual Display Requirements

The following sections describe the proposed requirements for visual displays used to present images of the area behind a vehicle. NHTSA believes these requirements are important to achieving reasonable system effectiveness. Further, we note that one potential concern expressed to NHTSA is that specifying requirements could increase costs for display manufacturers by requiring them to conduct expensive certification tests of equipment. We note that the requirements proposed today are vehicle requirements, not equipment requirements, and so we do not believe that equipment manufacturers will be unduly burdened.

a. Rearview Image Size

NHTSA is proposing a performance requirement of at least 5 minutes of arc [80] for the displayed size (*i.e.,* how large the cylinders appear) in the rearview image of three test cylinders (cylinders A, B, and C) that are located 20 feet aft of the rearmost point on the vehicle's rear bumper. Specifically, we are proposing to require that when the images of these three test cylinders are measured, the average size of the three displayed test cylinders must not be less than 5 minutes of arc. Additionally, the displayed size of each of the three displayed test cylinders individually must not be less than 3 minutes of arc. NHTSA does not believe that there is a need to propose displayed size requirements for any of the other test cylinders, because the three furthest test objects will always appear the smallest, thus representing the worst case visually observable condition for the 7 cylinders, and any additional measurements would be an unnecessary burden.

The reason for proposing 5 minutes of arc for the average displayed size of the test cylinders is that NHTSA believes this is the minimum size needed for non-professional drivers to distinguish and react to images. The 3 and 5 minutes of arc figures are based on research originally published by Satoh, Yamanaka, Kondoh, Yamashita, Matsuzaki, and Akisuzuki in 1983.[81] Satoh et al examined the relationship between an object's subtended visual angle [82] at a person's eyes and a person's subjective ability to see the object and to make judgments about what he or she is seeing. Satoh asserted that an object must subtend at least 5 minutes of arc for a person to be able to make judgments about the object.

To date, NHTSA has based its requirements for minimum image size (the minimum subtended visual angle at the driver's eyes) on the Satoh et al. research. The school bus cross view mirror requirements in FMVSS No. 111 are based in part on the Satoh

[80] A minute of arc is a unit of angular measurement that is equal to one-sixtieth of a degree.

[81] Satoh, H., Yamanaka, A., Kondoh, T., Yamashita, M., Matsuzaki, M., and Akisuzuki, K., "Development of a Periscope Mirror System," *JSAE Review,* November 1983.

[82] The angle which an object or detail subtends at the point of observation; usually measured in minutes of arc. If the point of observation is the pupil of a person's eye, the angle is formed by two rays, one passing through the center of the pupil and touching the upper edge of the observed object and the other passing though the center of the pupil and touching the lower edge of the object.

research.[83] For example, paragraph S9.4 of FMVSS No. 111 requires a school bus cross-view mirror to show the driver a specified child surrogate test object located at a specified location with a subtended visual angle of at least 3 minutes of arc for the worse case test object, cylinder "P". The rationale for using a visual angle value less than 5 minutes of arc for the school bus mirror requirements is threefold.

First, school bus drivers must be specially licensed before they can drive a school bus carrying children. They are required to obtain a Commercial Drivers License with a School Bus Endorsement. The training required to obtain this special license and the necessity of being vigilant in all types of crashes in order to retain their license and employment is expected to increase school bus drivers' awareness of the possibility of pedestrians suddenly entering danger areas around their bus. The combined effect of this training and the necessity for attentiveness is expected to encourage drivers to pay more attention to small images that are visible in a bus's mirrors.

Second, school bus drivers are specifically trained in the use of their bus's cross view mirrors. In the late 1980's, when the school bus cross-view mirror requirements of FMVSS No. 111 were being developed, 49 states plus Washington, DC[84] required annual training for all school bus drivers in the use of their bus's cross view mirrors. This training is expected to allow drivers to make better use of very small images that they see.

Third, school bus cross-view mirrors are intended to be used before the bus begins to move, while the bus is stationary. As a result, drivers can take as much time as they need to determine what they see in their bus's cross-view mirrors. In contrast, in the passenger vehicle environment, drivers may use the display while the vehicle is stationary and while the vehicle is in motion backing up (albeit at fairly low speeds). As a result, drivers may have limits on the amount of time that they may use to determine what they are seeing in a rearview video display. Again, this argues for a larger minimum image size requirement.

NHTSA considered whether the image size criterion used for school bus cross-view mirror requirements currently in FMVSS No. 111 should also be applied to rearview images required for passenger vehicles. After careful consideration, NHTSA has concluded it is appropriate to propose a stronger requirement for passenger vehicles since passenger vehicle drivers do not have the same vehicle and system (*e.g.,* mirror use) training as school bus drivers do, nor do passenger vehicles typically use the systems in a stationary scenario. Based on this, the Satoh-recommended 5 minutes of arc subtended visual angle requirement is warranted and therefore recommended as a minimum performance requirement.

Based upon NHTSA test data from an examination of a 2007 Honda Odyssey minivan fitted both with an original equipment (from a 2008 Honda Odyssey) 2.4-inch diagonal rearview video display and an original equipment 3.5-inch diagonal rearview video display (from a GM vehicle), NHTSA estimates that a 2.8-inch or larger diagonal rearview video display in the interior rearview mirror would be necessary to meet the proposed 5 minutes of arc requirement for this vehicle.

b. Image Response Time

Image response time is the time delay between the moment the vehicle's transmission is shifted into reverse gear, and the moment which an image to the rear of the vehicle is displayed. For vehicles in which an existing navigation system visual display is used to display a rearview video image, we believe that adopting a maximum image response time value will prevent manufacturers from giving priority, at ignition, to the loading of navigation system applications instead of the rearview video applications. We believe that giving display priority to a rearview video system image should increase the effectiveness of such systems in preventing backing crashes. As stated previously, NHTSA is concerned that if the display takes too long to appear, drivers will be more likely to begin a backing maneuver before the image of the area behind the vehicle is displayed. Given the importance of the "initial check" behind the vehicle, a long image response time could have a strong negative effect on the overall effectiveness of a rearview video system. As an appropriate balance between the importance of a quickly provided image and the need for sufficient opportunity to conduct system checks as noted in the ANPRM comments (see section IV.G), NHTSA proposes a 2.0-second maximum image response time after the vehicle's transmission is shifted into reverse based on the minimum time in which such system checks can be conducted.

c. Image Linger Time

Image linger time refers to the period in which the rearview video image continues to be displayed after the vehicle's transmission has been shifted out of reverse gear. In the ANPRM, NHTSA indicated that a maximum of 8 seconds of linger time may be appropriate after the vehicle is shifted from the reverse position. Based on their observations of drivers making parking maneuvers, the AAM recommended a maximum linger time of 10 seconds or an alternative speed-based value in which the rearview video display would turn off when the vehicle reach a speed of 20 kph (12.4 mph).Similarly, GM recommended a maximum linger time of 10 seconds or a speed-based limit of 5 mph (8 kph). Based on commenters' findings regarding actual, observed maneuver durations, NHTSA is proposing a time-based maximum linger time of 10.0 seconds to better aid to the driver.

d. Visual Display Luminance

We believe it is appropriate to adopt a minimum visual display luminance value to ensure that the rearview video system visual display image is adequately visible in varying conditions, such as bright sunlight or low levels of ambient light. Adequately visible, in this case, would mean that a driver can discern the presence of and identify obstacles displayed within the rearview video image. Gentex recommended that a brightness level of 500 cd/m^2 for in-mirror displays as measured at room temperature and in a dark room, and said that it has been confirmed by vehicle manufacturer research to be the minimally accepted value, presumably to account for a wide possible range of ambient conditions. Therefore, we are proposing a minimum visual display luminance requirement of 500 cd/m^2 for rearview image displays.

e. Other Aspects of Visual Display

NHTSA also requires comments regarding other aspects of visual display and image quality performance such as image resolution, minification, distortion, contrast ratio and low-light performance as well as regarding display location. While existing systems may perform well with regard to these aspects of performance, there is no certainty that future systems will be designed to perform as well. Depending on the public comments and other available information, we may include requirements on some or all of these aspects of performance in the final rule.

[83] Garrott, W.R., Rockwell, T.H., and Kiger, S.W. (1990). Ergonomic Research on School Bus Cross View Mirror Systems. National Highway Traffic Safety Administration, DOT 807 676.

[84] California had no such requirement.

If we were to include requirements for some aspects, how should those aspects be regulated, at what level of stringency, and why? For example, what test procedures should be used for measuring these aspects of performance? Do any existing voluntary consensus standards have test procedures that would be appropriate for assessing performance?

iii. Requirements for External System Components

We believe that for rear visibility systems to be effective in preventing real-world crashes, it is imperative that they perform across a wide range of environments typically encountered by drivers. For example, such systems should operate in various temperature ranges and should not be rendered inoperable by conditions such as rain or normal corrosion.

As part of our technical review, we considered the possibility of adopting requirements from industry consensus standards. Unfortunately, such standards do not currently exist as manufacturers have indicated they consider their internal technical specifications for such systems to be proprietary. It is the agency's understanding that no such industry consensus standards will be developed and available for consideration within the timeframe of the current rulemaking process.

Therefore, we reviewed existing requirements in our safety standards for other vehicle equipment in these areas. We believe there is merit in reviewing existing requirements for exterior motor vehicle equipment, such as lighting, particularly because components such as video cameras utilized in rearview video systems are typically mounted near rear lamps and subject to the same environmental conditions. While we considered that some vehicle manufacturers may conduct indirect vehicle level environmental tests that could potentially address some of these areas of interest, we noted that such testing is not required and that there is no basis to believe all vehicle manufacturers would adopt similar criteria. Therefore, based on the requirements outlined in FMVSS No. 108 for lighting, we are proposing requirements for the following areas to address rear visibility system external component durability: Salt spray (fog), temperature cycle, and humidity.

We believe a salt spray evaluation will address both the necessary corrosion performance, as well as general moisture resistance required so that rear visibility systems can deliver the expected effectiveness to motorists in the real world. We are proposing that exterior components used in rear visibility systems application meet the required minimum performance of exterior lamps, which are required to be tested in accordance with ASTM B117–73, Method of Salt Spray (Fog) Testing for a total period of 50 hours. The 50 hour total period is comprised of 2 identical periods of 24 hours of exposure followed by 1 hour of drying time. We believe that this standardized test procedure is a reasonable proxy for normal environmental conditions. At the end of the test, the system would still be required to meet the visibility and field of view requirements.

We believe a specification combining temperature cycles and humidity levels is appropriate to establish the ability of rearview video systems to provide the anticipated level of effectiveness across a range of real world driving conditions. We are proposing to require that systems operated across both a high and low temperature range, with varying humidity level. Again, at the conclusion of the proposed test cycles, the system would be required to function within acceptable limits.

B. Proposed Compliance Tests

i. Ambient Lighting Conditions

NHTSA believes that the ambient lighting conditions present for testing should mimic the lighting conditions in which the visual displays will be used. To ensure test repeatability, NHTSA believes that ambient lighting of a particular brightness level should be specified for testing. Daytime outdoor lighting (sunlight and varying degrees of cloud cover) ranges from 10,000 lux to 100,000 lux in full sunlight.[85] NHTSA believes that the lower end of this brightness range should be used for testing to mimic the most typical manner of incidence of the sun's rays upon a console-mounted rearview image, which would involve at least some degree of obstruction by the vehicle's roof. Therefore, we propose that testing be conducted with evenly distributed lighting of 10,000 lux intensity as measured at the center of the exterior surface of vehicle's roof. While actual natural sunlight may strike an in-vehicle display at various angles through the day, for the purpose of test repeatability we believe that ambient lighting during testing should be provided by overhead light sources with the light presented in an evenly distributed manner. Because the overwhelming majority of backover crashes occur during the day, we are not proposing testing under nighttime ambient lighting conditions.

ii. Rear Visibility Test Object

For the purpose of determining compliance with the performance requirements specified in the preceding sections, NHTSA is proposing that a cylindrical test object be used for testing. Specifically, the agency is proposing the test cylinder be a 32-inch tall cylinder with a diameter of 12 inches to represent the approximate height and width of an average, standing 18-month-old child. The age of 18 months was selected based upon the agency's review of SCI backover cases and consideration of comments on the ANPRM. We believe that a test object with these dimensions is necessary to ensure robust performance not only of a countermeasure system's ability to meet specified coverage area requirements behind a vehicle, but also the system's ability to display an image of a rear obstacle to a driver.

