OOIDA Foundation

RESEARCH · SAFETY · ECONOMICS

WHITE PAPER

Analysis of NHTSA's

Electronic Stability Control Systems for Heavy Vehicles Final Rule

6/5/2015

Table of Contents

Introduction 2
Concerns with the NPRM 2
Table 1: NPRM Limitations 3
The Final Rule 3
Table 2: Truck Tractor and Bus Compliance Schedule 4
ESC versus RSC 5
ESC Disablement 5
Negative Safety Consequences 6
Table 3: Real-World Situations where Stability Control Systems are and are not effective 6
Benefit and Cost Analysis 8
Table 4: Initial Target Crashes, Fatalities, Injuries, and Property-Damage-Only Crashes 8
Table 5: Projected Crashes, Fatalities, Injuries, and Property-Damage-Only Crashes 9
Table 6: NPRM and Final Rule Effectiveness Rates for ESC and RSC by Target Crashes 10
Table 7: NPRM and Final Rule Safety Benefits 10
Table 8: Undiscounted Monetized Benefits of the Final Rule (2013 Dollars) 10
Table 9: Component Cost Estimates for Baseline ABS and Four Stability Technology Systems (2013 dollars) 12
Table 10: Total Cost of the Final Rule (NHTSA Estimates) 13
Table 11: NPRM and Final Rule Summary of Vehicle Costs 14
Table 12: Summary of Cost-Effectiveness and Net Benefits by Discount Rate 14
Conclusion 15
Table 13: Summary of Cost Estimates 15
Bibliography 16

Introduction

In July 2012, President Barak Obama signed in to law the Moving Ahead for Progress in the 21st Century Act (MAP-21), which directed the National Highway Traffic Safety Administration (NHTSA) to consider requiring stability enhancing technology on motorcoaches. In addition to the directive as part of MAP-21, NHTSA filed a notice of proposed rulemaking (NPRM) in the *Federal Register* in May 2012. The NPRM proposed to reduce rollover and loss of directional control truck tractors and large buses by establishing a new standard, Federal Motor Vehicle Safety Standard No. 136, *Electronic Stability Control Systems for Heavy Vehicles*. The standard required truck tractors and certain buses with a gross vehicle weight rating (GVWR) of greater than 11,793 kilograms (26,000 pounds) to be equipped with and electronic stability control (ESC) system.

Utilizing data derived from three studies conducted by the American Transportation Research Institute (ATRI), the University of Michigan Transportation Research Institute (UMTRI), and Meritor WABCO (Meritor), NHTSA concluded that equipping large trucks and buses could prevent 40% to 56% of untripped rollover crashes and 14% of loss-of-control (LOC) crashes. Moreover, the agency estimated that mandating an ESC would prevent 1,807 to 2,329 crashes, 649 to 858 injuries, and 49 to 60 fatalities. However, the Owner-Operator Independent Drivers Association Foundation (OOFI), which is the research and educational arm of OOIDA, the largest non-for-profit association representing small business owners and professional truck drivers, found a number of limitations with NHTSA's research.

Concerns with the NPRM

As stated above, NHTSA believed that mandating a stability control system (SCS) could prevent 28% to 36% of untripped rollover crashes, 14% of LCC, 1,807 to 2,329 crashes, 649 to 858 injuries, and 49 to 60 fatalities. However, according to *Traffic Safety Facts* 2009, only 4.4% of all combination truck crashes and 2.2% of single-unit truck crashes were rollovers, and of those 53% were first-event untripped rollover crashes and 47% were LOC. Therefore, the agency's targeted population was 7,723 crashes for heavy-duty vehicles, while the overall crash problem for heavy trucks was 296,000. Thus, the proposed mandate which would cost millions of dollars annually was only projected to cover .03% of all crashes. Hence, while rollovers are often serious accidents, they constitute a very small percentage of the overall population of combination truck crashes.

Further, while focusing on the possibility of mandating either an ESC system or an Roll Stability Control (RSC) system, NHTSA failed to look at more reasonable alternatives, such as driver training in order to avoid a rollover situation altogether or the structural design of large trucks, especially cargo tankers, which are highly prone to rollovers. Though cargo-tank motor vehicles represent approximately 6% of all large trucks on the nation's highways, their rollover rate is more than double that of non-tank trucks and account for around 50% of truck driver fatalities and 50% of incapacitating injuries.[1] According to the *Cargo Tank Roll Stability Study*, 55.5% of cargo-tank rollovers involved a truck-tractor in combination

