DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

49 CFR Parts 571 and 585

[Docket No. NHTSA–2006–25801]

RIN 2127–AJ77

Federal Motor Vehicle Safety Standards; Electronic Stability Control Systems

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

ACTION: Notice of proposed rulemaking (NPRM).

SUMMARY: As part of a comprehensive plan for reducing the serious risk of rollover crashes and the risk of death and serious injury in those crashes, this document proposes to establish a new Federal motor vehicle safety standard (FMVSS) No. 126 to require electronic stability control (ESC) systems on passenger cars, multipurpose vehicles, trucks and buses with a gross vehicle weight rating of 4,536 Kg (10,000 pounds) or less. ESC systems use automatic computer-controlled braking of individual wheels to assist the driver in maintaining control in critical driving situations in which the vehicle is beginning to lose directional stability at the rear wheels (spin out) or directional control at the front wheels (plow out).

Based on our own crash data studies, NHTSA estimates that the installation of ESC will reduce single-vehicle crashes of passenger cars by 34 percent and single vehicle crashes of sport utility vehicles (SUVs) by 59 percent, with a much greater reduction of rollover crashes.

Preventing single-vehicle loss-of-control crashes is the most effective way to reduce deaths resulting from rollover crashes. This is because most loss of control crashes culminate in the vehicle leaving the roadway, which dramatically increases the probability of a rollover. NHTSA estimates that ESC has the potential to prevent 71 percent of passenger car rollovers and 84 percent of SUV rollovers in single-vehicle crashes.

NHTSA estimates that ESC would save 5,300 to 10,300 lives and prevent 168,000 to 252,000 injuries in all types of crashes annually if all light vehicles on the road were equipped with ESC systems. ESC systems would substantially reduce (by 4,200 to 5,400) of the more than 10,000 deaths each year on American roads resulting from rollover crashes.

About 29 percent of model year (MY) 2006 light vehicles sold in the U.S. were equipped with ESC, and manufacturers intend to increase the number of ESC installations in light vehicles to 71 percent by MY 2011. This rule would require a 100 percent installation rate for ESC by MY 2012 (with exceptions for some vehicles manufactured in stages or by small volume manufacturers). Of the overall projected annual 5,300 to 10,300 highway deaths and 168,000 to 252,000 injuries prevented, we would attribute 1,536 to 2,211 prevented fatalities (including 1,161 to 1,445 involving rollover) to this proposed rulemaking, in addition to the prevention of 50,594 to 69,630 injuries.

DATES: You should submit your comments early enough to ensure that Docket Management receives them not later than November 17, 2006.

ADDRESSES: You may submit comments identified by DOT DMS Docket Number above by any of the following methods:

- *Web Site: http://dms.dot.gov.* Follow the instructions for submitting comments on the DOT electronic docket site.
- *Fax:* 1–202–493–2251.
- *Mail:* Docket Management Facility; U.S. Department of Transportation, 400 Seventh Street, SW., Nassif Building, Room PL–401, Washington, DC 20590
- *Hand Delivery:* Room PL–401 on the plaza level of the Nassif Building, 400 Seventh Street, SW., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal Holidays.
- *Federal eRulemaking Portal:* Go to *http://www.regulations.gov.* Follow the online instructions for submitting comments.

Instructions: All submissions must include the agency name and docket number or Regulatory Identification Number (RIN) for this rulemaking. 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://dms.dot.gov,* including any personal information provided. Please see the Privacy Act heading under Regulatory Notices.

Docket: For access to the docket to read background documents or comments received, go to *http://dms.dot.gov* at any time or to Room PL–401 on the plaza level of the Nassif Building, 400 Seventh Street, SW., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal Holidays.

FOR FURTHER INFORMATION CONTACT: For non-legal issues, you may call Mr. Patrick Boyd, Office of Crash Avoidance Standards at (202) 366–2272. His FAX number is (202) 366–7002.

For legal issues, you may call Mr. Eric Stas, Office of the Chief Counsel at (202) 366–2992. His FAX number is (202) 366–3820.

You may send mail to both of these officials at National Highway Traffic Safety Administration, 400 Seventh Street, SW., Washington, DC 20590.

SUPPLEMENTARY INFORMATION:

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I. Executive Summary

As part of a comprehensive plan for reducing the serious risk of rollover crashes and the risk of death and serious injury in those crashes, this rule proposes to establish Federal Motor Vehicle Safety Standard (FMVSS) No. 126, *Electronic Stability Control Systems,* which would require passenger cars, multipurpose passenger vehicles (MPVs), trucks, and buses that have a gross vehicle weight rating (GVWR) of 4,536 kg (10,000 pounds) or less to be equipped with an ESC system that meets the requirements of the standard. ESC systems use automatic, computer-controlled braking of individual wheels to assist the driver in maintaining control (and the vehicle's intended heading) in situations where the vehicle is beginning to lose directional stability (*e.g.*, where the driver misjudges the severity of a curve or over-corrects in an emergency situation). In such situations (which occur with considerable frequency), intervention by the ESC system can assist the driver in preventing the vehicle from leaving the roadway, thereby preventing fatalities and injuries associated with crashes involving vehicle rollover or collision with various objects (*e.g.*, trees, highway infrastructure, other vehicles).

Based upon current estimates regarding the effectiveness of ESC systems, we believe that an ESC standard could save thousands of lives each year, providing potentially the greatest safety benefits produced by any safety device since the introduction of seat belts. The following discussion highlights the research and regulatory efforts that have culminated in the present proposal.

Since the early 1990's, NHTSA has been actively engaged in finding ways to address the problem of vehicle rollover, because crashes involving rollover are responsible for a disproportionate number of fatalities and serious injuries (over 10,000 of the 33,000 fatalities of vehicle occupants in 2004). Although various options were explored, the agency ultimately chose to add a rollover resistance component to its New Car Assessment Program (NCAP) consumer information program in 2001. In response to NCAP's market-based incentives, vehicle manufacturers made modifications to their product lines to increase their vehicles' geometric stability and rollover resistance by utilizing wider track widths (typically associated with passenger cars) on many of their newer sport utility vehicles (SUVs) and by making other improvements to truck-based SUVs during major redesigns (*e.g.*, introduction of roll stability control). This approach was successful in terms of reducing the much higher rollover rate of SUVs and other high-center-of-gravity vehicles, as compared to passenger cars. However, manipulating vehicle configuration alone cannot entirely resolve the rollover problem (particularly when consumers continue to demand vehicles with greater carrying capacity and higher ground clearance).

Accordingly, the agency began exploring technologies that could confront the issue of vehicle rollover from a different perspective or line of inquiry, which led to today's proposal. We believe that our proposed ESC requirement offers a complementary approach that would provide substantial benefits to drivers of both passenger cars and LTVs (light trucks/vans). Undoubtedly, keeping vehicles from leaving the roadway is the best way to prevent deaths and injuries associated with rollover, as well as other types of crashes. Based on its crash data studies, NHTSA estimates that the installation of ESC systems will reduce single vehicle crashes of passenger cars by 34 percent and single vehicle crashes of sport utility vehicles (SUVs) by 59 percent. Its effectiveness is especially great for single-vehicle crashes resulting in rollover, where ESC systems were estimated to prevent 71 percent of passenger car rollovers and 84 percent of SUV rollovers in single vehicle crashes (*see* section VII).

In short, we believe that preventing single-vehicle loss-of-control crashes is the most effective way to reduce rollover deaths, and we believe that ESC offers considerable promise in terms of meeting this important safety objective while maintaining a broad range of vehicle choice for consumers. In fact, among the agency's ongoing and planned rulemakings, it is the single most effective way of reducing the total number of traffic deaths. It is also the most cost-effective of those rulemakings.

We note that this proposal is consistent with recent congressional legislation contained in section 10301 of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users of 2005 (SAFETEA–LU).[1] That provision requires the Secretary of Transportation to ''establish performance criteria to reduce the occurrence of rollovers consistent with stability enhancing technologies'' and to ''issue a proposed rule * * * by October 1, 2006, and a final rule by April 1, 2009.''

The balance of this notice explains in detail: (1) The size of the safety problem (*see* section II); (2) how ESC systems would act to mitigate that safety problem (*see* section II); (3) the basics of ESC operation (*see* section III); (4) findings from ESC-related research (*see* section IV);(5) the specifics of our regulatory proposal (*see* section V); (6) lead time and phase-in requirements (*see* section VI), and (7) costs and benefits associated with this proposal (*see* section VII). The following section summarizes the key points of the proposal.

A. Proposed Requirements for ESC Systems

Consistent with the congressional mandate in section 10301 of SAFETEA–LU, NHTSA is proposing to require all light vehicles to be equipped with an ESC system with, at the minimum, the capabilities of current production systems. We believe that a requirement for such ESC systems would be practicable in terms of both ensuring technological feasibility and providing the desired safety benefits in a cost-effective manner. Although vehicle manufacturers have been increasing the share of the light vehicle fleet equipped with ESC, we believe that given the relatively high cost of this technology, a mandatory standard is necessary to maximize the safety benefits associated with electronic stability control, and is consistent with the mandate arising out of SAFETEA–LU.

In order to realize these benefits, we have tentatively decided to require vehicles both to be equipped with an ESC system meeting definitional requirements and to pass a dynamic test. The definitional requirements specify the necessary elements of a stability control system that would be capable of both effective oversteer and understeer intervention. These requirements are necessary due to the extreme difficulty in establishing a test adequate to ensure the desired level of ESC functionality.[2] The test is necessary to ensure that the ESC system is robust and meets a level of performance at least comparable to that of current ESC systems. These requirements are summarized below.

- Consistent with the industry consensus definition of ESC contained in the Society of Automotive Engineers (SAE) Surface Vehicle Information Report J2564 (rev. June 2004), we are proposing to require vehicles covered under the standard to be equipped with an ESC system that:

(1) Augments vehicle directional stability by applying and adjusting the vehicle's brakes individually to induce correcting yaw torques to a vehicle;

(2) Is computer-controlled, with the computer using a closed-loop algorithm[3] to limit vehicle oversteer and to limit vehicle understeer when appropriate;

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[1] Pub. L. 109–59, 119 Stat. 1144 (2005).

[2] Without an equipment requirement, it would be almost impossible to devise a single performance test that could not be met through some action by the manufacturer other than providing an ESC system. Even a battery of performance tests still might not achieve our intended results, because although it might necessitate installation of an ESC system, we expect that it would be unduly cumbersome for both the agency and the regulated community.

[3] A ''closed-loop algorithm'' is a cycle of operations followed by a computer that includes automatic adjustments based on the result of previous operations or other changing conditions.

(3) Has a means to determine vehicle yaw rate [4] and to estimate its sideslip [5];

(4) Has a means to monitor driver steering input, and

(5) Is operational over the full speed range of the vehicle (except below a low-speed threshold where loss of control of the vehicle is unlikely).

- The proposed ESC system as defined above would also be required to be capable of applying all four brakes individually and to have an algorithm that utilizes this capability. The system would also be required to be operational during all phases of driving, including acceleration, coasting, and deceleration (including braking), and it would be required to remain operational when the antilock brake system or traction control system is activated.
- We are also proposing to require vehicles covered under the standard to meet a performance test that would satisfy the standard's stability criteria and responsiveness criterion when subjected to the Sine with Dwell steering maneuver test. This test involves a vehicle coasting at an initial speed of 50 mph while a steering machine steers the vehicle with a steering wheel pattern as shown in Figure 2. The test maneuver is then repeated over a series of increasing maximum steering angles. This test maneuver was selected over a number of other alternatives, because we tentatively decided that it has the most optimal set of characteristics, including severity of the test, repeatability and reproducibility of results, and the ability to address lateral stability and responsiveness (*see* section V.B).

The maneuver is severe enough to produce spinout for most vehicles without ESC. The stability criteria for the test measure how quickly the vehicle stops turning after the steering wheel is returned to the straight-ahead position. A vehicle that continues to turn for an extended period after the driver steers straight is out of control, which is what ESC is designed to prevent. The stability criteria are expressed in terms of the percent of the peak yaw rate after maximum steering that persists at a period of time after the steering wheel has been returned to straight ahead. They require that the vehicle yaw rate decrease to no more than 35 percent of the peak value after one second and that it continues to drop to no more than 20 percent after 1.75 seconds. Since a vehicle that simply responds very little to steering commands could meet the stability criteria, a minimum responsiveness criterion is applied to the same test. It requires that the ESC-equipped vehicle must move laterally at least 1.83 meters (half a 12 foot lane width) during the first 1.07 seconds after the initiation of steering (a discontinuity in the steering pattern that is convenient for timing a measurement).

- Because the benefits of the ESC system can only be realized if the system is functioning properly, we are proposing to require a telltale be mounted inside the occupant compartment in front of and in clear view of the driver and be identified by the symbol shown for ''ESC Malfunction Telltale'' in Table 1 of FMVSS No. 101, *Controls and Displays.* The ESC malfunction telltale would be required to illuminate not more than two minutes after the occurrence of one or more malfunctions that affect the generation or transmission of control or response signals in the vehicle's ESC system. Such telltale must remain continuously illuminated for as long as the malfunction(s) exists, whenever the ignition locking system is in the ''On'' (''Run'') position. (Vehicle manufacturers would be permitted to use the ESC malfunction telltale in a flashing mode to indicate ESC operation.)
- In certain circumstances, drivers may have legitimate reasons to disengage the ESC system or limit its ability to intervene, such as when the vehicle is stuck in sand/gravel or when the vehicle is being run on a track for maximum performance. Accordingly, under this proposal, vehicle manufacturers would be permitted to include a driver-selectable switch that places the ESC system in a mode in which it would not satisfy the performance requirements of the standard (e.g., ''sport'' mode or full-off mode). However, if the vehicle manufacturer chooses this option, it would be required to ensure that the ESC system always returns to a mode that satisfies the requirements of the standard at the initiation of each new ignition cycle, regardless of the mode the driver had previously selected. The manufacturer would be required to provide an ''ESC Off'' switch and a telltale that is mounted inside the occupant compartment in front of and in clear view of the driver and which is identified by the symbol shown for ''ESC Off'' in Table 1 of FMVSS No. 101. Such telltale must remain continuously illuminated for as long as the ESC is in a mode that renders it unable to meet the performance requirements of the standard, whenever the ignition locking system is in the ''On'' (''Run'') position.
- We are not proposing to require the ESC system to be equipped with a roll stability control function (or a separate system to that effect). Roll stability control systems involve relatively new technology, and there is currently insufficient data to judge the efficacy of such systems. However, the agency will continue to monitor the development of roll stability control systems. Vehicle manufacturers may supplement the ESC system we are proposing to require with a roll stability control system/feature.

B. Leadtime and Phase-In

In order to provide the public with what are expected to be the significant safety benefits of ESC systems as rapidly as possible, NHTSA is proposing to require all light vehicles covered by this standard to be equipped with a FMVSS No. 126-compliant ESC system by September 1, 2011. We are proposing that compliance would commence on September 1, 2008, which would mark the start of a three-year phase-in period. Subject to the special provisions discussed below, the proposed phase-in schedule for FMVSS No. 126 would be as follows: 30 percent of a vehicle manufacturer's light vehicles manufactured during the period from September 1, 2008 to August 31, 2009 would be required to comply with the standard; 60 percent of those manufactured during the period from September 1, 2009 to August 31, 2010; 90 percent of those manufactured during the period from September 1, 2010 to August 31, 2011, and all light vehicles thereafter.

In general, we believe that it would be practicable for vehicle manufacturers to meet the requirements of the phase-in discussed above. We anticipate that vehicle manufacturers would be able to meet the requirements of the proposed standard by installing ESC systems currently in production, and most vehicle lines would likely experience some level of redesign over the next four to five years, which would provide an opportunity to incorporate an ESC system during the course of the manufacturer's normal production cycle (*see* section VI for a more complete discussion).

However, NHTSA is proposing to exclude multi-stage manufacturers and alterers from the requirements of the phase-in and to extend by one year the time for compliance by those manufacturers (i.e., until September 1, 2012). This NPRM also proposes to exclude small volume manufacturers

[4] ''Yaw rate'' means the rate of change of the vehicle's heading angle measured in degrees/second of rotation about a vertical axis through the vehicle's center of gravity.

[5] ''Sideslip'' means the arctangent of the lateral velocity of the center of gravity of the vehicle divided by the longitudinal velocity of the center of gravity.

(i.e., manufacturers producing less than 5,000 vehicles for sale in the U.S. market in one year) from the phase-in, instead requiring such manufacturers to fully comply with the standard on September 1, 2011.

Under our proposal, vehicle manufacturers would be permitted to earn carry-forward credits for compliant vehicles, produced in excess of the phase-in requirements, which are manufactured between the effective date of the final rule and the conclusion of the phase-in period.[6]

C. Anticipated Impacts of the Proposal

As noted above, we believe that ESC has among the highest life-saving potential of any vehicle safety device developed in the past three decades, ranking with seatbelts and air bags in terms of importance. NHTSA estimates that ESC would save 5,300 to 10,300 lives and prevent 168,000 to 252,000 injuries in all types of crashes annuvly if all light vehicles on the road were equipped with ESC systems. A large portion of these savings would come from rollover crashes. ESC systems would substantially reduce (by 4,200 to 5,400) of the more than 10,000 deaths each year on American roads resulting from rollover crashes.

About 29 percent of model year (MY) 2006 light vehicles sold in the U.S. were equipped with ESC, and manufacturers intend to increase the number of ESC installations in light vehicles to 71 percent by MY 2011.[7] This rule would require a 100 percent installation rate for ESC by MY 2012 (with exceptions for some vehicles manufactured in stages or by small volume manufacturers). As the discussion below demonstrates, ESC has very significant life-saving and injury-preventing potential in absolute terms, but it does so in a very cost-effective manner vis-á-vis other agency rulemakings. ESC offers consistently strong benefits and cost-effectiveness across all types of light vehicles, including passenger cars, SUVs, vans, and pick-up trucks.

Of the 5,300 to 10,300 highway deaths and 168,000 to 252,000 MAIS 1–5 injuries which we project will be prevented annually for all types of crashes once all light vehicles on the road are equipped with ESC, we would attribute 1,536 to 2,211 prevented fatalities (including 1,161 to 1,445 involving rollover) to this proposed rulemaking, in addition to the prevention of 50,594 to 69,630 injuries. This compares favorably with the Regulatory Impact Analyses for other important rulemakings such as FMVSS No. 208 mandatory air bags (1,964 to 3,670 lives saved), FMVSS No. 214 side impact protection (690 to 1,030 lives saved), and FMVSS No. 201 upper interior head impact protection (870 to 1,050 lives saved). (*See* section VII, Benefits and Costs of this notice and the Preliminary Regulatory Impact Analysis submitted to the docket for this rulemaking). In addition, the agency estimates that property damage and travel delay costs would be reduced by $260 to $453 million annually.

The agency estimates that the production-weighted, average cost per vehicle to meet the proposed standard's requirements would be $58 ($90.3 per passenger car and $29.2 per light truck). These are incremental costs over the MY 2011 installation of ABS, which is expected to be installed in almost 93 percent of the light vehicle fleet, and ESC, which is expected to be installed in 71 percent of the light vehicle fleet. Vehicle costs are estimated to be $368 (in 2005$) for anti-lock brakes (ABS) and an additional $111 for ESC, for a total system cost of $479 per vehicle. Currently, every vehicle that is equipped with ESC, is also equipped with ABS and traction control. However, the agency believes that traction control is a convenience feature. Accordingly, it is not required by this proposal. We also assumed an annual production of 17 million light vehicles (9 million light trucks and 8 million passenger cars). Thus, the total annual vehicle cost of this regulation, corresponding to ESC installation beyond manufacturers' planned production, is expected to be approximately $985 million.

In terms of cost-effectiveness, this proposal for passenger cars and light trucks would save 1,536 to 2,211 lives and prevent 50,594 to 69,630 injuries at a cost of $0.19 to $0.32 million per equivalent life saved at a 3 percent discount rate and $0.27 to $0.43 at a 7 percent discount rate. Again, the cost-effectiveness for ESC compares favorably with the Regulatory Impact Analyses for other important rulemakings such as FMVSS No. 202 head restraints safety improvement ($2.61 million per life saved), FMVSS No. 208 center seat shoulder belts ($3.39 to $5.92 million per life saved), FMVSS No. 208 advanced air bags ($1.9 to $9.0 million per life saved), and FMVSS No. 301 fuel system integrity upgrade ($1.96 to $5.13 million per life saved).

We note that the costs for passenger cars are higher because a greater portion of those vehicles require installation of ABS in addition to ESC. Nevertheless, the proposal remains highly cost-effective even when passenger cars are considered alone. The passenger car portion of the proposal would save 956 lives and prevent 34,902 injuries at a cost of $0.35 million per equivalent life saved at a 3 percent discount rate and $0.47 at a 7 percent discount rate. Therefore, the agency deemed it appropriate to make the proposed standard applicable to all light vehicles, because such approach makes sense from both a safety and cost standpoint.

II. Safety Problems Addressed by the Proposed Standard

Crash data studies conducted in the U.S., Europe and Japan indicate that ESC is very effective in reducing single-vehicle crashes. Studies of the behavior of ordinary drivers in critical situations using the National Advanced Driving Simulator also show a very large reduction in instances of loss of control when the vehicle is equipped with ESC. Based on its crash data studies, NHTSA estimates that ESC will reduce single vehicle crashes of passenger cars by 34 percent and single vehicle crashes of SUVs by 59 percent. NHTSA's latest crash data study also shows that ESC is most effective in reducing single-vehicle crashes that result in rollover. ESC is estimated to prevent 71 percent of passenger car rollovers and 84 percent of SUV rollovers in single vehicle crashes. It is also estimated to reduce some multi-vehicle crashes but at a much lower rate than its effect on single vehicle crashes.

A. Single-Vehicle Crash and Rollover Statistics

About one in seven light vehicles involved in police-reported crashes collide with something other than another vehicle. However, the proportion of these single-vehicle crashes increases steadily with increasing crash severity, and almost half of serious and fatal injuries occur in single-vehicle crashes. We can describe the relationship between crash severity and the number of vehicles involved in the crash using information from the agency's crash data programs. We limit our discussion here to light vehicles, which consist of (1) passenger cars and (2) multipurpose passenger vehicles, trucks and buses under 4,536

[6] We note that carry-forward credits would not be permitted to be used to defer the mandatory compliance date of September 1, 2011 for all covered vehicles.

[7] In April 2006, NHTSA sent letters to seven vehicle manufacturers requesting voluntary submission of information regarding their planned production of ESC-equipped vehicles for model years 2007 to 2012. Manufacturers responded with product plans containing confidential information. These agency letters and manufacturer responses (with confidential information redacted) may be found in the docket for this rulemaking.

kilograms (10,000 pounds) gross vehicle weight rating (GVWR).[8]

The 2000–2004 data from the National Automotive Sampling System (NASS) Crashworthiness Data System (CDS) and 2004 data from the Fatality Analysis Reporting System (FARS) were combined to estimate the current target population for this rulemaking. It includes 28,252 people who were killed as occupants of light vehicles. Over half of these (15,007) occurred in single-vehicle crashes. Of these, 8,460 occurred in rollovers. About 1.1 million injuries (AIS 1–5) occurred in crashes that could be affected by ESC, almost 500,000 in single vehicle crashes (of which almost half were in rollovers). Multi-vehicle crashes that could be affected by ESC accounted for 13,245 fatalities and almost 600,000 injuries.

Rollover crashes are complex events that reflect the interaction of driver, road, vehicle, and environmental factors. We can describe the relationship between these factors and the risk of rollover using information from the agency's crash data programs.

According to 2004 data from FARS, 10,555 people were killed as occupants in light vehicle rollover crashes, which represents 33 percent of all occupants killed that year in crashes. Of those, 8,567 were killed in single-vehicle rollover crashes. Seventy-four percent of the people who died in single-vehicle rollover crashes were not using a seat belt, and 61 percent were partially or completely ejected from the vehicle (including 50 percent who were completely ejected). FARS shows that 55 percent of light vehicle occupant fatalities in single-vehicle crashes involved a rollover event.

