261058

U.S. Department
of Transportation
National Highway
Traffic Safety
Administration

Memorandum

NHTSA-03-16523-2

Subject: ACTION: Final Regulatory Evaluation
FMVSS No. 301 Upgrade

Date: DEC - 1 2003

From: Noble N. Bowie
Associate Administrator
for Planning, Evaluation and Budget

Reply to
Attn. of:

To: Docket

Thru: Jacqueline Glassman
Chief Counsel

Please submit the attached "Final Regulatory Evaluation, FMVSS No. 301 Upgrade", November 2003, to Docket No. NHTSA-03-16523.

Attachment

Distribution:
Senior Associate Administrator for Vehicle Safety
Associate Administrator for Rulemaking
Associate Administrator for Enforcement
Chief Counsel

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FINAL REGULATORY EVALUATION

FMVSS NO. 301 UPGRADE

Office of Planning, Evaluation and Budget
November 2003

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EXECUTIVE SUMMARY

The accompanying Final Rule amends the rear and side impact tests of FMVSS 301, Fuel System Integrity. For the rear impact test, the agency is requiring a more stringent offset test using a lighter moving deformable barrier, but at a higher test speed of 80 km/h (50 mph). The agency is also replacing the side test for FMVSS 301, with the FMVSS 214 (side impact protection) test. No changes were considered for the frontal barrier crash test for FMVSS 301.

Costs: The average costs for vehicles which would need corrective action is $5.31 per vehicle. Based on an estimate of 46 percent of the fleet not meeting the standard currently, when spread out over the entire fleet, costs are estimated to be $2.45 per vehicle. Total costs for the fleet are estimated to be $41 million annually (in 2002 dollars).

Target Population: Over the past 11 years passenger vehicles averaged 1,279 fires annually in FARS (Fatality Analysis Reporting System). This involves all types of crashes, including passenger vehicles struck by other types of vehicles. In addition, there are an estimated 4,000 passenger vehicles involved in injury crashes with fire and over 5,000 property-damage-only passenger vehicles with fire (based on 2001 NASS-GES). However, examining only multi-vehicle crashes, where a passenger vehicle is struck in the rear by another passenger vehicle, catches on fire, and using estimates of the percent of the time in which the fire (rather than the trauma of the crash) was the cause of death or injury (using FARS and NASS-CDS data), there are 58 fatalities and 119 non-fatal injuries annually in the target population. The non-fatal burn injuries were mostly minor and were typically not the maximum injury to the occupant. Therefore, they were not included in the Benefits analysis.

Benefits: Vehicles that pass the Final Rule rear impact requirements will provide protection against crashes in which the impact produces a 39 to 50 percent higher delta V (which corresponds to 110 percent more energy being dissipated in the crash) compared to the current requirements. Benefits are estimated to range from 8 to 21 lives saved annually, once all vehicles on-the-road meet the final rule. While we believe the FMVSS 214 side impact test is somewhat stricter than the current side impact test in FMVSS 301, we could not quantify any benefit since only one out of more than 100 vehicles failed the fuel leakage requirements after a FMVSS 214 test.

Cost effectiveness: $1.96 to $5.13 million per life saved.

I. Introduction

This Final Regulatory Evaluation accompanies a Final Rule to upgrade the rear and side impact performance requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 301, Fuel System Integrity. The purpose of this rulemaking is to reduce fatalities and injuries caused by fires that are the result of rear and side impacts in motor vehicle crashes. Specifically, the agency is making the current rear impact crash performance requirements more stringent for vehicles with gross vehicle weight rating (GVWR) of 10,000 pounds (4,536 kg) or less, and replacing the present FMVSS No. 301 side impact test requirement with the FMVSS No. 214 side impact test requirements.

This evaluation provides background information on the events leading up to this notice, discusses the agency's proposed rear and side impact fuel system upgrade, and analyzes data on crashes involving fire and the likelihood of fire occurring in rear and side impact crashes. This evaluation also discusses the costs, benefits and other impacts that could result from the Final Rule.