[1] The Trucker Staff, "NTSB faults driver in 2009 tanker rollover, explosion," The Trucker, http://www.thetrucker.com/news/stories/2011/7/27/NTSBfaultsdriverin2009tankerrolloverexplosion.aspx (accessed July 5, 2012)

with a cargo tank semitrailer. Of those rollovers, approximately 12% could be prevented by simply lowering the center of gravity height 3 inches. Another 17% could be prevented by increasing the track width by 6 inches. In comparison, installing a RSC could only reduce rollovers by 5%.[2]

In addition, OOFI found a number of caveats throughout NHTSA's research. For example, while UMTRI tested the effectiveness of the ESC and RSC systems by having the test truck driver suddenly change lanes on both dry and snow covered roads, the research stated, "These events provided a greater challenge for the stability control systems due to the aggressive steering and braking inputs from drivers. Neither stability control system showed benefits in preventing rollover on the dry road surface. ESC systems did provide improved control on snow-covered surface; however, two jackknife events still occurred with the ESC system.[3]" The following table includes quotes from the NPRM.

Table 1: NPRM Limitations

Page Number	Quotation
34	One method for assessing the safety benefits of vehicle technologies is to analyze crash datasets containing data on the safety performance of vehicles equipped with the subject technology. However, because deployment of the stability control technologies for large trucks is still in its early stages, national crash databases do not yet have sufficient cases that can be used to evaluate the safety performance of stability control technology. Given this limitation, this study used an indirect method to estimate the safety performance stability control technologies based on probable outcome estimates derived from hardware-in-the-loop simulation, field test experience, expert panel assessment, and crash data from trucking fleets.
35	First, identifying relevant loss-of-control and rollover crashes within the national databases proved a difficult task because the databases are developed for general use and this project required very precise definitions of loss-of-control and rollover. Furthermore, many of the crashes involved vehicles that were not equipped with ABS.
35	However, the inability to determine with confidence if a vehicle lost control and the lack of detailed information on driver input and vehicle state placed limitations on the ability to assess the potential for stability control technologies to alter the outcome of a particular crash scenario.
38	However in several instances the ESC system was found to activate at abnormally high levels of lateral acceleration in a curve with a high-friction road surface.

The Final Rule

In June 2015, NHTSA submitted a final rule mandating ESC systems be equipped on truck tractors and large buses with a GVWR greater than 26,000 lbs. in order to utilize engine torque control and computer-controlled braking of individual wheels to help the driver maintain control of the vehicle as so

[2] NTSB, *Rollover of a Truck-Tractor and Cargo Tank Semitrailer Carrying Liquefied Petroleum Gas and Subsequent Fire Indianapolis, Indiana, October 22, 2009: Highway Accident Report*, National Transportation Safety Board, pg. 79.
[3] NPRM, pg. 37

to prevent rollover and LOC crashes stemming from roll instability, understeer, overseer, trailer swing, or other yaw motion that leads to loss of directional control. The agency projected that the final rule would prevent 40% to 56% of untripped rollovers, meaning those crashes that are not caused by striking an obstacle or leaving the roadway, and 14% of LOC crashes, which would result in the reduction of 1,424 to 1,759 crashes, 505 to 649 injuries, and 40 to 49 fatalities. According to the final rule, all new three-axle truck tractors manufactured on or after August 1, 2017 must come equipped with an ESC system, while all other truck tractors, including those with two-axles, will be given four years of lead time. However, existing truck tractors and buses are not required to be retrofitted with ESC.

Table 2: Truck Tractor and Bus Compliance Schedule

Applicable Vehicle	Lead Time
3-axle truck over 26,000 lbs.	2 years
Other trucks over 26,000 lbs.	4 years
Bus between 26-33,000 lbs.	3 years
Bus over 33,000	4 years

Similar to the NPRM, NHTSA did not take into consideration reasonable alternatives to mandating an ESC system. The agency explained in the final rule that "high lateral acceleration is one of the primary causes of rollovers.[4]" In particular, a turning maneuver begun by a driver's steering input is separated into two phases. First, as the steering wheel is turned, the displacement of the front wheels produces a slip angle at the front wheels and a lateral force is generated, which leads to vehicle rotation starting at the vehicle's center of gravity. The vehicle's yaw then causes the rear wheels to experience a slip angle that produces lateral force to be generated at the rear tires, which again creates vehicle rotation. These actions establish a steady-state turn in which lateral acceleration and the yaw rate is constant.