Using data from the 2000–2004 NASS CDS files, we estimate that 280,000 light vehicles were towed from a police-reported rollover crash each year (on average), and that 29,000 occupants of these vehicles were seriously injured. Of these 280,000 light vehicle rollover crashes, 230,000 were single-vehicle crashes. Sixty-two percent of those people who suffered a serious injury in a single-vehicle tow-away rollover crash were not using a seat belt, and 52 percent were partially or completely ejected (including 41 percent who were completely ejected). Estimates from NASS CDS indicate that 82 percent of tow-away rollovers were single-vehicle crashes, and that 88 percent (202,000) of the single-vehicle rollover crashes occurred after the vehicle left the roadway. An audit of 1992–96 NASS CDS data showed that about 95 percent of rollovers in single-vehicle crashes were tripped by mechanisms such as curbs, soft soil, pot holes, guard rails, and wheel rims digging into the pavement, rather than by tire/road interface friction as in the case of untripped rollover events.

B. The Agency's Comprehensive Response to Rollover

As mentioned above, this proposal for ESC is part of the agency's comprehensive plan to address the issue of vehicle rollover. The following provides background on NHTSA's comprehensive plan to reduce rollover crashes. In 2002, the agency formed an Integrated Project Team (IPT) to examine the rollover problem and make recommendations on how to reduce rollovers and improve safety when rollovers nevertheless occur. In June 2003, based on the work of the team, the agency published a report entitled, ''Initiatives to Address the Mitigation of Vehicle Rollover.'' [9] The report recommended improving vehicle stability, ejection mitigation, roof crush resistance, as well as road improvement and behavioral strategies aimed at consumer education.

Since then, the agency has been working to implement these recommendations as part of it comprehensive agency plan for reducing the serious risk of rollover crashes and the risk of death and serious injury when rollover crashes do occur. It is evident that the most effective way to reduce deaths and injuries in rollover crashes is to prevent the rollover crash from occurring. This proposal to adopt a new Federal motor vehicle safety standard for electronic stability control systems is one part of that comprehensive agency plan.

Moreover, we note that the agency also published a notice of proposed rulemaking in the **Federal Register** in August 2005, seeking to upgrade our safety standard on roof crush resistance (FMVSS No. 216); that notice, like the present one, contains an in-depth discussion of the rollover problem and the countermeasures which the agency intends to pursue as part of its comprehensive response to the rollover problem (*see* 70 FR 49223 (August 23, 2005)).

III. Electronic Stability Control Systems

Although Electronic Stability Control (ESC) systems are known by many different trade names such as Vehicle Stability Control (VSC), Electronic Stability Program (ESP), StabiliTrak and Vehicle Stability Enhancement (VSE), their function and performance are similar. They are systems that uses computer control of individual wheel brakes to help the driver maintain control of the vehicle during extreme maneuvers by keeping the vehicle headed in the direction the driver is steering even when the vehicle nears or reaches the limits of road traction.

When a driver attempts an ''extreme maneuver'' (e.g., one initiated to avoid a crash or due to misjudgment of the severity of a curve), the driver may lose control if the vehicle responds differently as it nears the limits of road traction than it does during ordinary driving. The driver's loss of control can result in either the rear of the vehicle ''spinning out'' or the front of the vehicle ''plowing out.'' As long as there is sufficient road traction, a highly skilled driver may be able to maintain control in many extreme maneuvers using countersteering (i.e., momentarily turning away from the intended direction) and other techniques. However, average drivers in a panic situation in which the vehicle beginning to spin out would be unlikely to countersteer to regain control.

ESC uses automatic braking of individual wheels to adjust the vehicle's heading if it departs from the direction the driver is steering. Thus, it prevents the heading from changing too quickly (spinning out) or not quickly enough (plowing out). Although it cannot increase the available traction, ESC affords the driver the maximum possibility of keeping the vehicle under control and on the road in an emergency maneuver using just the natural reaction of steering in the intended direction.

Keeping the vehicle on the road prevents single-vehicle crashes, which are the circumstances that lead to most rollovers. However, if the speed is simply too great for the available road traction, even a vehicle with ESC will unavoidably drift off the road (but not spin out). Furthermore, ESC cannot prevent road departures due to driver inattention or drowsiness rather than loss of control.

A. How ESC Prevents Loss of Vehicle Control

The following explanation of ESC operation illustrates the basic principle of yaw stability control, but it does not attempt to explain advanced refinements of the yaw control strategy described below that use vehicle sideslip (lateral sliding that may not alter yaw rate) to optimize performance on slippery pavements.

[8] For brevity, we use the term light trucks in this document to refer to multipurpose passenger vehicles, such as vans, minivans, and SUVs, trucks and buses under 4,536 kilograms (10,000 pounds) GVWR.

[9] *See* Docket Number NHTSA 2003–14622–1.

An ESC system maintains what is known as ''yaw'' (or heading) control by determining the driver's intended heading, measuring the vehicle's actual response, and automatically turning the vehicle if its response does not match the driver's intention. However, with ESC, turning is accomplished by applying counter torques from the braking system rather than from steering input.

Speed and steering angle measurements are used to determine the driver's intended heading. The vehicle response is measured in terms of lateral acceleration and yaw rate by onboard sensors. If the vehicle is responding in a manner corresponding to driver input, the yaw rate will be in balance with the speed and lateral acceleration.

The concept of ''yaw rate'' can be illustrated by imaging the view from above of a car following a large circle painted on a parking lot. One is looking at the top of the roof of the vehicle and seeing the circle. If the car starts in a heading pointed north and drives half way around circle, its new heading is south. Its yaw angle has changed 180 degrees. If it takes 10 seconds to go half way around the circle, the ''yaw rate'' is 180 degrees per 10 seconds or 18 deg/sec. If the speed stays the same, the car is constantly rotating at a rate of 18 deg/sec around a vertical axis that can be imagined as piercing its roof. If the speed is doubled, the yaw rate increases to 36 deg/sec.

While driving in a circle, the driver notices that he must hold the steering wheel tightly to avoid sliding toward the passenger seat. The bracing force is necessary to overcome the lateral acceleration that is caused by the car following the curve. The lateral acceleration is also measured by the ESC system. When the speed is doubled the lateral acceleration increases by a factor of four if the vehicle follows the same circle. There is a fixed physical relationship between the car's speed, the radius of its circular path, and its lateral acceleration.

The ESC system uses this information as follows: Since the ESC system measures the car's speed and its lateral acceleration, it can compute the radius of the circle. Since it then has the radius of the circle and the car's speed, the ESC system can compute the correct yaw rate for a car following the path. Of course, the system includes a yaw rate sensor, and it compares the actual measured yaw rate of the car to that computed for the path the car is following. If the computed and measured yaw rates begin to diverge as the car that is trying to follow the circle speeds up, it means the driver is beginning to lose control, even if the driver cannot yet sense it. Soon, an unassisted vehicle would have a heading significantly different from the desired path and would be out of control either by oversteering (spinning out) or understeering.

When the ESC system detects an imbalance between the measured yaw rate of a vehicle and the path defined by the vehicle's speed and lateral acceleration, the ESC system automatically intervenes to turn the vehicle. The automatic turning of the vehicle is accomplished by uneven brake application rather than by steering wheel movement. If only one wheel is braked, the uneven brake force will cause the vehicle's heading to change. Figure 1 shows the action of ESC using single wheel braking to correct the onset of oversteering or understeering. (Please note that all Figures discussed in this preamble may be found at the end of the preamble, immediately preceding the proposed regulatory text.)

• *Oversteering.* In Figure 1 (bottom panel), the vehicle has entered a left curve that is extreme for the speed it is traveling. The rear of the vehicle begins to slide which would lead to a vehicle without ESC turning sideways (or ''spinning out'') unless the driver expertly countersteers. In a vehicle equipped with ESC, the system immediately detects that the vehicle's heading is changing more quickly than appropriate for the driver's intended path (i.e., the yaw rate is too high). It momentarily applies the right front brake to turn the heading of the vehicle back to the correct path. The action happens quickly so that the driver does not perceive the need for steering corrections. Even if the driver brakes because the curve is sharper than anticipated, the system is still capable of generating uneven braking if necessary to correct the heading.

• *Understeering.* Figure 1 (top panel) shows a similar situation faced by a vehicle whose response as it nears the limits of road traction is to slide at the front (''plowing out'' or understeering) rather than oversteering. In this situation, the ESC system rapidly detects that the vehicle's heading is changing less quickly than appropriate for the driver's intended path (i.e., the yaw rate is too low). It momentarily applies the left rear brake to turn the heading of the vehicle back to the correct path.

While Figure 1 may suggest that particular vehicles go out of control as either vehicles prone to oversteer or vehicles prone to understeer, it is just as likely that a given vehicle could require both understeer and oversteer interventions during progressive phases of a complex avoidance maneuver such as a double lane change.

Although ESC cannot change the tire/road friction conditions the driver is confronted with in a critical situation, there are clear reasons to expect it to reduce loss-of-control crashes, as discussed below.

In vehicles without ESC, the response of the vehicle to steering inputs changes as the vehicle nears the limits of road traction. All of the experience of the average driver is in operating the vehicle in its ''linear range'', i.e., the range of lateral acceleration in which a given steering wheel movement produces a proportional change in the vehicle's heading. The driver merely turns the wheel the expected amount to produce the desired heading. Adjustments in heading are easy to achieve because the vehicle's response is proportional to the driver's steering input, and there is very little lag time between input and response. The car is traveling in the direction it is pointed, and the driver feels in control. However, at lateral accelerations above about one-half ''g'' on dry pavement for ordinary vehicles, the relationship between the driver's steering input and the vehicle's response changes (toward oversteer or understeer), and the lag time of the vehicle response can lengthen. When a driver encounters these changes during a panic situation, it adds to the likelihood that the driver will loose control and crash because the familiar actions learned by driving in the linear range would not be the correct steering actions.

However, ordinary linear range driving skills are much more likely to be adequate for a driver of a vehicle with ESC to avoid loss of control in a panic situation. By monitoring yaw rate and sideslip, ESC can intervene early in the impending loss-of-control situation with the appropriate brake forces necessary to restore yaw stability before the driver would attempt an over correction or other error. The net effect of ESC is that the driver's ordinary driving actions learned in linear range driving are the correct actions to control the vehicle in an emergency. Also, the vehicle will not change its heading from the desired path in a way that would induce further panic in a driver facing a critical situation. Studies using a driving simulator, discussed in Section IV, demonstrate that ordinary drivers are much less likely to lose control of a vehicle with ESC when faced with a critical situation.

Besides allowing drivers to cope with emergency maneuvers and slippery pavement using only ''linear range'' skills, ESC provides more powerful control interventions than those available to even expert drivers of non-ESC vehicles. For all practical purposes, the yaw control actions with non-ESC vehicles are limited to steering. However, as the tires approach the maximum lateral force sustainable under the available pavement friction, the yaw moment generated by a given increment of steering angle is much less than at the low lateral forces occurring in regular driving.[10]. This means that as the vehicle approaches its maximum cornering capability, the ability of the steering system to turn the vehicle is greatly diminished, even in the hands of an expert driver. ESC creates the yaw moment to turn the vehicle using braking at an individual wheel rather than the steering system. This intervention remains powerful even at limits of tire traction because both the braking force of the individual tire and the reduction of lateral force that accompanies the braking force act to create the desired yaw moment. Therefore, ESC can be especially beneficial on slippery surfaces. While a vehicle's possibility of staying on the road in a critical maneuver ultimately is limited by the tire/pavement friction, ESC maximizes an ordinary driver's ability to use the available friction.

B. Additional Features of Some ESC Systems

In addition to the basic operation of ''yaw stability control'', many ESC systems include additional features. For example, most systems reduce engine power during intervention to slow the vehicle and give it a better chance of being able to stay on the intended path after its heading has been corrected.

Other ESC systems may go further by performing high deceleration automatic braking at all four wheels. Of course, such braking would be performed unevenly side to side so that the same net yaw torque or ''turning force'' would be applied to the vehicle as in the basic case of single-wheel braking.

ESC systems used on vehicles with a high center of gravity (c.g.), such as SUVs, are often programmed to perform an additional function known as ''roll stability control.'' Roll stability control (RSC) is a direct countermeasure for on-pavement rollover crashes of high c.g. vehicles. Some RSC systems measure the roll angle of the vehicle using an additional roll rate sensor to determine if the vehicle is in danger of tipping up. Other systems rely on the existing ESC sensors for steering angle, speed, and lateral acceleration, along with knowledge of vehicle-specific characteristics to estimate whether the vehicle is in danger of tipping up.

Regardless of the method used to detect the risk of tip-up, the various types of roll stability control intervene in the same way. Specifically, they intervene by reducing lateral acceleration which is the cause of the roll motion of the vehicle on its suspension, thus preventing the possibility of it rolling so much that the inside wheels may lift off the pavement. The intervention is performed the same way as the oversteer intervention shown in the Figure 1. The outside front brake is applied heavily to turn the vehicle toward a path of less curvature and, therefore, less lateral acceleration.

The difference between a roll stability control intervention and an oversteer intervention by the ESC system operating in the basic yaw stability control mode is the triggering circumstance. The oversteer intervention occurs when the vehicle's excessive yaw rate indicates that its heading is departing from the driver's intended path, but the roll stability control intervention occurs when there is a risk the vehicle could roll over. Thus, the roll stability control intervention occurs when the vehicle is still following the driver's intended path. The obvious trade-off of roll stability control is that the vehicle must depart to some extent from the driver's intended path in order to reduce the lateral acceleration from the level that could cause tip-up.

If the determination of impending rollover that triggers the roll stability intervention is very certain, then the possibility of the vehicle leaving the roadway as a result of the roll stability intervention represents a lower relative risk to the driver. Obviously, systems that intervene only when absolutely necessary and then with the minimum loss of lateral acceleration to prevent rollover are the most effective. However, roll stability control is a new technology that is still evolving. Roll stability control is not a subject of this rulemaking because it is too soon for actual crash statistics to illuminate its practical effect on crash reduction.

IV. Effectiveness of ESC

Electronic stability control can directly reduce a vehicle's susceptibility to on-road untripped rollovers as measured by the ''fishhook'' test that is part of NHTSA's NCAP rollover rating program. The direct effect is mostly limited to untripped rollovers on paved surfaces. However, untripped on-road rollovers are a relatively infrequent type of rollover crash. In contrast, the vast majority of rollover crashes occur when a vehicle runs off the road and strikes a tripping mechanism such as soft soil, a ditch, a curb or a guardrail.

We expect that requiring ESC to be installed on light trucks and passenger cars would result in a large reduction in the number of rollover crashes by greatly reducing the number of single-vehicle crashes. As noted previously, over 80 percent of rollovers are the result of a single-vehicle crash. The purpose of ESC is to assist the driver in keeping the vehicle on the road during impending loss-of-control situations. In this way, it can prevent the exposure of vehicles to off-road tripping mechanisms. We note, however, that this yaw stability function of ESC is not direct ''rollover resistance'' and cannot be measured by the NCAP rollover resistance rating.

Although ESC is an indirect countermeasure to prevent rollover crashes, we believe it is the most powerful countermeasure available to address this serious risk. Effectiveness studies by NHTSA and others worldwide [11] estimate that ESC reduces single vehicle crashes by at least a third in passenger cars and perhaps reduces loss-of-control crashes (e.g., road departures leading to rollovers) by an even greater amount. In fact, NHTSA's latest data study that is discussed in this section found a reduction in single-vehicle crashes leading to rollover of 71 percent for passenger cars and 84 percent for SUVs. Thus, ESC can reduce the numbers of rollovers of all vehicles, including lower center of gravity vehicles (e.g., passenger cars, minivans and two-wheel drive pickup trucks), as well as of the higher center of gravity vehicle types (e.g., SUVs and four-wheel drive pickup trucks). ESC can affect both crashes that would have resulted in rollover as well as other types of crashes

[10] Liebemann *et al.,* (2005) Safety and Performance Enhancement: The Bosch Electronic Stability Control (ESP), 19th International Technical Conference on the Enhanced Safety of Vehicles (ESV), Washington, DC.

[11] Aga M, Okada A. (2003) Analysis of Vehicle Stability Control (VSC)'s Effectiveness from Accident Data, 18th International Technical Conference on the Enhanced Safety of Vehicles (ESV), Nagoya.

Dang, J. (2004) Preliminary Results Analyzing Effectiveness of Electronic Stability Control (ESC) Systems, Report No. DOT HS 809 790. U.S. Dept. of Transportation, Washington, DC.

Farmer, C. (2004) Effect of Electronic Stability Control on Automobile Crash Risk, Traffic Injury Prevention Vol 5:317–325.

Kreiss J-P, *et al.* (2005) The Effectiveness of Primary Safety Features in Passenger Cars in Germany. 19th International Technical Conference on the Enhanced Safety of Vehicles (ESV), Washington, DC

Lie A., *et al.* (2005) The Effectiveness of ESC (Electronic Stability Control) in Reducing Real Life Crashes and Injuries. 19th International Technical Conference on the Enhanced Safety of Vehicles (ESV), Washington, DC.

(e.g., road departures resulting in impacts) that result in deaths and injuries.

A. Human Factors Study on the Effectiveness of ESC

A study by the University of Iowa using the National Advanced Driving Simulator demonstrated the effect of ESC on the ability of ordinary drivers to maintain control in critical situations.[12] A sample of 120 drivers equally divided between men and women and between three age groups (18–25, 30–40, and 55–65) was subjected to the following three critical driving scenarios. The ''Incursion Scenario'' forced drivers to attempt a double lane change at high speed (65 mph speed limit signs) by presenting them first with a vehicle that suddenly backs into their lane from a driveway and then with another vehicle driving toward them in the left lane. The ''Curve Departure Scenario'' presented drivers with a constant radius curve that was uneventful at the posted speed limit of 65 mph followed by another curve that appeared to be similar but that had a decreasing radius that was not evident upon entry. The ''Wind Gust Scenario'' presented drivers with a sudden lateral wind gust of short duration that pushed the drivers toward a lane of oncoming traffic. The 120 drivers were further divided evenly between two vehicles, a SUV and a midsize sedan. Half the drivers of each vehicle drove with ESC enabled, and half drove with ESC disabled.

In 50 of the 179 test runs performed in a vehicle without ESC, the driver lost control. In contrast, in only six of the 179 test runs performed in a vehicle with ESC, did the driver lose control. One test run in each ESC status had to be aborted. These results demonstrate an 88 percent reduction in loss-of-control crashes when ESC was engaged. The study also concluded that the presence of an ESC system helped reduce loss of control regardless of age or gender, and that the benefit was substantially the same for the different driver subgroups in the study. Because of the obvious danger to participants, an experiment like this cannot be performed safely with real vehicles on real roads. However, the National Advanced Driver Simulator provides extraordinary verisimilitude with the driver sitting in a real vehicle, seeing a 360-degree scene and experiencing the linear and angular accelerations and sounds that would occur in actual driving of the specific vehicle.

B. Crash Data Studies of ESC Effectiveness

There have been a number of studies of ESC effectiveness in Europe and Japan beginning in 2003[13]. All of them have shown large potential reductions in single vehicle crashes as a result of ESC. However, the sample sizes of crashes of vehicles new enough to have ESC tended to be small in these studies. A preliminary NHTSA study published in September 2004[14] of crash data from 1997–2003 found ESC to be effective in reducing single-vehicle crashes, including rollover. Among vehicles in the study, the results suggested that ESC reduced single vehicle crashes in passenger cars by 35 percent and in SUVs by 67 percent. In October 2004, the Insurance Institute for Highway Safety (IIHS) released the results of a study of the effectiveness of ESC in preventing crashes of cars and SUVs. The IIHS found that ESC is most effective in reducing fatal single-vehicle crashes, reducing such crashes by 56 percent. NHTSA's later peer-reviewed study[15] of ESC effectiveness found that that ESC reduced single vehicle crashes in passenger cars by 34 percent and in SUVs by 59 percent, and that its effectiveness was greatest in reducing single vehicle crashes resulting in rollover (71 percent reduction for passenger cars and an 84 percent reduction for SUVs). It also found reductions in fatal single-vehicle crashes and fatal single-vehicle rollover crashes that were commensurate with the overall crash reductions cited. ESC reduced fatal single-vehicle crashes in passenger cars by 35 percent and in SUVs by 67 percent and reduced fatal single-vehicle crashes involving rollover by 69 percent in passenger cars and 88 percent in SUVs.

(a) NHTSA's Preliminary Study

In September, 2004, NHTSA issued an evaluation note on the *Preliminary Results Analyzing the Effectiveness of Electronic Stability Control (ESC) Systems*. The study evaluated the effectiveness of ESC in reducing single vehicle crashes in various domestic and imported cars and SUVs. It was based on Fatality Analysis Reporting System (FARS) data from calendar years 1997–2003 and crash data from five States that reported partial Vehicle Identification Number (VIN) information in their data files (Florida, Illinois, Maryland, Missouri, and Utah) from calendar years 1997–2002. The data were limited to mostly luxury vehicles because ESC first became available in 1997 in luxury vehicles such as Mercedes-Benz and BMW. The analysis compared specific make/models of passenger cars and SUVs with ESC versus earlier versions of the same make/models, using multi-vehicle crash involvements as a control group.

The passenger car sample consisted of mainly Mercedes-Benz and BMW models (61 percent). Mercedes-Benz installed ESC in certain luxury models in 1997 and had made it standard equipment in all their models (except one) by 2000. BMW also installed ESC in certain 5, 7, and 8 series models as early as 1997 and had made it standard equipment in all their models by 2001. The passenger car sample also included some luxury GM cars, which constituted 23 percent of the sample, and a few cars from other manufacturers. GM cars where ESC was offered as standard equipment are the Buick Park Avenue Ultra, the Cadillac DeVille, Seville STS and SLS, the Oldsmobile Aurora, the Pontiac Bonneville SSE and SSEi, and the Chevrolet Corvette. The SUV make/models in the study with ESC include Mercedes-Benz (ML320, ML350, ML430, ML500, G500, G55 AMG), Toyota (4Runner, Landcruiser), and Lexus (RX300, LX470).

The first set of analyses used multi-vehicle crash involvements as a control group, essentially assuming that ESC has no effect on multi-vehicle crashes. Specific make/models with ESC were compared with earlier versions of similar make/models using multi-vehicle crash involvements as a control group, creating 2x2 contingency tables as shown in Tables 1 and 2. The study found that single vehicle crashes were reduced by

$$1 - \{(699/1483)/(14090/19444)\} = 35 \text{ percent}$$

for passenger cars and by 67 percent for SUVs (Table 1). Similarly, fatal single vehicle crashes were reduced by 30 percent in cars and by 63 percent in SUVs (Table 2). Reductions of single vehicle crashes in passenger cars and SUVs were statistically significant at the .01 level, as evidenced by chi-square statistics exceeding 6.64 in each 2×2 contingency table (Table 1). Reductions of *fatal* single vehicle crashes are statistically significant at the .01 level in SUVs and at the .05 level in passenger

[12] Papelis *et al.* (2004) Study of ESC Assisted Driver Performance Using a Driving Simulator, Report No. N04–003–PR, University of Iowa.

[13] See Footnote 10.

[14] Dang, J. (2004) Preliminary Results Analyzing Effectiveness of Electronic Stability Control (ESC) Systems, Report No. DOT HS 809 790. U.S. Dept. of Transportation, Washington, DC.

[15] Dang, J. (2006) Statistical Analysis of The Effectiveness of Electronic Stability Control (ESC) Systems, U.S. Dept. of Transportation, Washington, DC (publication pending peer review). A draft version of this report, as supplied to peer reviewers, has been placed in the docket for this rulemaking.

cars with chi-square statistic greater than 3.84 (Table 2).