II. Background

Preserving fuel system integrity in a crash to prevent occupant exposure to fire is extremely important. Although vehicle fires are relatively rare events (occurring in only one percent of towed vehicles in crashes), they tend to be severe in terms of casualties. According to an analysis of the agency's Fatality Analysis Reporting System (FARS), from 1991 through 2001, 2.5 to 2.8 percent of light vehicle occupant fatalities occurred in crashes involving fire (the fatalities may have been due to impact injuries and/or burns, and may not have been in the vehicle(s) on fire). The greatest changes required by this rulemaking would involve crashes in which passenger vehicles are struck in the rear by other passenger vehicles. There could also be some benefit in vehicle to vehicle side impact crashes. All other crashes would probably not be affected, including fires in other parts of the vehicle aside from the rear fuel tank, fires which started after being struck by a large truck or bus, fires which started after striking the front of the vehicle or in non-contact rollovers, and cases where the rear of the fire-involved vehicle spun into a pole or tree.

To reduce deaths and injuries occurring from fires caused by leaking fuel during and after a crash, FMVSS 301, *Fuel System Integrity* sets performance requirements for fuel systems in crashes. The standard limits the amount of fuel spillage from fuel systems of vehicles tested under the procedures in the standard during and after specified front, rear, and lateral barrier impact tests. The standard limits fuel spillage due to these required impact tests to 28 grams (1 ounce) by weight during the time from the start of the impact until motion of the vehicle has stopped and to a total of 142 grams (5 ounces) by weight in the 5-minute period after the stop.

For the subsequent 25-minute period, fuel spillage during any 1-minute interval is limited to 28 grams (1 ounce) by weight. Similar fuel spillage limits are required for the standard's static rollover test procedure. The rollover test is conducted after the front, rear or lateral impact tests.

Previous Post-hoc Studies

There have been five NHTSA studies evaluating the FMVSS 301 standard as it evolved [1, 2, 3, 4, 5]. All have used data from selected states where fires, and sometimes fuel leaks, could be identified. Cases from national databases were too few for statistical analysis, but were useful in identifying factors that affected fire incidence. The first three focused on fuel leaks and fires rather than injuries and deaths. The fourth and fifth added analyses of injury, death, and overall cost effectiveness.

Study one (Flora) was based on six years of police crash data in Illinois and three years of police crash data in Michigan. These states were chosen because of the quality of their data, especially

[1] **Evaluation of FMVSS 301: Fuel System Integrity Using Police Accident Data**. Final Report, March 1982. Jairus D. Flora, Jr,. James O'Day. DOT HS-806-362. Hereafter referred to as the Flora report.

[2] **A Statistical Evaluation of the Effectiveness of FMVSS 301: Fuel System Integrity.** Report 7 of 7, June 1981. Donald W. Reinfurt. DOT HS-805 969. Hereafter referred to as Reinfurt, 1981.

[3] **A Statistical Evaluation of the Effectiveness of the 1976 Version of FMVSS 301: Fuel System Integrity.** Final Report, November, 1982. Donald W. Reinfurt. DOT HS-806-365. Hereafter referred to as Reinfurt, 1982.

[4] **Evaluation of Federal Motor Vehicle Safety Standard 301-75, Fuel System Integrity: Passenger Cars.** NHTSA Office of Program Evaluation, Glenn G. Parsons. DOT HS-806-335. Hereafter referred to as Parsons, 1983.

[5] **Motor Vehicle Fires in Traffic Crashes and the Effects of the Fuel System Integrity Standard.** NHTSA Office of Program Evaluation, Glenn G. Parsons. DOT HS 807 675. Hereafter referred to as Parsons, 1990.

regarding fuel leakage. Results showed significant reductions in fire rates and leakage rates in passenger cars, and some reduction in leakage rates in light trucks. It could not be proven that the standard was the only cause of these improvements. Data regarding leakage and fires are rare, because these events are quite rare.