Second, is the turning response of the trailer, which is similar to, but slightly delayed when compared to the turning response of the tractor. Thus, if the later forces at either the front or rear wheels exceed the friction limits between the road surface and tires, the result will be a vehicle loss-of-control in the form of severe understeer (loss of traction at the steer tires) or sever oversteer (loss of traction at the rear tires). Moreover, rollover conditions occur on a vehicle when high lateral forces are generated at the tires from steering or sliding and result in a vehicle lateral acceleration that exceeds the rollover threshold of the vehicle.[5] Hence, simple training and proper education of the driver would assist them in correctly negotiating turns and thus would prevent many untripped rollovers from ever occurring. Rather than just mandate a technology in order to assist a driver in maintaining directional control during a rollover type situation, OOFI suggests that a professional trained driver would eliminate the situation from ever arising in the first place.

[4] *Federal Motor Vehicle Safety Standards; Electronic Stability Control Systems for Heavy Vehicles Final Rule*, NHTSA (2015), pg. 20.
[5] Ibid, pg. 20.

ESC versus RSC

Although the NPRM suggested that an ESC system be required over an RSC system, the agency requested comments on which system should be mandated. In short, an RSC system consists of an electronic control unit that is mounted on the vehicle and which continually monitors the vehicle's speed and lateral acceleration based on an accelerometer, and estimates vehicle mass based on engine torque information. When the vehicle's lateral acceleration approaches the roll stability threshold the RSC system intervenes by one or more of the following actions:[6]

- Decreasing engine power using engine braking,
- Applying the tractor's drive-axle brakes, or
- Applying the trailer's brakes

An ESC system incorporates all of the same inputs as an RSC system with two additional sensors that monitor a loss of directional control due to either understeer or oversteer. The first additional sensor is a steering wheel angle sensor, which senses the driver's steering input, and the second is a yaw rate sensor, which measures the turning movement of the vehicle. An ESC system intervenes by:[7]

- Decreasing engine power using engine braking,
- Selectively applying the brakes on the truck tractor, or
- Applying the trailer's brakes

The agency deferred to the ESC rather than the RSC because according to NHTSA's testing, the steering wheel angle sensor allowed the ESC system to anticipate changes in lateral acceleration based upon driver input and to intervene with engine torque reduction or selective braking sooner, rather than wait for the lateral acceleration sensors to detect potential instability, thereby resulting in higher net benefits.[8] Nevertheless, the American Trucking Association commented that the agency should require an RSC system because of a study conducted by the American Transportation Research Institute (ATRI), which stated that the RSC system prevented more crashes than an ESC system. NHTSA responded by stating that the results of the study were illogical and must be the result of confirmation bias because an ESC system has two additional sensors.

ESC Disablement

As part of the NPRM, NHTSA considered including a control for the ESC that could be disabled by the driver. However, despite many of the manufacturers, including Bendix and Meritor, recommending that the agency allow ESC systems to be disabled in certain conditions such as slippery roads in snow and mud, off-road operation, and when using snow chains on tires, NHTSA concluded to not allow such a control in the final rule because, according to them, "heavy vehicles currently equipped with ESC

[6] Ibid, pg. 21
[7] Ibid, pg. 22
[8] Ibid, pg. 46.

systems do not include on/off controls for ESC that allow a driver to deactivate or adjust the ESC system.[9]" ESC disablement will be discussed in more detail in the next section.

Negative Safety Consequences

According to the final rule, "a stability control system will not prevent all rollover and loss-of-control crashes. A stability control system has the capability to prevent many untripped on-road rollovers and first-event loss-of-control events. Nevertheless, there are real-world situations in which stability control systems may not be as effective in avoiding a potential crash.[10]" Interestingly, the final rule gives two separate lists of real-world situations in which stability control systems may and may not prevent or lessen the severity of both rollover and LCC crashes. Portions of the two lists, presented below, contradict one another.

Table 3: Real-World Situations where Stability Control Systems are and are not effective

Real-world Situation	SCS may be effective	SCS may not be effective
Off-road recovery maneuvers	The driver makes an abrupt steering maneuver…or attempts to perform an off-road recovery maneuver, generating a lateral acceleration that is sufficiently high to cause roll or yaw instability. Maneuvering a vehicle on off-road, unpaved surfaces such as grass or gravel may require a larger steering input (larger wheel slip angle) to achieve a given vehicle response, and this can lead to a large increase in lateral acceleration once the vehicle returns to the paved surface	Off-road recovery maneuvers in which a vehicle departs the roadway and encounters a steep incline or an unpaved surface that significantly reduces the predictability of the vehicle's landing
Entry speeds negotiating a curve	The entry speed of vehicle is too high to safely negotiate a curve. When the lateral acceleration of a vehicle during a steering maneuver exceeds the vehicle's roll or yaw stability threshold, a rollover or loss of control is initiated. Curves can present both roll and yaw instability issues to these types of vehicles due to varying heights of loads (low versus high, empty versus full) and road surface friction levels (e.g., wet, dry, icy, snowy).	Entry speeds that are much too high for a curved roadway or entrance/exit ramp
Cargo/Loading Conditions	It is also possible that improperly secured cargo can shift while the vehicle is negotiating a curve, thereby reducing roll or yaw stability. Sloshing can occur in tankers transporting liquid bulk cargoes,	Cargo load shifts on the trailer during a steering maneuver

[9] Ibid, pg. 136.
[10] Ibid, pg. 24.

	which is of particular concern when the tank is partially full because the vehicle may experience significantly reduced roll stability during certain maneuvers.