TABLE 1.—EFFECTIVENESS OF ESC IN REDUCING SINGLE VEHICLE CRASHES IN PASSENGER CARS AND SUVS

[Preliminary Study with 1997–2002 crash data from five States]

	Single Vehicle Crashes	Multi-Vehicle Crashes (control group)
Passenger Cars:		
No ESC	1483	19444
ESC	699	14090
Percent reduction in single vehicle crashes in passenger cars with ESC	35%	
Approximate 95 percent confidence bounds	29% to 41%	
Chi-square value	84.1	
SUVs:		
No ESC	512	6510
ESC	95	3661
Percent reduction in single vehicle crashes in SUVs with ESC	67%	
Approximate 95 percent confidence bounds	60% to 74%	
Chi-square value	104.4	

TABLE 2.—EFFECTIVENESS OF ESC IN REDUCING FATAL SINGLE VEHICLE CRASHES IN PASSENGER CARS AND SUVS

[Preliminary Study with 1997–2003 FARS data]

	Fatal Single Vehicle Crashes	Fatal Multi-Vehicle Crashes (control group)
Passenger Cars:		
No ESC	186	330
ESC	110	278
Percent reduction in fatal single vehicle crashes in passenger cars with ESC	30%	
Approximate 95 percent confidence bounds	10% to 50%	
Chi-square value	6.0	
SUVs:		
No ESC	129	199
ESC	25	103
Percent reduction in fatal single vehicle crashes in SUVs with ESC	63%	
Approximate 95 percent confidence bounds	44% to 81%	
Chi-square value	16.1	

(b) NHTSA's Updated Study

NHTSA has now updated and modified last year's report, extending it to model year 1997–2004 vehicles—and to calendar year 2004 for the FARS analysis and calendar year 2003 for the State data analysis. Nevertheless, even as of 2004, a large proportion of the vehicles equipped with ESC were still luxury vehicles. Moreover, only passenger cars and SUVs had been equipped with ESC—no pickup trucks or minivans.

The state databases included crash cases from California (2001–2003), Florida (1997–2003), Illinois (1997–2002), Kentucky (1997–2002), Missouri (1997–2003), Pennsylvania (1997–2001, 2003), and Wisconsin (1997–2003). The FARS database included fatal crash involvements from calendar years 1997 to 2004. The extra year of exposure and the availability of data from more states significantly increased the sample size of crashes of vehicles with ESC. In the preliminary study, the state crash database contained 699 single-vehicle crashes of cars with ESC and 95 single-vehicle crashes of SUVs with ESC. The FARS database contained 110 single-vehicle crashes of cars with ESC and 25 single-vehicle crashes of SUVs with ESC. For the updated study, the state crash database contains 2,251 single-vehicle crashes of cars with ESC and 553 single-vehicle crashes of SUVs with ESC, and the FARS database of fatal single-vehicle crashes contains 157 and 47 crashes respectively, for passenger cars and SUVs with ESC.

The larger sample of crashes in the updated study facilitated a new analysis of the effectiveness of ESC on specific subsets of single-vehicle crashes (SV run-off-road crashes and SV crashes resulting in rollover). It also facilitated the use of a more focused control group of crashes that were unlikely to be affected by ESC so that a new analysis of the effect of ESC on multi-vehicle crashes could be undertaken.

The basic analytical approach was to estimate the reduction of crash involvements of the types that are most likely to have benefited from ESC—relative to a control group of other types of crashes where ESC is unlikely to have made a difference in the vehicle's involvement. Crash types taken as the new control group (non-relevant involvements because ESC would in almost all cases not have prevented the crash) were crash involvements in which a vehicle:

(1) Was stopped, parked, backing up, or entering/leaving a parking space prior to the crash,

(2) Traveled at a speed less than 10 mph,

(3) Was struck in the rear by another vehicle, or

(4) Was a non-culpable party in a multi-vehicle crash on a dry road.

The types of crash involvements where ESC would likely or at least possibly have an effect are:

(1) All single vehicle crashes, except those with pedestrians, bicycles, or animals (SV crashes).

(2) Single vehicles crashes in which a vehicle ran off the road (SV ROR) and hit a fixed object and/or rolled over.

(3) Single vehicles crashes in which a vehicle rolled over (SV Rollover), mostly a subset of SV ROR.

(4) Involvements as a culpable party in a multi-vehicle crash on a dry or wet road (MV Culpable).

(5) Collisions with pedestrians, bicycles, or animals (Ped, Bike, Animal).

In the updated study we performed the state data analysis separately for each state. Then we used the median of the estimates from the seven states as the best indicator of the central tendency of the data, and the variation of the seven states as a basis for judging statistical significance and estimating confidence bounds. The results of this analysis are presented in Table 3.

TABLE 3.—UPDATED STUDY—MEAN EFFECTIVENESS OF ESC IN REDUCING CRASHES IN PASSENGER CARS AND SUVS BASED ON SEPARATE ANALYSES OF 1997–2003 CRASH DATA FROM SEVEN STATES

	SV crashes	SV ROR	SV rollover	MV culpable	Ped, bike, animal
Passenger Cars:					
Mean percent reduction of listed crash type in passenger cars with ESC.	34%	46%	71%	11%	34%
Approximate 90 percent confidence bounds.	20% to 46%	35% to 55%	60% to 78%	4% to 18%	5% to 55%.
SUVs:					
Mean percent reduction of listed crash type in SUVs with ESC.	59%	75%	84%	16%	−4% not statistically significant.
Approximate 90 percent confidence bounds.	47% to 68%	68% to 80%	75% to 90%	7% to 24%	−28% to 15%.

Fatal crashes were analyzed separately using the FARS database as was done in the preliminary study, but larger sample sizes were possible because of an additional year of data. The results are given in Table 4.

TABLE 4.—UPDATED STUDY-EFFECTIVENESS OF ESC IN REDUCING FATAL CRASHES OF PASSENGER CARS AND SUVS BASED ON 1997–2004 FARS DATA

	SV crashes	SV ROR	SV rollover	MV culpable	Ped, bike, animal	Control group
Passenger Cars:						
No ESC	223	217	36	176	46	166
ESC	157	154	12	156	69	181
Percent reduction of listed crash type in passenger cars with ESC.	35%	36%	69%	19% not statistically significant.	−38% not statistically significant.	
Approximate 90 percent confidence bounds.	20% to 51%	19% to 51%	52% to 87%	−2% to 39%	−87% to 12%	
Chi-square value	8.58	8.17	12.45	1.82	2.14	
SUVs:						
No ESC	197	191	106	108	56	153
ESC	47	38	9	48	40	109
Percent reduction of listed crash type in SUVs with ESC.	67%	72%	88%	38%	0% not statistically significant.	
Approximate 90 percent confidence bounds.	55% to 78%	62% to 82%	81% to 95%	16% to 60%	−40% to 40%	
Chi-square	29.57	36.44	42.4	4.89	0.00	

The effectiveness of ESC in reducing fatal single-vehicle crashes is similar to the effectiveness in reducing single-vehicle crashes from state data that included mostly non-fatal crashes. In the case of fatal crashes as well, the effectiveness of ESC in reducing single-vehicle rollover crashes was particularly high. The effectiveness of ESC in reducing fatal culpable multi-vehicle crashes of SUVs was also higher than in the analysis of state data, and the parallel analysis of multi-vehicle crashes of passenger cars did not achieve statistical significance.

The updated study of ESC effectiveness yielded robust results. The analysis of state data and a separate analysis of fatal crashes both reached similar conclusions on ESC effectiveness. ESC reduced single vehicle crashes of passenger cars by 34 percent and single vehicle crashes of SUVs by 59 percent. The separate analysis of only fatal crashes supported the analysis of state data that included mostly non-fatal crashes. Therefore, the overall crash reductions demonstrated a significant life-saving potential for this technology. The effectiveness of ESC in reducing SV crashes shown in the latest data (Tables 3–4) is similar to the results of the preliminary analysis.

The effectiveness of ESC tended to be at least as great and possibly even greater for more severe crashes. Furthermore, the effectiveness of ESC in reducing the most severe type of crash in the study, the single-vehicle rollover crash, was remarkable. ESC reduced single-vehicle rollover crashes of passenger cars by 71 percent and of SUVs by 84 percent. This high level of effectiveness also carried over to fatal single-vehicle rollover crashes.

The benefits presented in Section VII were calculated on the basis of the single-vehicle crash and single-vehicle rollover crash effectiveness results of Table 3 for reductions in non-fatal crashes and of Table 4 for reductions in fatal crashes. The single-vehicle rollover crash effectiveness results were applied only to first harmful event rollovers with the lower single-vehicle crash effectiveness results applied to all other rollover crashes for a more conservative benefit estimate.

V. Agency Proposal

As discussed in detail in section VII, NHTSA's crash data study leads to the conclusion that an ESC requirement for light vehicles would save 1,536 to 2,211 lives annually once all light vehicles have ESC. The level of life saving associated with ESC would be second only to seatbelts among the items of equipment or elements of design regulated by the Federal motor vehicle safety standards. It is further estimated that an ESC requirement would prevent between 50,594 and 69,630 MAIS 1–5 injuries annually. The life saving benefits of ESC are considered very cost effective with a cost per equivalent fatality of $0.19 million under the most favorable assumptions and $0.43 million under the least favorable assumptions.

In order to capture these significant safety benefits NHTSA is proposing to establish FMVSS No. 126, *Electronic Stability Control Systems*, which would require passenger cars, light trucks and buses that have a GVWR under 4,536 Kg (10,000 lbs) GVWR to be equipped with an ESC system with a yaw stability control function equal to that of vehicles in current production. The benefits demonstrated by NHTSA's crash data studies and sought by the proposed safety standard are the result of yaw stability control greatly reducing single-vehicle crashes and reducing some multi-vehicle crashes as well. None of the study vehicles was equipped with a roll stability control system. Thus, we are proposing equipment requirements that are met by every ESC-equipped vehicle in current production and performance requirements that we believe are met by about 98 percent of ESC-equipped vehicles in current production and will require nothing more than slight retuning of the other two percent.

We are not proposing a roll stability control system because there are no data currently available to determine the effect of roll stability control on crashes. However, vehicle manufacturers may supplement the proposed ESC systems with roll stability control.

As proposed, FMVSS No. 126 would incorporate both an equipment requirement and a performance requirement. Specifically, we are proposing an equipment requirement for ESC that would define the necessary elements of a yaw stability control system capable of effective oversteer and understeer interventions. The ESC equipment requirement is augmented by a performance test of the system's oversteer intervention. We believe that an equipment requirement is necessary because establishing performance tests that would ensure that the ESC system operates under all road conditions and phases of driving is impractical. The number of tests would be immense, and many tests (particularly those using slippery surfaces) would not be repeatable enough for an objective regulation. A test requirement for understeer mitigation is particularly problematic because the understeer mitigation for many light trucks is programmed to occur only on slippery surfaces to avoid potential roll instability.

The proposed standard includes a performance test of oversteer intervention conducted with a single highly repeatable maneuver performed on dry pavement over a range of steering angles with an automated steering machine. It is designed to ensure that the performance of the system is comparable to current production systems under a limited set of conditions that are optimal for repeatable testing, and it proves that the ESC system is programmed to perform its most basic task under ideal conditions.

Most vehicles without ESC will spin out in this maneuver; so, a vehicle that avoids spin-out according to our objective yaw rate decay definition demonstrates that it has an ESC system typical of 2006 production vehicles. However, the maneuver is not so extreme that every vehicle without ESC will actually spin out. A few non-ESC vehicles will pass this particular maneuver test, however they would certainly spin out on slippery surfaces. Therefore, the test without the definition does not assure the safety benefits of ESC.

All model year 2006 vehicles with ESC systems would satisfy the definitional requirements of the standard. Of the sixty-two ESC vehicles tested by NHTSA or the Alliance of Automobile Manufacturers (Alliance), whose test fleet supplemented NHTSA's, only one would need minor reprogramming to pass the performance test.

Some of the older vehicles in NHTSA's crash data study would not pass the proposed requirements (e.g., among the early ESC systems, there were some that were not capable of understeer intervention). Nevertheless, over 85 percent of the data in NHTSA's study represent vehicles (1998–2003 model years) that we believe would satisfy the proposed requirements of the new safety standard. The study vehicles that did not satisfy the proposed standard had systems that were beneficial but less effective than the average.

A. Definition of ESC

The Society of Automotive Engineers (SAE) Surface Vehicle Information Report on Automotive Stability Enhancement Systems J2564 Rev JUN2004 provides an industry consensus definition of an ESC system. The definition in paragraph 4.6 of SAE J2564 specifies that a ESC system:

(a) Is computer controlled and the computer contains a closed-loop algorithm [16] designed to limit understeer and oversteer of the vehicle.

(b) Has a means to determine vehicle yaw velocity and sideslip.

(c) Has a means to monitor driver steering input.

(d) Has a means of applying and adjusting the vehicle brakes to induce correcting yaw torques to the vehicle.

(e) Is operational over the full speed range of the vehicle (except below a low-speed threshold where loss of control is unlikely).

We believe the SAE definition is a good basis for the proposed equipment requirement but that it requires minor clarifications to adequately describe current production systems. The definition that NHTSA proposes contains changes in paragraphs (a) and (b). Paragraph (a) has been changed to read: ''(a) is computer controlled with the computer using a closed-loop algorithm to limit vehicle oversteer and to limit vehicle understeer when appropriate.''

[16] A closed-loop algorithm is a cycle of operations followed by a computer that includes automatic adjustments based on the result of previous operations or other changing conditions.

This change recognizes that while all current ESC systems constantly limit oversteer, many of the systems used on vehicles with a high center of gravity only limit understeer on slippery surfaces where there is no danger that the understeer intervention could increase the possibility of tip-up. We also changed the expression about the ''computer containing the algorithm'' to refer to the ''computer using the algorithm'' to reduce ambiguity. Furthermore, we note that ''limiting'' understeer and oversteer means keeping those conditions within bounds that allow ordinary drivers to maintain control of the vehicle in critical situations. It does not mean reducing understeer and oversteer to zero under all circumstances because that is an impossibility, certainly not representative of production ESC systems.

Paragraph (b) has been changed to read: ''(b) has a means to determine the vehicle's yaw rate and to estimate its side slip. A distinction has been made between the ways yaw rate and side slip are obtained.'' Current ESC systems use sensors to measure yaw rate, constituting an actual determination of this crucial metric, but they estimate rather than measure side slip.

Also, the term ''yaw velocity'' has been changed to ''yaw rate'' because that is the term used in our research reports. Both terms have the same meaning.

The SAE document also defines four categories of ESC systems: Two wheel and four wheel systems, each with or without engine control. The minimum system capable of understeer and oversteer intervention is the four-wheel system without engine control. SAE describes systems in this category as having the following attributes:

(a) The system must have means to apply all four brakes individually and a control algorithm, which utilizes this capability.

(b) The system must be operational during all phases of driving including acceleration, coasting, and deceleration (including braking).

(c) The system must stay operational when ABS or Traction Control are activated.

The proposed regulatory language would require an ESC system that combines the SAE definition with the minor clarifications discussed and the attributes of the four-wheel system without engine control. Nothing in the regulatory language conflicts with systems that employ engine control.

In addition, the proposed regulatory language supplements the ESC equipment definition with a test of oversteer intervention which would define the minimum intensity of the oversteer intervention under certain test conditions. The test is performed with the vehicle coasting on a dry pavement with a high coefficient of friction. The test conditions are very narrow in comparison with the operational conditions specified in the equipment definition, but they are necessary to produce a practical test with the high level of repeatability. The performance test specifies a severe steering regime that would produce oversteer loss of control in nearly every vehicle without a modern ESC system, and it specifies a maximum time for the vehicle to cease its yaw motion after the steering returns to straight ahead.

At this time, we cannot propose a similar test of the intensity of the ESC system's understeer intervention. Typically, systems on vehicles with high centers of gravity do not perform understeer intervention on dry surfaces because that could increase the possibility of an on-road untripped rollover. In such case, attempting to maintain the driver's desired path would increase lateral acceleration and roll moment. In fact, roll stability control works by inducing high levels of understeer when required to prevent tip-up. Therefore, tests of understeer intervention must be performed on low coefficient surfaces to avoid prohibiting roll stability control systems. Unfortunately, the regular methods of producing wet, slippery, or icy conditions at automotive proving grounds are useful only for such purposes as back-to-back comparisons of vehicles because repeatable friction conditions cannot be maintained or precisely reproduced. A practical test of understeer intervention is a topic of ongoing research.

B. Performance Test of ESC Oversteer Intervention and Stability Criteria

Selection of Maneuver

NHTSA performed research to define a practical, repeatable and realistic maneuver test of ESC oversteer intervention. We also made use of the results of testing performed by the Alliance on some candidate maneuvers to supplement the agency's information. NHTSA's detailed research report [17] has been placed in the docket, and this section represents a summary of its major points.

The desired test should discriminate strongly between vehicles with and without ESC. Vehicles with ESC disabled were used as non-ESC vehicles in the research. It must also facilitate the evaluation of both the lateral stability of the vehicle (prevention of spinout) and its responsiveness in avoiding obstacles on the road, since stability can be gained at the expense of responsiveness. The research program consisted of two phases:

Phase 1: The evaluation of many maneuvers capable of quantifying the performance of ESC oversteer intervention using a small sample of diverse test vehicles.

Phase 2: Evaluation of many vehicles using a reduced suite of candidate maneuvers.

Phase 1 testing occurred during the period of April through October 2004. In this effort, twelve maneuvers were evaluated using five test vehicles. Maneuvers utilized automated and driver-based steering inputs. If driver-based steering was required, multiple drivers were used to assess input variability. To quantify the effects of ESC, each vehicle was evaluated with ESC enabled and disabled. Dry and wet surfaces were utilized; however, the wet surfaces introduced an undesirable combination of test variability and sensor malfunctions. Table 5 summarizes the Phase 1 test matrix. Additional details pertaining to Phase 1, including more detailed maneuver descriptions and details pertaining to test conduct, have been previously documented.[18]

[17] Forkenbrock, G. *et al.* (2005) Development of Criteria for Electronic Stability Control Performance Evaluation, DOT HS 809 974.

[18] Forkenbrock *et al* (2005) NHTSA's Light Vehicle Handling and ESC Effectiveness Research Program, 19th International Technical Conference on the Enhanced Safety of Vehicles (ESV), Washington, DC.

TABLE 5.—NHTSA'S 2004 LIGHT VEHICLE HANDLING/ESC TEST MATRIX

Test group 1	Test group 2	Test group 3
• Slowly Increasing Steer		• Closing Radius Turn.
• NHTSA J-Turn (Dry, Wet)	• Modified ISO 3888–22	• Pulse Steer (500 deg/s, 700 deg/s).
• NHTSA Fishhook (Dry, Wet)	• Constant Radius Turn	• Sine Steer (0.5 Hz, 0.6 Hz, 0.7 Hz, 0.8 Hz).
		• Increasing Amplitude Sine Steer (0.5 Hz, 0.6 Hz, 0.7 Hz.
		• Sine with Dwell (0.5 Hz, 0.7 Hz).
		• Yaw Acceleration Steering Reversal (YASR) (500 deg/s, 720 deg/s).
		• Increasing Amplitude YASR (500 deg/s, 720 deg/s).

To determine whether a particular test maneuver was capable of providing a good assessment of ESC performance, NHTSA considered the extent to which it possessed three attributes:

1. A high level of severity that would exercise the oversteer intervention of every vehicle's ESC system.

2. A high level of repeatability and reproducibility.

3. The ability to assess both lateral stability and responsiveness.

Phase 2 testing examined the four maneuvers that were considered most promising from Phase 1: (1) Sine with Dwell; (2) Increasing Amplitude Sine Steer; (3)Yaw Acceleration Steering Reversal (YASR); and (4) YASR with Pause.[19] The two yaw acceleration steering reversal maneuvers were designed to overcome the possibility that fixed-frequency steering maneuvers would discriminate on the basis of vehicle properties other than ESC performance, such as wheelbase length. They were more complex than the other maneuvers, requiring the automated steering machines to trigger on yaw acceleration peaks. However, Phase 2 research revealed an absence of effects of yaw natural frequency. Therefore, the YASR maneuvers were dropped from further consideration because their increased complexity was not warranted in light of equally effective but simpler alternatives, and their details will not be discussed in this summary of NHTSA research. Additional detail on the remaining maneuvers is presented below:

Sine With Dwell

As shown in Figure 2, the Sine with Dwell maneuver was based on a single cycle of sinusoidal steering input. Although the peak magnitudes of the first and second half-cycles were identical, the Sine with Dwell maneuver included a 500 ms pause after completion of the third quarter-cycle of the sinusoid. In Phase 1, frequencies of 0.5 and 0.7 Hz were used. In Phase 2, only 0.7 Hz Sine with Dwell maneuvers were performed. As described in NHTSA's report,[20] the 0.7 Hz frequency was found to be consistently more severe than its 0.5 Hz counterpart (in the context of this research, severity was quantified by the amount of steering wheel angle required to produce a spinout). In Phase 1, the 0.7 Hz Sine with Dwell was able to produce spinouts with lower steering wheel angles for four of the five vehicles evaluated, albeit by a small margin (no more than 20 degrees of steering wheel angle for any vehicle).

In a presentation [21] given to NHTSA on December 3, 2004, the Alliance also reported that the 0.5 Hz Sine with Dwell did not correlate as well with the responsiveness versus controllability ratings made by its professional test drivers in a subjective evaluation (the same vehicles evaluated with the Sine with Dwell maneuvers were also driven by the test drivers), and it provided less input energy than the 0.7 Hz Sine with Dwell.

Increasing Amplitude Sine

As shown in Figure 3, the Increasing Amplitude Sine maneuver was also based on a single cycle of sinusoidal steering input. However, the amplitude of the second half-cycle was 1.3 times greater than the first half-cycle for this maneuver. In Phase 1, frequencies of 0.5, 0.6, and 0.7 Hz were used for the first half cycle; the duration of the second half cycle was 1.3 times that of the first.

The Phase 1 vehicles were generally indifferent to the frequency associated with the Increasing Amplitude Sine maneuver. Given our desire to reduce the test matrix down from three maneuvers based on three frequencies to one, NHTSA selected just the 0.7 Hz frequency Increasing Amplitude Sine for use in Phase 2. In the previously mentioned presentation given to NHTSA on December 3, 2004, the Alliance also reported that the 0.6 Hz Increasing Amplitude Sine did not induce vehicle responses significantly different than the 0.5 and 0.7 Hz Increasing Amplitude Sine maneuvers.

To select the best overall maneuver from those used in Phase 2, NHTSA considered three attributes: (1) Maneuver severity, (2) face validity, and (2) performability. Of the two sinusoidal maneuvers used in Phase 2, we determined that the Sine with Dwell was the best candidate for evaluating the lateral stability component of ESC effectiveness because of its relatively greater severity. Specifically, it required a smaller steering angle to produce spinouts (for test vehicles with ESC disabled). Also, the Increasing Amplitude Sine maneuver produced the lowest yaw rate peak magnitudes in proportion to the amount of steering, implying the maneuver was the least severe for most vehicles evaluated by NHTSA in Phase 2.

The performability of the Sine with Dwell and Increasing Amplitude Sine maneuvers is excellent. The maneuvers are very easy to program into the steering machine, and their lack of rate or acceleration feedback loops simplifies the instrumentation required to perform the tests. As mentioned previously, Phase 2 testing revealed that the extra complexity of YASR maneuvers was unnecessary because the tests were not affected by yaw natural frequency differences between vehicles.

All Phase 2 maneuvers (including the YASR maneuvers) possess an inherently high face validity because they are each comprised of steering inputs similar to those capable of being produced by a human driver in an emergency obstacle avoidance maneuver. However, the Increasing Amplitude Sine maneuver may possess the best face validity. Conceptually, the steering profile of this maneuver is the most similar to that expected to be used by real drivers, and even with steering wheel angles as large

[19] Ibid.

[20] Forkenbrock, G. *et al.* (2005) Development of Criteria for Electronic Stability Control Performance Evaluation, Dot HS 809 974.

[21] Docketed at NHTSA–2004–19951, item 1.

as 300 degrees, the maneuver's maximum effective steering rate is a very reasonable 650 deg/sec.

In light of the above, NHTSA is proposing to use the Sine with Dwell maneuver to evaluate the performance of light vehicle ESC systems in preventing spinout (oversteer loss of control). On the balance we believe that it offers excellent face validity and performability, and its greater severity makes it a more rigorous test while maintaining steering rates within the capabilities of human drivers.

Spinout Criteria

The foregoing maneuver selection process required a definition of ''spinout.'' Spinout can be best explained in the context of the Sine with Dwell maneuver. Figure 4 shows the steering wheel angle driven by a robotic steering machine during three runs of the maneuver at increasing steering amplitudes and the resulting measurements of the yaw rate of an actual vehicle being tested. The maneuver is the same as that shown in Figure 2, except that the first steering is to the left in Figure 4 while it is to the right in Figure 2.