In developing the characteristics of the test object, NHTSA reviewed its own research, real world crash data, industry research, existing test procedures, and comments on the ANPRM. NHTSA considered and evaluated a number of different options ranging from crash dummies, clothing mannequins, and polyvinyl chloride (PVC) pipe to traffic cones for use as possible compliance test objects. NHTSA also considered using a child-shaped, clothing mannequin identified by the agency's Advanced Collision Avoidance Technology (ACAT) Backing Crash Countermeasure Program as having a radar cross-section equivalent to that of a small child. However, this shape is not proposed since the sensitivity of the test object to radar detection is not relevant to the evaluation of a visual rearview image and the asymmetrical shape of the mannequin would cause rearview image quality measurement difficulties. Given that the test object is intended to be used both to confirm countermeasure coverage area and test cylinder displayed size, a shape that is conducive to accurate completion of both tests is needed. While the shape of the test object is not critical for assessment of countermeasure coverage area as long as the object's dimensions are appropriate, use of a sided shape could cause measurement difficulties when assessing visual display image quality. A cylindrical test object with a vertical axis would appear to have the same relative width regardless of the angle at which it is viewed and would not appear skewed, as a square column might. A cylindrical test object is also

[85] Ander, Gregg D. (1995). Daylighting performance and design. Wiley, John & Sons, Incorporated.

suggested by the requirements of ISO 17386 that specify use of a cylinder to test the detection performance of ultrasonic parking aids. Therefore, the proposed test object shape consists of a cylinder with a vertical axis that can adequately represent the proportions of the children most commonly at risk in backover scenarios while at the same time ensuring robust system performance.

To best represent the manner in which a child is displayed to the driver in a rearview image, NHTSA proposes that the cylindrical test object shall have a diameter of 12 inches to represent the width of an average 18-month-old child. Based on 2000 CDC data for the head breadth an 18-month-old child, NHTSA proposes 5.9 inches (15 cm) as the minimum width that must be visible in the rearview image for the three test objects located nearest the rear bumper of the vehicle.[86] To aid in the assessment of whether the minimum width is visible, a contrasting colored vertical stripe of width 5.9 inches is proposed for the two cylinders closest to the vehicle.

Furthermore, given that the visual appearance of the test object is the dominant factor in the compliance test, we do not believe that we need to specify material properties at this time. While ultrasonic and radar sensors are better at detecting some materials and surface textures than others, rearview video systems display images of objects of all opaque material types. For these reasons, NHTSA is proposing that the test object merely consist of a cylindrical object of the dimensions specified above. However, we note that if in the future sensor-based systems are developed that may fulfill the requirements of providing to the driver a visual image of the area behind the vehicle, alternative test object material characteristics and dimensions may need to be specified in order to ensure that the object accurately simulates the physical presence of an 18-month-old child to the particular sensor technology being used.

To provide a consistent and repeatable location in which to measure apparent test object width as part of rearview image quality assessment, NHTSA proposes that the three rearmost test objects be constructed with a 5.9-inch high colored band surrounding the perimeter of the upper portion of the cylinder that is of a different color than the rest of the cylinder. The 5.9-inch dimension is based on the breadth of the average 18-month-old child's head.[87] The band can be of any color that contrasts with that of the rest of the test object.

iii. Rear Visibility Compliance Test Procedures

NHTSA is proposing a test to ensure that a rearview image provided to the driver (1) covers the required area behind the vehicle and (2) displays the images of obstacles with sufficient size to permit a driver to visually perceive their presence. The test procedure used to determine countermeasure performance in terms of rearview video system viewable area is similar to that currently used for school bus mirrors (Section 13, "School bus mirror test procedures" of FMVSS No. 111, "Rearview mirrors"). Like the school bus mirror test, the proposed test uses a large format camera placed with the imaging sensor located at a specific eyepoint location, referred to here as the "test reference point". A matte finish ruler affixed beneath the visual display and aligned laterally along the bottom edge of the visual display provides a reference for scaling purposes in the image quality portion of the test procedure.

The proposed test reference point is intended to simulate the location of a 50th percentile male driver's eyes (rather than the 95th percentile male used in existing FMVSS No. 111 rearview mirror requirements) when glancing at the rearview image. Based on observations of drivers using rearview video systems in NHTSA testing,[88] we assume that for visual displays located in the vicinity of the center console or interior rearview mirror, the driver will turn his or her head to look at the display with little or no lateral eye rotation. Therefore, to estimate the location of the driver's eyes when looking at a rearview image, the forward-looking eyepoint of the driver can be simulated to rotate toward the center of the vehicle as though the driver is turning his head. Anthropometric data from a NHTSA-sponsored study of the dimensions of 50th percentile male drivers seated with a 25-degree seat-back angle ("Anthropometry of Motor Vehicle Occupants"[89]) give the longitudinal and vertical location, with respect to the H point, of the left and right infraorbitale (a point just below each eye) and the head/neck joint center at which the head rotates about the spine. Given an average vertical eye diameter of approximately 0.96 inch (24 mm), we can assume that the center of the eye is located 0.48 inches (12 mm) above the infraorbitale. Taking the midpoint of the lateral locations of the driver's eyes gives a point in the mid-sagittal plane (the vertical/longitudinal plane of symmetry of the human body) of the driver's body indicated by M_f in Figure 5. Using the point at which the head rotates, M_f can be rotated toward the rearview image to obtain a new eyepoint, the test reference point, representing an eye midpoint for a driver when the head is turned to look at a rearview image. The proposed regulatory requirement sets forth clear instructions as to how to position the camera to conduct the test.

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[86] CDC, Clinical Growth Charts. Birth to 36 months: Boys; Length-for-age and Weight-for-age percentiles. Published May 30, 2000 (modified 4/20/2001) CDC, Clinical Growth Charts. Birth to 36 months: Girls; Length-for-age and Weight-for-age percentiles. Published May 30, 2000 (modified 4/20/2001).

[87] CDC, Clinical Growth Charts. Birth to 36 months: Boys; Length-for-age and Weight-for-age percentiles. Published May 30, 2000 (modified 4/20/2001) CDC, Clinical Growth Charts. Birth to 36 months: Girls; Length-for-age and Weight-for-age percentiles. Published May 30, 2000 (modified 4/20/2001).

[88] Mazzae, E.N., Barickman, F.S., Baldwin, G.H.S., and Ranney, T.A. (2008). On-Road Study of Drivers' Use of Rearview Video Systems (ORSDURVS). National Highway Traffic Safety Administration, DOT 811 024.

[89] Schneider, L.W., Robbins, D.H., Pflüg, M.A. and Snyder, R.G. (1985). Anthropometry of Motor Vehicle Occupants; Volume 1—Procedures, Summary Findings and Appendices. National Highway Traffic Safety Administration, DOT 806 715.

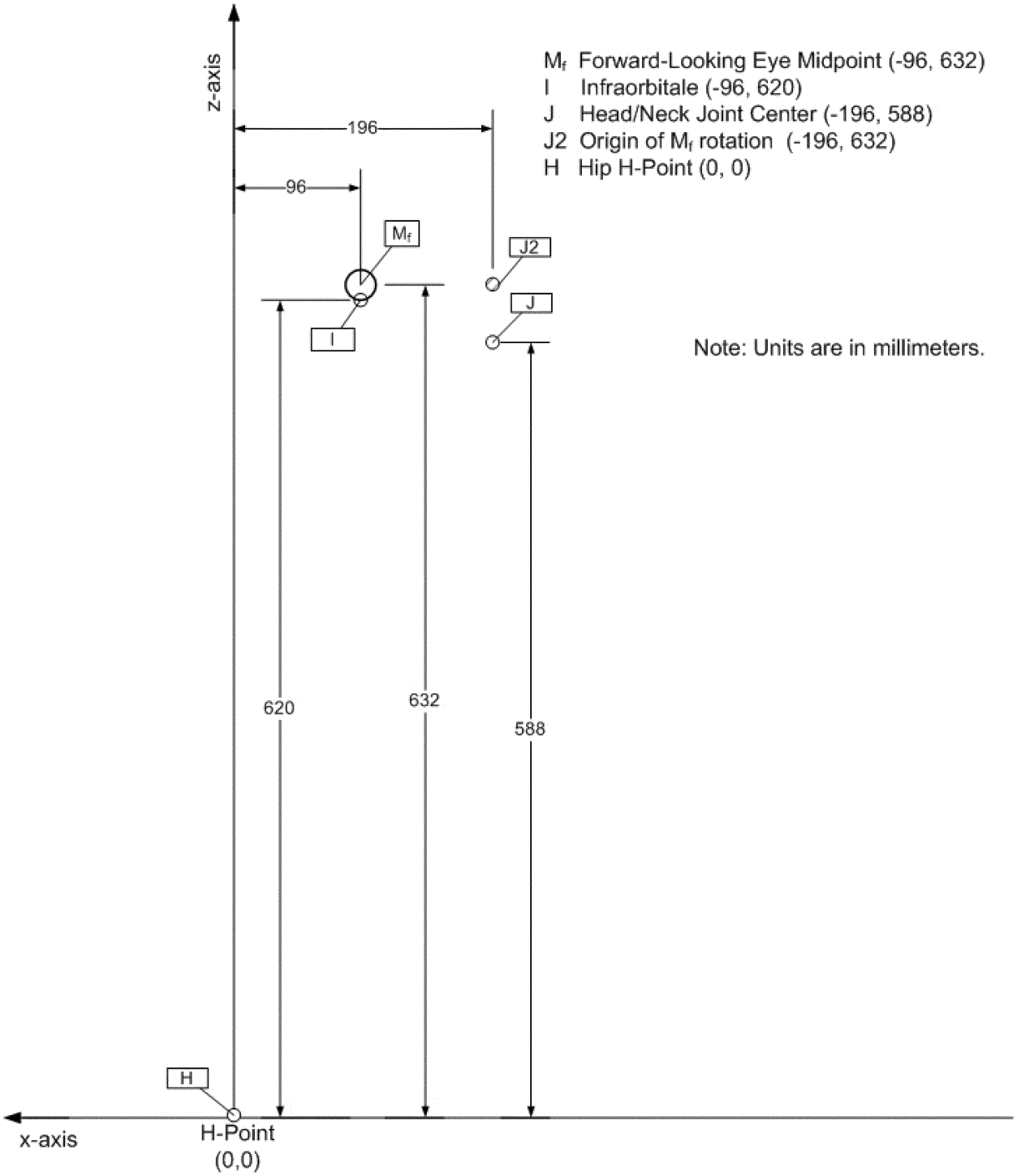

Figure 5. Coordinates of the Forward-Looking Eye Midpoint and Joint Center of Head/Neck Rotation of a 50th Percentile Male Driver with respect to the H point in the Sagittal Body Plane

a. Rear Field of View Test Procedure

To demonstrate a system's compliance with the field of view requirements, we are proposing that the perimeter of the minimum detection area that must be visible is marked using seven test objects. The locations of the seven test objects, represented by black circles, are illustrated in Figure 6.

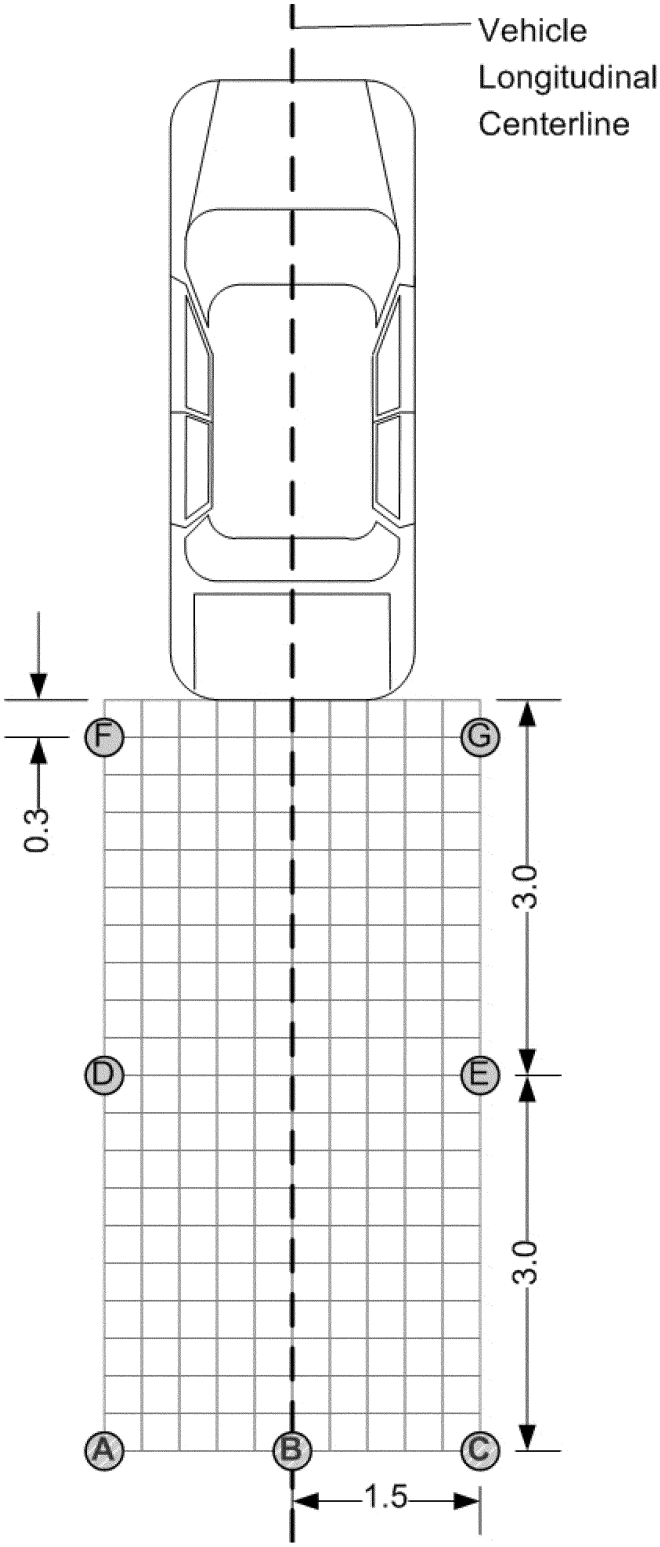

Figure 6. Countermeasure Performance Test Area Illustration and Required Test Object Locations (Units are meters)

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For school bus cross-view mirrors, FMVSS No. 111 requires that the entire top surface of each cylinder must be visible. However, due to the potential for rearview video cameras to be mounted at heights of less than 32 inches on some compact cars and sporty vehicles, NHTSA is proposing an alternative detection criterion for this test. For test objects located 10 or more feet aft of the vehicle's rear bumper, NHTSA proposes that the entire height and width of each test object must be visible. This criterion equates to the driver being able to see the entire body

of an 18-month-old child and serves to ensure that detection of a child, if present, between 10 and 15 feet behind the vehicle is possible.