Furthermore, several comments were filed which seriously questioned the safety benefits of mandating SCS. In particular, commenters expressed concerns that SCS might have negative safety effects. Yankee Trucks remarked that SCS add to the complexity of the braking system and if the SCS malfunctioned, the anti-lock braking system (ABS) would not function. An additional commenter related a personal experience in which the SCS often engaged the service brakes while they were negotiating curves. Moreover, others were apprehensive that drivers might become too dependent on the technology, which might encourage them to drive faster through curves and give them a false sense of security, instead of a proper amount of caution learned through driver training.

According to a study conducted by the Virginia Tech Transportation Institute entitled *Safety Manger and Commercial Driver Opinions and Acceptance of Onboard Safety Systems*, both drivers and mangers thought it was possible to become overly reliant on the SCS, meaning if the system did not function properly, it would result in a crash. Furthermore, drivers were also concerned the SCS activating in dangerous conditions, such as rain or ice.[11]

Similarly, commenters on the final rule questioned whether it was safe to have SCS braking the vehicle automatically in wet conditions or on curves. The Associated Logging Contractors also believed that mandating SCS would have a negative safety effect, stating that an SCS mandate would cause safety issues on forest roads. However, regardless of the many safety concerns expressed, the OOIDA Foundation feels that NHTSA failed to properly or adequately address these possible safety risks, most of which were disregarded altogether. Rather, the Agency gave a single comment in respect to utilizing an ESC on wet conditions:

> *With respect to the comments suggesting that vehicles braking during a curve or on wet conditions could have adverse safety consequences, we observe that an ESC system is designed to slow the vehicle in a curve in order reduce the lateral acceleration and allow the operator to maintain roll and yaw control of the vehicle only in situations where instability is imminent.*[12]

Nonetheless, several manufacturers, including the only two suppliers of truck tractor and large bus stability control systems, Bendix and Meritor WABCO,[13] recommended that NHTSA allow drivers to disable the ESC system in certain conditions such as slippery roads in snow and mud, off-road operation, and using snow chains on tires.[14] Moreover, Daimler stated that the ESC and traction

[11] Jessica Mabry et al., *Safety Manger and Commercial Driver Opinions and Acceptance of Onboard Safety Systems*, Virginia Tech Transportation Institute (2012), pg. 13.
[12] *Final Rule*, pg. 45.
[13] Ibid, pg. 61
[14] Ibid, pg. 137

control systems are interlinked, and thus the disablement of traction control will disable ESC systems. Daimler argued that disabling the traction control might be necessary in conditions "such as starting from rest on sloped ground, driving on slippery roads, and using snow chains.[15]" HDBMC and Meritor similarly asserted that ESC disablement is needed for gaining traction in snow and mud and to provide optimum performance when using snow chains.

EMA suggested further that those truck tractors that perform off-road should have an ESC disablement function, and there is at least one manufacturer that currently had a vehicle equipped with such a capability. HDMBC and Meritor suggested that the ESC systems be equipped with a lamp indicating that the system is turned off. In response to the comments, the agency stated, "Because, heavy vehicles currently equipped with ESC systems do not include on/off controls for ESC that allow a driver to deactivate or adjust the ESC system, the agency did not propose allowing an on/off switch for ESC systems…While we agree that traction control may need to be disabled in slippery conditions such as snow or mud or other off-road conditions, the commenters do not explain why ESC functions must be disabled in those circumstances.[16]"

Benefit and Cost Analysis

NHTSA updated the estimates from the 2012 NPRM which utilized data from the Fatality Analysis Reporting System (FARS) and the General Estimate System (GES) between 2006 and 2008, to the FARS and GES data from 2006 to 2012. Overall, there was a reduction in rollover crashes but an increase in loss-of-control (LOC) crashes. The initial target crash population for estimating the potential benefits is summarized below.