The test protocol requires the test to be performed at an entrance speed of 50 mph (coasting) in both directions at increasing steering amplitudes up to a preset maximum or to the point at which the vehicle spins out (failing the test). The preset maximum steering angle is the larger of either 270 degrees or an angle equal to 6.5 times the steering angle that produces 0.3g steady state lateral acceleration for the particular test vehicle. This specification of maximum test steering angle takes into account differences in steering gear ratio, wheelbase, and other factors between vehicles, but provides for testing to a steering wheel angle of at least 270 degrees. This maximum steering wheel angle is not achieved in the event that the test is terminated by spinout at a lower steering wheel angle.

As shown in Figure 4, in the first run, the steering wheel is turned 80 degrees to the left, then 80 degrees to the right following a smooth 0.7 Hz sinusoidal pattern. It is held steady for a dwell time of 0.5 second at 80 degrees right, and then returned to zero (straight ahead) also following a sinusoidal pattern. After a short lag, the vehicle begins to yaw counter-clockwise in response to the left steering. The absolute value of the yaw velocity increases with the absolute value of the steering angle, and then the vehicle changes to clockwise yaw velocity in response to right steering. At two seconds after the beginning of steering, the steering wheel has been turned back to straight ahead, and the yaw rate returns to zero after a fraction of a second response time. At that point, the vehicle is being steered straight ahead, and it is going straight ahead without any yaw rotation. The vehicle is responding closely to the steering input, and the driver is in control.

When the steering amplitude is increased to 120 degrees in the next run, the vehicle achieves greater yaw velocity because it is following a tighter path at the same speed, but it exhibits the same good response to steering and remains in control.

However, when the steering amplitude is increased to 169 degrees, the vehicle spins out, exhibiting oversteer loss of control. This condition is identified in the yaw rate trace. When the steering is straight ahead at time = 2 seconds, the yaw rate for this run is still about 35 deg/sec. However, there is a time lag past the instant of steering to straight ahead even for the previous runs where there was no loss of control. What is different is that the yaw rate does not swiftly decline to zero as it does with a vehicle under control. At time = 3 seconds, the yaw rate is still the same, and it has actually increased at time = 4 seconds in this example. The physical interpretation of this graph is that the driver has turned the wheels straight ahead and wants the vehicle to go straight, but the vehicle is spinning clockwise about a vertical axis through its center of gravity. It is out of control in a spinout. The driver's steering input is not causing the vehicle to take the desired path and heading, and the vehicle would depart the road surface sideways or even backward.

Figure 4 illustrates that the Sine with Dwell Maneuver is very severe. It induced a dramatic spinout in this test vehicle with only 169 degrees of steering to one direction followed by 169 degrees to the other. It is possible that steering angles below 169 degrees but above 120 degrees would also have caused spinout. Since the test is predicated on steering angles up to (or possibly exceeding) 270 degrees, it would cause spinout in vehicles with far greater lateral stability than this test vehicle.

Figure 5 shows another series of tests of the same vehicle but with ESC enabled. The first two runs were at 80 and 120 degrees of steering angle, and the vehicle's yaw rate declined to zero in a fraction of a second after the steering command. This is the same good response to steering exhibited by the vehicle with ESC disabled in the previous figure. The third run was conducted at 180 degrees of steering angle. This is greater than the 169 degrees that caused a severe loss of control without ESC, but the yaw rate returned to zero with the steering angle just as quickly as in the runs with less steering.

The final set of curves in Figure 5 represent a run conducted with 279 degrees of steering angle. This would be the left-right portion of the performance test proposed for the ESC system of this vehicle since 279 degrees is 6.5 times the steering angle that produces 0.3g steady state lateral acceleration for this example vehicle. In this case, the yaw rate did not return to zero nearly instantaneously as it had at lower steering angle. Instead, it steadily declined after the steering was turned to straight ahead, and the vehicle was completely stable and going straight in about 1.75 seconds. Clearly, the vehicle remained in control compared to its behavior without ESC (see Figure 4) in which turning the steering to straight ahead had no effect on the vehicle's heading. However, the ESC system required some time to cause the vehicle to stop turning in response to the driver's straight ahead steering command because the preceding maneuver was so destabilizing. The time it takes for the vehicle to stop rotating after it is steered straight ahead in this maneuver is a measure of the aggressiveness of the ESC oversteer intervention. Some of the early ESC systems were tuned to be less aggressive than the example vehicle, and the lag time for the vehicle to ''recover'' from the Sine with Dwell Maneuver would be longer.

The first goal of an ESC system is to prevent spinout, but there is no hard quantitative definition of spinout. Obviously, the example in Figure 4 shows spinout. The vehicle turned nearly front to rear in four seconds with the steering wheel straight ahead. In the example of Figure 5, the vehicle always responded to steering, but some response time was required for it to fully stabilize. In seeking to define ''spinout'', the agency believes that the question is: How long must the response time be before the result would be considered a spinout in the severe test maneuver?

NHTSA used an empirical definition of spinout based on observations from vehicle maneuver testing as a rule of thumb. This empirically-based criterion stipulates that in a symmetric steer maneuver, in which the amount of right and left steering is equal, if the final heading angle is more than 90 degrees from the initial heading, the vehicle has spun out. If a symmetric steer maneuver is performed at a very low speed that eliminates tire slippage, the heading does not change at all. However, a change of heading of about 20 degrees would occur even at low speed in the Sine with Dwell Maneuver because of the asymmetric dwell portion, making this empirical criterion more conservative. NHTSA's research report[22] contains a statistical study on how quickly an ESC system would have to respond to prevent a heading change of more than 90 degrees during the Sine with Dwell Maneuver at 50 mph with full steering using data from all 40 vehicles tested by NHTSA and the Alliance.

Two measures of response time were considered: (1) The remaining yaw rate (as a percent of peak) one second after the steering wheel was turned straight ahead, and (2) the remaining percent of peak yaw rate after 1.75 seconds. The peak yaw rate is the highest yaw rate during the second part of the maneuver. In the example of Figure 5 (test run with 279 degrees steering wheel angle) the steering returned to straight ahead at 2 seconds. At 3 seconds (one second later), the remaining yaw rate was about 30 percent of the peak value achieved at about 1.2 seconds. At 3.75 seconds (1.75 seconds after zero steer), the remaining yaw rate is zero percent. Statistical analyses performed by NHTSA predict that, if the remaining yaw rate at one second after zero steer was no more than 35 percent, there is a 95 percent (or greater) probability that the heading change will not exceed 90 degrees (no spinout by the empirical criterion). For the 1.75 second time interval, a remaining yaw rate of no more than 20 percent leads to the same prediction.

The heading change criterion and its statistical interpretation provide a context in which to view the yaw rate data in the Sine with Dwell tests conducted by NHTSA and by the Alliance on a large sample of 62 vehicles in production in 2005. Figure 6 illustrates the yaw rate response (as a percent of the second yaw rate peak) versus time after completion of steer (COS) input, for the 0.7 Hz Sine with Dwell maneuver (left to right steering) for all vehicles tested by NHTSA and the Alliance. The data represents the most severe yaw rate response produced for each vehicle during a particular test series. The form of the graph corresponds to the yaw rate curve (for the 169 degree test) shown in Figure 4, except that the yaw rate has been normalized and the time axis has been shifted by 2.0 seconds so as to focus on the yaw rate response after COS. The cluster of curves at the top of Figure 6 represents the yaw rate response for vehicles with the ESC totally disabled, and the cluster at the bottom are for vehicles with the ESC fully enabled. Figure 7 shows data from the same vehicles but in a test conducted with right-left steering rather than left-right as in Figure 6.

Figures 6 and 7 also show the proposed criteria for maximum yaw rate at 1.0 second and 1.75 seconds after completion of steering. All of the 62 current production vehicles tested met or exceeded the proposed criteria with ESC enabled when tested in the left-right sequence as shown in Figure 6. However, one of the vehicles did not meet the criteria when tested in the right-left sequence as shown in Figure 7. Nevertheless, we believe the proposed criteria reasonably represent the minimum performance of the oversteer intervention for present vehicles with ESC, and that the vehicle representing the single exception to the rule can be tuned to operate as well in the right-left steering as it did in the left-right test. NHTSA also tested a number of the older vehicles whose crash data were used to evaluate the effectiveness of ESC in crash reduction. We believe that over 85 percent of these vehicles have ESC systems that would pass the proposed criteria. Therefore, the following proposed performance criteria for the Sine with Dwell Maneuver test of ESC oversteer intervention is associated with the high level of crash prevention benefits we expect and is also typical of the minimum performance of the present fleet of ESC vehicles:

Criterion #1: $\text{Percent } \dot{\psi}_{\text{Peak, COS = 1.0 sec}} \le 35\%$

where, $$\text{Percent } \dot{\psi}_{\text{Peak, COS = 1.0 sec}} = 100 * \left(\frac{\dot{\psi}(t_0 + 1.0)}{\dot{\psi}_{\text{Peak}}} \right)$$

Criterion #2: $\text{Percent } \dot{\psi}_{\text{Peak, COS = 1.75 sec}} \le 20\%$

where, $$\text{Percent } \dot{\psi}_{\text{Peak, COS = 1.75 sec}} = 100 * \left(\frac{\dot{\psi}(t_0 + 1.75)}{\dot{\psi}_{\text{Peak}}} \right)$$

In both criteria,

$$\dot{\psi}_{\text{Peak}} = \text{first yaw rate peak produced after the start of dwell period}$$

$$\dot{\psi}_{(t_0 + x)} = \text{yaw rate at x seconds after completion of a maneuver's dynamic steering inputs}$$

C. Responsiveness Criteria

NHTSA's track tests demonstrate dramatic improvements in yaw stability provided by ESC. However, NHTSA believes these improvements should not come at the expense of poor lateral displacement response to the driver's steering inputs. An extreme example of this potential lack of responsiveness would occur if an ESC system locked both front wheels as the driver begins an abrupt obstacle avoidance maneuver. Assuming the road is reasonably level, and the surface friction is uniform, it is very likely the wheel lock would suppress any tendency for the vehicle to spin out or tip up. However, having the wheels lock would also prevent the

[22] Forkenbrock, g. *et al.* (2005) Development of Criteria for Electronic Stability Control Performance Evaluation, DOT HS 809 974

vehicle from responding to the driver's steering inputs. This would cause the vehicle to plow straight ahead and collide with the obstacle the driver was trying to avoid. Clearly this is not a desirable compromise.

To ensure an acceptable balance between lateral stability and the ability for the vehicle to respond to the driver's inputs, NHTSA believes a ''responsiveness'' criterion must supplement the agency's lateral stability criteria. We propose to use the same series of tests with the Sine with Dwell maneuver to characterize both the aggressiveness of the oversteer intervention and the lateral responsiveness of the vehicle. This maneuver is severe enough to exercise the ESC system on any vehicle and test its oversteer intervention, and it is possible to measure other metrics during the Sine with Dwell maneuver to characterize the vehicle's responsiveness as well.

NHTSA considered a number of metrics to describe the ability of the vehicle to react to the steering input, especially in the direction of the first half sine of the steering pattern that would relate most directly to obstacle avoidance. These metrics involved the lateral movement of the vehicle, the lateral speed of the vehicle, the lateral acceleration of the vehicle and lag times and distances between steering inputs and the various types of responses.

The lateral movement of the vehicle has the most obvious and direct bearing on obstacle avoidance. However, the measurement of lateral movement appeared to introduce an undesirable degree of difficulty. NHTSA has been measuring the path of vehicles during the development of various rollover and handling test maneuvers using a differentially corrected Global Positioning System (GPS) method. This method is capable of measuring the lateral movement of the vehicle at its center of gravity (a good way to compare vehicles of different sizes), but it requires costly instruments both on the track and in the vehicle and complex procedures. Instruments imbedded in the track would seem to be a possible alternative, but they are also problematic. It is difficult to place each test vehicle over the instrumented section of roadway during the exact same position in the Sine with Dwell steering pattern, and it is difficult to determine the lateral movement of the center of gravity from roadway sensors when the vehicles approach at various side slip angles.

However, during a briefing [23] on September 7, 2005, the Alliance presented a technique that would greatly simplify the measurement of NHTSA's preferred responsiveness metric—lateral displacement in the direction of the first steering of the Sine with Dwell maneuver. It involves mathematical integration of the onboard lateral acceleration measurement at the vehicle center of gravity to obtain lateral velocity, and then a second integration of lateral velocity to obtain lateral displacement. Double integration of acceleration to calculate displacement is not used as a general measurement technique because small errors in zero levels of acceleration and speed can produce large errors in displacement over time. However, the idea presented by the Alliance required double integration for only about one second, and the resulting displacement calculations were in good agreement with the GPS measurements for vehicles tested by NHTSA.

Figure 8 shows the typical lateral displacement as a function of time for a vehicle performing the Sine with Dwell maneuver successfully (without spinning out). Since the longitudinal travel is roughly proportional to time, the bottom trace resembles the path of the vehicle with the lateral travel exaggerated. Assuming the wheel is first turned to the left, the figure shows that the maximum movement of the vehicle to the left lags the maximum left steering angle by almost two seconds in this example. Because this maneuver includes a very fast steering reversal, the steering wheel has been turned sharply to the right before the vehicle has achieved its maximum reaction to the initial left steering.

We propose to use the lateral displacement at 1.07 seconds after initiation of steering in the Sine with Dwell maneuver as the responsiveness metric rather than the maximum lateral displacement for the following reasons. The maximum lateral displacement occurs later in the maneuver and occurs at different times for different vehicles. Therefore, it is subject to greater potential error from the double integration technique, and the errors could systematically affect some types of vehicles more than others.

More importantly, since the interpretation of the metric is the obstacle avoidance capability of the vehicle, it makes the most sense to measure the lateral displacement of every vehicle the same distance from the initiation of steering. This is equivalent to placing the same size obstruction at the same place on the roadway for every vehicle. Since steering is initiated at 50 mph for all tests, and not much speed is scrubbed off in the first second (except for a few systems that start automatic braking very early in the maneuver), lateral displacement at a set time is roughly equivalent to lateral displacement at a set distance. Certainly, the difference in distance traveled among test vehicles is much less at 1.07 seconds into the maneuver than at the point of maximum lateral displacement.

A set time of 1.07 seconds is desirable because it coincides with an easily recognized discontinuity in the steering trace (the dwell period); it is short enough to assure accuracy of the double integration technique, and it is long enough to include a high percent of the maximum lateral displacement. It is also important to note that differences between vehicles in the lateral displacement metric at 1.07 seconds correlated well with the subjective evaluations of vehicle responsiveness provided by expert drivers from several vehicle manufacturers.

The choice of the criterion for this metric was based on the responsiveness of the present fleet of cars and light trucks, represented by a group of 61 vehicles in 107 vehicle configurations (ESC on or ESC off). The group ranged from high-performance sports cars to a 15-passenger van with ESC and several long wheelbase diesel pickup trucks with GVWRs near 4,536 Kg (10,000 lb) and no ESC. Figure 9 shows the range of responsiveness for this fleet, characterized by the proposed metric. The least responsive vehicles were not the 15-passenger van or large pickup trucks, but rather SUVs with roll stability control. The highest criterion that can be used without prohibiting these implementations of roll stability control is a minimum lateral displacement of 1.83 m (half a 12-foot lane width), 1.07 seconds after initiation of steering in the Sine with Dwell maneuver conducted with steering angles of 180 degrees or greater. Therefore, we are proposing the test criterion for minimum vehicle responsiveness described above because it is practical for all types of light vehicles including 15-passenger vans, long wheelbase diesel pickups and SUVs with roll stability control. All of the test vehicles would satisfy this criterion, including nine SUVs with a roll stability control function. However, we expect that manufacturers would make some software alterations to the roll stability control programs of a few SUVs to gain a greater margin of compliance.

[23] Docketed at NHTSA–2004–19951, item 21.

D. Other Issues

1. ESC Off Switches

Many vehicles are equipped with ESC systems featuring driver-selectable modes. These modes are generally subdivided into two groups: (1) Systems in which the driver has the ability to fully disable the ESC (i.e., throttle and brake intervention are both eliminated), and (2) those in which the ESC may only be partially disabled. If the option to fully disable the ESC exists, the manner in which it is accomplished depends largely on the vehicle's make and model. For some vehicles, disabling the ESC is accomplished by momentarily pushing an on/off button typically located on the instrument panel, center console, or dashboard. Other vehicles require the driver to push the ESC on/off button for approximately three to five seconds before the ESC can be fully disabled.

Regardless of which method the vehicle manufacturer has selected, the action to manually disable ESC requires a conscious effort by the driver. The default setting of every ESC system known to NHTSA is ''ESC-enabled.'' In other words, at the beginning of each ignition cycle, the ESC is always fully enabled regardless of what mode the driver had been operating the vehicle in during the previous ignition cycle.

Although many contemporary vehicles are equipped with ESC on/off switches, simply pushing the ESC on/off button does not necessarily give the driver the ability to fully disable the vehicle's ESC. For some vehicles, when the drivers select ''ESC off,'' they are actually diminishing, but not fully removing, the aggressiveness of their vehicles' ESC intervention.

Although the crash and test track data clearly demonstrate the profound safety benefits of ESC, there are special circumstances in which drivers may wish to partially or fully disable their vehicles' ESC. Examples of such situations may include:

• Attempting to ''rock'' a vehicle stuck in a deformable surface such as snow or mud
• Attempting to initiate movement on deep snow or ice (especially if the vehicle is equipped with snow chains)
• Driving through a deep, deformable surface such as mud or sand
• Driving with a compact spare tire, tires of mismatched sizes or tires with chains.

To understand how ESC may hinder a driver's ability to operate his vehicle in these special conditions, it is important to recall the primary ways in which ESC attempts to improve stability: (1) Removal or augmentation of drive torque, and (2) brake intervention. In each of the examples provided above, the vehicle may require significant longitudinal wheel slip in order to initiate or maintain forward progress. If ESC remains fully enabled, it will endeavor to reduce what it perceives as excessive wheel slip via throttle and/or brake intervention. By reducing wheel slip, the vehicle's lateral stability is improved; however, this may also inhibit forward progress to the point that the vehicle may become (or remain) stuck. Not only can this be frustrating for the driver (i.e., the vehicle is not responding to their commands), but it may also introduce a potential safety problem (e.g., the vehicle slows to a near stop while attempting to be driven through a busy intersection).

Another reason a driver may wish to disable ESC has less to do with mobility, and more to do with driving enjoyment. NHTSA acknowledges there is a driver demographic that considers the automobile more than just a means of transportation. These drivers enjoy participation in activities such as motorsports competition and high-performance driving schools. In these situations, it is quite possible the driver may not wish to realize the improved lateral stability offered by a fully enabled ESC, because the intervention providing improved lateral stability is achieved by removing the driver's throttle inputs and applying the brakes. In a controlled environment, such as the confines of a racetrack, this can be frustrating for the driver because ESC intervention will have the effect of slowing the vehicle and contradict the driver's desire to achieve the lowest possible lap times. In other words, aggressive intervention intended to improve safety on the public roads may not be appropriate at a racetrack.

To accommodate these special situations, NHTSA believes vehicle manufacturers should be allowed the freedom to install ESC on/off switches on all vehicles. Furthermore, the agency is hopeful that this provision will have a positive effect on ESC design philosophy. For every ESC system presently in production, there exists a balance between lateral stability and intervention magnitude. Generally speaking, an ESC tuned to optimize lateral stability will require intrusive interventions. Conversely, a vehicle equipped with an ESC designed with transparent intervention which is not noticeable to the driver (often associated with ''sport'' modes), will tend to exhibit lower lateral stability. By giving vehicle manufacturers the freedom to install ESC on/off switches, both intervention strategies can be accommodated, with the more aggressive safety-biased tuning set as the system default. The more sport-oriented, transparent interventions could then be accessed via the same switch capable of fully disabling the ESC. This provision should satisfy the demand for safe, versatile, and enjoyable vehicles.

Vehicle and ESC manufacturers have expressed concern that if ESC on/off switches were to be prohibited, there would exist a risk that some drivers will fully disable their vehicle's ESC by other means, such as disconnecting or removing sensors required by the ESC. By opting to disable ESC in this manner, drivers might unknowingly disable other important safety features such as the vehicle's antilock brakes. In some cases, the vehicle's electronic brake proportioning may also be adversely affected, thereby resulting in a significant reduction of the vehicle's braking capability. Recognizing the diverse operating conditions their vehicles may encounter, many vehicle manufacturers presently equip their vehicles with ESC on/off switches.

In light of the above, we are proposing to permit installation of ESC Off switches as a manufacturer option. However, in order to preserve the safety benefits presently associated with ESC, NHTSA is proposing to require a vehicle equipped with an ESC on/off switch to satisfy three important criteria:

1. The vehicle's ESC must always be fully enabled at the initiation of each new ignition cycle, regardless of what mode the driver had previously specified.

2. When evaluated with its ESC fully enabled, the vehicle performance must be in compliance with the minimum ESC oversteer intervention and responsiveness test criteria.

3. The vehicle manufacturer must provide a telltale light that illuminates to indicate when the vehicle has been put into a mode that completely disables ESC or renders it unable to satisfy the ESC oversteer intervention test criteria.

In summary, although there is no way to guarantee drivers will not use ESC on/off switches to disable their vehicle's ESC during normal driving, potentially negating the significant safety benefits such systems offer, NHTSA cannot ignore the fact there are certain operating conditions under which on/off switches are advantageous. Furthermore, NHTSA anticipates that ESC developers will utilize this design flexibility facilitated by the use of ESC on/off switches to maximize the ESC effectiveness in its default, fully enabled mode.

2. ESC Activation and Malfunction Symbols and Telltale

Most current ESC systems provide an indication to the driver when the ESC system is actively intervening to stabilize the vehicle and provide a warning to the driver if ESC is unavailable due to a failure in the system. When an ESC Off switch is provided, a telltale reminds the driver when the ESC has been disabled.

We believe that there are safety benefits associated with certain of these warnings. There is an obvious safety need to warn the driver in case of an ESC malfunction so that the system can be repaired. The safety need to remind the driver of a driver-selected ESC Off state is also obvious because the driver should restore the ESC function as soon as possible in order to realize the system's safety benefits. However, the safety need for an ESC activation indicator to alert the driver during an emergency situation that ESC is intervening is not obvious, so the agency undertook research on this point as discussed below.

NHTSA conducted a study [24] using the National Advanced Driving Simulator (NADS) that included experiments to gain insight into the various possibilities regarding ESC activation indicators. The NHTSA study involved 200 participants in four age groups and simulated driving on wet pavement. It used maneuvers similar to those described in Section IV of the Papelis study [25] also using the NADS. The activation indicator experiments used road departures and eye glances to the instrument panel as measures of driver performance. The NHTSA study compared the performance of drivers given either no indication of ESC activation, a steady-burning icon telltale, a flashing icon telltale, or an auditory warning. The ESC telltale used in this study was the ISO J.14 symbol with the text ''Active'' under it.

Participants presented with only auditory ESC activation indications experienced significantly more road departures (15) than participants receiving visual only indications (steady 8, flashing 8) or no ESC activation indications (7). This finding was most evident for the older driver group who experienced a statistically significant increase in road departure events with the auditory ESC indication compared to the other three conditions. Younger drivers also showed an increased road departure rate with the auditory ESC indication, although not at a statistically significant level. These results of the road departure study are presented in Table 6.

TABLE 6.—PERCENT ROAD DEPARTURES BY ESC ACTIVATION INDICATION AND AGE GROUP—ESC TRIALS ONLY

	All age groups combined (percent)	Novice (percent)	Younger (percent)	Middle (percent)	Older (percent)
None	7	8	8	6	6
Steady	8	10	4	6	10
Flashing	8	9	6	9	8
Auditory	15	6	14	10	30

Eye glance behavior was examined to determine whether providing drivers with an indication of ESC activation would cause them to glance at the instrument panel. Results show that participants presented with a flashing ESC telltale glanced at the instrument panel significantly more frequently (14, statistically significant) during the crash-imminent event than did participants in the other three ESC conditions. Participants presented with a flashing ESC telltale also glanced at the instrument panel approximately twice during the crash-imminent event versus once for participants in the other three ESC conditions. However, average glance duration was approximately twice as long for the auditory ESC indication condition than for the other three ESC conditions (see Table 7), although this difference was not statistically significant.