Due to camera angle, only a portion of a child or child-sized object in close proximity to the rear bumper may be visible, particularly at the edges of the camera's viewing angle. To ensure that at least a portion of test objects 'F' and 'G' (in Figure 6) are visible, the proposed compliance test positions them 1 foot aft of the rear bumper face. To give the driver enough information to be able to discern an "object" as a child, if present, and to provide a quantitative basis for assessing field of view compliance, NHTSA believes it is important to indicate how much of the test objects must be visible. Seeing a child's face or another body area of similar size would likely result in successful visual recognition of the child by the driver. Therefore, NHTSA proposes that a minimum of a 5.9-inch width of test objects 'F' and 'G' must be visible.[90] This criterion would result in a 5.9-inch square or larger portion of an object or child being visible.

For NHTSA compliance testing, the displayed rearview image would be photographed to document the test results of this field of view test, as well as to provide data for use in completing the image quality test, which is described in the next section.

b. Rearview Image Size Test Procedure

As stated previously, industry standards applicable to an image-based rear visibility system do not exist. Therefore, to develop a method for assessing image quality, NHTSA looked to its prior work relating to school bus cross-view mirrors. The test procedure described below follows the same basic concept as the existing school bus mirror test procedure in FMVSS No. 111. This test serves to ensure that a minimum image quality is maintained throughout the required coverage area of the rearview image. Essentially, we are proposing that the apparent image of the individual test objects be large enough for an average driver to quickly determine their presence and nature.

The test procedure proposed for use in assessing countermeasure visual display image quality compliance requires one additional step beyond the rearview video system viewable area test described above. Using the printed photograph of the rearview image taken to document the viewable area covered by the system, the size of each of the three test objects positioned 20 feet aft of the rear bumper (indicated in Figure 5 labeled 'A', 'B', and 'C') is measured. The horizontal width of each of the three test objects is measured within the colored band surrounding the upper portion of the cylindrical test object by selecting a point at both the left and right edges of the object's displayed image. Similarly, two points on the ruler shown in the photograph are selected to acquire a measurement for use as a lateral scaling factor. Using the two measure widths and the distance between the driver's eyepoint (*i.e.,* midpoint between an average 50th percentile male's eyes) and the center of the rearview image, the visual angle subtended by each test object may be calculated. To reduce the effects of measurement errors, the measured visual angle subtended from each of the three test objects (A, B, and C) are averaged together. Acceptable image quality is defined as the average measured visual angle subtended by the test object's width from these three locations exceeding 5 minutes of arc. The average value is used to assess compliance to minimize the effect of individual measurement error. The subtended visual angle for each of the three locations must exceed 3 minutes of arc.

C. Proposed Effective Date and Phase-In Schedule

In accordance with the schedule set forth by Congress in the K.T. Safety Act, we are proposing that the requirement for rearview video systems be phased in within four years of publication of the final rule. Because we anticipate that a final rule will be published in early 2011, the statutory requirement would require that full compliance be achieved in late 2014 or early 2015. Furthermore, because we anticipate that this rule will require substantial design work to implement, we are proposing that, like other substantial rules, the compliance dates for the various stages of the phase-in be September 1 of the relevant year, in order to correspond with model years. Therefore, given the likely schedule of this rulemaking, we are proposing that full compliance be achieved by September 1, 2014.

NHTSA is concerned about the potential costs imposed on automotive manufacturers by this proposal, and is therefore taking into account both the current and projected future implementation of rearview video systems in our proposed phase-in schedule. Another factor that is being taken into consideration is the vehicle redesign cycle. Specifically, we are aware that it could cost substantially more to implement the best available technology (*i.e.,* rearview video systems) into vehicles if it is not done during the normal vehicle design cycle. We are aware, for example, in comments received from Honda that the statutory deadline may not provide enough time for most vehicles to undergo a redesign before full compliance is required. In its comment, AIAM suggested that a 6-year phase-in schedule, rather than a 4-year one, might be needed in order to assure that the substantial majority of affected vehicles can integrate rearview video systems as part of their normal redesign cycle. The agency appreciates the challenges posed by the proposed rule, but notes that a phase-in period longer than four years would be inconsistent with the limitation specified by Congress.

With the above considerations, we are proposing a rear-loaded phase-in schedule. For the year following the first September 1 after publication of the final rule (likely to be September 1, 2011), we are proposing a compliance target that is less than the total number of vehicles already anticipated to be equipped with rearview video systems. The proposed phase-in schedule then requires steady increases in the total percentage of the compliant vehicles in the two following years, based on these considerations and the percentage of vehicles that are anticipated to undergo a scheduled redesign. Finally, we are proposing to apply the requirements to all vehicles manufactured on or after September 1 of the following year (likely 2014). The specific percentages of the phase-in schedule are shown in Table 11 below.

TABLE 11—PROPOSED PHASE-IN SCHEDULE

	Percent
Vehicles manufactured before September 1, 2011	0
Vehicles manufactured on or after September 1, 2011, and before September 1, 2012	0
Vehicles manufactured on or after September 1, 2012, and before September 1, 2013	10
Vehicles manufactured on or after September 1, 2013, and before September 1, 2014	40
Vehicles manufactured on or after September 1, 2014	100

Furthermore, we are proposing that small volume manufacturers need only comply with the requirement for

[90] The 5.9-inch dimension is the average breadth of an 18-month-old child's head per CDC's "Clinical Growth Charts. Birth to 36 months: Boys; Length-for-age and Weight-for-age percentiles" and "Clinical Growth Charts. Birth to 36 months: Girls; Length-for-age and Weight-for-age percentiles." Published May 30, 2000 (modified 4/20/2001).

rearview video systems when the requirement has been fully phased in, that is, on September 1, 2014. This is based in part on the comment from AIAM, which requested this provision for small volume manufacturers due to their longer product life cycles and their reduced access to technology.

The reasons for allowing small volume manufacturers a delay in the compliance schedule are twofold. First, because these manufacturers generally produce a single or low number of lines of vehicles, they would need to install these systems on a large portion or all of their fleet in order to meet the fleet percentage requirement. Considering that the installation of rearview video systems is most efficiently accomplished during a vehicle redesign, this would mean that small volume manufacturers are disproportionately negatively impacted by the requirement because they would likely have to install these systems in the middle of the design cycle, increasing their costs. Second, because small volume manufacturers frequently have longer product cycles than larger manufacturers, the need for a delay until the end of the compliance increases the likelihood that they will have the opportunity to integrate the rearview video system with their normal redesign cycle. While we believe that rearview video systems and displays are readily available so that small volume manufacturers will have access, we believe that the other two reasons are adequate to delay mandatory compliance until the end of the phase-in period.

We are also proposing to include provisions under which manufacturers can earn credits towards meeting the applicable phase-in percentages if they meet the new rear visibility requirements ahead of schedule. In addition, as we have done with other standards, we are proposing a separate alternative schedule to address the special problems faced by limited line and multistage manufacturers and alterers in complying with phase-ins. A phase-in generally permits vehicle manufacturers flexibility with respect to which vehicles they choose to initially redesign to comply with new requirements. However, if a manufacturer produces a very limited number of lines, a phase-in would not provide such flexibility. NHTSA is accordingly proposing to permit "limited line" manufacturers that produce three or fewer carlines the option of achieving full compliance when the phase-in is completed. Flexibility would be allowed for vehicles manufactured in two or more stages and altered vehicles from the phase-in requirements. These vehicles would not be required to meet the phase-in schedule and would not have to achieve full compliance until the phase-in is completed. Also, as with previous phase-ins, NHTSA is proposing reporting requirements to accompany the phase-in.

D. Summary of Estimated Effectiveness, Costs and Benefits of Available Technologies

i. System Effectiveness

Some systems, like airbags, have binary states; that is to say that either they are activated or they are not. Analysis includes a probability of whether or not it was being used, followed by a calculation of benefits in cases where it was in use.

For rear visibility technologies, three conditions must be met for such a technology to provide a benefit to the driver. First, the crash must be one that is "avoidable" through use of the device; *i.e.,* the pedestrian must be within the target range for the sensor, or the viewable area of the camera or mirror. Second, once the pedestrian is within the system's range, the device must "sense" that fact, *i.e.,* provide the driver with information about the presence and location of the pedestrian. Third, there must be sufficient "driver response," *i.e.,* before impact with the pedestrian, the driver must receive this information and respond appropriately by confirming whether someone is or is not behind the vehicle before proceeding. As noted above, these factors are denoted as f_A, f_S, and f_{DR}, respectively, in this analysis. Table 12 below shows these factors and their product, the final system effectiveness.

TABLE 12—FINAL SYSTEM EFFECTIVENESS

System	F_A (%)	F_S (%)	F_{DR} (%)	Final effectiveness (%) $F_A \times F_S \times F_{DR}$ = FE
180° Camera	90	100	55	49
130° Camera	76	100	5	42
Ultrasonic	49	70	7	2.5
Radar	54	70	7	2.7
Mirrors	*33	100	**0	0

* F_A for mirrors is taken from separate source due to lack of inclusion in the SCI case review that generated F_A for cameras and sensors.
** F_{DR} for mirrors is taken from a small sample size of 20 tests. It is 0% because throughout testing, drivers did not take advantage of either cross-view or lookdown mirrors to avoid the obstacle in the test.

ii. Costs

The most expensive technology option that the agency has evaluated is the rearview camera. When installed in a vehicle without any existing adequate display screen, rearview camera systems are estimated to cost consumers between $159 and $203 per vehicle. For a vehicle that already has an adequate display, such as one found in navigation units, their incremental cost is estimated at $58. The total incremental cost to equip a 16.6 million vehicle fleet with camera systems is estimated to be $1.9 to $2.7 billion.

Rear object sensor systems are estimated to cost between $52 and $92 per vehicle. The total incremental cost to equip a 16.6 million vehicle fleet with sensor systems is estimated to be $0.3 to $1.2 billion.

Several different types of mirrors were investigated. Interior look-down mirrors could be mounted on vans and SUVs, but not cars, and are estimated to cost $40 per vehicle. The total incremental cost to equip a 16.6 million vehicle fleet with lookdown mirrors is estimated to be $0.6 billion.

We also estimated the net property damage effects to consumers from using a camera or sensor system to avoid backing into fixed objects, along with the additional cost when a vehicle is struck in the rear and the camera or sensor is destroyed.

TABLE 13—COSTS (2007 ECONOMICS)

Costs Per Vehicle	$51.49 to $202.94.
Total Fleet	$723M to $2.4B.

iii. Benefits

As noted above, the agency has spent considerable effort trying to determine the final effectiveness of these systems in reducing crashes, injuries and fatalities. We have researched the capabilities of the systems, the crash circumstances, and the percent of drivers that would observe and react in time to avoid a collision with a pedestrian or pedalcyclist. The estimated injury and fatality benefits of the various systems, based on NHTSA research to date, are shown below.

TABLE 14—QUANTIFIABLE BENEFITS

	180° Camera view	130° Camera view	Ultrasonic	Radar	Look-down mirror
Fatalities Reduced	112	95	3	3	0
Injuries Reduced	8,374	7,072	233	257	0

iv. Net Benefits

In addition to the one-time installation costs, and the benefits that occur over the life of the vehicle, there would also be maintenance costs as well as repair costs due to rear-end collisions and "property damage only crashes" (which, like the benefits, occur over time). Below Table 15 contains lifetime monetized benefits and lifetime costs, and their difference, the net benefit. In this case, the quantifiable costs outweigh the quantifiable benefits and therefore the final number is a cost. (Note that this analysis does not include nonquantifiable benefits, a point to which we will shortly return.) The primary estimate is based on a 130 degree camera system with an in-mirror display. The low estimate is based on an ultrasonic system. The high estimate is based on a 180 degree camera system with an in-mirror display.