Table 4: Initial Target Crashes, Fatalities, Injuries, and Property-Damage-Only Crashes[17]

Crash Type	Crashes	Fatalities	Injuries	PDO
Rollover	4,577	122	1,957	2,510
Loss of control	6,266	184	1,510	5,351
Total	**10,843**	**306**	**3,467**	**7,861**

In order for the agency to determine the estimated benefits, NHTSA formulated two subsets from the total crash population, namely those vehicles that would not be equipped with ESC (Base 1) and those vehicles that would be equipped with RSC systems (Base 2). Utilizing manufacturer production estimates in 2012 coupled with installation projection rates from 2013 to 2018, NHTSA estimated by 2018 that 33.9% of vehicles would be equipped with ESC system, while 21.3% would be equipped with RSC.

[15] Ibid
[16] Ibid, pg. 136 and 139
[17] Ibid, pg. 150

Table 5: Projected Crashes, Fatalities, Injuries, and Property-Damage-Only Crashes[18]

Crash Type	Crashes	Fatalities	Injuries	PDO
Base 1				
Rollover	2,099	56	898	1,151
Loss of control	2,813	86	678	2,403
Total	4,912	139	1,576	3,554
Base 2				
Rollover	998	27	426	547
Loss of control	1,337	39	322	1,142
Total	2,335	66	748	1,689
Base 1 + Base 2				
Rollover	3,097	83	1,324	1,698
Loss of control	4,150	122	1,000	3,545
Total	**7,247**	**205**	**2,324**	**5,243**

NHTSA reiterated that data does not show the effectiveness of SCS because stability control technology for heavy trucks is relatively new. The agency's effectiveness rates were thereby derived from three studies:

1. A 2008 study on RSC that was conducted by ATRI and sponsored by the Federal Motor Carrier Safety Administration (FMCSA),
2. A 2009 study that was conducted by UMTRI and Meritor WABCO and sponsored by NHTSA, and
3. The 2011 NHTSA Research Note.

According to NHTSA, "none of these studies derived the effectiveness from a statistical analysis of real-world crashes.[19]" Instead, the first two studies were based upon computer simulated results, expert panel assessments of available crash data, input from trucking fleets who have already adopted the technology, and research experiments, while the third study simply refined the effectiveness rates that was established during the second study.

Nevertheless, ATRI's study did gather information from 135,712 trucks, of which 68,647 (50.6%) trucks were equipped with RSC, 39,529 (29.1%) with ESC, and 27,536 with no SCS. ATRI calculated the crash rate per 100 million miles traveled, the crash cost per 1,000 miles traveled, the annual benefits, and crash costs, and discovered that RSC resulted in fewer rollover, jackknife, and tow/struck crashes than ESC. The study concluded that RSC would provide greater safety benefits at lower costs.

However, NHTSA decided that it was inappropriate to utilize ATRI's results to calculate the benefits and cost-effectiveness of ESC and RSC systems because of potential bias. In addition, the agency stated a concern with the self-reporting of data, and that the results of ATRI's study which demonstrated that RSC systems were more effective than ESC systems were illogical because ESC includes two additional functions.

[18] Ibid, pg. 151
[19] Ibid, pg. 153

Regardless, NHTSA utilized almost the same effectiveness estimate as the NPRM with two exceptions. First, they included an additional LOC crash type, namely a non-collision single-vehicle jackknife crash, which should have been included previously. Second, because of the additional crash type, the agency reweighted the ratio of rollover to LOC crashes. These modifications did not significantly change the effectiveness rates for the SCS from those presented in the NPRM.

Table 6: NPRM and Final Rule Effectiveness Rates for ESC and RSC by Target Crashes

Technology	Overall effectiveness (%)	Untripped rollover effectiveness (%)	Loss of control effectiveness (%)
NPRM Estimate			
ESC	28-36	40-56	14
RSC	21-30	37-53	3
Final Rule Estimate			
ESC	25-32	40-46	14
RSC	17-24	37-53	2

NHTSA formulated their safety benefits by multiplying the projected target population, including the various crash types, by the effectiveness rate for rollover and LOC crashes, thus the estimated benefits were presented as a range because the ESC effectiveness rate was a range. The following table compares the agency's final rule and NPRM estimates.

Table 7: NPRM and Final Rule Safety Benefits

Crash Type	Crashes	Fatalities	Injuries	PDO
NPRM Estimate				
Rollover	1,332-1,854	27-38	537-746	797-1,109
Loss of control	475	22	112	390
Total	1,807-2,329	49-60	649-858	1,187-1,499
Final Rule Estimate				
Rollover	870-1,205	23-32	372-516	476-661
Loss of control	554	17	133	473
Total	1,424-1,759	40-49	505-649	949-1,134

In contrast to the NPRM, which only considered property damage and travel delay, NHTSA associated the reduction of crashes with additional supposed tangible benefits, such as medical care, emergency services, insurance administration, workplace costs, legal costs, congestion, property damage, and productivity, in the final rule. In addition, the agency measured the value of statistical life (VSL) at $9.2 million in the final rule, whereas the NPRM utilized a VSL of $6 million. Therefore, the agency estimated the following undiscounted monetized benefits of the rule.