TABLE 7.—EFFECT OF ESC ACTIVATION INDICATION ON EYE GLANCE BEHAVIOR—ESC TRIALS ONLY

	Percent trials with any glance to icon	Number of glances per trial		Duration of glances(s)	
		M	SD	M	SD
None	28	1.4	3.9	0.3	0.9
Steady	27	1.1	2.6	0.2	0.1
Flashing	41	2.3	4.7	0.3	0.8
Auditory	27	1	2.6	0.6	1.6

Overall, the significant finding was that the drivers who received various ESC activation indicators did not perform better than drivers given no indicator. Therefore, there does not appear to be a safety need to propose a requirement for an ESC activation indicator as part of this rulemaking, and none is proposed. In fact, presentation of an auditory indication of ESC activation was shown to increase the likelihood of road departure, particularly for older drivers. As a result, use of an auditory indication of ESC activation presented during the ESC activation is not recommended.

The flashing indicator was associated with a greater number of glances to the instrument panel during the critical driving maneuvers. Therefore, flashing would not seem to be a desirable feature, but there was no measurable consequence in road departures. The current practice for many vehicles is to

[24] Mazzae, E. *et al.* (2005) The effectiveness of ESC and related Telltales: NADS Wet Pavement Study, DOT HS 809 978.

[25] Papelis *et al.* (2004) Study of ESC Assisted Driver Performance Using a Driving Simulator, Report No. N)4–003–PR, University of Iowa.

use the same ESC telltale for both activation and malfunction. It flashes to indicate activation and stays on continuously in a steady burning mode to indicate ESC malfunction. Since NHTSA is proposing to not regulate the activation mode, the current practice need not be affected.

The threshold of ESC intervention that would trigger an indication of activation is likely to vary with the philosophy of the manufacturer. Some manufacturers would also favor displaying the activation signal to the driver shortly after the critical driving maneuver has ended. This idea may be more intuitively appealing because the driver would be warned of slippery road conditions while avoiding potential distraction during the critical maneuver. This rulemaking does not propose regulation in this area.

NHTSA believes that the symbol used to identify ESC malfunction (and activation if the telltale is shared) should be standardized. This is not the case for presently available systems. There are three main types of identifiers for ESC activation and malfunction. One type of icon shows the rear of a vehicle trailed by a pair of ''S'' shaped skid marks. This is the ISO ESC symbol (designated J.14 in ISO standard 2575). We observed seven variations of this icon in production vehicles. The second type is based on a triangle surrounding an exclamation mark, which is also used to indicate ABS and traction control activation on some vehicles. A variation of this type adds an outer counterclockwise semicircular arrow to indicate rotation. The third type includes English language phrases and acronyms often referring to trade names for specific ESC systems.

To the extent possible, NHTSA favors symbols over English abbreviations to promote harmonization. Also, acronyms for different trade names for ESC would only serve to confuse drivers who operate different vehicles produced by different manufacturers.

NHTSA collected data on the recognition of various identifiers related to ESC and other vehicle systems by administration of an icon comprehension test. A total of 20 members of the general public participated in this data collection effort. Gender was balanced. Each participant was first presented with an instructional sheet describing the procedure for the icon test. The instructions included the following statement: ''You are driving down the road and this image illuminates on your vehicle's instrument panel * * *''. Participants were then given the test, which consisted of a hand-sized packet containing the 20 icons, each on a different page. Each page contained two separate questions to ensure that responses were sufficiently detailed. The questions were: ''What system or part of the car is the light referring to?'' and ''What is the light telling you about that part or system?'' A fill-in-the-blank line for participant response followed each question.

Responses for ESC-related symbols were given full credit as correct if they contained the words ''stability control'' or ''ESC.'' ESC icon responses containing the word ''traction'' were given partial credit. Selected results of the comprehension test are presented in Figure 10. While few people knew what ''ESC'' meant, the ISO J.14 icon was the most successful in communicating to people a message relating to traction. The icon consisting of a counterclockwise, circular arrow surrounding a triangle containing an exclamation point, while present in a number of current vehicles, was not meaningful to any of the 20 respondents, and there was little recognition of the triangle without the arrow.

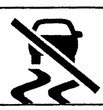
Based upon the results of this albeit limited study, the ISO J.14 symbol appears to be the best choice of the identifiers in use for a standard symbol for ESC. As with any symbol, drivers will have to learn its precise meaning, but we believe that, to some extent, it correctly evokes an association with skidding. Also, the ISO J.14 symbol and close variations were the symbols used presently by the greatest number of vehicle manufacturers that used an ESC symbol. Therefore, NHTSA is proposing the ISO J.14 symbol as the required ESC symbol in FMVSS No. 126.

3. ESC Off Switch Symbol and Telltale

There is an obvious safety need to prevent drivers from misunderstanding the operation of the ESC Off switch. Drivers usually encounter vehicle dashboard switches as a means of turning on vehicle functions that are off when the vehicle is started. However, an ESC Off switch presents the opposite situation, because full ESC operation is the default condition of the vehicle following each ignition cycle. Therefore, we believe that the switch must be labeled unambiguously.

The ISO convention is to draw a slash through a symbol to signify negation—the disabling or turning off of a vehicle function. However, Table 8, which examines potential symbols to indicate when the ESC system is off, shows that this convention applied to the ISO J.14 ESC symbol does not create an unambiguous symbol for ESC off.

Table 8. Potential ESC Off Switch Symbols

Once again, the ISO J.14 symbol is desirable because it connoted the idea of traction and skidding even to people who had not heard of electronic stability control. However, the literal meaning of the symbol of a vehicle skidding with a slash through it is the negation of skidding, which could be assumed to mean ESC on. The problem with the slash symbol is not just that a driver will not understand it and have to consult the owner's manual, but that the driver could reasonably understand it to have the opposite meaning and believe it is not necessary to consult the owner's manual. Therefore, a purely pictographic approach to adapting the ESC symbol for the off switch is not feasible. NHTSA believes it is necessary to make the identification of when ESC is turned off explicit by using the English word ''OFF,'' as shown in the right hand box of Table 8.

The same situation occurs for the telltale indicating what the current state of ESC system is. The off switch toggles the ESC system between the on and off states. Even someone who understands that the ESC Off switch is not required to use ESC normally must be certain of the ESC state after he has touched the switch. Therefore, the slash symbol cannot be used for the telltale either because it leads to the same ambiguity regarding the state of the ESC system when the telltale is lighted. Also, even though it is used for malfunction indication, the ISO J.14 symbol alone would create ambiguity about the on/off state of ESC if it were used with the Off switch. Therefore, the symbol with the English word ''OFF'' is also proposed for the telltale that will be required for the ESC Off switch.

E. Alternatives to the Agency Proposal

Section 10301 of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users of 2005 [26] (SAFETEA–LU) requires that the Secretary ''establish performance criteria to reduce the occurrence of rollovers consistent with stability enhancing technologies'' and ''issue a proposed rule * * * by October 1, 2006, and a final rule by April 1, 2009.'' NHTSA has long been concerned about the number of rollover fatalities and injuries, and it has pursued a number of actions in the past to reduce rollovers that were alternatives to the present proposal.

One of the past alternatives sought to require higher rollover resistance for light trucks. NHTSA published an Advance Notice of Proposed Rulemaking in 1992 [27] which explored the idea of setting a minimum level of rollover resistance based on the track width and height of the center of gravity. These are the primary components of ''geometric stability'' which can be expressed by metrics such as Static Stability Factor (SSF) or Tilt Table Ratio which is a related measurement using a ''tilt table'' to measure how far a vehicle on a platform could be tilted laterally before tipping over.

However, the contemplated approach of regulating the geometric stability of vehicles did not lead to a mandatory standard. Its effect would have been crash mitigation by reducing the number of single-vehicle crashes that turn into rollovers rather than crash prevention. In order to produce life saving benefits, the proposed geometric stability level would have had to be placed above that of almost all contemporary SUVs, pickup trucks with four-wheel drive, and full size vans. A regulation of this type would have made classes of vehicles with high ground clearance unavailable to consumers.

Rather than pursue such a rulemaking, NHTSA chose instead to add rollover resistance to the NCAP consumer information program in 2001. In this way, persons needing vehicles with high ground clearance (which have poorer rollover resistance) could make an informed choice about the tradeoffs, but consumers would be encouraged to choose vehicles with greater rollover resistance. The NCAP program uses market-based incentives to encourage manufacturers to maximize rollover resistance within the limitations of the vehicle class. Manufacturers responded to these NCAP ratings with improvements in rollover resistance resulting from the generally wider track widths of newer SUVs derived from passenger car platforms and also improvements where possible in truck-based SUVs during major redesigns. A recent trend in improving the rollover resistance of SUVs has been the addition of roll stability control. This feature prevents tip-up in the maneuver test that was added to NCAP in the 2004 model year, resulting in a small reduction in the predicted rollover rate.

We believe the NCAP approach has been a successful way to address the dilemma of higher rollover resistance being at odds with some of the features that draw consumers to light trucks. Despite the recent trend of improvement, SUVs cannot match passenger cars in geometric stability because taller bodies and higher ground clearance are the features that distinguish SUVs from passenger cars. Nevertheless, the rollover resistance of SUVs has substantially improved since the establishment of NCAP ratings, and consumers are in a better position to make vehicle decisions for themselves and for young drivers in their family.

While the use of ESC to prevent single vehicle crashes is a better way of reducing rollovers than any countermeasures previously available, there are alternatives in terms of how NHTSA could regulate ESC systems. The agency considered two alternatives to the proposal. The first was to limit the ESC standard's applicability only to LTVs. The second alternative was to not require a 4-wheel system, which would allow a 2-wheel system to be used by manufacturers.

The agency considered the first alternative for two reasons: (a) The ESC effectiveness rates for LTVs against single-vehicle crashes were almost twice as high of the effectiveness rates for passenger cars (PCs), and (b) LTVs generally had a higher propensity for rollover than PCs. The alternative would address the core rollover issue and target the high-risk rollover vehicle population. However, after examining the safety impact and the cost-effectiveness of the alternative, the agency determined that an excellent opportunity to reduce passenger car crashes would be lost if PCs were excluded from the proposal.

We examined this alternative by looking at the impacts of requiring ESC for passenger cars. Requiring ESC for passenger cars would save 956 lives and reduce 34,902 non-fatal injuries. Following this analysis through the cost-effectiveness equations, the cost-effectiveness analysis shows that ESC is highly cost-effective for PCs alone. For PCs, the cost per equivalent life saved is estimated to be $0.35 million at a 3 percent discount rate and $0.47 million at a 7 percent discount rate. The benefit-cost would be $4.8 billion at a 3 percent discount rate and $3.8 billion at a 7 percent discount rate.

Given the fact that ESC is highly cost-effective and that extending the ESC applicability to PCs would save a large number of additional lives (956) and reduce a large number of additional injuries (34,902), the agency is not proposing this alternative.

The second alternative considered was to require only that ESC operate on the two front wheels. General Motors has utilized a 2-wheel ESC system in many of its ESC-equipped passenger cars through MY 2005, but it is using 4-wheel ESC systems exclusively in MY 2006. All other manufacturers have utilized a 4-wheel ESC system in their vehicles. Only 4-wheel systems are capable of both understeer and oversteer mitigation.

Statistical analyses comparing 2-wheel to 4-wheel ESC systems were performed.[28] The effectiveness estimates show a potentially enhanced benefit of 4-wheel ESC systems over 2-wheel ESC systems in reducing single-vehicle run-off-road crashes (significant at the 0.05 level or better), although the benefit could not have been shown in a separate analysis of fatal-only crashes likely due to the small sample size.

The agency's contractor performed a teardown study to determine the difference in costs between a 2-wheel and 4-wheel system, and it found that the 2-wheel system is about $10.00 less expensive. However, it is not intuitively obvious that the difference need be this much, and with a sample size of one, it is possible that other changes in design may be affecting this estimate.

Since the industry has moved away from the 2-wheel system on its own, and it appears that the difference in cost of $10 or less will be insignificant compared to the additional benefits

[26] Pub. L. 109–59, 119 stat. 1144 (2005).

[27] 57 FR 242 (Jan. 3, 1992).

[28] Dang, J. (2006) Statistical Analysis of The Effectiveness of Electronic Stability Control (ESC) Systems, U.S. Dept. of Transportation, Washington, DC (publication pending peer review). A draft version of this report, as supplied to peer reviewers, has been placed in the docket for this rulemaking.

achieved with 4-wheel ESC, we are not providing a full analysis of this alternative at this time.

Based on the available information, the agency is proposing the 4-wheel system. The agency's decision is based on our and the industry's engineering judgment that the 4-wheel system is more effective, the effectiveness study showing that the 4-wheel system is more effective than the 2-wheel system in reducing crashes, the industry trend towards installing the 4-wheel system in their vehicles, and the minimal cost differences between 2-wheel and 4-wheel ESC systems.

We have also examined the possibility that there may be alternative approaches to achieving the benefits of ESC that could involve simpler or less costly technology. To answer this question we first identified the basic functional requirements of a vehicle control system that would maintain vehicle path control in both oversteer and understeer situations. The first functional requirement is a means of predicting what the driver's intended path, i.e., where the driver wants the vehicle to go. The second functional requirement is to be able to determine the current actual path of the vehicle, i.e., its current dynamic state. The final requirement is to determine how the intended and actual paths deviate and then to exercise automatic control to minimize or eliminate this deviation. The basic question then is whether there exists another fundamentally different technological approach to achieving the three key functional requirements identified above, than those employed in current ESC systems.

Functional Requirement No. 1: One may infer the desired path from a knowledge of the driver's instantaneous steering, throttle, and braking commands as well as the current dynamic state of the vehicle. This requires that sensors be installed to determine the values of each of these control inputs. Although specific sensor technology and costs may vary from one manufacturer to another, there is no known alternative to acquiring knowledge of the driver's intent other than through this system of vehicle sensors.

Functional Requirement No. 2: Once the intended path is established, the next requirement is determine the vehicle's actual path. Here again a range of sensor information is needed to establish the vehicle's dynamic state. Among the state variables that must be determined, the two most critical are lateral acceleration and yaw velocity. Acquiring information of these quantities requires special vehicle dynamic sensors. Again, though sensor technology and cost may vary, we are not aware of any alternative approach to acquiring this essential information.

Functional Requirement No. 3: With information on the driver's desired path and the actual vehicle path, a means of comparing the two and eliminating or minimizing deviations is needed. This requires an electronic comparator and error generator. A means of altering the actual vehicle path so as to bring it into alignment with the desired path is the third critical function. The vehicle path can only be changed as a result of forces generated between the tire and roadway. Drivers intuitively rely on lateral tire forces generated through steering inputs to change the vehicle heading and path. Though not comprehended by most drivers, the heading (and consequently the path) can also be changed by means of unbalanced braking forces, which is the approach used by ESC. We do not believe that an approach that would assume control of the driver's steering authority as an alternative method of correcting the vehicle path would be acceptable to most drivers. Also, braking intervention at individual wheels is much more likely to produce the necessary yaw torque on slippery surfaces than steering intervention, and steering intervention would have limited effect on understeer loss-of-control even on surfaces with high levels of friction. No manufacturer has proposed this method of intervention to correct path deviation in loss of control situations.

In summary, while specific differences in the implementation may exist between ESC systems, the basic elements of the feed-back control systems are common to all. We have concluded that to accomplish the goal of preventing a vehicle from losing path or directional control a vehicle must be equipped with all of the essential components of the current ESC systems. There does not appear to be any current alternative to the technology that is being mandated that attains the goals of this proposed rule. We solicit comment on alternatives to mandating the installation of ESC, consistent with our statutory directive.

VI. Leadtime

Considering the very high level of potential life-saving benefits of this proposed safety standard, NHTSA wishes to avoid excessive delay in its development and implementation. Except for possibly some low-production-volume vehicles with infrequent design changes, NHTSA believes that most other vehicles can reasonably be equipped with ESC within three to four model years (MY) from the date of issuance of a final rule. This proposal does not require improvements in ESC technology over the present 2006 MY systems, and most vehicles would likely experience some level of redesign in the next five years in the normal course of business. There already is a strong trend to provide ESC as standard equipment on SUVs, and it is likely that market segment will be equipped with ESC prior to a final rule becoming effective. We have taken these considerations into account in proposing both the phase-in plan as well as the final compliance date for full implementation of the standard.

Our intention is to have 90 percent of the subject fleet equipped with ESC in the 2011 model year that starts September 1, 2010. Accordingly, assuming the final rule is published in June 2008, and becomes effective September 1, 2008, we are proposing the following phase-in schedule:

September 1, 2008—30 percent of fleet.
September 1, 2009—60 percent of fleet.
September 1, 2010—90 percent of fleet.
September 1, 2011—All light vehicles.

However, NHTSA is proposing to exclude multi-stage manufacturers and alterers from the requirements of the phase-in and to extend by one year the time for compliance by those manufacturers (i.e., until September 1, 2012). This NPRM also proposes to exclude small volume manufacturers (i.e., manufacturers producing less than 5,000 vehicles for sale in the U.S. market in one year) from the phase-in, instead requiring such manufacturers to fully comply with the standard on September 1, 2011.

Under our proposal, vehicle manufacturers would be permitted to earn carry-forward credits for compliant vehicles, produced in excess of the phase-in requirements, which are manufactured between the effective date of the final rule and the conclusion of the phase-in period. We note that carry-forward credits would not be permitted to be used to defer the mandatory compliance date of September 1, 2011 for all covered vehicles.

The initial phase-in of 30 percent occurring almost simultaneously with the effective date is the result of our belief that all manufacturers subject to the phase-in already plan to exceed that level of ESC installation in the 2009 MY. Confidential information submitted to NHTSA by many manufacturers indicate that all responding manufacturers will exceed a 30 percent installation rate, and that several will exceed it by a large margin that would earn considerable carry-forward credits.

VII. Benefits and Costs

A. Summary

This section summarizes our analysis of the benefits, costs, and cost per equivalent life saved as a result of the proposed ESC requirement. As noted previously, the life- and injury-saving potential of ESC is very significant, both in absolute terms and when compared to prior agency rulemakings. This proposal for ESC, if made final, would save 1,536 to 2,211 lives and cause a reduction of 50,594 to 69,630 MAIS 1–5 injuries annually once all passenger vehicles have ESC. This compares favorably with the Regulatory Impact Analyses for other important rulemakings such as FMVSS No. 208 mandatory air bags (1,964 to 3,670 lives saved), FMVSS No. 214 side impact protection (690 to 1,030 lives saved), and FMVSS No. 201 upper interior head impact protection (870 to 1,050 lives saved). The ESC proposal would also save $396 to $555 million annually in property damage and travel delay (undiscounted). The total cost of the proposal is estimated to be $985 million.

The proposal is extremely cost-effective. The cost per equivalent life saved would range from $0.19 to $0.32 million at a 3 percent discount and $0.27 to $0.43 million at a 7 percent discount. Again, the cost-effectiveness for ESC compares favorably with the Regulatory Impact Analyses for other important rulemakings such as FMVSS No. 202 head restraints safety improvement ($2.61 million per life saved), FMVSS No. 208 center seat shoulder belts ($3.39 to $5.92 million per life saved), FMVSS No. 208 advanced air bags ($1.9 to $9.0 million per life saved), and FMVSS No. 301 fuel system integrity upgrade ($1.96 to $5.13 million per life saved).

For a more complete discussion of the benefits and costs associated with this proposed rulemaking for ESC, please consult the Preliminary Regulatory Impact Analysis (PRIA), which is available in the docket for this rulemaking.

B. ESC Benefits

As discussed in detail in Chapter IV (Benefits) of the PRIA, we anticipate that this rulemaking would prevent 70,344 to 95,153 crashes (1,408 to 2,355 fatal crashes and 69,936 to 91,798 non-fatal crashes). Preventing these crashes entirely is the ideal safety outcome and would translate into 1,536 to 2,211 lives saved and 50,594 to 69,630 MAIS 1–5 injuries prevented.

The above figures include benefits related to rollover crashes. However, in light of the relatively severe nature of crashes involving rollover, ESC's contribution toward mitigating the problem associated with this subset of crashes should be noted. We anticipate that this rulemaking would prevent 37,309 to 41,147 rollover crashes (1,057 to 1,314 fatal crashes and 36,252 to 39,833 non-fatal crashes). This would translate into 1,161 to 1,445 lives saved and 43,901 to 49,010 MAIS 1–5 injuries prevented in rollovers.

In addition, preventing crashes would also result in benefits in terms of travel delay savings and property damage savings. We estimate that this rulemaking would save $396 to $555 million, undiscounted, in these two categories ($310 to $348 million of this savings attributable to prevented rollover crashes).

C. ESC Costs

In order to estimate the cost of the additional components required to equip every vehicle in future model years with an ESC system, assumptions were made about future production volume and the relationship between equipment found in anti-lock brake systems (ABS), traction control (TC), and ESC systems. We assumed that in an ESC system, the equipment of ABS is a prerequisite. Thus, if a passenger car did not have ABS, it would require the cost of an ABS system plus the additional incremental costs of the ESC system to comply with an ESC standard. We assumed that traction control (TC) was not required to achieve the safety benefits found with ESC. We estimated a future annual production of 17 million light vehicles consisting of nine million light trucks and eight million passenger cars.

An estimate was made of the MY 2011 installation rates of ABS and ESC. It served as the baseline against which both costs and benefits are measured. Thus, the cost of the standard is the incremental cost of going from the estimated MY 2011 installations to 100 percent installation of ABS and ESC. The estimated MY 2011 installation rates are presented in Table 9.

TABLE 9.—MY 2011 PREDICTED INSTALLATIONS

[Percent of the light vehicle fleet]

	ABS	ABS + ESC
Passenger Cars	86	65
Light Trucks	99	77

Based on the assumptions above and the data provided in Table 9, Table 10 presents the percent of the MY 2011 fleet that would need these specific technologies in order to equip 100 percent of the fleet with ESC.

TABLE 10.—PERCENT OF THE LIGHT VEHICLE FLEET REQUIRING TECHNOLOGY TO ACHIEVE 100% ESC INSTALLATION

	None	ABS + ESC	ESC only
Passenger Cars	65	14	21
Light Trucks	77	1	22

The cost estimates developed for this analysis were taken from tear down studies that contractors have performed for NHTSA. This process resulted in estimates of the consumer cost of ABS at $368 and the incremental cost of ESC at $111. Thus, it would cost a vehicle that does not have ABS currently, $479 to meet this proposal. Combining the technology needs in Table 10 with the cost above and assumed production volumes yields the cost estimate in Table 11 for the proposed standard.

TABLE 11.—SUMMARY OF VEHICLE COSTS FOR THE ESC PROPOSAL

[2005$]

	Average vehicle costs	Total costs (million)
Passenger Cars	$90.3	$728
Light Trucks	29.2	363
Total	58	985

In summary, Table 11 shows that the new vehicle costs of providing electronic stability control and antilock brakes will add approximately $985 million to new light vehicles at a cost averaging over $58 per vehicle.

In addition, we note that this proposal would add weight to vehicles and consequently would increase their lifetime use of fuel. Most of the added weight is for ABS components and very little is for the ESC components. Since 99 percent of light trucks are predicted to have ABS in MY 2011, the weight increase for light trucks is less than one pound and is considered negligible. The average weight gain for passenger cars is estimated to be 2.1 pounds, resulting in 2.6 more gallons of fuel being used over the lifetime of these vehicles. The present discounted value of the added fuel cost over the lifetime of the average passenger car is estimated to be $2.73 at a 7 percent discount rate and $3.35 at a 3 percent discount rate.

We have not included in these cost estimates, allowances for ESC system maintenance and repair. Although all complex electronic systems will experience component failures from time to time necessitating repair, our experience to date with existing systems is that their failure rate is not outside the norm. Also, there are no routine maintenance requirements for ESC systems.

VIII. Public Participation

How Can I Influence NHTSA's Thinking on This Notice?