TABLE 15—SUMMARY OF BENEFITS AND COSTS PASSENGER CARS AND LIGHT TRUCKS (MILLIONS 2007$) MY 2016 AND THEREAFTER

	Primary estimate	Low estimate	High estimate	Discount rate (%)
Benefits:				
Lifetime Monetized	$618.6	$37.1	$732.6	7
Lifetime Monetized	777.6	46.7	920.8	3
Costs:				
Lifetime Monetized	1,933.3	22.6	2,362.4	7
Lifetime Monetized	1,861.3	730.4	2,296.9	3
Net Benefits:				
Lifetime Monetized	−1,314.7	−685.5	−1,629.8	7
Lifetime Monetized	−1,083.7	−683.7	−1,376.1	3

v. Cost Effectiveness

While we examine several application scenarios (all passenger cars and all light trucks, only light trucks, and some combinations) and discount rates of 3 and 7 percent, the net cost per equivalent life saved for camera systems ranged from $11.8 to $19.7 million. For sensors, it ranged from $95.5 to $192.3 million per life saved. According to our present model, none of the systems are cost effective based on our comprehensive cost estimate of the value of a statistical life of $6.1 million.

TABLE 16—COST PER EQUIVALENT LIFE SAVED

	Cost per equivalent life saved
Sensors (Ultrasonic and Radar).	$95.5 to $192.3 mill.

TABLE 16—COST PER EQUIVALENT LIFE SAVED—Continued

Camera Systems	$11.8 to $19.7 mill.

The range presented is from a 3% to 7% discount rate.

The agency is proposing requirements that would likely be currently met by using cameras for both passenger cars and light trucks. We also seek comment on an alternative aimed at reducing net costs that could be met by requiring having cameras for light trucks and either cameras or ultrasonic sensors for passenger cars. We also request comment on the extent to which the effectiveness of sensors and the response of drivers to sensor warnings could be improved.

E. Comparison of Regulatory Alternatives

In order to explore fully other possible rulemaking options, the agency examined a variety of combinations of technology, specifically, ones in which light trucks were equipped with a rearview video system and passenger cars were either given no extra equipment, a rearview video system (using a camera) or another technology such as a sensor system. The results of examining such combinations are available below. Note the camera/radar and camera/ultrasonic options have decreased costs compared to mandating cameras for both vehicle types, but have a higher cost per life saved. It would not fulfill the requirements of the statute to require cameras for light trucks and nothing for passenger cars; those numbers are provided only as a point of comparison. Also, the camera/radar option has a higher net costs associated with it than simply mandating cameras for both, and will most likely not be viable on those grounds. Comments on these alternatives and suggestions of others are welcome.

TABLE 17—REAR VISIBILITY PROPOSAL AND ALTERNATIVES DISCOUNTED AT 3%

[Millions of 2007 $]

[In decreasing order of installation costs and monetized safety benefits]

Proposal and alternatives	Per vehicle costs and benefits				Net cost per equivalent life saved
	Installation costs [91]	Monetized safety Benefits	Property damage costs	Net costs	
LT Camera, PC Camera	$1,919 to $2,275	$778	$−414	$727 to $1,084	$11.8 to $14.6.
LT Camera, PC Radar	$1,512 to $1,710	439	−149	$924 to $1,122 [92]	$18.9 to $21.7.[93]
LT Camera, PC Ultrasonic [94]	$1,215 to $1,413	437	−165	$613 to $811	$14.7 to $17.4.
LT Camera, PC Nothing [95]	$841 to $1,039	415	−189	$237 to $435	$9.6 to $12.5.

The most effective technology option that the agency has evaluated is the rearview video system which, as already noted, consists of a video camera and a visual display. It is also the most expensive technology. When installed in a vehicle that does not already have any visual display screen, rearview video systems are estimated to cost consumers between $159 and $203 per vehicle. The upper end of the cost range is based on systems that have in-mirror (as opposed to in-dash or console) displays and a 180 degree (as opposed to 130 degree) lens. For a vehicle that already has a suitable visual display, such as one found in navigation units, the incremental cost of a rearview video system is estimated at $58–$88, depending on the angular width of the lens. The total incremental cost to equip a 16.6 million vehicle fleet with rearview video systems is estimated to be $1.9 to $2.7 billion.

Commenters on the ANPRM noted that rearview video systems are a relatively new technology and stated that considerable reductions in costs will occur as these technologies proliferate in the fleet. NHTSA agrees that technological innovation will occur over the next couple of years and that the costs are likely to be substantially less when actually installed in future model years. However, we have not identified a way to estimate this lower cost.

Given the effectiveness estimates that we have generated and assuming that all vehicles will be equipped with the most likely countermeasure technology, namely a rearview video system and associated display, we believe the fatalities that are occurring in backing crashes could be reduced by 95 to 112 per year. Similarly, injuries would be reduced by 7,072 to 8,374 per year. We estimate that the cost per equivalent lives for rearview video systems would range from $11.8 million based on a 3% discount rate and on the low end of the per vehicle cost range to $19.7 million based on a 7% discount rate and the high end of the per vehicle cost range.

We note that while this cost per equivalent lives saved, even at the low end, is nearly double the Departmental value of a statistical life of $6.1 million,[96] the proposed solution is the most comprehensive and effective, currently available solution to mitigate backover crashes, fatalities, and injuries. As we discussed above, the quantitative analysis does not offer a complete accounting. We have noted that well over 40 percent of the victims of backover crashes are very young children (under the age of five), with nearly their entire life ahead of them. Executive Order 12866 also refers explicitly to considerations of equity. ("(I)n choosing among alternative regulatory approaches, agencies should select those approaches that maximize net benefits (including * * * equity), and there are strong reasons, grounded in those considerations, to prevent the deaths at issue here. In addition, this regulation will, in many cases, reduce a qualitatively distinct risk, which is that of directly causing the death or injury of one's own child.[97] Drivers will also benefit from increased rear visibility in a variety of ways, including increased ease and convenience with respect to parking.

While these benefits cannot be monetized, they could be significant. A breakeven analysis suggests that if the nonquantified benefits amount $65 to $79 per vehicle, the benefits would justify the costs. Taking all of the foregoing points alongside the quantifiable figures and the safety issue at hand, the agency tentatively concludes that the benefits do justify the costs. More specifically, we emphasize the following data and considerations:

- 100 of the 228 (44%) annual victims of backover crashes are under 5 years of age with nearly their entire lives ahead of them; 80 of the 100 children are under 3 years of age.[98]
- While this rulemaking would result in great cost if made final as proposed, it would also have substantial benefits, reducing the annual fatalities in backover crashes by 95 to 112 fatalities, and annual injuries by 7,072 to 8,374 injuries.
- In addition to those benefits, there are other benefits that are hard to quantify, but are nonetheless real and significant. One such benefit is that of not being the direct cause of the death or injury of a person and particularly a small child at one's place of residence. In some of these cases, parents are responsible for the deaths of their own children; avoiding that horrible outcome is a significant benefit. Another hard-to-

[91] The range of camera costs assumes 130 degree camera with the display in the dash (lower cost) to the display in the mirror (higher cost).

[92] The net costs are substantially more than those for any of the other options.

[93] The cost per equivalent life saved is substantially more for this option than that for any of the other options.

[94] Under this alternative, passenger cars could be equipped with either sensor systems or camera systems. For a fuller description of this alternative, see the discussion above at the very end of section I, Executive Summary.

[95] The agency tentatively concludes that not requiring any improved performance by passenger cars would be inconsistent with the mandate in the Cameron Gulbransen Kids Transportation Safety Act of 2007.

[96] The $6.1 million represents the 2007 Departmental value of $5.8 million for a statistical life (VSL) adjusted for economic cost factors that are not inherently a part of the $5.8 million. These include, medical care, emergency services, legal costs, insurance administrative costs, workplace costs, property damage and the taxed portion of lost market productivity (the untaxed portion is assumed to be inherently included in the VSL).

[97] On the relevance of this fact, see J.K. Hammitt and K. Haninger, "Valuing Fatal Risks to Children and Adults: Effects of Disease, Latency, and Risk Aversion," *Journal of Risk and Uncertainty* 40(1): 57–83, 2010.

[98] Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks * * * Section 1. Policy. 1–101. A growing body of scientific knowledge demonstrates that children may suffer disproportionately from * * * safety risks. These risks arise because: children's neurological, immunological, digestive, and other bodily systems are still developing; * * * and children's behavior patterns may make them more susceptible to accidents because they are less able to protect themselves. * * *

quantify benefit is the increased ease and convenience of driving, and especially parking, that extend beyond the prevention of crashes. While these benefits cannot be monetized at this time, they could be considerable.

• There is evidence that many people value the lives of children more than the lives of adults.[99] [100] In any event, there is special social solicitude for protection of children. In the area of motor vehicle safety, this special solicitude for the welfare of children has been evident in the area of motor vehicle safety in the mandates [101] by Congress over the years for issuing standards primarily benefiting children. This solicitude regarding children is based, to a significant extent, on their greater vulnerability to injury and their inability to protect themselves.

• Given the very young age of most of the children fatally-injured in backover crashes, attempting to provide them with training relevant to the particular circumstances of those crashes or with an audible warning would not enable them to identify or take steps to protect themselves, given their impulsiveness, their lack of understanding of the abstract concept of risk/danger/safety, and their lack of situational awareness, judgment and physical ability (*e.g.,* dexterity) to take timely and effective self-protective action.

• Given the impossibility of reducing backover crashes through changing the behavior of very young children and given Congress' mandate, it is reasonable and necessary to rely on vehicle technology to address backover crashes and to that end the agency examined a variety of technologies to assess their value in improving driver awareness and performance: mirrors, sensors, cameras, and other technologies.

• Based on its extensive testing to determine how much area behind a vehicle a driver must be able to see in order to avoid backover crashes and on the relative effectiveness of the various technologies in improving driver awareness and performance, the agency has tentatively concluded that a camera-based system is the only effective type of technology currently available.

• Requiring additional rearview mirrors or changes to existing review mirrors cannot provide an effective solution to the problem of backover crashes. Changes to outside rearview mirrors mounted near the driver offer only very limited opportunities for any improvement in the existing rearward view to the sides of vehicles and no opportunity for providing any view of the area directly behind vehicles. While rearview mirrors mounted at or near the rear of vehicles could provide a view to the rear of vehicles, the coverage area would be relatively small. Further, the image, as viewed by the driver indirectly via outside rearview mirrors mounted near the driver, would be fairly small and distorted, making the viewed objects difficult to discern. Finally, rear-mounted rearview mirrors might not be reasonable, practicable and appropriate for many types of light vehicles.

• The agency's testing indicated that currently available sensors, which are designed primarily to avoid collisions with objects (like posts and other vehicles) that can cause property damage, had two shortcomings. First, they often failed to detect a human, particularly a small moving child, in tests in which the vehicle was not actually moving. Second, in tests in which the vehicle was moving, and in which the sensors did detect a manikin representing a child, the resulting warning did not induce drivers to pause more than briefly in backing. Being unable to confirm visually whether there was something or someone behind them, the drivers in these tests resumed their backing.

• In contrast, in the agency's tests of vehicles equipped with video camera-based systems, drivers not only saw a child-sized obstacle, but also stopped and remained stopped, thereby avoiding striking the obstacle in a substantial percentage of the tests.

• Consequently, the agency has tentatively concluded that requirements must have the effect of ensuring that the driver is provided with some type of image of the area directly behind his or her vehicle. However, the agency is not proposing to require that video camera-based systems be installed to provide that image.

• Instead, the agency is proposing a performance-based requirement for any system that can provide the driver with the requisite image. The proposal does not specify a single location within the vehicle as the location in which the image must be provided. Thus, the image can be provided on a display in the dash or interior rearview mirror.

• In time, types of technology other than a video camera-based system may be able to provide a sufficiently clear visual image of the area behind the vehicle at lower cost than a video camera-based system can.

• In proposing a requirement that drivers must be provided with a visual image of the area behind their vehicles, the agency recognizes that among currently available candidate technologies, video cameras are the most expensive and mirrors are the least. Sensors fall in between.

• The agency's estimates of current costs for video camera-based systems may be too high as the estimates are based on data that are a few years old.

• The agency has a contract in place for the conducting of up-to-date tear down cost studies of both camera and sensor technologies. These studies could produce somewhat lower cost estimates.

• To the extent that the agency may have underestimated the extent to which technological innovation and other factors will lead to future reductions in the costs of video camera-based systems, the future costs may be even lower than currently expected.

• In view of statutory requirements, the agency is limited in its ability to reduce the cost of this rulemaking through adjusting either the requirements or application of the proposed rule or the schedule for its implementation.

• Congress has mandated the issuance of a final rule instead of allowing the agency to retain discretion to decide whether to issue a final rule based on its consideration of all the relevant factors and information.

• While Congress has not mandated a system that provides the driver with an image of the area behind his or her vehicle, less expensive countermeasures, *i.e.,* mirrors and sensors, have thus far shown very limited effectiveness and thus would not satisfy Congress' mandate for improving safety.

• Video camera-based systems are by far the most comprehensive and cost-effective currently available solution for reducing backover crashes, fatalities and

[99] J.K. Hammitt and K. Haninger, "Valuing Fatal Risks to Children and Adults: Effects of Disease, Latency, and Risk Aversion," *Journal of Risk and Uncertainty* 40(1): 57–83, 2010. This stated preference study finds that the willingness to pay to prevent fatality risks to one's child is uniformly larger than that to reduce risk to another adult or to oneself. Estimated values per statistical life are $6–10 million for adults and $12–15 million for children. We emphasize that the literature is in a state of development.