Table 8: Undiscounted Monetized Benefits of the Final Rule (2013 Dollars)

	Low	High
Societal Economic Savings for Crashworthiness	$27,013,989	$34,526,917
Congestion and Property Damage	$14,234,540	$17,566,251

Societal Economic Savings Total	$41,248,529	$52,093,168
VSL	$484,836,271	$603,762,776
Total Monetized Savings	**$526,084,800**	**$655,855,944**

In the NPRM, NHTSA based their cost estimate on the data which they received from the manufacturers, hence the agency estimated that the average unit cost for an ESC system was $1,160 and the average unit cost for an RSC system was $640 for both trucks and buses. Moreover, the agency calculated that it would cost $520 per vehicle to upgrade an RSC system to an ESC system. NHTSA projected that 150,000 truck tractors and 2,200 buses would be produced in 2012, and that 26.2% of truck tractors would already be equipped with an ESC system, while 16.5% would be outfitted with an RSC system. Thus, 57.8% of truck tractors would require an ESC system. NHTSA approximated that the total cost of the NPRM would be $113.6 million.

In 2012, NHTSA published a report entitled *Cost and Weight Analysis of Electronic Stability Control and Roll Stability Control for Heavy Trucks*, in which the agency examined the incremental costs of equipping vehicles with ESC and RSC systems over a baseline of ABS by looking at one truck quipped with only ABS, two trucks equipped with RSC, one truck equipped with ESC, and one large bus equipped with ESC [Table 6]. With the additional fees of $33.40 in order for a technician to tune the ESC system for each vehicle and $2.96 for the telltale lamp and wiring, NHTSA estimated that the total cost for installing an ESC system to be $585.22 on trucks and $269.38 on buses, while installing an RSC system for both was estimated to be $391.19.

After calculating costs and estimates of SCS penetration in the 2018 market, NHTSA projected the total cost of the final rule to be $45.6 million, which is $68 million less than the NPRM. However, in both the NPRM and the final rule, the agency failed to include the estimated cost per year, as the ESC costs will recur for many years. There are approximately, 2.5 million tractor-trailers and 865,000 buses,[20] of which 847,500 trucks and 692,000 buses have an ESC system equipped. According to NHTSA's estimates, 150,000 trucks and 2,200 buses are produced on average each year, thus it would take an additional eleven years for truck tractors and eight years for large buses before all trucks are replaced with compliant new trucks and buses. Therefore, after taking into account those RSC systems that would need to be upgraded and utilizing NHTSA's estimates, the total cost of the rule is $501.3 million.

Furthermore, NHTSA estimated that 40 to 49 fatalities would be prevented every year with the promulgation of the final rule. However, this estimate appears to be based upon the assumption that all large trucks and buses will be equipped with ESC within the first year. Nevertheless, NHTSA's own cost analysis, demonstrate that it will take roughly a decade before all mandated vehicles are equipped with an ESC system. Therefore, the idea that such results will be both achieved and be discernable is highly questionable and must be taken into account when considering a benefit and cost analysis.

[20] FMCSA, *Pocket Guide to Large Truck and Bus Crashes 2015*, pg. 7.

Table 9: Component Cost Estimates for Baseline ABS and Four Stability Technology Systems (2013 dollars)

Component	ABS WABCO		RSC Bendix		RSC WABCO		ESC Bendix		ESC WABCO	
	Tractor Baseline		Tractor		Tractor		Large Bus		Tractor	
	Component	Total	Component	Total	Component	Total	Component	Total	Component	Total
Wheel Speed Sensor	$11.85	$47.40	X	X	X	X	X	X	X	X
Wheel Speed Cables	$5.32	$21.28	X	X	X	X	X	X	X	X
Dual Modulator Valves	$284.82	$569.64	X	X	X	X	X	X	X	X
Modulator Valve Cables	$10.50	$42.00	X	X	X	X	X	X	X	X
ECU	$90.05	$90.05	X	X	X	X	X	X	X	X
Delta ECU*			$37.80	$37.80	$50.36	$50.36	$37.80	$37.80	$43.58	$43.58
Solenoid Valves			$29.20	$58.40	$29.20	$58.40	$29.20	$58.40	$29.20	$87.60
Solenoid Valve Cables			$9.58	$19.16	$9.58	$19.16	$9.58	$19.16	$9.58	$28.74
Lateral Accelerometer			$49.74	$49.74		In ECU		In Yaw Sensor		In ESC Module
Modulator Valve (for trailer)**			$197.82	$197.82	$197.82	$197.82			$197.82	$197.82
Modulator Valve Cables (for trailer)			$10.50	$10.50	$10.50	$10.50			$10.50	$10.50
Yaw Rate Sensor							$51.38	$51.38		In ESC Module
Pressure Sensor							$2.14	$6.42	$2.14	$6.42
Pressure Sensor Cable							$10.12	$30.36	$10.12	$30.36
Steering Angle Sensor							$29.50	$29.50	$29.50	$29.50
ESC Module									$85.48	$85.48
ESC Module Cable									$28.86	$28.86
Baseline ABS Cost		$770.37								
Incremental Costs Above Baseline ABS				$373.42		$336.24		$233.02		$548.86