In developing this notice, NHTSA tried to address the concerns of all stakeholders. Your comments will help us determine what standard should be set for ESC as part of FMVSS No. 126. We invite you to provide different views about the issues presented, new approaches and technologies about which we did not ask, new data, how this notice may affect you, or other relevant information. We welcome your views on all aspects of this notice. Your comments will be most effective if you follow the suggestions below:

- Explain your views and reasoning as clearly as possible.
- Provide empirical evidence, wherever possible, to support your views.
- If you estimate potential costs, explain how you arrived at that estimate.
- Provide specific examples to illustrate your concerns.
- Offer specific alternatives.
- Reference specific sections of the notice in your comments, such as the units or page numbers of the preamble, or the regulatory sections.
- Be sure to include the name, date, and docket number of the proceeding as part of your comments.

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.

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

You may also submit your comments to the docket electronically by logging onto the Dockets Management System Web site at *http://dms.dot.gov.* Click on ''Help & Information'' or ''Help/Info'' to obtain instructions for filing your document electronically.

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, stamped postcard in the envelope containing your comments. Upon receiving your comments, Docket Management will return the postcard by mail. Each electronic filer will receive electronic confirmation that his or her submission has been received.

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

How Can I Read the Comments Submitted by Other People?

You may read the comments received by Docket Management at the address given above under **ADDRESSES.** The hours of the Docket are indicated above in the same location.

You may also review filed public comments on the Internet. To read the comments on the Internet, take the following steps:

1. Go to the Docket Management System (DMS) Web page of the Department of Transportation (*http://dms.dot.gov/*).
2. On that page, click on ''search.''

3. On the next page (*http://dms.dot.gov/search/*), type in the four-digit docket number shown at the beginning of this document. (Example: If the docket number were ''NHTSA–1998–1234,'' you would type ''1234.'') After typing the docket number, click on ''search.''

4. On the next page, which contains docket summary information for the docket you selected, click on the desired comments. You may download the comments. Although the comments are imaged documents, instead of word processing documents, the ''pdf'' versions of the documents are word searchable.

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.

Data Quality Act Statement

Pursuant to the Data Quality Act, in order for substantive data submitted by third parties to be relied upon and used by the agency, it must also meet the information quality standards set forth in the DOT Data Quality Act guidelines. Accordingly, members of the public should consult the guidelines in preparing information submissions to the agency. DOT's guidelines may be accessed at *http://dmses.dot.gov/submit/DataQualityGuidelines.pdf.*

IX. Regulatory Analyses and Notices

A. Vehicle Safety Act

Under 49 U.S.C. Chapter 301, *Motor Vehicle Safety* (49 U.S.C. 30101 *et seq.*), the Secretary of Transportation is responsible for prescribing motor vehicle safety standards that are practicable, meet the need for motor vehicle safety, and are stated in objective terms.[29] These motor vehicle safety standards set the minimum level of performance for a motor vehicle or motor vehicle equipment to be considered safe.[30] When prescribing such standards, the Secretary must consider all relevant, available motor vehicle safety information.[31] The Secretary also must consider whether a proposed standard is reasonable, practicable, and appropriate for the type of motor vehicle or motor vehicle equipment for which it is prescribed and the extent to which the standard will further the statutory purpose of reducing traffic accidents and associated deaths.[32] The responsibility for promulgation of Federal motor vehicle safety standards has been delegated to NHTSA.[33]

As noted previously, section 10301 of SAFETEA–LU mandated a regulation to reduce the occurrence of rollovers ''consistent with stability enhancing technologies.'' In developing this proposed rule for ESC, the agency carefully considered the statutory requirements of both SAFETEA–LU and 49 U.S.C. Chapter 301.

First, in preparing this document, the agency carefully evaluated available research, testing results, and other information related to ESC technology. The agency performed extensive research on its own and made use of research performed by the Alliance of Automobile Manufacturers. We have also performed analyses of ESC using actual crash data to determine the effectiveness of ESC in reducing single-vehicle crashes and rollovers. In sum, this document reflects our consideration of all relevant, available motor vehicle safety information.

Second, to ensure that the ESC requirements are practicable, the agency research and the Alliance research documented the capabilities of current ESC systems and dynamic performance of model year 2005 vehicles equipped with them. We have tentatively concluded that all current production vehicles equipped with ESC systems would comply with the equipment requirements, that all but one vehicle would comply with the performance tests proposed, and that only minor software tuning would be required to bring that vehicle into compliance. In sum, we believe that this proposed rule is practicable, in that it could be implemented with existing technology and is quite cost effective given its potential to prevent thousands of deaths and injuries each year, particularly those associated with single-vehicle crashes leading to rollover.

Third, the regulatory text following this preamble is stated in objective terms in order to specify precisely what equipment constitutes an ESC system, what performance is required and how performance would be tested under the standard. The proposed definition of an ESC system is based on an industry consensus definition developed by the Society of Automotive Engineers (SAE). The proposed rule also includes performance requirements and test procedures for the timing and intensity of the oversteer intervention of the ESC system and the responsiveness of the vehicle. This test procedure involves a precisely defined steering pattern performed by a robotic steering machine under a defined set of test conditions (e.g., ambient temperature, road test surface, vehicle load, vehicle speed). Performance is defined by objective measurements of yaw rate and lateral acceleration taken by scientific instruments at precise times with reference to the steering pattern. The standard's test procedures carefully delineate how testing would be conducted. Thus, the agency believes that this test procedure is sufficiently objective and would not result in any uncertainty as to whether a given vehicle satisfies the requirements of the ESC standard.

Finally, we believe that this proposed rule is reasonable and appropriate for motor vehicles subject to the applicable requirements. As discussed elsewhere in this notice, the agency is addressing Congress' concern about rollover crashes resulting in fatalities and serious injuries. Under section 10301 of SAFETEA–LU, Congress mandated installation of stability enhancing technologies in new vehicles to reduce rollovers. NHTSA has determined that ESC systems meeting the requirements of this proposed rule offer an effective countermeasure to rollover crashes and to other single-vehicle and certain multi-vehicle crashes. Accordingly, we believe that this proposed rule is appropriate for vehicles that would become subject to these provisions because it furthers the agency's objective of preventing deaths and serious injuries, particularly those associated with rollover crashes.

B. Executive Order 12866 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 Office of Management and Budget (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;

[29] 49 U.S.C. 30111(a).

[30] 49 U.S.C. 30102(a)(9).

[31] 49 U.S.C. 30111(b).

[32] *Id.*

[33] 49 U.S.C. 105 and 322; delegation of authority at 49 CFR 1.50.

(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 impact of this action under Executive Order 12866 and the Department of Transportation's regulatory policies and procedures. This action has been determined to be economically significant under the Executive Order, and it is also a subject of congressional interest and a mandate under section 10301 of SAFETEA–LU. The agency has prepared and placed in the docket a Preliminary Regulatory Impact Analysis. This rulemaking action is also significant within the meaning of the Department of Transportation's Regulatory Policies and Procedures (44 FR 11034; February 26, 1979). Accordingly, this rulemaking document was reviewed by the Office of Management and Budget under Executive Order 12866, ''Regulatory Planning and Review.'' The agency has estimated that compliance with this proposal would cost approximately $985 million per year and have net benefits as high as $10.6 billion per year. Thus, this rule would have greater than a $100 million effect.

C. Regulatory Flexibility Act

Pursuant to the Regulatory Flexibility Act of 1980 (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 rulemaking for any proposed 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). However, no regulatory or flexibility analysis is required if the head of an agency certifies that the rule 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 rule will not have a significant economic impact on a substantial number of small entities.

NHTSA has considered the effects of this rulemaking action under the Regulatory Flexibility Act and has included an initial regulatory flexibility analysis in the PRE. This analysis discusses potential regulatory alternatives that the agency considered that would still meet the identified safety need of reducing the occurrence of rollovers through stability enhancing technologies. Alternatives considered included (a) applying the standard to light trucks but not to passenger cars and (b) permitting front-wheel-only ESC systems that are incapable of understeer intervention. The first alternative was rejected because passenger car ESC systems would save 956 lives and reduce 34,902 injuries annually at a cost per equivalent fatality that would easily justify a separate rule for passenger cars. The second alternative was rejected because front-wheel-only ESC systems would prevent 30 percent fewer single-vehicle crashes without producing a large cost saving.

To summarize the conclusions of that analysis, the agency believes that the proposal would have a significant economic impact on a substantial number of small businesses. There are currently four small domestic motor vehicle manufacturers in the United States, each having fewer than 1,000 employees. Although the cost for an ESC system is relatively high, we believe that these manufacturers would be able to pass the associated costs on to purchasers without decreasing sales volume, because the demand for these high-end, luxury vehicles tends to be inelastic and the increase in total vehicle cost is expected to be only 0.2–1.1 percent.

There are a significant number of final-stage manufacturers and alterers that could be impacted by the proposed rule for ESC, some of which buy incomplete vehicles. However, final-stage manufacturers and alterers typically do not modify the brake system of the vehicle, so the original manufacturer's certification of the ESC system should pass through for these vehicles. We believe that increased costs associated with ESC would impact all such final-stage manufacturers and alterers equally, and that such costs would be passed on to consumers. Furthermore, we have no reason to believe that an average cost of $90 per passenger car and $29 per truck will cause a significant decline in overall vehicle sales.

We do not expect manufacturers of ESC systems to be classified as small businesses.

D. Executive Order 13132 (Federalism)

Executive Order 13132 sets forth principles of federalism and the related policies of the Federal government. NHTSA has analyzed this rule in accordance with the principles and criteria set forth in Executive Order 13132, Federalism, and has determined that it does not have sufficient Federal implications to warrant consultation with State and local officials or the preparation of a Federalism summary impact statement. The rule will not have any substantial impact on the States, or on the current Federal-State relationship, or on the current distribution of power and responsibilities among the various local officials. However, under 49 U.S.C. 30103, whenever a Federal motor vehicle safety standard is in effect, a State may not adopt or maintain a safety standard applicable to the same aspect of performance which is not identical to the Federal standard, except to the extent that the state requirement imposes a higher level of performance and applies only to vehicles procured for the State's use.

E. Executive Order 12988 (Civil Justice Reform)

Pursuant to Executive Order 12988, ''Civil Justice Reform'' (61 FR 4729, February 7, 1996), the agency has considered whether this proposed rule would have any retroactive effect. This proposed rule would not have any retroactive effect. Under 49 U.S.C. 30103, whenever a Federal motor vehicle safety standard is in effect, a State may not adopt or maintain a safety standard applicable to the same aspect of performance of a motor vehicle or motor vehicle equipment which is not identical to the Federal standard, except to the extent that the State requirement imposes a higher level of performance and applies only to vehicles procured for the State's use. 49 U.S.C. 30161 sets forth a procedure for judicial review of final rules establishing, amending, or revoking Federal motor vehicle safety standards. That section does not require submission of a petition for reconsideration or other administrative proceedings before parties may file suit in court.

F. 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 19855, April 23, 1997), applies to any rule that: (1) Is determined to be ''economically significant'' as defined under Executive Order 12866, and (2) concerns an environmental, health, or safety risk that the agency has reason to believe may have a disproportionate effect on children. If the regulatory action meets both criteria, the agency must evaluate the environmental health or safety effects of the planned rule on children, and explain why the planned regulation is preferable to other potentially effective and reasonably feasible alternatives considered by the agency.

Although the proposed rule for ESC has been determined to be an economically significant regulatory action under Executive Order 12866, the problems associated with loss of vehicle control equally impact all persons riding in a vehicle, regardless of age. Consequently, the proposed rule does not involve a decision based on environmental, health, or safety risks that disproportionately affect children and would not necessitate further analyses under Executive Order 13045.

G. 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. The Department of Transportation is 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 Electronic Stability Control Systems.

Type of Request: Routine.

OMB Clearance Number: 2127–New.

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, and buses 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 hour burden is 42 hours.

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 Collection of Information: This collection would require manufacturers of passenger cars, multipurpose passenger vehicles, trucks, and buses with a gross vehicle weight rating of 4,536 Kg (10,000 pounds) or less to provide motor vehicle production data for the following three years: September 1, 2008 to August 31, 2009; September 1, 2009 to August 31, 2010; and September 1, 2010 to August 31, 2011.

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. 126, *Electronic Stability Control Systems,* during the phase-in of those requirements. NHTSA requests comments on the agency's estimates of the total annual hour and cost burdens resulting from this collection of information. These comments must be received on or before October 18, 2006.

H. National Technology Transfer and Advancement Act

Section 12(d) of the National Technology Transfer and Advancement Act of 1995 (NTTAA), Public Law 104–113, section 12(d) (15 U.S.C. 272) directs NHTSA to use voluntary consensus standards in its regulatory activities unless doing so would be inconsistent with applicable law or otherwise impractical. 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 NHTSA to provide Congress, through OMB, explanations when the agency decides not to use available and applicable voluntary consensus standards. The NTTAA does not apply to symbols.

The equipment requirements of this standard are based (with minor modifications) on the SAE Surface Vehicle Information Report on Automotive Stability Enhancement Systems J2564 Rev JUN2004 that provides an industry consensus definition of an ESC system. However, there is no voluntary consensus standard for ESC that contains any specifications for a performance test.

I. Unfunded Mandates Reform Act

Section 202 of the Unfunded Mandates Reform Act of 1995 (UMRA) requires Federal agencies to prepare a written assessment of the costs, benefits, and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditure by State, local or tribal governments, in the aggregate, or by the private sector, of more than $100 million in any one year (adjusted for inflation with base year of 1995, so currently about $118 million in 2004 dollars). Before promulgating a rule for which a written statement is needed, section 205 of the UMRA generally requires NHTSA to identify and consider a reasonable number of regulatory alternatives and adopt the least costly, most cost-effective, or least burdensome alternative that achieves the objectives of the rule. The provisions of section 205 do not apply when they are inconsistent with applicable law. Moreover, section 205 allows NHTSA to adopt an alternative other than the least costly, most cost-effective or least burdensome alternative if we publish with the final rule an explanation why that alternative was not adopted.

This proposal would not result in the expenditure by State, local, or tribal governments, in the aggregate, of more than $118 million annually, but it would result in the expenditure of that magnitude by vehicle manufacturers and/or their suppliers.

In this proposed rule, the agency is presenting not only its proposed regulatory approach for ESC, but also the regulatory alternatives it has considered. In addition, as part of the public comment process, the agency is open to suggestions regarding ways to promote flexibility and to minimize costs of compliance, while achieving the safety purposes of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users of 2005.

J. National Environmental Policy Act

NHTSA has analyzed this proposed 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.

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.

L. Privacy Act

Please note that anyone is able to search the electronic form of all comments received into any of our dockets by the name of the individual submitting the comment (or signing the comment, if submitted on behalf of an association, business, labor union, etc.). You may review DOT's complete

Privacy Act Statement in the **Federal Register** published on April 11, 2000 (Volume 65, Number 70; pages 19477–78) or you may visit *http://dms.dot.gov.*

BILLING CODE 4910–59–P

Figures to Preamble

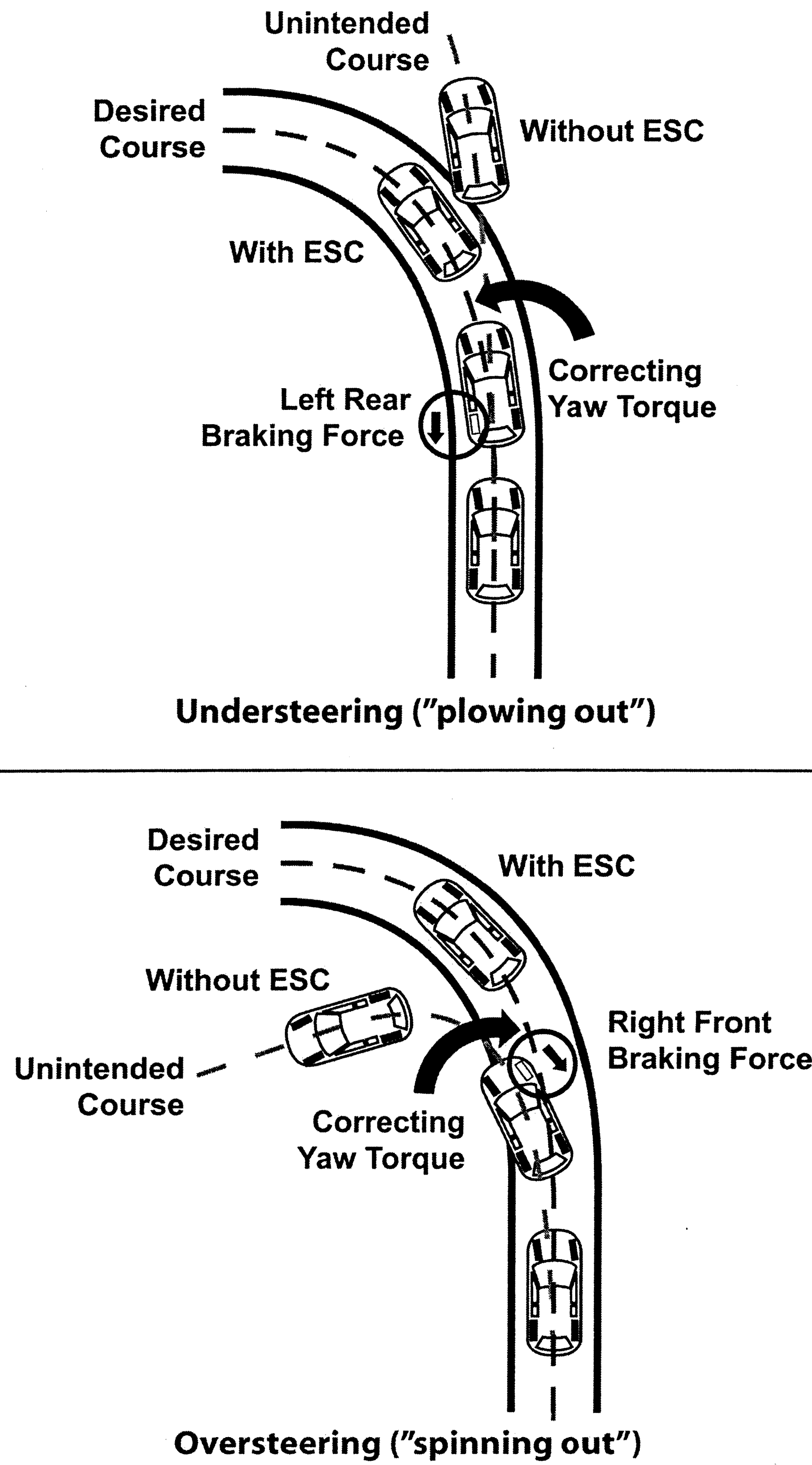


Figure 1. ESC Interventions for Understeering and Oversteering

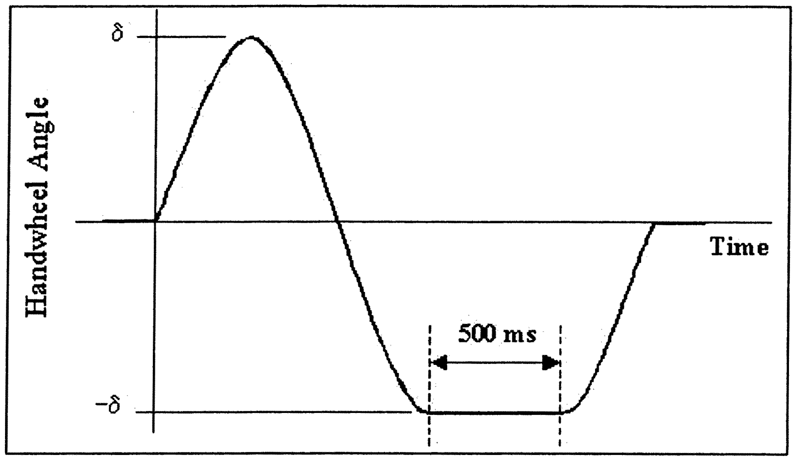


Figure 2. Sine with Dwell handwheel inputs.

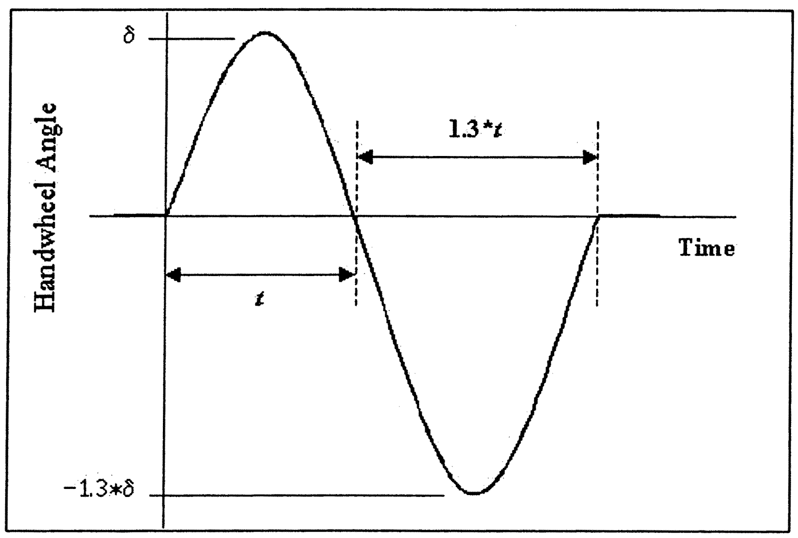


Figure 3. Increasing Amplitude Sine handwheel inputs.