[100] Other people argue for valuing all lives equally, regardless of age, and note there is also a special solicitude for another vulnerable population, the elderly. Some of the elderly have difficulty quickly moving out of dangerous situations. Special solicitude for the elderly is very germane to this rulemaking given that persons 70 years of age or older account for another large segment of fatalities, *i.e.,* 74 (33 percent) of the 228 annual fatalities.

[101] Recent examples include Anton's Law, Public Law 107–318, Dec. 4, 2002, and the K.T. Safety Act. That solicitude is also evident in the requirement in Omnibus Consolidated and Emergency Supplemental Appropriations Act of 1999, *Public Law 105–277* (*5 U.S.C. 601* note) for assessment of impacts of Federal regulations and policies on families.

injuries. As the most cost-effective alternative, a requirement for a system that provides an image of the area behind the vehicle would be consistent with the policy preference underlying the Unfunded Mandates Reform Act.

• The agency is limited by law as to the amount of leadtime it can provide for this final rule. Were the agency able to provide even more leadtime than permitted, that additional time might be sufficient to enable suppliers to develop cheaper cameras. Given the limits within which the agency must operate, which require the agency to provide not more than four years of leadtime, the agency has proposed a back-loaded phase-in schedule, *i.e.,* one focused on the latter part of the phase-in period, to maximize leadtime.

As stated above, NHTSA is also considering whether there are any circumstances under which it would be appropriate and permissible under the K.T. Safety Act to limit the application of the proposed requirements to LTVs only, *i.e.,* to exclude passenger cars. The agency's tentative conclusion is that there are not. If the improved rear visibility requirements [102] were applied only to LTVs, we estimate that the fatalities occurring in backover crashes would still be reduced by 70 to 83 per year. Similarly, injuries would still be reduced by 3,284 to 3,888 per year. We estimate that the cost per equivalent lives for rearview video systems would range from $9.6 million based on a 3% discount rate to $17.0 million based on a 7% discount rate. Table 18 contrasts the proposal and the alternative below using a 3% discount rate and 7% discount rate. The table includes ranges of costs and benefits based on a video camera having a 130- to 180-degree horizontal viewing angle.

TABLE 18—SUMMARY OF ESTIMATED COSTS AND BENEFITS—3% AND 7% DISCOUNT RATE SCENARIOS [103]

Applicability	Total cost	Fatalities prevented	Injuries prevented	Net cost per equivalent life saved
Passenger Cars, MPVs, Trucks, Buses with a GVWR of 10,000 pounds or less.	$1.9–2.7 billion	95–112	7,072–8,374	$11.8–19.7 million.
MPVs, Trucks, Buses with a GVWR of 10,000 pounds or less	0.8–1.2 billion	70–83	3,284–3,888	9.6–17.0 million.

Table 19 summarizes the impacts based on a primary estimate which assumes a 130 degree camera with the display in the rearview mirror, a low estimate that assumes ultrasonic sensors and auditory warnings, and a high estimate that assumes a 180 degree camera with the display in the rearview mirror. Property damage estimates are included in the costs, and net property damage costs are significantly different (even in sign) between ultrasonic/radar and any camera system.

TABLE 19—SUMMARY OF BENEFITS AND COSTS PASSENGER CARS AND LIGHT TRUCKS (MILLIONS 2007$) MY 2015 AND THEREAFTER

	Primary estimate	Low estimate	High estimate	Discount rate (%)
Benefits:				
Lifetime Monetized	$618.6	$37.1	$732.6	7
Lifetime Monetized	777.6	46.7	920.8	3
Costs:				
Lifetime Monetized	1,933.3	722.6	2,362.4	7
Lifetime Monetized	1,861.3	730.4	2,296.9	3
Net Benefits:				
Lifetime Monetized	−1,314.7	−685.5	−1,629.8	7
Lifetime Monetized	−1,083.7	−683.7	−1,376.1	3

VIII. Public Participation

How do I prepare and submit comments?

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

Your comments must not be more than 15 pages long. (49 CFR 553.21). We established this limit to encourage you to write your primary comments in a concise fashion. However, you may attach necessary additional documents to your comments. There is no limit on the length of the attachments.

Comments may be submitted to the docket electronically by logging onto the Docket Management System Web site at *http://www.regulations.gov.* Follow the online instructions for submitting comments.

You may also submit two copies of your comments, including the attachments, to Docket Management at the address given above under **ADDRESSES.**

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

How can I be sure that my comments were received?

If you wish Docket Management to notify you upon its receipt of your comments, enclose a self-addressed,

[102] For illustration purposes, figures indicated represent rear visibility improvement provided using a rearview video system with 130-degree video camera.

[103] For illustration purposes, figures indicated represent rear visibility improvement provided using a rearview video system with 130-degree video camera.

stamped postcard in the envelope containing your comments. Upon receiving your comments, Docket Management will return the postcard by mail.

How do I submit confidential business information?

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

Will the agency consider late comments?

We will consider all comments that Docket Management receives before the close of business on the comment closing date indicated above under **DATES**. To the extent possible, we will also consider comments that Docket Management receives after that date. If Docket Management receives a comment too late for us to consider in developing a final rule (assuming that one is issued), we will consider that comment as an informal suggestion for future rulemaking action.

How can I read the comments submitted by other people?

You may read the comments received by Docket Management at the address given above under **ADDRESSES**. The hours of the Docket are indicated above in the same location. You may also see the comments on the Internet. To read the comments on the Internet, go to *http://www.regulations.gov.* Follow the online instructions for accessing the dockets.

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

IX. Rulemaking Analyses

A. Executive Order 12866 (Regulatory Planning and Review) and DOT Regulatory Policies and Procedures

Executive Order 12866, "Regulatory Planning and Review" (58 FR 51735, October 4, 1993), provides for making determinations whether a regulatory action is "significant" and therefore subject to OMB review and to the requirements of the Executive Order. The Order defines a "significant regulatory action" as one that is likely to result in a rule that may:

(1) Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or Tribal governments or communities;

(2) Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;

(3) Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or

(4) Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order.

We have considered the potential impact of this proposal under Executive Order 12866 and the Department of Transportation's regulatory policies and procedures. This rulemaking is economically significant because it is likely to have an annual effect on the economy of $100 million or more and was reviewed by the Office of Management and Budget under E.O. 12866. The rulemaking action has also been determined to be significant under the Department's regulatory policies and procedures. The preliminary regulatory impact analysis (PRIA) fully discusses the estimated costs and benefits of this rulemaking action. The costs and benefits are also summarized in section VII of this preamble, *supra.*

B. Regulatory Flexibility Act

Pursuant to the Regulatory Flexibility Act (5 U.S.C. 601 *et seq.,* as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996), whenever an agency is required to publish a notice of proposed rulemaking or final rule, it must prepare and make available for public comment a regulatory flexibility analysis that describes the effect of the rule on small entities (*i.e.,* small businesses, small organizations, and small governmental jurisdictions). The Small Business Administration's regulations at 13 CFR part 121 define a small business, in part, as a business entity "which operates primarily within the United States." (13 CFR 121.105(a)). No regulatory flexibility analysis is required if the head of an agency certifies the proposal will not have a significant economic impact on a substantial number of small entities. SBREFA amended the Regulatory Flexibility Act to require Federal agencies to provide a statement of the factual basis for certifying that a proposal will not have a significant economic impact on a substantial number of small entities.

I hereby certify that this proposed rule would not have a significant economic impact on a substantial number of small entities. Small organizations and small governmental units would not be significantly affected since the potential cost impacts associated with this action would not significantly affect the price of new motor vehicles. We believe that the rulemaking would not have a significant economic impact on the small vehicle manufacturers because the systems are not technically hard to develop or install and the cost of the systems ($160 to $200) is a small proportion (less than half of one percent) of the overall vehicle cost for most of these specialty cars.

The proposal would directly affect motor vehicle manufacturers and final-stage manufacturers. The majority of motor vehicle manufacturers would not qualify as a small business. There are six manufacturers of passenger cars that are small businesses.[104] These manufacturers, along with manufacturers that do not qualify as a small business, are already required to comply with the current mirror requirements of FMVSS No. 111. Similarly, there are several manufacturers of low-speed vehicles that are small businesses. Currently, FMVSS No. 111 does not apply to low-speed vehicles, although they are required to have basic mirrors pursuant to FMVSS No. 500, Low-speed vehicles (including the option of having either an exterior driver-side mirror or an interior rearview mirror). The addition of a rearview video system can be accomplished via the purchase of an exterior video camera, integration of a console video screen or the addition of an interior rearview mirror-mounted screen, and wiring to connect the two as well as to connect them to the vehicle.

Because the K.T. Safety Act encompasses all motor vehicles with a GVWR or 10,000 pounds or less (except motorcycles and trailers) in its mandate

[104] Fisker, Mosler, Panoz, Saleen, Standard Taxi, Tesla.

to reduce backovers, all of these small manufacturers could be affected by the proposed requirements. However, the economic impact upon these entities would not be significant for the following reasons.

(1) Potential cost increases are small compared to the price of the vehicles being manufactured and can be passed on to the consumer as nearly all vehicles are subject to the proposed requirements.

(2) The proposal provides four years lead-time, the limit permitted by the K.T. Safety Act, and would allow small volume manufacturers the option of waiting until the end of the phase-in (until September 1, 2014) to meet the rear visibility requirements.

In this NPRM, the agency has also considered several alternatives that could help to reduce the burden on small businesses. The agency considered an alternative under which passenger cars would be required to be equipped with either a visibility system or with a system that includes an ultrasonic sensor that monitors the specified area behind the vehicle and an audible warning, and other vehicles rated at 10,000 pounds or less, gross vehicle weight, would be required to be equipped with a visibility system. This alternative would have substantially lower, but still significant, safety benefits, substantially lower installation costs and higher cost per equivalent life saved. The agency also considered reducing the types of vehicles subject to rear visibility performance by excluding low-speed vehicles explicitly or, in the alternative, limiting the applicability of the rule to MPVs and trucks with a GVWR of 10,000 pounds or less.

C. Executive Order 13132 (Federalism)

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

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

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

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

Pursuant to Executive Order 13132 and 12988, NHTSA has considered whether this proposal could or should preempt State common law causes of action. The agency's ability to announce its conclusion regarding the preemptive effect of one of its rules reduces the likelihood that preemption will be an issue in any subsequent tort litigation.

To this end, the agency has examined the nature (*e.g.,* the language and structure of the regulatory text) and objectives of today's proposal and finds that this proposal, like many NHTSA rules, prescribes only a minimum safety standard. As such, NHTSA does not intend that this proposal preempt state tort law that would effectively impose a higher standard on motor vehicle manufacturers than that established by today's proposal. Establishment of a higher standard by means of State tort law would not conflict with the minimum standard proposed here. Without any conflict, there could not be any implied preemption of a State common law tort cause of action.

We solicit the comments of the States and other interested parties on this assessment of issues relevant to E.O. 13132.

D. Executive Order 12988 (Civil Justice Reform)

When promulgating a regulation, *Executive Order 12988* specifically requires that the agency must make every reasonable effort to ensure that the regulation, as appropriate: (1) Specifies in clear language the preemptive effect; (2) specifies in clear language the effect on existing Federal law or regulation, including all provisions repealed, circumscribed, displaced, impaired, or modified; (3) provides a clear legal standard for affected conduct rather than a general standard, while promoting simplification and burden reduction; (4) specifies in clear language the retroactive effect; (5) specifies whether administrative proceedings are to be required before parties may file suit in court; (6) explicitly or implicitly defines key terms; and (7) addresses other important issues affecting clarity and general draftsmanship of regulations.

Pursuant to this Order, NHTSA notes as follows. The preemptive effect of this proposal is discussed above in connection with E.O. 13132. NHTSA notes further that there is no requirement that individuals submit a petition for reconsideration or pursue other administrative proceeding before they may file suit in court.

E. Executive Order 13045 (Protection of Children From Environmental Health and Safety Risks)

Executive Order 13045, "Protection of Children from Environmental Health and Safety Risks," (62 FR 19885; April 23, 1997) applies to any proposed or final rule that: (1) Is determined to be "economically significant," as defined in Executive Order 12866, and (2) concerns an environmental health or safety risk that NHTSA has reason to believe may have a disproportionate effect on children. If a rule meets both criteria, the agency must evaluate the

environmental health or safety effects of the rule on children, and explain why the rule is preferable to other potentially effective and reasonably feasible alternatives considered by the agency.

This proposed rule is subject to Executive Order 13045 because it is economically significant and available data demonstrate that the safety risk addressed by this proposal disproportionately involves children, especially very young ones. The issues that must be analyzed under this Executive Order are discussed extensively in the preamble above and in the PRIA.

F. National Technology Transfer and Advancement Act

Under the National Technology Transfer and Advancement Act of 1995 (NTTAA) (Pub. L. 104–113), "all Federal agencies and departments shall use technical standards that are developed or adopted by voluntary consensus standards bodies, using such technical standards as a means to carry out policy objectives or activities determined by the agencies and departments." Voluntary consensus standards are technical standards (*e.g.,* materials specifications, test methods, sampling procedures, and business practices) that are developed or adopted by voluntary consensus standards bodies, such as the Society of Automotive Engineers (SAE). The NTTAA directs us to provide Congress, through OMB, explanations when we decide not to use available and applicable voluntary consensus standards. The agency is not aware of any applicable voluntary consensus standards that apply to rearview video systems.