Nevertheless, it is important to understand that the half a billion dollar estimate is still too low because NHTSA might have understated the actual average per unit cost of an ESC system. As mentioned previously, the agency indicated that the average cost of an ECS was $1,160 in the NPRM, while the final rule altered that estimate to $585.22. Both of the prices are suspect given that Fred Andersky, director of government affairs for Bendix Commercial Vehicle Systems Bendix Corp., one of the major vendors of ESC systems, has said that the cost for its ESC system runs between $2,000 and $2,300 per truck.[21] Therefore, utilizing the lower end price of $2,000 for the cost of installing an ESC and $1,608.81 for upgrading an RSC system to an ESC system ($2,000 - $391.19 = $1,608.81), the total cost for installing an ESC on all covered truck tractors would be $185.9 million annually.

Moreover, although it is not connected directly with this final rule, NHTSA and the Environmental Protection Agency are expected to soon release their Phase II Heavy-Duty Greenhouse Gas and Fuel Efficiency Standards Final Rule, which is estimated to add between $12,000 and $14,000[22] to the price of a new truck. Combined, these two rules are estimated to cost the trucking industry between $1.9 and $2.2 billion, which will only further burden the small business truck driver from being able to purchase a new vehicle, as the average net income of a driver is roughly $40,000 per year.

Furthermore, while the agency changed the VSL and added other supposed tangible benefits, NHTSA did not alter their estimated cost of a truck or the truck freight demand elasticity. According to the 2014 Owner-Operator Member Profile Survey, the average price of a new truck is approximately $125,000. Interestingly, although the estimated number of trucks produced, the cost of a truck, and the truck freight demand elasticity were not changed, the agency calculated a different number reduction in truck tractors sold. In particular, the NPRM estimated that 388 less units would be sold as a result of the proposal, while the final rule calculated only 101 units.

Table 10: Total Cost of the Final Rule (NHTSA Estimates)

	Technology Upgrade Needed		
Truck Tractors	**None**	**Upgrade RSC to ESC**	**ESC**
% Needing Improvements	33.9%	21.3%	44.8%
150,000 Sales Estimated	50,850	31,950	67,200
Costs per Affected Vehicle	0	$194.03	$585.22
Total Costs	**0**	**$6.2 M**	**$39.3 M**
Large Buses			
% Needing Improvements	80%	0%	20%
2,200 Sales Estimated	1,760	0	440
Costs per Affected Vehicle	0	NA	$269.38
Total Costs	**0**	**$0 M**	**$0.1 M**

[21] Jeff Plungis, "Bendix, Meritor Look for Boost From NHTSA's Truck-Rollover Rule," Bloomberg, http://www.bloomberg.com/news/2011-07-13/bendix-meritor-look-for-boost-from-nhtsa-s-truck-rollover-rule.html
[22] Aaron M. Kessler and Coral Davenport, "E.P.A. Proposal Will Put Bigger Trucks on a Fuel Diet," *New York Times*, http://www.nytimes.com/2015/05/31/business/energy-environment/epa-proposal-will-put-bigger-trucks-on-a-fuel-diet.html?_r=1

Table 11: NPRM and Final Rule Summary of Vehicle Costs

	Average Vehicle Costs	Total Costs
NPRM Estimate		
Truck Tractors	$ 753.7	$ 113.1 M
Large Buses	$ 232.0	$ 0.5 M
Total	**$ 746.1**	**$ 113.6 M**
Final Rule Estimate		
Truck Tractors	$303.50	$45.5 M
Large Buses	$53.90	$0.1 M
Total	**$299.90**	**$45.6 M**

Finally, NHTSA calculated the cost-effectiveness and net benefits at the usual discounted rates of 3% and 7%. According to the agency's estimates, the final net benefits ranged from $412 to $525 million at a 3% discount rate and from $312 to $401 million at a 7% discount rate.[23]