Study two (Reinfurt, 1981) looked at fire incidence, comparing passenger cars built before 1968 to passenger cars built after the standard was implemented. Since a fire is more likely in an older car, groups of cars of like ages were compared. The authors used data from the National Crash Severity Study (NCSS) and North Carolina crash data. There were too few data for investigating fuel spillage in cars. The data from the NCSS were too scant for anything but obvious conclusions, i.e., fires were more likely when cars collided with trucks or fixed objects. The data from North Carolina showed a significant **increase** in the probability of fires in cars built after the standard took effect. This conclusion held even after confounding factors (such as speed, side of the car hit, and age of the car) were statistically controlled through logistic regression.

Study three (Reinfurt, 1982) was similar to the second but assessed the effectiveness of the 1976 version of FMVSS 301. They again used North Carolina data, and replicated the findings from Maryland data. Fire rates in 1969-1975 model-year vehicles were compared to fire rates in 1976-1981 model-year vehicles. This time, there were **decreases** in the probability of fires. The decreases were statistically significant in North Carolina, but not in Maryland, which had less than half the cases that North Carolina had.

The fourth study (Parsons, of NHTSA, 1983) was an overall evaluation of the FMVSS 301 which was in force in 1975. It was based on state data from Illinois, North Carolina, Maryland, Pennsylvania, and especially Michigan because they had additional data on fuel spillage. It concluded that FMVSS 301 "has significantly reduced post-crash fires in passenger car crashes. The reduction in crash fires has resulted annually in: 400 fewer fatalities, 520 fewer serious injuries, 110 fewer moderate injuries, and 6,500 fewer crash fires." (Page i) However, these numbers were derived from one state's data, and were rescinded in a later study (see next).

The fifth study (Parsons, 1990) was a re-examination of FMVSS 301 which concluded there were reduced fires due to the various permutations of FMVSS 301, but there were not enough data to emphatically conclude that lives had been saved. The author suggested that the speed threshold in the present standard may be too low: " . . .[I]t appears that the bulk of the fire hazard for vehicle occupants involved in fire crashes is focused at the upper end of the severity spectrum i.e., the risk of serious injury or fatality. Since these crashes typically involve high levels of crash or impact severity, it is possible that these levels typically exceed the 20 and 30 miles per hour [32 and 48 km/hr] requirements in FMVSS 301. Data developed in Chapter 3 indicate that most fatal crashes involving fire occur at speeds higher than these." (Pages 4-6).

Overall, these studies are inconclusive. There is general agreement that fires have been reduced, but estimates of death and injury benefits from the original FMVSS 301 are low to none. Generally, they were not able to collect sufficient useful data from the proper model years to conclude that deaths and injuries due to motor vehicle fires have been reduced significantly due to the standard. In addition, they investigated all post-crash fires, whereas the Final Rule is expected to affect mainly fuel-tank fires resulting from rear impacts. The previous studies did not have enough data to significantly differentiate fuel-tank fires from motor-compartment fires, or rear impacts from other impacts.

Studies Leading to the Final Rule

NHTSA contracted with GESAC, Inc.[6] to examine FARS and NASS crash data to determine the types of crashes that were causing fire-related fatalities and injuries and developed a new crash test procedure to simulate the most frequent crash scenario that leads to fire and fire related fatalities and injuries. GESAC selected for detailed analysis 150 NASS cases involving fire and any occupant injury of AIS 2 or greater. One of the objectives of the study was to suggest a test crash to simulate crashes that cause fire. The suggested crash simulation includes impact mode, speed, barrier type, impact location and barrier orientation.

For vehicles receiving rear damage, the report indicated that a moving deformable barrier with a partial overlap (the percentage of the rear width of the vehicle involved in the crash) would be the most common simulated crash. Overlap ranged from 30 to 95 percent with an average level of 71 percent. In rear impacts, the delta V ranged from 11 km/h to 73 km/h (7 to 45 mph) with a median delta V of 42 km/h (26 mph). There were 11 rear impacts with delta V estimates and burn injuries and NHTSA concluded that further study was needed.