While the agency examined two voluntary industry standards, International Standards Organization (ISO) 17386 and ISO 15008, as potentially relevant, the agency does not believe that either is relevant and thus has tentatively decided not to utilize them. While both standards have aspects that relate to the issue of rear visibility performance, neither addresses the specific type of rearview video system being proposed in this notice. ISO 17386, Maneuvering Aids for Low Speed Operations (MALSO), relates to the performance aspects of sensor-based rear object detection systems. While such systems were considered, NHTSA has not proposed them in this document, due to issues related to driver performance. ISO 15008 relates to the ergonomic aspects of in-vehicle screens.[105] However, it specifically does not apply to the types of screens at issue in this proposal, which would be required to show closed-circuit video images. Furthermore, in response to comments, NHTSA endeavored to propose a requirement that is as performance based and technologically-neutral as possible, to allow maximum design freedom while still meeting the performance requirements needed for safety.

G. Unfunded Mandates Reform Act

The Unfunded Mandates Reform Act of 1995 requires agencies to prepare a written assessment of the costs, benefits and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditure by State, local or tribal governments, in the aggregate, or by the private sector, of more than $100 million annually (adjusted for inflation with base year of 1995). NHTSA must comply with that requirement in connection with this rulemaking as the proposed rule would result in expenditures by the private sector of over $100 million annually.

As noted previously, the agency has prepared a detailed economic assessment in the PRIA. In that assessment, the agency analyzes the benefit and costs of a rear visibility countermeasure performance requirement for passenger cars, multipurpose passenger vehicles, trucks, buses, and low-speed vehicles with a GVWR of 10,000 pounds or less. NHTSA's preliminary analysis indicates that the proposal could result in private expenditures of up to $2.7 billion annually.

The PRIA also analyzes the expected benefits and costs of a wide variety of alternative countermeasure options, including mirrors, cameras, and sensors, as specified in the K.T. Safety Act. The agency subjected several types of each class of countermeasure to thorough effectiveness testing and cost-benefit analysis. Additionally, the agency previously published a detailed ANPRM and separate PRIA, in order to explain its thoughts on the technological solutions available and solicit information on costs, benefits, and applications on all possible solutions to the safety concern. NHTSA received a large variety of comments on the ANPRM and PRIA and used that information in formulating the instant proposal.

Although the application of the rear visibility requirement to MPVs, trucks, and passenger cars is the highest cost option, the agency tentatively concludes that the costs are justified. As explained in detail in the PRIA for this NPRM, after carefully exploring all possible alternatives, NHTSA tentatively concludes that rearview video systems offer not only the highest overall benefits, but also the most efficient cost per life saved ratio.

Above, NHTSA solicits comment on other alternatives, including one alternative limiting the application of rearview video systems to only MPVs and trucks with a GVWR of 10,000 pounds or less and another alternative requiring those systems for MPVs and trucks and either sensors or those systems for cars. The PRIA summarizes the costs, benefits, and cost per life saved for the proposal and these alternatives. We note that, at this time, while one of the alternatives has overall lower costs and a slightly more efficient cost per life saved ratio than NHTSA's proposal, the agency tentatively concludes that the increased benefits of the proposal, especially in terms of fatalities and injuries to children, are worth the additional costs above those in the more limited alternative scenario.

Since the agency has estimated that the proposed rule could result in expenditures of over $1 billion annually, NHTSA has performed a probabilistic uncertainty analysis to examine the degree of uncertainty in its cost and benefit estimates and included that analysis in the PRIA.

H. National Environmental Policy Act

NHTSA has analyzed this rulemaking action for the purposes of the National Environmental Policy Act. The agency has determined that implementation of this action would not have any significant impact on the quality of the human environment.

[105] ISO 15008–2009 specifies minimum requirements for the image quality and legibility of displays containing dynamic (changeable) visual information presented to the driver of a road vehicle by on-board transport information and control systems (TICS) used while the vehicle is in motion. These requirements are intended to be independent of display technologies, while reference to test methods and measurements for assessing compliance with them have been included where necessary.

ISO 15008–2009 is applicable to mainly perceptual, and some basic cognitive, components of the visual information including character legibility and color recognition. It is not applicable to other factors affecting performance and comfort such as coding, format and dialogue characteristics, or to display using:

Characters presented as part of a symbol or pictorial information;

Superimposed information on the external field (*e.g.,* high-up displays);

Pictorial images (*e.g.,* rear view camera);

Maps and topographic representations (*e.g.,* those for setting navigation systems); or

Quasi-static information.

http://www.iso.org/iso/iso_catalogue/catalogue_ics/catalogue_detail_ics.htm?csnumber=50805

I. Paperwork Reduction Act

Under the Paperwork Reduction Act of 1995 (PRA), a person is not required to respond to a collection of information by a Federal agency unless the collection displays a valid OMB control number. This proposal would include a collection of information, *i.e.,* the proposed phase-in reporting requirements. If approved, the requirements would require manufacturers of passenger cars and of trucks, buses, MPVs and low-speed vehicles with a GVWR of 4,536 kg (10,000 lb) or less, to annually submit a report for each of two years concerning the number of such vehicles that meet the rear visibility system requirements.

Accordingly, the Department of Transportation will be submitting the following information collection request to OMB for review and clearance under the PRA.

Agency: National Highway Traffic Safety Administration (NHTSA).

Title: Phase-In Production Reporting Requirements for Rear Visibility Systems.

Type of Request: New request.

OMB Clearance Number: None assigned.

Form Number: This collection of information will not use any standard forms.

Affected Public: The respondents are manufacturers of passenger cars, multipurpose passenger vehicles, trucks, buses, and low-speed vehicles having a gross vehicle weight rating of 4,536 kg (10,000 pounds) or less. The agency estimates that there are about 21 such manufacturers.

Estimate of the Total Annual Reporting and Recordkeeping Burden Resulting from the Collection of Information: NHTSA estimates that the total annual burden is 42 hours (2 hours per manufacturer per year). Two reports per manufacturer would be collected.

Estimated Costs: NHTSA estimates that the total annual cost burden, in U.S. dollars, will be $2,100. No additional resources would be expended by vehicle manufacturers to gather annual production information because they already compile this data for their own uses.

Summary of the Collection of Information: This collection would require manufacturers of passenger cars, multipurpose passenger vehicles, trucks, buses, and low-speed vehicles having a gross vehicle weight rating of 4,536 kg (10,000 pounds) or less to provide motor vehicle production data for the following two years: September 1, 2012 through August 31, 2013; and September 1, 2013 through August 31, 2014.

Description of the Need for the Information and the Proposed Use of the Information: The purpose of the reporting requirements will be to aid NHTSA in determining whether a manufacturer has complied with the requirements of Federal Motor Vehicle Safety Standard No. 111, Rearview Mirrors, during the phase-in of new requirements for rear visibility systems.

NHTSA requests comments on the agency's estimates of the total annual hour and cost burdens resulting from this collection of information. Organizations and individuals that wish to submit comments on the information collection requirements should direct them to NHTSA's docket for this NPRM. These comments must be received on or before February 7, 2011.

J. Plain Language

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

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

If you have any responses to these questions, please include them in your comments on this proposal.

K. Regulation Identifier Number (RIN)

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

IX. Proposed Regulatory Text

List of Subjects in 49 CFR Parts 571 and 585

Motor vehicle safety, Reporting and recordkeeping requirements, Tires.

In consideration of the foregoing, NHTSA proposes to amend 49 CFR parts 571 and 585 as follows:

PART 571—FEDERAL MOTOR VEHICLE SAFETY STANDARDS

1. The authority citation for part 571 of title 49 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. Section 571.111 is amended by revising the heading, S1 and S3, adding in alphabetical order the following definitions to S4, and adding S5.5 through S5.5.3.7, S6.2 through S6.2.3.7, S14 through S14.3.3, and Figures 5 and 6 to read as follows:

§ 571.111 Standard No. 111; Rear visibility.

S1. *Scope.* This standard specifies requirements for rearview devices and systems.

* * * * *

S3. *Application.* This standard applies to passenger cars, multipurpose passenger vehicles, trucks, buses, school buses, motorcycles and low-speed vehicles.

S4. *Definitions.*

* * * * *

Limited line manufacturer means a manufacturer that sells three or fewer carlines, as that term is defined in 49 CFR 583.4, in the United States during a production year.

Rearview image means a visual image of the area directly behind a vehicle that is provided in a single location to the vehicle operator and by means of indirect vision.

Small manufacturer means an original vehicle manufacturer that produces or assembles fewer than 5,000 vehicles annually for sale in the United States.

* * * * *

S5.5 *Rear visibility.*

(a) For passenger cars manufactured on or after September 1, 2012, but not later than August 31, 2014, a percentage of each manufacturer's production, as specified in S5.5.3, shall display a rearview image meeting the requirements of S5.5.1 through S5.5.2.

(b) Each passenger car manufactured on or after September 1, 2014, shall display a rearview image meeting the requirements of S5.5.1 through S5.5.2.

S5.5.1 *Rearview image performance.*

S5.5.1.1 *Field of view.* When tested in accordance with the procedures in S14.1 through S14.2.3, the rearview image shall display, in a location visible to a driver properly restrained by seat belts:

(a) A minimum of a 150-mm wide portion of each test object located at positions F and G in Figure 5; and

(b) The full width and height of each test object located at positions A through E in Figure 5.

S5.5.1.2 *Size.* When the rearview image is measured in accordance with the procedures in S14.1 through S14.2.3, the calculated visual angle subtended by the horizontal width of:

(a) The three test objects located at positions A, B, and C in Figure 5 shall average not less than 5 minutes of arc; and

(b) The angular size of each individual test object (A, B, and C) shall not be less than 3 minutes of arc.

S5.5.1.3 *Response time.* The rearview image meeting the requirements of S5.5.1 through 5.5.1.6 shall be displayed within 2.0 seconds of the time at which the vehicle transmission is shifted into reverse gear; and

S5.5.1.4 *Linger time.* The rearview image shall not be displayed for more than 10.0 seconds after the vehicle transmission has been shifted out of reverse gear.

S5.5.1.5 *Deactivation.* The rearview image shall not be extinguishable by any driver-controlled means.

S5.5.1.6 *Display luminance.* When tested in accordance with S14.2, the luminance of an interior visual display used to present the rearview image shall not be less than 500 cd/m^2.

S5.5.2 *Durability performance.* After the vehicle is subjected to the test procedures in S14.2.1 through S14.2.3, the vehicle shall meet the requirements of S5.5.1.1 and S5.5.1.2.

S5.5.3 *Phase-in schedule.*

S5.5.3.1 *Vehicles manufactured on or after September 1, 2012 and before September 1, 2014.* At any time during the production years ending August 31, 2012 and August 31, 2013, each manufacturer shall, upon request from the Office of Vehicle Safety Compliance, provide information identifying the vehicles (by make, model and vehicle identification number) that have been certified as complying with this standard. The manufacturer's designation of a vehicle as a certified vehicle is irrevocable.

S5.5.3.2 *Vehicles manufactured on or after September 1, 2012 and before September 1, 2013.* Except as provided in S5.5.3.4, for passenger cars manufactured by a manufacturer on or after September 1, 2012, and before September 1, 2013, the number of passenger cars complying with S5.5 through S5.5.2 shall be not less than 10 percent of the manufacturer's—

(a) Production of passenger cars during that period; or

(b) Average annual production of passenger cars manufactured in the three previous production years.

S5.5.3.3 *Vehicles manufactured on or after September 1, 2013 and before September 1, 2014.* Except as provided in S5.5.3.4, for passenger cars manufactured by a manufacturer on or after September 1, 2013, and before September 1, 2014, the number of passenger cars complying with S5.5 through S5.5.2 shall be not less than 40 percent of the manufacturer's—

(a) Production of passenger cars during that period; or

(b) Average annual production of passenger cars manufactured in the three previous production years.

S5.5.3.4 *Exclusions from phase-in.* The requirements in S5.5.3.2 and S5.5.3.3 do not apply to—

(a) Vehicles that are manufactured by small manufacturers or by limited line manufacturers.

(b) Vehicles that are altered (within the meaning of 49 CFR 567.7) before September 1, 2014, after having been previously certified in accordance with part 567 of this chapter, and vehicles manufactured in two or more stages before September 1, 2014.

S5.5.3.5 *Vehicles produced by more than one manufacturer.* For the purpose of calculating average annual production of vehicles for each manufacturer and the number of vehicles manufactured by each manufacturer under S5.5.3.1 through S5.5.3.3, a vehicle produced by more than one manufacturer shall be attributed to a single manufacturer as follows, subject to S5.5.3.6—

(a) A vehicle that is imported shall be attributed to the importer.

(b) A vehicle manufactured in the United States by more than one manufacturer, one of which also markets the vehicle, shall be attributed to the manufacturer that markets the vehicle.