Table 12: Summary of Cost-Effectiveness and Net Benefits by Discount Rate

	3% Discount Rate		7% Discount Rate	
	Low	High	Low	High
Fatal Equivalents	40	50	32	40
Societal Economic Savings for Crashworthiness	$21,816,498	$27,883,938	$17,288,953	$22,097,227
Congestion and property Damage	$11,495,815	$14,186,504	$9,110,106	$11,242,401
Total Societal Economic Savings (1)	$33,312,313	$42,070,442	$26,399,059	$33,339,628
VSL	$424,352,045	$528,442,215	$331,681,943	$413,040,877
Total Monetized Savings (2)	$457,664,358	$570,512,657	$358,081,002	$446,380,505
Vehicle Costs*	$45,644,570	$45,644,570	$45,644,570	$45,644,570
Net Costs (3)	$12,332,257	$3,574,128	$19,245,511	$12,304,942
Net Cost Per Fatal Equivalent (4)	$308,306	$71,483	$601,422	$307,624
Net Benefits (5)	**$412,019,788**	**$524,868,087**	**$312,436,432**	**$400,735,935**

* Vehicle costs are not discounted, since they occur when the vehicle is purchased, whereas benefits occur over the vehicle's lifetime and are discounted back to the time of purchase.
(1) = Societal Economic Savings for Crashworthiness + VSL Savings
(2) = Societal Economic Savings + VSL
(3) = Vehicle Costs –Total Societal Economic Savings
(4) = Net Costs/Fatal Equivalents
(5) = VSL – Net Costs

[23] Final Rule, pg. 166.

Conclusion

It is important to remember that NHTSA's cost estimates might very well be understated, which would cut the net benefits by almost 50%. In addition, it would take several years before the mandatory installation of ESC's would have an effect. While NHTSA's final rule requiring all passenger cars, multipurpose passenger vehicles, trucks, and buses with a GVWR of 10,000 lbs. or less to be equipped with an ESC system went into full effect in 2012, the agency does not have any demonstrable data that the rule has had an effect on safety, especially considering that rollover crashes have been on a steady decline for over a decade. Therefore, considering these facts and bearing in mind the small percentage of truck accidents that will potentially be affected by the final rule, the costs appear to be exceedingly high compared to other alternatives, such as driver training, especially after combing the costs of the final rule with the costs of the Phase II Heavy-Duty Greenhouse Gas and Fuel Efficiency Standards Final Rule.

Table 13: Summary of Cost Estimates

Rule	Cost (millions)
Electronic Stability Control Final Rule	$185.9
Phase II GHG and Fuel Efficiency Final Rule	$1,800-$2,100
Total	**$1,985-$2,285**

The cost estimates coupled with the unaddressed potential negative safety effects and the limitations from the previous UMTRI study, bring many questions and concerns of the accuracy of the agency's final rule. While OOFI is not against technology, we highly question the ideology behind mandating ESC systems for every new truck, especially considering the variety of operation and business models found in the trucking industry today. Moreover, OOFI strongly believes that a professionally trained driver will be able to mitigate many untripped rollover type situations from ever occurring.

Bibliography

FMCSA. (2015). *2015 Pocket Guide to Large Truck and Bus Crashes.* Washington DC: U.S. Department of Transportation.

Kessler, A. M., & Davenport, C. (2015, May 30). *E.P.A. Proposal Will Put Bigger Trucks on a Fuel Diet*. Retrieved May 30, 2015, from New York Times: http://www.nytimes.com/2015/05/31/business/energy-environment/epa-proposal-will-put-bigger-trucks-on-a-fuel-diet.html?_r=1

Mabry, J., Hickman, J., Camden, M., Marburg, L., & Hanowski, R. J. (2012). *Safety Manger and Commercial Driver Opinions and Acceptance of Onboard Safety Systems.* Blacksburg: Virginia Tech Transportation Institute.

NHTSA. (2015). *Federal Motor Vehicle Safety Standards; Electronic Stability Control Systems for Heavy Vehicles.* Washington DC: National Highway Traffic Safety Administration.

NTSB. (2009). *Rollover of a Truck-Tractor and Cargo Tank Semitrailer Carrying Liquefied Petroleum Gas and Subsequent Fire Indianapolis, Indiana, October 22, 2009: Highway Accident Report.* Washington DC: National Transportation Safety Board.

Plungis, J. (2011, August 18). *Bendix, Meritor Look for Boost from NHTSA's Truck-Rollover Rule*. Retrieved 2012, from Truckinginfo News: http://www.bloomberg.com/news/2011-07-13/bendix-meritor-look-for-boost-from-nhtsa-s-truck-rollover-rule.html