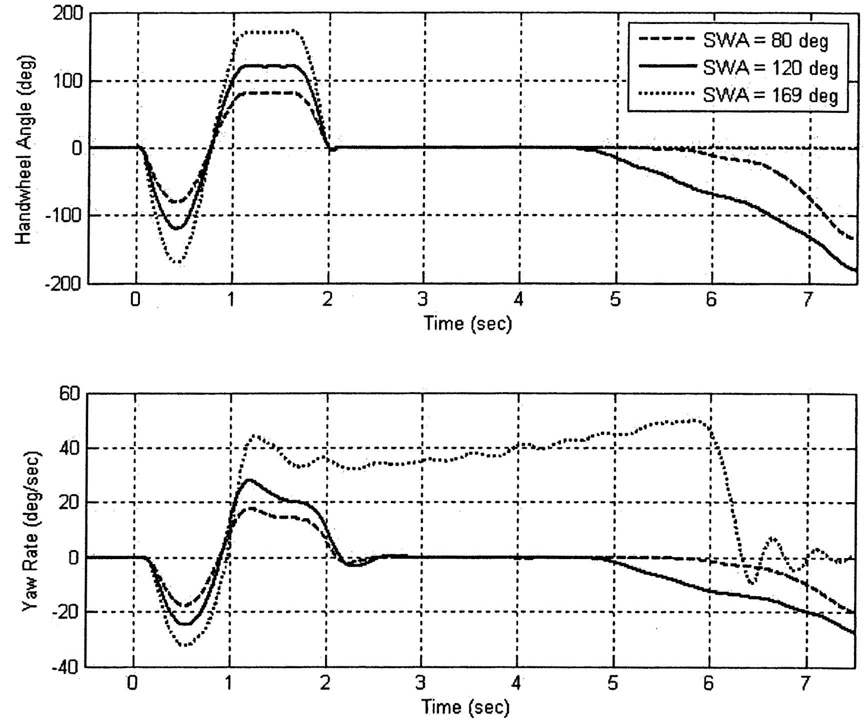


Figure 4. Sine with Dwell Maneuver Test of a Vehicle without ESC

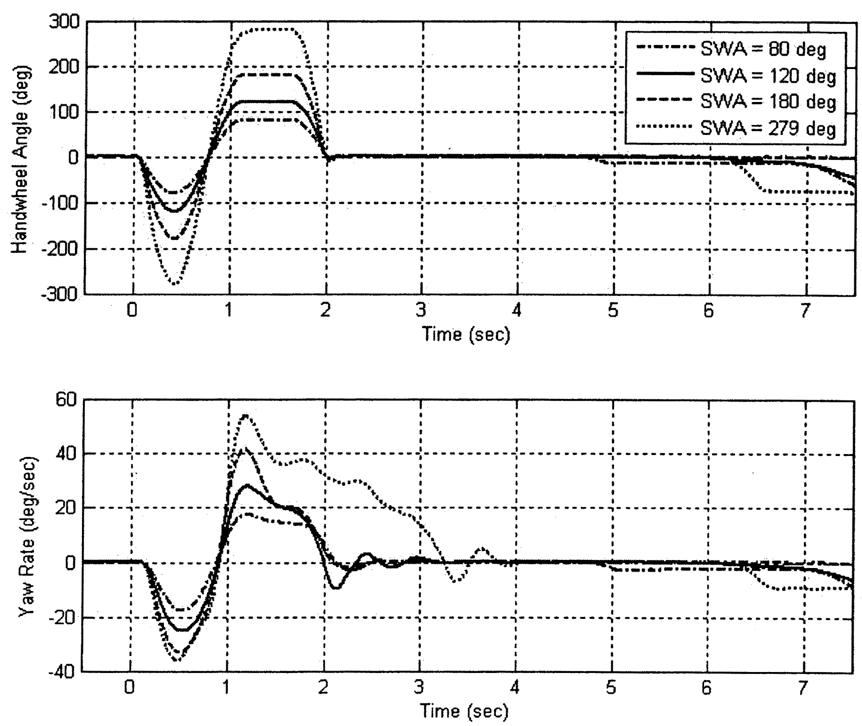


Figure 5. Sine with Dwell Maneuver Test of the Vehicle in Figure 4, with ESC Enabled

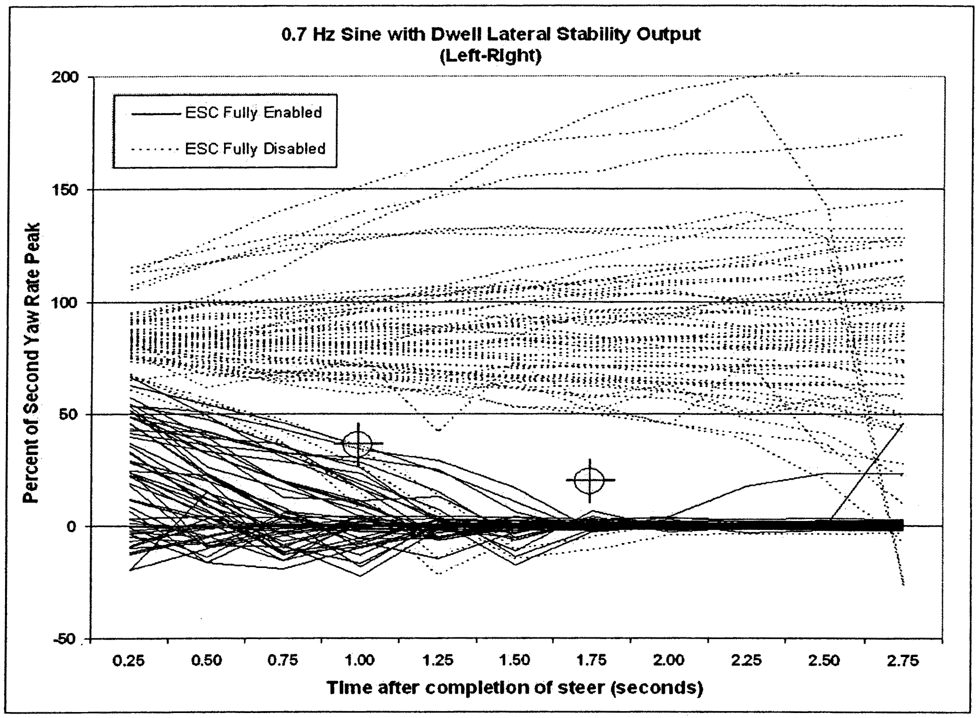


Figure 6. Sine with Dwell tests performed with left-right steering. Yaw rate ratio plotted as a function of time after completion of steer. Two crosshairs indicate proposed lateral stability requirements.

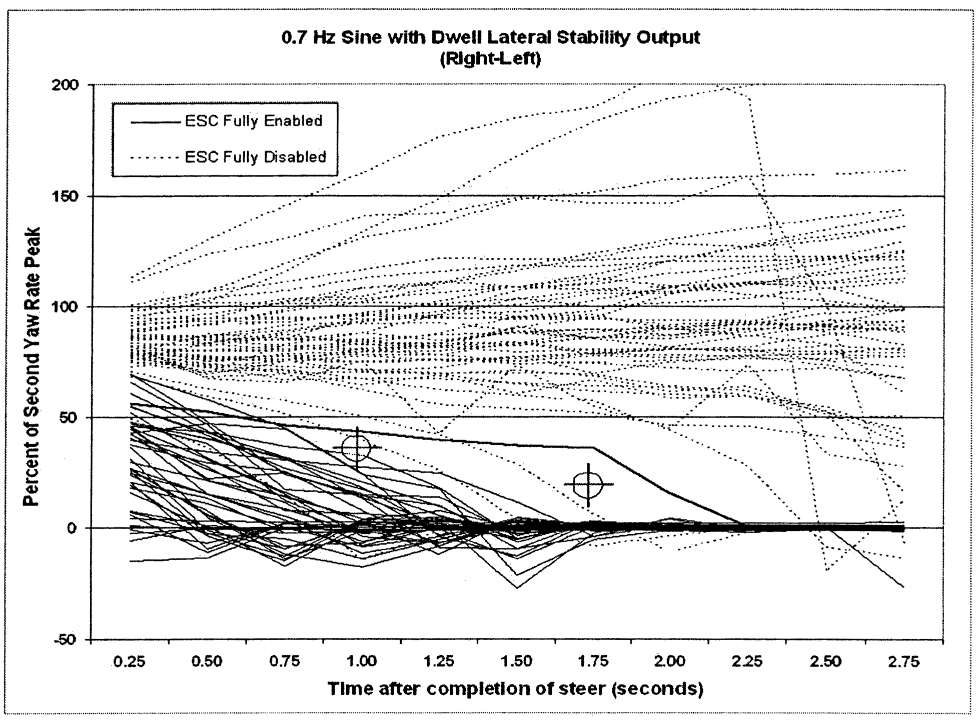


Figure 7. Sine with Dwell tests performed with right-left steering. Yaw rate ratio plotted as a function of time after completion of steer. Two crosshairs indicate proposed lateral stability requirements.

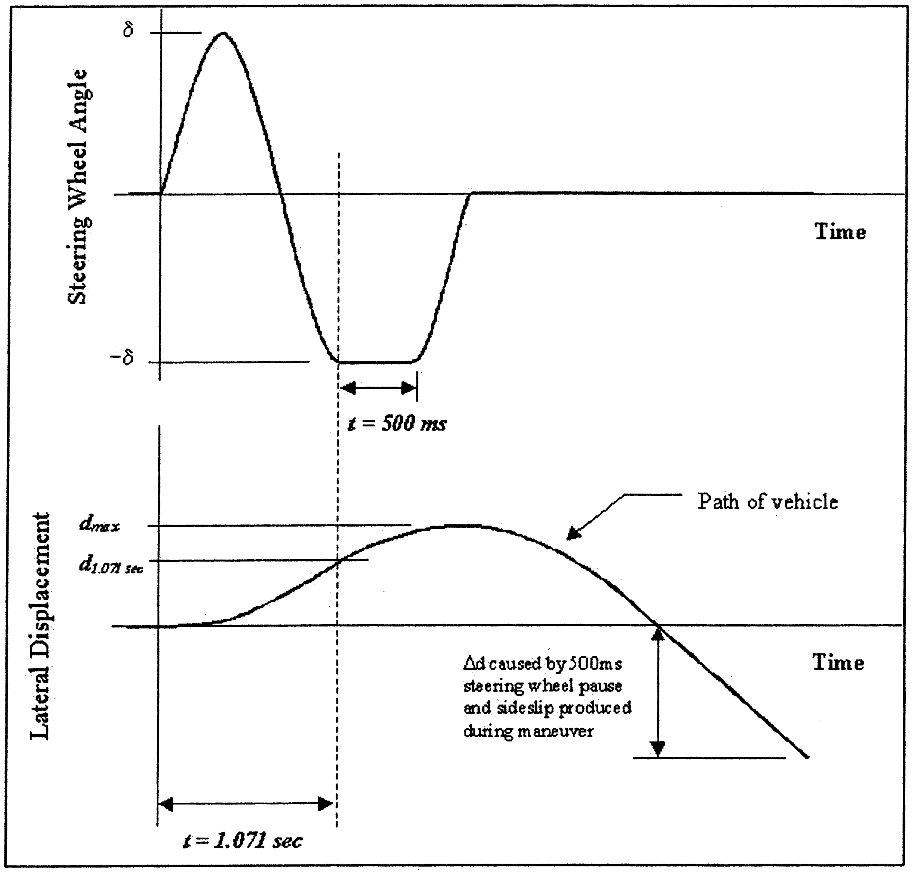


Figure 8. Lateral Displacement in the Sine with Dwell Maneuver

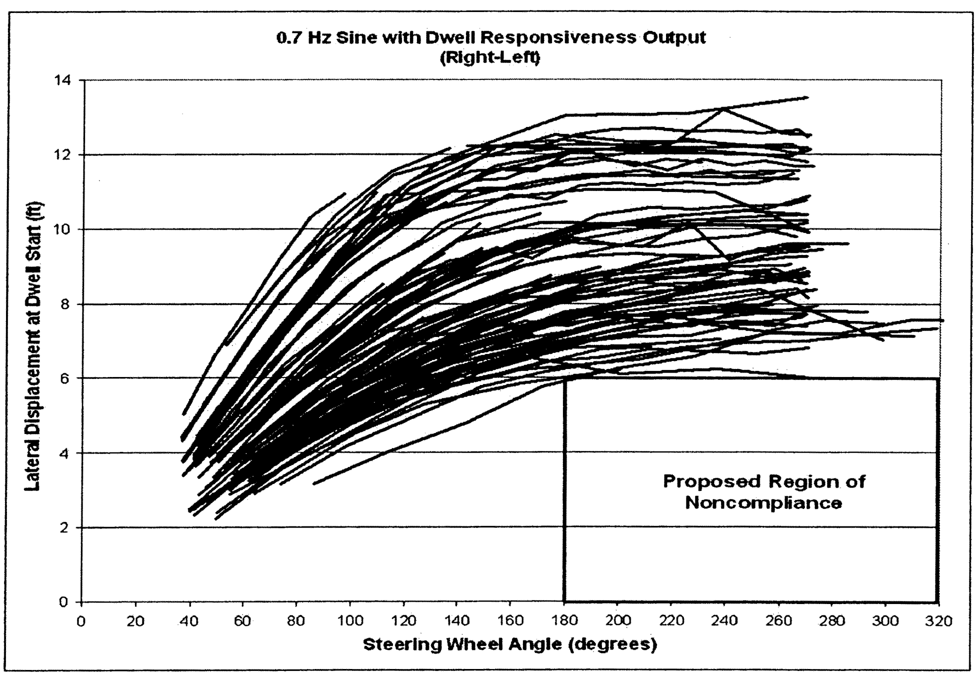


Figure 9. Responsiveness of the vehicle fleet in terms of lateral displacement at 1.07 seconds in the Sine with Dwell maneuver.

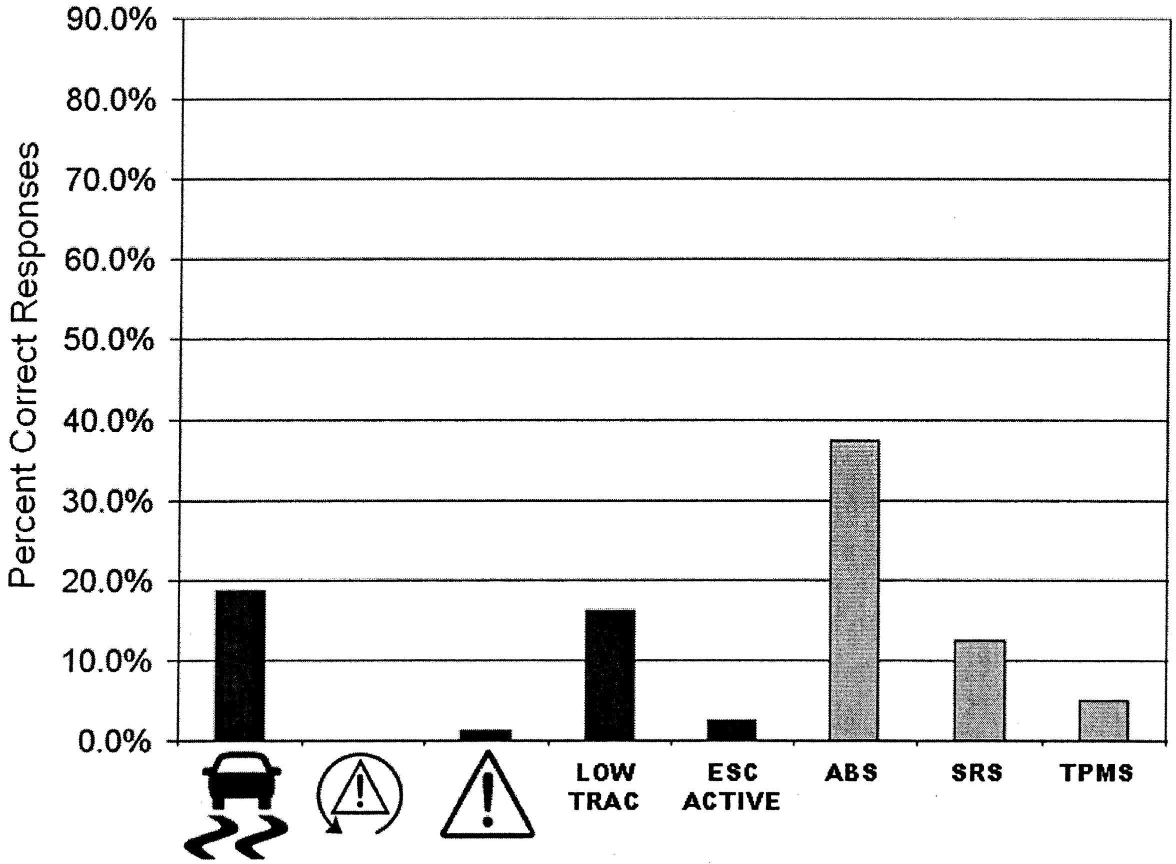


Figure 10. Selected Icon Comprehension Quiz Results

Proposed Regulatory Text

List of Subjects in 49 CFR Parts 571 and 585

Imports, Motor vehicle safety, Report and recordkeeping requirements, Tires.

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

PART 571—FEDERAL MOTOR VEHICLE SAFETY STANDARDS

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

Authority: 49 U.S.C. 322, 30111, 30115, 30117, and 30166; delegation of authority at 49 CFR 1.50.

2. Section 571.101 is amended by revising Table 1 to read as follows:

§ 571.101 Standard No. 101; Controls and displays.

* * * * *

Table 1
Controls, Telltales, and Indicators with Illumination or Color Requirements[1]

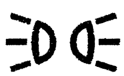
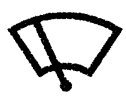
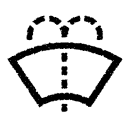
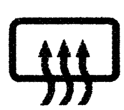
Column 1 ITEM	Column 2 SYMBOL	Column 3 WORDS OR ABBRE-VIATIONS	Column 4 FUNCTION	Column 5 ILLUMIN-ATION	Column 6 COLOR
Highbeam [2]	 [3,5]	—	Telltale	—	Blue or Green [4]
Turn signals [2]	 [3,6]	—	Control	—	—
			Telltale	—	Green [4]
Hazard warning signal	 [3]	Hazard	Control	Yes	—
		—	Telltale [7]	—	—
Position, side marker, end-outline marker, identification, or clearance lamps	 [3] [8]	Marker Lamps or MK Lps [8]	Control	Yes	—
Windshield wiping system		Wiper or Wipe	Control	Yes	—
Windshield washing system		Washer or Wash	Control	Yes	—
Windshield washing and wiping system combined		Washer-Wiper or Wash-Wipe	Control	Yes	—
Windshield defrosting and defogging system		Defrost, Defog or Def.	Control	Yes	—
Rear window defrosting and defogging system		Rear Defrost, Rear Defog, Rear Def., or R-Def.	Control	Yes	—

Table 1
Controls, Telltales, and Indicators with Illumination or Color Requirements[1]

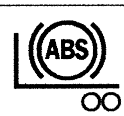
Column 1 ITEM	Column 2 SYMBOL	Column 3 WORDS OR ABBRE-VIATIONS	Column 4 FUNCTION	Column 5 ILLUMIN-ATION	Column 6 COLOR
Brake system malfunction	—	Brake	Telltale	—	Red[4]
Antilock brake system malfunction for vehicles subject to FMVSS 105 or 135	—	Antilock, Anti-lock, or ABS [9]	Telltale	—	Yellow
Malfunction in Variable Brake Proportioning System	—	Brake Proportioning [9]	Telltale	—	Yellow
Regenerative brake system malfunction	—	RBS or ABS/RBS [9]	Telltale	—	Yellow
Malfunction in antilock system for vehicles other than trailers subject to FMVSS 121	—	ABS or Antilock [9]	Telltale	—	Yellow
Antilock brake system trailer fault for vehicles subject to FMVSS 121		Trailer ABS or Trailer Antilock	Telltale	—	Yellow
Brake Pressure (for vehicles subject to FMVSS 105 or 135)	—	Brake Pressure [9]	Telltale	—	Red[4]
Low brake fluid condition (for vehicles subject to FMVSS 105 or 135)	—	Brake Fluid [9]	Telltale	—	Red[4]
Parking brake applied (for vehicles subject to FMVSS 105 or 135)	—	Park or Parking Brake [9]	Telltale	—	Red[4]
Brake lining wear-out condition (for vehicles subject to FMVSS 135)	—	Brake Wear [9]	Telltale	—	Red[4]
Electronic Stability Control System Malfunction (manufact-urer may use this telltale in flashing mode to indicate ESC operation. See FMVSS 126.)		—	Telltale	—	Yellow
Electronic Stability Control System "OFF"		—	Control	Yes	—
		—	Telltale	—	Yellow

Table 1
Controls, Telltales, and Indicators with Illumination or Color Requirements

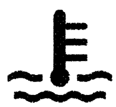
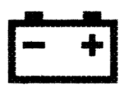
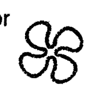
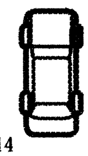
Column 1 ITEM	Column 2 SYMBOL	Column 3 WORDS OR ABBREVIATIONS	Column 4 FUNCTION	Column 5 ILLUMINATION	Column 6 COLOR
Engine oil pressure	 [10]	Oil	Telltale	—	—
			Indicator	Yes	—
Engine coolant temperature	 [10]	Temp	Telltale	—	—
			Indicator	Yes	—
Electrical charge		Volts or Charge or Amp	Telltale	—	—
			Indicator	Yes	—
Engine stop	—	Engine Stop [11]	Control	Yes	—
Automatic vehicle speed (cruise control)	—	—	Control	Yes	—
Speedometer	—	MPH, or MPH and km/h [12]	Indicator	Yes	—
Heating and Air conditioning system	—	—	Control	Yes	—
Automatic transmission control position *(park)* *(reverse)* *(neutral)* *(drive)*	—	P R N D [13]	Indicator	Yes	—
Heating and/or air conditioning fan	 or 	Fan	Control	Yes	—
Low Tire Pressure (including malfunction) (See FMVSS 138)	 [14]	Low Tire [14]	Telltale	—	Yellow

Table 1
Controls, Telltales, and Indicators
with Illumination or Color Requirements[1]

Column 1 ITEM	Column 2 SYMBOL	Column 3 WORDS OR ABBRE-VIATIONS	Column 4 FUNCTION	Column 5 ILLUMIN-ATION	Column 6 COLOR
Low Tire Pressure (including malfunction) that identifies involved tire (See FMVSS 138)	 [14]	Low Tire [14]	Telltale	—	Yellow
Tire Pressure Monitoring System Malfunction (See FMVSS 138)[15]	—	TPMS [14, 16]	Telltale	—	Yellow

Notes:

1. An identifier is shown in this table if it is required for a control for which an illumination requirement exists or if it is used for a telltale for which a color requirement exists. If a line appears in column 2 and column 3, the control, telltale or indicator is required to be identified, however the form of the identification is the manufacturer's option. Telltales are not considered to have an illumination requirement, because by definition the telltale must light when the condition for its activation exists.
2. Additional requirements in FMVSS 108.
3. Framed areas of the symbol may be solid; solid areas may be framed.
4. Blue may be blue-green. Red may be red-orange.
5. Symbols employing four lines instead of five may also be used.
6. The pair of arrows is a single symbol. When the controls or telltales for left and right turn operate independently, however, the two arrows may be considered separate symbols and be spaced accordingly.
7. Not required when arrows of turn signal telltales that otherwise operate independently flash simultaneously as hazard warning telltale.
8. Separate identification not required if function is combined with master lighting switch.
9. Refer to FMVSS 105 or FMVSS 135, as appropriate, for additional specific requirements for brake telltale labeling and color. If a single telltale is used to indicate more than one brake system condition, the brake system malfunction identifier must be used.
10. Combination of the engine oil pressure symbol and the engine coolant temperature symbol in a single telltale is permitted.
11. Use when engine control is separate from the key locking system.
12. If the speedometer is graduated in both miles per hour and in kilometers per hour, the scales must be identified "MPH" and "km/h", respectively, in any combination of upper- and lowercase letters.
13. The letters 'P', 'R', 'N', and 'D' are considered separate identifiers for the individual gear positions. Their locations within the vehicle, and with respect to each other, are governed by FMVSS 102. The letter 'D' may be replaced by another alphanumeric character or symbol chosen by the manufacturer.
14. Required only for FMVSS 138 compliant vehicles.
15. Alternatively, either low tire pressure telltale may be used to indicate a TPMS malfunction. See FMVSS 138.
16. Required only for vehicles manufactured on or after September 1, 2007.

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* * * * *

3. Section 571.126 is added to read as follows:

§ 571.126 Standard No. 126; Electronic stability control systems.

S1. *Scope.* This standard establishes performance and equipment requirements for electronic stability control (ESC) systems.

S2. *Purpose.* The purpose of this standard is to reduce the number of deaths and injuries that result from crashes in which the driver loses directional control of the vehicle.

S3. *Application.* This standard applies to passenger cars, multipurpose passenger vehicles, trucks, and buses with a gross vehicle weight rating of 4,536 kilograms (10,000 pounds) or less, according to the phase-in schedule specified in S8 of this standard.

S4. *Definitions.*

Ackerman Steer Angle means the angle whose tangent is the wheelbase divided by the radius of the turn at a very low speed.

Electronic Stability Control System or ESC System means a system that has all of the following attributes:

(1) That augments vehicle directional stability by applying and adjusting the vehicle brakes individually to induce correcting yaw torques to a vehicle;

(2) That is computer controlled with the computer using a closed-loop algorithm to limit vehicle oversteer and to limit vehicle understeer when appropriate;

(3) That has a means to determine the vehicle's yaw rate and to estimate its side slip;

(4) That has a means to monitor driver steering inputs, and

(5) That is operational over the full speed range of the vehicle (except below a low-speed threshold where loss of control is unlikely).

Oversteer means a condition in which the vehicle's yaw rate is greater than the yaw rate that would occur at the vehicle's speed as result of the Ackerman Steer Angle.

Sideslip or side slip angle means the arctangent of the lateral velocity of the center of gravity of the vehicle divided by the longitudinal velocity of the center of gravity.

Understeer means a condition in which the vehicle's yaw rate is less than the yaw rate that would occur at the vehicle's speed as result of the Ackerman Steer Angle.

Yaw rate means the rate of change of the vehicle's heading angle measured in degrees/second of rotation about a vertical axis through the vehicle's center of gravity.

S5. *Requirements.* Subject to the phase-in set forth in S8, each vehicle must be equipped with an ESC system that meets the requirements specified in S5 under the test conditions specified in S6 and the test procedures specified in S7 of this standard.

S5.1 *Required Equipment.* Vehicles to which this standard applies must be equipped with an electronic stability control system that:

S5.1.1 Is capable of applying all four brakes individually and has a control algorithm that utilizes this capability.