S5.5.3.6 A vehicle produced by more than one manufacturer shall be attributed to any one of the vehicle's manufacturers specified by an express written contract, reported to the National Highway Traffic Safety Administration under 49 CFR part 585, between the manufacturer so specified and the manufacturer to which the vehicle would otherwise be attributed under S5.5.3.5.

S5.5.3.7 *Calculation of complying vehicles.*

(a) For the purposes of calculating the vehicles complying with S5.5.3.2, a manufacturer may count a vehicle if it is manufactured on or after [date that is 30 days after publication of the final rule in the **Federal Register**] but before September 1, 2013.

(b) For purposes of complying with S5.5.3.3, a manufacturer may count a vehicle if it—

(1) Is manufactured on or after [date that is 30 days after publication of the final rule in the **Federal Register**] but before September 1, 2014 and,

(2) Is not counted toward compliance with S5.5.3.2.

(c) For the purposes of calculating average annual production of vehicles for each manufacturer and the number of vehicles manufactured by each manufacturer, each vehicle that is excluded from having to meet the applicable requirement is not counted.

* * * * *

S6.2 *Rear visibility.*

(a) For multipurpose passenger vehicles, low-speed vehicles, trucks, and buses with a GVWR of 4.536 kg or less manufactured on or after September 1, 2012, but not later than August 31, 2014, a percentage of each manufacturer's production, as specified in S6.2.3, shall display a rearview image meeting the requirements of S6.2.1 through S6.2.2.

(b) Each multipurpose passenger vehicle, low-speed vehicle, truck, and bus with a GVWR of 4.536 kg or less manufactured on or after September 1, 2014, shall display a rearview image meeting the requirements of S6.2.1 through S6.2.2.

S6.2.1 *Rearview image performance.*

S6.2.1.1 *Field of view.* When tested in accordance with the procedures in S14.1 through S14.2.3, the rearview image shall display, in a location visible to a driver properly restrained by seat belts:

(a) A minimum of a 150-mm wide portion of each test object located at positions F and G in Figure 5; and

(b) The full width and height of each test object located at positions A through E in Figure 5.

S6.2.1.2 *Size.* When the rearview image is measured in accordance with the procedures in S14.1 through S14.2.3, the calculated visual angle—subtended by the horizontal width of

(a) The three test objects located at positions A, B, and C in Figure 5 shall average not less than 5 minutes of arc; and

(b) The angular size of each individual test object (A, B, and C) shall not be less than 3 minutes of arc.

S6.2.1.3 *Response time.* The rearview image meeting the requirements of S6.2.1 through 6.2.1.6 shall be displayed within 2.0 seconds of the time at which the vehicle transmission is shifted into reverse gear; and

S6.2.1.4 *Linger time.* The rearview image shall not be displayed for more than 10.0 seconds after the vehicle transmission has been shifted out of reverse gear.

S6.2.1.5 *Deactivation.* The rearview image shall not be extinguishable by any driver-controlled means.

S6.2.1.6 *Display luminance.* When tested in accordance with S14.2, the luminance of an interior visual display used to present the rearview image shall not be less than 500 cd/m^2.

S6.2.2 *Durability performance.* After the vehicle is subjected to the test procedures in S14.2.1 through S14.2.3, the vehicle shall meet the requirements of S6.2.1.1 and S6.2.1.2.

S6.2.3 *Phase-in schedule.*

S6.2.3.1 *Vehicles manufactured on or after September 1, 2012 and before September 1, 2014.* At any time during the production years ending August 31, 2012 and August 31, 2013, each manufacturer shall, upon request from the Office of Vehicle Safety Compliance, provide information identifying the vehicles (by make, model and vehicle identification number) that have been certified as complying with this standard. The manufacturer's designation of a vehicle as a certified vehicle is irrevocable.

S6.2.3.2 *Vehicles manufactured on or after September 1, 2012 and before September 1, 2013.* Except as provided in S6.2.3.4, for multipurpose passenger vehicles, trucks, buses, and low-speed vehicles with a GVWR of 4.536 kg or less, manufactured by a manufacturer on or after September 1, 2012, and before September 1, 2013, the number of such vehicles complying with S6.2 through S6.2.2 shall be not less than 33 percent of the manufacturer's—

(a) Production of such vehicles during that period; or

(b) Average annual production of such vehicles manufactured in the three previous production years.

S6.2.3.3 *Vehicles manufactured on or after September 1, 2013 and before September 1, 2014.* Except as provided in S6.2.3.4, for multipurpose passenger vehicles, trucks, buses, and low-speed vehicles with a GVWR of 4.536 kg or less, manufactured by a manufacturer on or after September 1, 2013, and before September 1, 2014, the number of such vehicles complying with S6.2 through S6.2.2 shall be not less than 67 percent of the manufacturer's—

(a) production of such vehicles during that period; or

(b) average annual production of such vehicles manufactured in the three previous production years.

S6.2.3.4 *Exclusions from phase-in.* The requirements in S6.2.3.2 and S6.2.3.3 do not apply to—

(a) Vehicles that are manufactured by small manufacturers or by limited line manufacturers.

(b) Vehicles that are altered (within the meaning of 49 CFR 567.7) before September 1, 2014, after having been previously certified in accordance with part 567 of this chapter, and vehicles manufactured in two or more stages before September 1, 2014.

S6.2.3.5 *Vehicles produced by more than one manufacturer.* For the purpose of calculating average annual production of vehicles for each manufacturer and the number of vehicles manufactured by each manufacturer under S6.2.3.1 through S6.2.3.3, a vehicle produced by more than one manufacturer shall be attributed to a single manufacturer as follows, subject to S6.2.3.6—

(a) A vehicle that is imported shall be attributed to the importer.

(b) A vehicle manufactured in the United States by more than one manufacturer, one of which also markets the vehicle, shall be attributed to the manufacturer that markets the vehicle.

S6.2.3.6 A vehicle produced by more than one manufacturer shall be attributed to any one of the vehicle's manufacturers specified by an express written contract, reported to the National Highway Traffic Safety Administration under 49 CFR part 585, between the manufacturer so specified and the manufacturer to which the vehicle would otherwise be attributed under S6.2.3.5.

S6.2.3.7 *Calculation of complying vehicles.*

(a) For the purposes of calculating the vehicles complying with S6.2.3.2, a manufacturer may count a vehicle if it is manufactured on or after [date that is 30 days after publication of the final rule in the **Federal Register**] but before September 1, 2013.

(b) For purposes of complying with S6.2.3.3, a manufacturer may count a vehicle if it—

(1) Is manufactured on or after [date that is 30 days after publication of the final rule in the **Federal Register**] but before September 1, 2014 and,

(2) Is not counted toward compliance with S6.2.3.2.

(c) For the purposes of calculating average annual production of vehicles for each manufacturer and the number of vehicles manufactured by each manufacturer, each vehicle that is excluded from having to meet the applicable requirement is not counted.

* * * * *

S14 *Rear visibility test procedure.*

S14.1 *Test setup.*

S14.1.1 *Lighting.* The ambient illumination conditions in which testing is conducted consists of light that is evenly distributed from above and is at an intensity of 10,000 lux, as measured at the center of the exterior surface of vehicle's roof.

S14.1.2 *Vehicle conditions.*

S14.1.2.1 *Tires.* The vehicle's tires are set to the vehicle manufacturer's recommended cold inflation pressure.

S14.1.2.2 *Fuel tank loading.* The fuel tank is full.

S14.1.2.3 *Vehicle load.* The vehicle is loaded to simulate the weight of the driver and four passengers or the designated occupant capacity, if less, based on an average occupant weight of 68 kg. The weight of each occupant is represented by 45 kg resting on the seat pan and 23 kg resting on the vehicle floorboard.

S14.1.2.4 *Driver's seat positioning.*

S14.1.2.4.1 Adjust the driver's seat to the midpoint of the longitudinal adjustment range.

S14.1.2.4.2 Adjust the driver's seat to the lowest point of all vertical adjustment ranges present.

S14.1.2.4.3 Using the three dimensional SAE J826 (rev. Jul 95) manikin, adjust the driver's seat back angle at the vertical portion of the H-point machine's torso weight hanger to 25 degrees. If this adjustment setting is not available, adjust the seat-back angle to the positional detent setting closest to 25 degrees in the direction of the manufacturer's nominal design riding position.

S14.1.3 *Test object.* Each test object is a right circular cylinder that is 0.8 m high and 0.3 m in external diameter. There are seven test objects, A–G. Test objects A, B, C, D, and E are marked with a horizontal band encompassing the uppermost 150 mm of the side of the cylinder. Test objects F and G are marked on the side with a solid vertical stripe of 150 mm width extending from the top to the bottom of each cylinder. Both the horizontal band and vertical stripe shall be of a color that contrasts with both the rest of the cylinder and the test surface.

S14.1.4 *Test object locations and orientation.* Place cylinders at locations specified in S14.1.5(a) through(d) and illustrated in Figure 5. Measure the distances shown in Figure 5 from a cylinder to another cylinder or another object from the center (axis) of the cylinder as viewed from above. Each test object is oriented so that its axis is vertical.

(a) Place cylinders G and F so that their centers are in a transverse vertical plane that is 0.3 m to the rear of a transverse vertical plane tangent to the rearmost surface of the rear bumper. Place cylinders E and D so that their centers are in a transverse vertical plane

that is 0.9 m to the rear of a transverse vertical plane tangent to the rearmost surface of the rear bumper. Place cylinders A, B and C so that their centers are in a transverse vertical plane that is 6.1 m to the rear of a transverse vertical plane tangent to the rearmost surface of the rear bumper.

(b) Place cylinder B so that its center is in a longitudinal vertical plane passing through the vehicle's longitudinal centerline.

(c) Place cylinders C, E, and G so that their centers are in a longitudinal vertical plane located 1.5 m, measured laterally and horizontally, to the left of the vehicle longitudinal center line.

(d) Place cylinders A, D, and F so that their centers are in a longitudinal vertical plane located 1.5 m, measured laterally and horizontally, to the right of the vehicle longitudinal center line.

S14.1.5 *Test reference point.* To obtain the test reference point, locate the center of the forward-looking eye midpoint (M_f) of a 50th percentile male driver in the sagittal plane of the driver's body, 632 mm vertically above the H point and 96 mm aft of the H point (H), as illustrated in Figure 6. Next, locate the head/neck joint center (J) illustrated in Figure 6 so that it is located 100 mm rearward of M_f and 588 mm vertically above the H point. Draw an imaginary horizontal line between M_f and a point vertically above J, defined as J_2. Rotate the imaginary line about J_2 in the direction of the rearview image until the straight-line distance between M_f and the center of the visual display reaches the shortest possible value. Define this new, rotated location of M_f to be M_r (eye midpoint rotated).

S14.1.6 *Measurement procedure.* Locate a 35 mm or larger format still camera, video camera, or digital equivalent such that the center of the camera's image plane is located at M_r and the camera lens is directed at the center of the visual display's rearview image. Affix a ruler at the base of the rearview image in an orientation parallel with a transverse cylinder centerline. Photograph the image of the visual display with the ruler included in the frame.

S14.1.6.1 *Extract photographic data.* Using the photograph, measure the horizontal width of a 50 mm delineated section of the in-photo ruler along the edge closest to the rearview image and at a point that would fall along the longitudinal centerline of the vehicle. Using the photograph, measure the horizontal width of the colored band at the upper portion of each of the three test objects located at positions A, B, and C in Figure 5. Define the measured horizontal widths of the colored bands of the three test objects as d_a, d_b, and d_c.

S14.1.6.2 *Obtain scaling factor.* Using the measured length of the 50 mm portion of the ruler as it appears in the photograph, divide this value by 50 mm to obtain a scaling factor. Define this scaling factor as s_{scale}.

S14.1.6.3 *Determine viewing distance.* Determine the actual distance from the rotated eye midpoint location (M_r) to the center of the rearview image. Define this viewing distance as a_{eye}.

S14.1.6.4 *Calculate visual angle subtended by test objects.* Use the following equation to calculate the subtended visual angles:

$$\theta_i = 60 \sin^{-1}\left(\frac{d_i}{a_{eye} s_{scale}}\right)$$

where *i* can take on the value of either *test object A, B,* or *C,* and arcsine is calculated in units of degrees.

S14.2 *Visual display luminance testing.* The visual display luminance is measured at room temperature in a dark room using a spectroradiometer. The minimum specified value of 500 cd/m² must be met at any measured point within the display.

S14.3 *Durability testing.*

S14.3.1 *Corrosion test procedure.* The vehicle is subjected to two 24-hour corrosion test cycles. In each corrosion test cycle, a portion of the vehicle, which must include all exterior components of the rear visibility system, is subjected to a salt spray (fog) test in accordance with ASTM B117–73, *Method of Salt Spray (Fog) Testing* (incorporated by reference, see § 571.5) for a period of 24 hours. Allow 1 hour to elapse without spray between the two test cycles.

S14.3.2 *Humidity exposure procedure.* The vehicle is subjected to 24 consecutive 3-hour humidity test cycles. In each humidity test cycle, the exterior of the vehicle is subjected to a temperature of 100° + 7° − 0 °F (38° + 4 °C) with a relative humidity of not less than 90% for a period of 2 hours. After a period not to exceed 5 minutes, the exterior of the vehicle is subjected to a temperature of 32° + 5° − 0 °F (0° + 3° −0 °C) and a humidity of not more than 30% ±° 10% for 1 hour. Allow no more than 5 minutes to elapse between each test cycle.

S14.3.3 *Temperature exposure procedure.* The vehicle is subjected to 4 consecutive 2-hour temperature test cycles. In each temperature test cycle, the exterior of the vehicle is first subjected to a temperature of 176° ± 5 °F (60° ± 3 °C) for a period of one hour. After a period not to exceed 5 minutes, the exterior of the vehicle is subjected to a temperature of 32° + 5° − 0 °F (0° + 3° − 0 °C) for 1 hour. Allow no more than 5 minutes to elapse between each test cycle.

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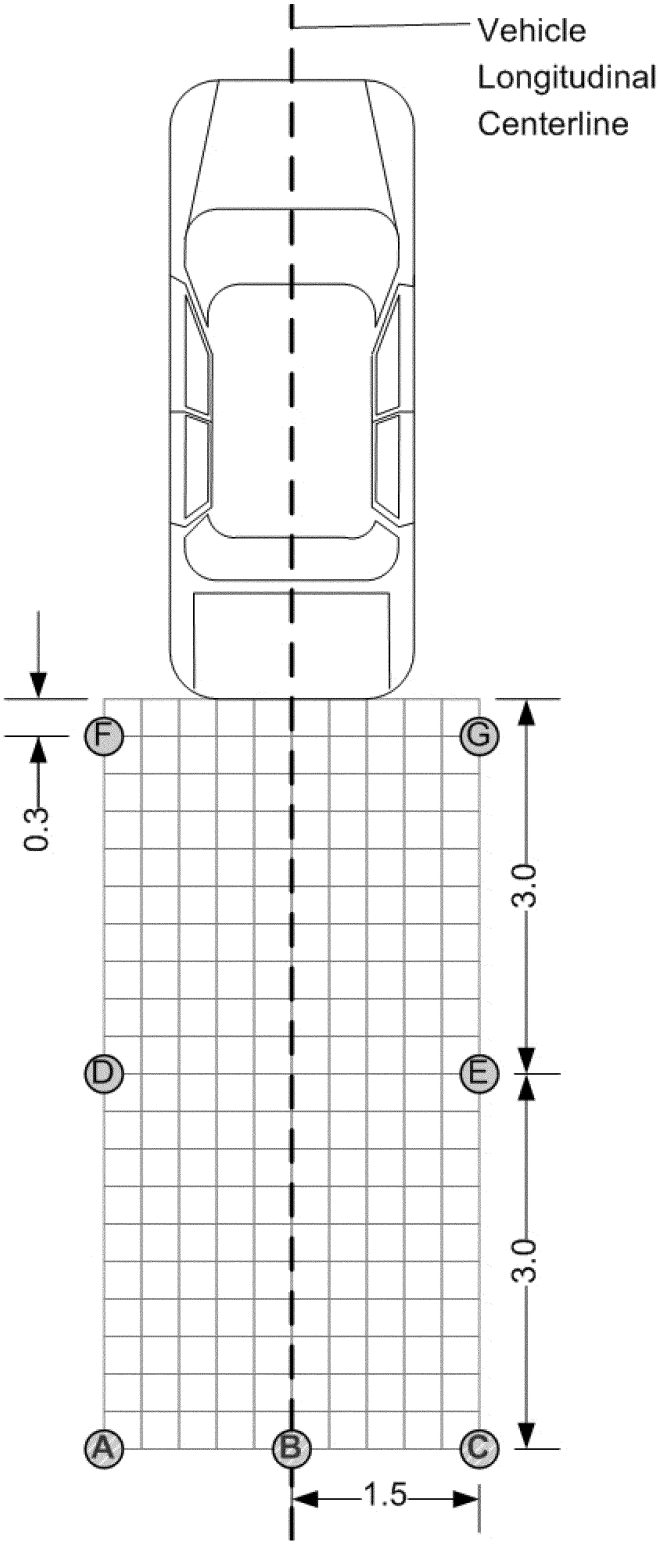

FIGURE 5: TEST CYLINDER LOCATIONS (Units in meters)

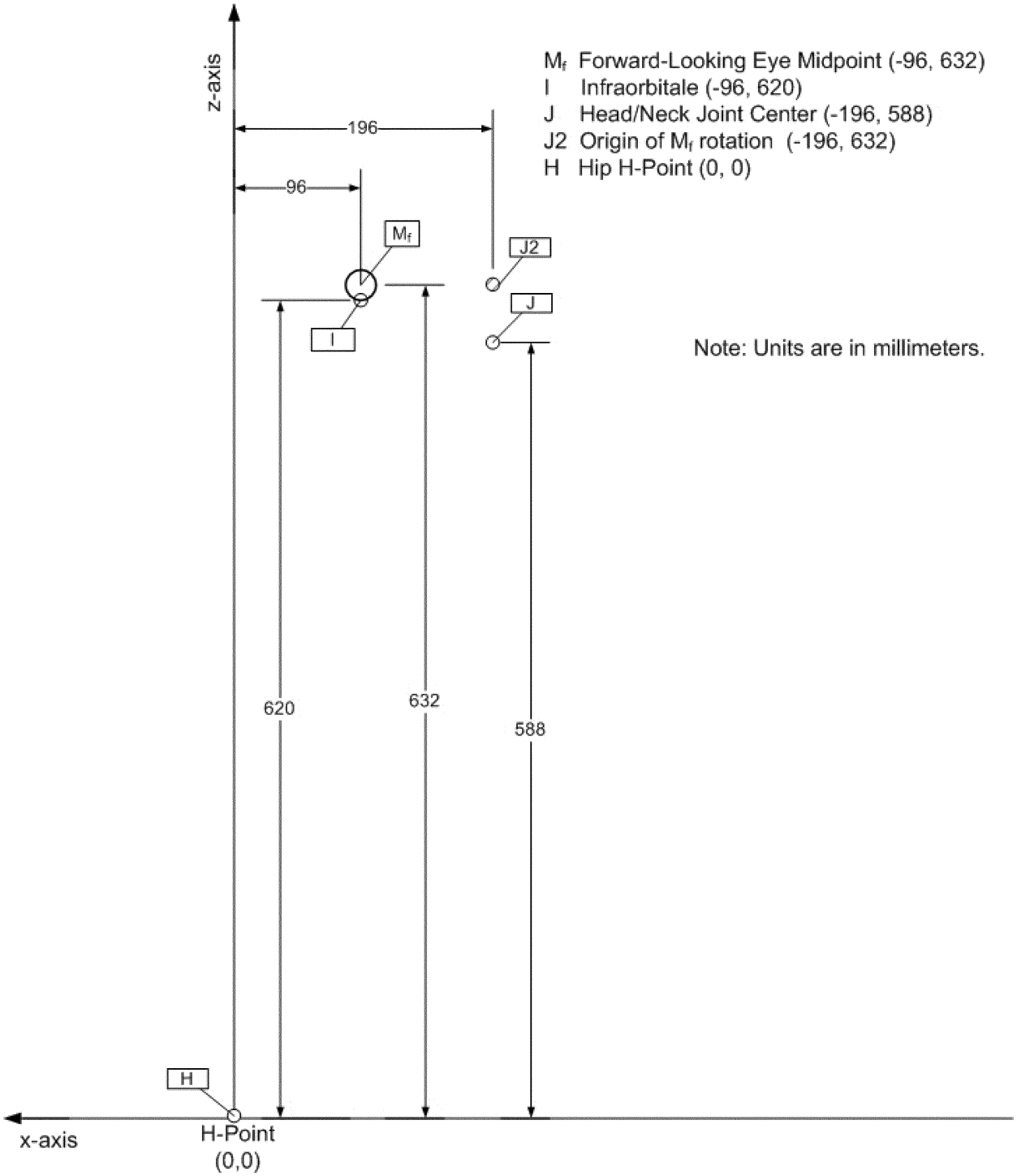

FIGURE 6: EYE MIDPOINT LOCATION (M_f) IN THE MID-SAGITTAL PLANE WITH RESPECT TO H POINT FOR FORWARD-LOOKING 50TH PERCENTILE MALE DRIVER SEATED WITH 25 DEGREE SEAT BACK ANGLE

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3. Section 571.500 is amended by adding paragraph (11) at the end of paragraph S5(b) to read as follows:

§ 571.500 Standard No. 500; Low-speed vehicles.

* * * * *

S5.* * *

(b)* * *

(11) Low-speed vehicles shall comply with the rear visibility requirements specified in S5.5 and S6.2 of FMVSS No. 111.

* * * * *

PART 585—PHASE–IN REPORTING REQUIREMENTS

4. The authority citation for part 585 would continue to read as follows:

Authority: 49 U.S.C. 322, 30111, 30115, 30117, and 30166; delegation of authority at 49 CFR 1.50.

5. Part 585 is amended by adding subpart M to read as follows:

Subpart M—Rear Visibility Improvements Reporting Requirements

Sec.
585.121 Scope.
585.122 Purpose.
585.123 Applicability.
585.124 Definitions.
585.125 Response to inquiries.
585.126 Reporting requirements.
585.127 Records.

Subpart M—Rear Visibility Improvements Reporting Requirements

§ 585.121 Scope.

This part establishes requirements for manufacturers of passenger cars, of trucks, buses, multipurpose passenger vehicles and low-speed vehicles with a gross vehicle weight rating (GVWR) of 4,536 kilograms (kg) (10,000 pounds (lb)) or less, to submit a report, and maintain records related to the report, concerning the number of such vehicles that meet the rear visibility requirements (S5.5 and S6.2) of Standard No. 111, Rearview mirrors (49 CFR 571.111).

§ 585.122 Purpose.

The purpose of these reporting requirements is to assist the National Highway Traffic Safety Administration in determining whether a manufacturer has complied with the rear visibility requirements (S5.5 and S6.2) of Standard No. 111, Rearview mirrors (49 CFR 571.111).

§ 585.123 Applicability.

This part applies to manufacturers of passenger cars, of trucks, buses, multipurpose passenger vehicles and low-speed vehicles with a gross vehicle weight rating (GVWR) of 4,536 kilograms (kg) (10,000 pounds (lb)) or less.

§ 585.124 Definitions.

(a) All terms defined in 49 U.S.C. 30102 are used in their statutory meaning.

(b) *Bus, gross vehicle weight rating or GVWR, low-speed vehicle, multipurpose passenger vehicle, passenger car, and truck* are used as defined in § 571.3 of this chapter.

(c) *Production year* means the 12-month period between September 1 of one year and August 31 of the following year, inclusive.

§ 585.125 Response to inquiries.

At anytime during the production years ending August 31, 2013, and August 31, 2014, each manufacturer shall, upon request from the Office of Vehicle Safety Compliance, provide information identifying the vehicles (by make, model and vehicle identification number) that have been certified as complying with the rear visibility requirements of Standard No. 111, Rearview mirrors (49 CFR 571.111). The manufacturer's designation of a vehicle as a certified vehicle is irrevocable.

§ 585.126 Reporting requirements.

(a) *Advanced credit phase-in reporting requirements.* Within 60 days after the end of the production year ending August 31, 2012, each manufacturer choosing to certify vehicles manufactured during that production year as complying with the rear visibility requirements of Standard No. 111 (49 CFR 571.111) shall submit a report to the National Highway Traffic Safety Administration providing the information specified in paragraph (c) of this section and in § 585.2 of this part.

(b) *Phase-in reporting requirements.* Within 60 days after the end of each of the production years ending August 31, 2013 and August 31, 2014, each manufacturer shall submit a report to the National Highway Traffic Safety Administration concerning its compliance with the rear visibility requirements of Standard No. 111 (49 CFR 571.111) for its vehicles produced in that year. Each report shall provide the information specified in paragraph (d) of this section and in section 585.2 of this part.

(c) *Advanced credit phase-in report content; production of complying vehicles.* With respect to the reports identified in § 585.126(a), each manufacturer shall report for the production year for which the report is filed the number of vehicles, by make and model year, that are certified as meeting the rear visibility requirements of Standard No. 111 (49 CFR 571.111).

(d) *Phase-in report content*—

(1) *Basis for phase-in production goals.* Each manufacturer shall provide the number of vehicles manufactured in the current production year, or, at the manufacturer's option, in each of the three previous production years. A new manufacturer that is, for the first time, manufacturing vehicles for sale in the United States must report the number of vehicles manufactured during the current production year.

(2) *Production of complying vehicles.* Each manufacturer shall report for the production year being reported on, and each preceding production year, to the extent that vehicles produced during the preceding years are treated under Standard No. 111 as having been produced during the production year being reported on, information on the number of vehicles that meet the rear visibility requirements of Standard No. 111 (49 CFR 571.111).

§ 585.127 Records.

Each manufacturer shall maintain records of the Vehicle Identification Number for each vehicle for which information is reported under § 585.126 until December 31, 2020.

Issued on: November 29, 2010.

Joseph S. Carra,

Acting Associate Administrator for Rulemaking.

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