S5.1.2 Is operational during all phases of driving including acceleration, coasting, and deceleration (including braking), except when the driver has disabled ESC or the vehicle is below a low speed threshold where loss of control is unlikely.

S5.1.3 Remains operational when the antilock brake system or traction control system is activated.

S5.2 *Performance Requirements.* During each test performed under the test conditions of S6 and the test procedure of S7.9, the vehicle with the ESC system engaged must satisfy the stability criteria of S5.2.1 and S5.2.2, and it must satisfy the responsiveness criterion of S5.2.3 during each of those tests conducted with a steering angle amplitude of 180 degrees or greater.

S5.2.1 The yaw rate measured one second after completion of the sine with dwell steering input (time $T_0 + 1$ in Figure 1) must not exceed 35 percent of the first peak value of yaw velocity recorded after the beginning of the dwell period

$$\left(\dot{\Psi}_{\text{Peak}} \text{in Figure 1}\right)$$

during the same test run, and

S5.2.2 The yaw rate measured 1.75 seconds after completion of the sine with dwell steering input must not exceed 20 percent of the first peak value of yaw velocity recorded after the beginning of the dwell period during the same test run.

S5.2.3 The lateral displacement of the vehicle center of gravity with respect to its initial straight path must be at least 1.83 m (6 feet) when computed 1.07 seconds after initiation of steering.

S5.2.3.1 The computation of lateral displacement is performed using double integration with respect to time of the measurement of lateral acceleration at the vehicle center of gravity, as expressed by the formula:

$$\text{Lateral Displacement} = \iint Ay_{c.g.}dt$$

S5.2.3.2 Time, t = 0 for the integration operation is the instant of steering initiation.

S5.3 *ESC Malfunction.* The vehicle must be equipped with a telltale that provides a warning to the driver not more than two minutes after the occurrence of one or more malfunctions that affect the generation or transmission of control or response signals in the vehicle's electronic stability control system. The ESC malfunction telltale:

S5.3.1 Must be mounted inside the occupant compartment in front of and in clear view of the driver;

S5.3.2 Must be identified by the symbol shown for ''ESC Malfunction Telltale'' in Table 1 of Standard No. 101 (49 CFR 571.101);

S5.3.3 Must remain continuously illuminated under the conditions specified in S5.3 for as long as the malfunction(s) exists, whenever the ignition locking system is in the ''On'' (''Run'') position; and

S5.3.4 Except as provided in paragraph S5.3.5, each ESC malfunction telltale must be activated as a check of lamp function either when the ignition locking system is turned to the ''On'' (''Run'') position when the engine is not running, or when the ignition locking system is in a position between ''On'' (''Run'') and ''Start'' that is designated by the manufacturer as a check position.

S5.3.5 The ESC malfunction telltale need not be activated when a starter interlock is in operation.

S5.3.6 The ESC malfunction telltale must extinguish after the malfunction has been corrected.

S5.3.7 The manufacturer may use the ESC malfunction telltale in a flashing mode to indicate ESC operation.

S5.4 *ESC Off Switch and Telltale.* The manufacturer may include a driver selectable switch that places the ESC system in a mode in which it will not satisfy the performance requirements of S5.2.1, S5.2.2 and S5.2.3 provided that:

S5.4.1 The vehicle's ESC system must always return to a mode that satisfies the requirements of S5.1 and S5.2 at the initiation of each new ignition cycle, regardless of what mode the driver had previously selected. If the system has more than one mode that satisfies these requirements, the default mode must be the mode that satisfies the performance requirements of S5.2 by the greatest margin.

S5.4.2 The vehicle manufacturer must provide a telltale indicating that the vehicle has been put into a mode that renders it unable to satisfy the requirements of S5.2.1, S5.2.2 and S5.2.3.

S5.4.3 The ''ESC Off'' switch and telltale must be identified by the symbol shown for ''ESC Off'' in Table 1 of Standard No. 101 (49 CFR 571.101).

S5.4.4 The ''ESC Off'' telltale must be mounted inside the occupant compartment in front of and in clear view of the driver.

S5.4.5 The ''ESC Off'' telltale remain continuously illuminated for as long as the ESC is in a mode that renders it unable to satisfy the requirements of S5.2.1, S5.2.2 and S5.2.3, and

S5.4.6 Except as provided in paragraph S5.4.7, each ''ESC Off'' telltale must be activated as a check of lamp function either when the ignition locking system is turned to the ''On'' (''Run'') position when the engine is not running, or when the ignition locking system is in a position between ''On'' (''Run'') and ''Start'' that is designated by the manufacturer as a check position.

S5.4.7 The ''ESC Off'' telltale need not be activated when a starter interlock is in operation.

S5.4.8 The ''ESC Off'' telltale must extinguish after the ESC system has been returned to its fully functional default mode.

S6. *Test Conditions.*

S6.1. *Ambient conditions.*

S6.1.1 The ambient temperature is between 0 °C (32 °F) and 40 °C (104 °F).

S6.1.2 The maximum wind speed is no greater than 10m/s (22 mph).

S6.2. *Road test surface.*

S6.2.1 The tests are conducted on a dry, uniform, solid-paved surface. Surfaces with irregularities and undulations, such as dips and large cracks, are unsuitable.

S6.2.2 The road test surface must produce a peak friction coefficient (PFC) of 0.9 ± 0.05 when measured using an American Society for Testing and Materials (ASTM) E1136 standard reference test tire, in accordance with ASTM Method E 1337–90, at a speed of 64.4 km/h (40 mph), without water delivery.

S6.2.3 The test surface has a consistent slope between level and 2%. All tests are to be initiated in the direction of positive slope (uphill).

S6.3 *Vehicle conditions.*

S6.3.1 The ESC system is enabled for all testing.

S6.3.2 *Test Weight.* The vehicle is loaded with the fuel tank filled to at least 75 percent of capacity, and total interior load of 168 kg (370 lbs) comprised of the test driver, approximately 59 kg (130 lbs) of test equipment (automated steering machine, data acquisition system and the power supply for the steering machine), and ballast as required by differences in the weight of test drivers and test equipment.

S6.3.3 *Tires.* The vehicle is tested with the tires installed on the vehicle at time of initial vehicle sale. The tires are inflated to the vehicle manufacturer's recommended cold tire inflation pressure(s) specified on the vehicle's placard or the tire inflation pressure label. Tubes may be installed to prevent tire de-beading.

S6.3.4 *Outriggers.* Outriggers must be used for tests of Sport Utility Vehicles (SUVs), and they are permitted on other test vehicles if deemed necessary for driver safety.

S6.3.5 A steering machine programmed to execute the required steering pattern must be used in S7.5.2, S7.5.3, S7.6 and S7.9.

S7. *Test Procedure.*

S7.1 Inflate the vehicles' tires to the cold tire inflation pressure(s) provided on the vehicle's placard or the tire inflation pressure label.

S7.2 *Telltale bulb check.* With the vehicle stationary and the ignition locking system in the ''Lock'' or ''Off'' position, activate the ignition locking system to the ''On'' (''Run'') position or, where applicable, the appropriate position for the lamp check. The ESC system must perform a check of lamp function for the ESC malfunction telltale, and if equipped, the ''ESC Off'' telltale, as specified in S5.3.4 and S5.4.6.

S7.3 *''ESC Off'' switch check.* For vehicles equipped with an ''ESC Off'' feature, with the vehicle stationary and the ignition locking system in the ''Lock'' or ''Off'' position, activate the ignition locking system to the ''On'' (''Run'') position. Activate the ''ESC Off'' switch and verify that the ''ESC Off'' telltale is illuminated. Turn the ignition locking system to the ''Lock'' or ''Off'' position. Again, activate the ignition locking system to the ''On'' (''Run'') position and verify that the ''ESC Off'' telltale has extinguished indicating that the ESC system has been reactivated as specified in S5.4.

S7.4 *Brake Conditioning.* Condition the vehicle brakes as follows:

S7.4.1 Ten stops are performed from a speed of 56 km/h (35 mph), with an average deceleration of approximately 0.5 g.

S7.4.2 Immediately following the series of 56 km/h (35 mph) stops, three additional stops are performed from 72 km/h (45 mph).

S7.4.3 When executing the stops in S7.4.2, sufficient force is applied to the brake pedal to activate the vehicle's antilock brake system (ABS) for a majority of each braking event.

S7.4.4 Following completion of the final stop in S7.4.2, the vehicle is driven at a speed of 72 km/h (45 mph) for five minutes to cool the brakes.

S7.5 *Tire Conditioning.* Condition the tires using the following procedure to wear away mold sheen and achieve operating temperature immediately before beginning the test runs of S7.6 and S7.9.

S7.5.1 The test vehicle is driven around a circle 30 meters (100 feet) in diameter at a speed that produces a lateral acceleration of approximately 0.5 to 0.6 g for three clockwise laps followed by three counterclockwise laps.

S7.5.2 Using a sinusoidal steering pattern at a frequency of 1 Hz, a peak steering wheel angle amplitude corresponding to a peak lateral acceleration of 0.5–0.6 g, and a vehicle speed of 56 km/h (35 mph), the vehicle is driven through four passes performing 10 cycles of sinusoidal steering during each pass.

S7.5.3 The steering wheel angle amplitude of the final cycle of the final pass is twice that of the other cycles. The maximum time permitted between all laps and passes is five minutes.

S7.6 *Slowly Increasing Steer Test.* The vehicle is subjected to two series of runs of the Slowly Increasing Steer Test using a steering pattern that increases by 13.5 degrees per second until a lateral acceleration of approximately 0.5 g is obtained. Three repetitions are performed for each test series. One series uses counterclockwise steering, and the other series uses clockwise steering. The maximum time permitted between each test run is five minutes.

S7.6.1 From the Slowly Increasing Steer tests, the quantity ''A'' is determined. ''A'' is the steering wheel angle in degrees that produces a steady state lateral acceleration of 0.3 g for the test vehicle. Utilizing linear regression, A is calculated, to the nearest 0.1 degrees, from each of the six Slowly Increasing Steer tests. The absolute value of the six A's calculated is averaged and rounded to the nearest degree to produce the final quantity, A, used below.

S7.7 After the quantity A has been determined, without replacing the tires, the tire conditioning procedure described in S7.5 is performed immediately prior to conducting the Sine with Dwell Test of S7.9.

S7.8 Check that the ESC system is enabled by ensuring that the ESC malfunction and ''ESC Off'' (if provided) telltales are not illuminated.

S7.9 *Sine with Dwell Test of Oversteer Intervention and Responsiveness.* The vehicle is subjected to two series of test runs using a steering pattern of a sine wave at 0.7 Hz frequency with a 500 ms delay beginning at the second peak amplitude as shown in Figure 2 (the Sine with Dwell tests). One series uses counterclockwise steering for the first half cycle, and the other series uses clockwise steering for the first half cycle. The maximum time permitted between each test run is five minutes.

S7.9.1 The steering motion is initiated with the vehicle coasting in high gear at 80 ± 1 km/h (50 ± 1 mph).

S7.9.2 In each series of test runs, the steering amplitude is increased from run to run, by 0.5A, provided that no such run will result in a steering amplitude greater than that of the final run specified in S7.9.4.

S7.9.3 The steering amplitude for the initial run of each series is 1.5A where A is the steering wheel angle determined in S7.6.1.

S7.9.4 The steering amplitude of the final run in each series is the greater of 6.5A or 270 degrees.

S7.9.5 Notwithstanding S7.9.4, the test is terminated after a run in which the vehicle does not satisfy S5.2.1 or S5.2.2.

S7.10 *ESC Malfunction Detection.*

S7.10.1 Simulate one or more ESC malfunction(s) by disconnecting the power source to any ESC component, or disconnecting any electrical connection between ESC components. When simulating an ESC malfunction, the electrical connections for the telltale lamp(s) are not to be disconnected.

S7.10.2 With the vehicle stationary and the ignition locking system in the ''Lock'' or ''Off'' position, activate the ignition locking system to the ''On'' (''Run'') position. Verify that within two minutes of activating the ignition locking system, the ESC malfunction indicator illuminates in accordance with S5.3.

S7.10.3 Deactivate the ignition locking system to the ''Off'' or ''Lock'' position. After a five-minute period, activate the vehicle's ignition locking system to the ''On'' (''Run'') position. Verify that the ESC malfunction indicator again illuminate to signal a malfunction and remains illuminated as long as the ignition locking system is in the ''On'' (''Run'') position.

S7.10.4 Restore the ESC system to normal operation and verify that the telltale has extinguished.

S8 *Phase-in schedule.*

S8.1 *Vehicles manufactured on or after September 1, 2008, and before September 1, 2009.* For vehicles manufactured on or after September 1, 2008, and before September 1, 2009, the number of vehicles complying with this standard must not be less than 30 percent of:

(a) The manufacturer's average annual production of vehicles manufactured on or after September 1, 2005, and before September 1, 2008; or

(b) The manufacturer's production on or after September 1, 2008, and before September 1, 2009.

S8.2 *Vehicles manufactured on or after September 1, 2009, and before September 1, 2010.* For vehicles manufactured on or after September 1, 2009, and before September 1, 2010, the number of vehicles complying with this standard must not be less than 60 percent of:

(a) The manufacturer's average annual production of vehicles manufactured on or after September 1, 2006, and before September 1, 2009; or

(b) The manufacturer's production on or after September 1, 2009, and before September 1, 2010.

S8.3 *Vehicles manufactured on or after September 1, 2010, and before September 1, 2011.* For vehicles manufactured on or after September 1, 2010, and before September 1, 2011, the number of vehicles complying with this standard must not be less than 90 percent of:

(a) The manufacturer's average annual production of vehicles manufactured on or after September 1, 2007, and before September 1, 2010; or

(b) The manufacturer's production on or after September 1, 2010, and before September 1, 2011.

S8.4 *Vehicles manufactured on or after September 1, 2011.* All vehicles manufactured on or after September 1, 2011 must comply with this standard.

S8.5 *Calculation of complying vehicles.*

(a) For purposes of complying with S8.1, a manufacturer may count a vehicle if it is certified as complying with this standard and is manufactured on or after (date to be inserted that is 60 days after publication date of final rule), but before September 1, 2009.

(b) For purpose of complying with S8.2, a manufacturer may count a vehicle if it:

(1)(i) Is certified as complying with this standard and is manufactured on or after (date to be inserted that is 60 days after date of publication of the final rule), but before September 1, 2010; and

(ii) Is not counted toward compliance with S8.1; or

(2) Is manufactured on or after September 1, 2009, but before September 1, 2010.

(c) For purposes of complying with S8.3, a manufacturer may count a vehicle if it:

(1)(i) Is certified as complying with this standard and is manufactured on or after (date to be inserted that is 60 days after date of publication of the final rule), but before September 1, 2011; and

(ii) Is not counted toward compliance with S8.1 or S8.2; or

(2) Is manufactured on or after September 1, 2010, but before September 1, 2011.

S8.6 *Vehicles produced by more than one manufacturer.*

S8.6.1 For the purpose of calculating average annual production of vehicles for each manufacturer and the number of vehicles manufactured by each manufacturer under S8.1 through S8.4, a vehicle produced by more than one manufacturer must be attributed to a single manufacturer as follows, subject to S8.6.2:

(a) A vehicle that is imported must 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, must be attributed to the manufacturer that markets the vehicle.

S8.6.2 A vehicle produced by more than one manufacturer must 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 S8.6.1.

S8.7 *Small volume manufacturers.*

Vehicles manufactured during any of the three years of the September 1, 2008 through August 31, 2011 phase-in by a manufacturer that produces fewer than 5,000 vehicles for sale in the United States during that year are not subject to the requirements of S8.1, S8.2, S8.3, and S8.5

S8.8 *Final-stage manufacturers and alterers.*

Vehicles that are manufactured in two or more stages or that are altered (within the meaning of 49 CFR 567.7) after having previously been certified in accordance with Part 567 of this chapter are not subject to the requirements of S8.1 through S8.5. Instead, all vehicles produced by these manufacturers on or after September 1, 2012 must comply with this standard.

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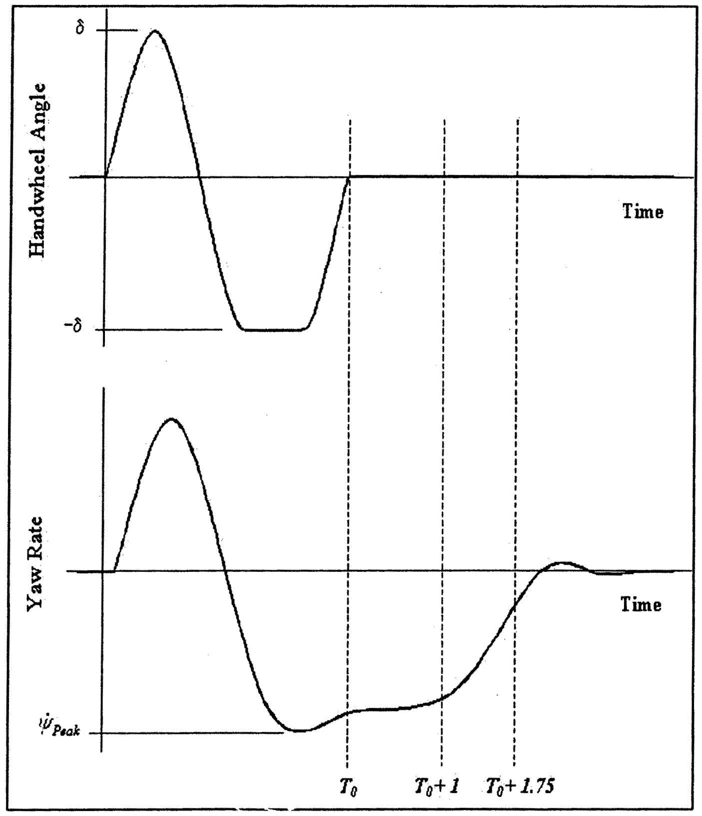

Figure 1. Steering wheel position and yaw velocity information used to assess lateral stability.

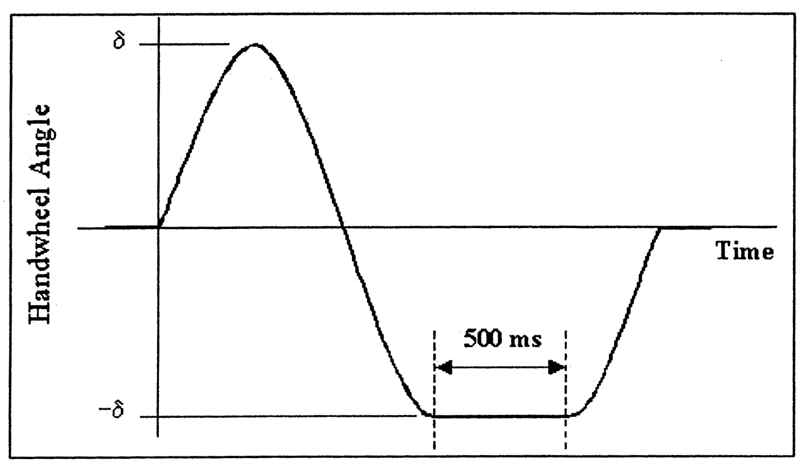

Figure 2. Sine with Dwell steering profile.

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PART 585—PHASE-IN REPORTING REQUIREMENTS

4. The authority citation for part 585 continues to read as follows:

Authority: 49 U.S.C. 322, 30111, 30115, 30117, and 30166; delegation of authority at 49 CFR 1.50.

5. Subpart I is added to read as follows:

Sec.

Subpart I—Electronic Stability Control System Phase-in Reporting Requirements

Subpart I—Electronic Stability Control System Phase-in Reporting Requirements

§ 585.81 Scope.

This subpart establishes requirements for manufacturers of passenger cars, multipurpose passenger vehicles, trucks, and buses with a gross vehicle weight rating of 4,536 kilograms (10,000 pounds) or less to submit a report, and maintain records related to the report, concerning the number of such vehicles that meet the requirements of Standard No. 126, *Electronic stability control systems* (49 CFR 571.126).

§ 585.82 Purpose.

The purpose of these reporting requirements is to assist the National Highway Traffic Safety Administration in determining whether a manufacturer has complied with Standard No. 126 (49 CFR 571.126).

§ 585.83 Applicability.

This subpart applies to manufacturers of passenger cars, multipurpose passenger vehicles, trucks, and buses with a gross vehicle weight rating of 4,536 kilograms (10,000 pounds) or less. However, this subpart does not apply to manufacturers whose production consists exclusively of vehicles manufactured in two or more stages, and vehicles that are altered after previously having been certified in accordance with part 567 of this chapter. In addition, this subpart does not apply to manufacturers whose production of motor vehicles for the United States market is less than 5,000 vehicles in a production year.

§ 585.84 Definitions.

For the purposes of this subpart: Production year means the 12-month period between September 1 of one year and August 31 of the following year, inclusive.

§ 585.85 Response to inquiries.

At any time prior to August 31, 2011, each manufacturer must, 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 Standard No. 126 (49 CFR 571.126). The manufacturer's designation of a vehicle as a certified vehicle is irrevocable. Upon request, the manufacturer also must specify whether it intends to utilize carry-forward credits, and the vehicles to which those credits relate.

§ 585.86 Reporting requirements.

(a) *General reporting requirements.* Within 60 days after the end of the production years ending August 31, 2009, August 31, 2010, and August 31, 2011, each manufacturer must submit a report to the National Highway Traffic Safety Administration concerning its compliance with Standard No. 126 (49 CFR 571.126) for its passenger cars, multipurpose passenger vehicles, trucks, and buses with a gross vehicle weight rating of less than 4,536 kilograms (10,000 pounds) produced in that year. Each report must—

(1) Identify the manufacturer;

(2) State the full name, title, and address of the official responsible for preparing the report;

(3) Identify the production year being reported on;

(4) Contain a statement regarding whether or not the manufacturer complied with the requirements of Standard No. 126 (49 CFR 571.126) for the period covered by the report and the basis for that statement;

(5) Provide the information specified in paragraph (b) of this section;

(6) Be written in the English language; and

(7) Be submitted to: Administrator, National Highway Traffic Safety Administration, 400 Seventh Street, SW., Washington, DC 20590.

(b) *Report content.*

(1) *Basis for statement of compliance.* Each manufacturer must provide the number of passenger cars, multipurpose passenger vehicles, trucks, and buses with a gross vehicle weight rating of 4,536 kilograms (10,000 pounds) or less, manufactured for sale in the United States for each of the three previous production years, or, at the manufacturer's option, for the current production year. A new manufacturer that has not previously manufactured these vehicles for sale in the United States must report the number of such vehicles manufactured during the current production year.

(2) *Production.* Each manufacturer must report for the production year for which the report is filed: The number of passenger cars, multipurpose passenger vehicles, trucks, and buses with a gross vehicle weight rating of 4,536 kilograms (10,000 pounds) or less that meet Standard No. 126 (49 CFR 571.126).

(3) *Statement regarding compliance.* Each manufacturer must provide a statement regarding whether or not the manufacturer complied with the ESC requirements as applicable to the period covered by the report, and the basis for that statement. This statement must include an explanation concerning the use of any carry-forward credits.

(4) *Vehicles produced by more than one manufacturer.* Each manufacturer whose reporting of information is affected by one or more of the express written contracts permitted by S8.6.2 of Standard No. 126 (49 CFR 571.126) must:

(i) Report the existence of each contract, including the names of all parties to the contract, and explain how the contract affects the report being submitted.

(ii) Report the actual number of vehicles covered by each contract.

§ 585.87 Records.

Each manufacturer must maintain records of the Vehicle Identification Number for each vehicle for which information is reported under § 585.86(b)(2) until December 31, 2013.

§ 585.88 Petition to extend period to file report.

A manufacturer may petition for extension of time to submit a report under this Part. A petition will be granted only if the petitioner shows good cause for the extension and if the extension is consistent with the public interest. The petition must be received not later than 15 days before expiration of the time stated in § 585.86(a). The filing of a petition does not automatically extend the time for filing a report. The petition must be submitted to: Administrator, National Highway Traffic Safety Administration, 400 Seventh Street, SW., Washington, DC 20590.

Issued: September 7, 2006.

Stephen R. Kratzke,

Associate Administrator for Rulemaking.

[FR Doc. 06–7598 Filed 9–14–06; 10:00 am]

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