6 "Fuel System Integrity Upgrade - NASS & FARS Case Study", DOT Contract No. DTNH-22-92-D-07064, March 1994.

A detailed case study of 214 fire related crash cases from 1990 to 1993 FARS data was conducted to help determine the relationship between vehicle crash specifics and fire fatality outcome.[7] Crash records were retrieved from seven states which recorded more complete case histories regarding fire crashes. There were 65 burn-related (not trauma-related) fatalities in 45 of these cases. Thirty of these fatalities occurred in rear impacts. The determination of whether the fatality cause was fire related or trauma related was based upon autopsy reports (5), coroner or death certificate (14), or the authors' judgment (11). A thorough review of the crash conditions in these rear impact cases concluded that striking a stationery vehicle at 50-55 mph (80-88 km/hr) with a moving deformable barrier (MDB) at a 70 percent overlap would provide a reasonable crash simulation of real world cases involving a rear impact resulting in fatal burns.

This study also estimated that there are 143 burn fatalities annually in rear impact crashes (a confidence interval around that estimate was also provided at 95 to 195 burn fatalities annually in rear impact crashes). However, these estimates appear high. These estimates are based on the 16 rear-end crashes that resulted in 30 fatalities with fires. One crash in the sample involved eight fatalities. The number of fatalities per crash in this sample is much higher than typical (30/16 = 1.875 compared to the 2001 totals of 125 *total* fatalities in 132 vehicles (125/132 = 0.947) in rear impacts. In a more narrowly defined group, passenger vehicles struck in the rear by passenger vehicles, the ratio averages 1.40 between 1991 and 2001, ranging from 1.21 to 1.56 (See Table IV-1, bottom line), still considerably lower than 1.875. Thus, the sample may over represent the importance of rear impacts as part of the fire population. In addition, the 143 *burn*

[7] "A Case Study of 214 Fatal Crashes Involving Fire" by Carl Ragland and Hsi-Sheng Hsia, Paper No. 98-S4-O-08, The Sixteenth International Technical Conference on the Enhanced Safety of Vehicles, Windsor, Canada, June 1998.

fatalities in rear impacts estimated in the case study is much higher than the 125 fatalities *including trauma-related fatalities* reported in FARS for 2001 in which a passenger car or light truck was struck in the rear and there was a fire. Thus, this estimate was not used in this analysis.

When considering the test set-up for the standard, one must consider the striking-vehicle weight. In the 16 cases of the sample, there were 8 passenger cars, 2 light trucks, and 6 heavy trucks. Thus, heavy trucks are over represented in the fatal rear crashes that involve fire. This finding, that heavy trucks are over-represented as being the striking vehicle causing fires, appears in both the sample of crashes investigated and in the yearly FARS counts.

The cases in this study included photographs and witness accounts, which greatly enhances estimates of impact speed. However, only eight of these cases had sufficient detail to estimate impact speed, and three of these involved a heavy truck as the striking vehicle, probably a more forceful crash than the Final Rule test.

The 1995 ANPRM

On April 12, 1995, NHTSA published an Advance Notice of Proposed Rulemaking (ANPRM) (60 FR 18566) on FMVSS No. 301. We announced our plans to consider research and rulemaking activities in three areas:

1) define performance criteria for fuel system components,

2) modify the existing FMVSS No. 301 crash test procedures and performance criteria to better

simulate the crashes that lead to serious injury and fatalities in fires, and

3) define the role of environmental and aging factors, such as corrosion, as it affects fuel system integrity

This Final Rule only addresses the second of these research agendas.

The NPRM

NHTSA published a Notice of Proposed Rulemaking (NPRM) on November 23, 2000 (65 FR 67693, Docket Number 2000-8248).

The previous rear impact test of FMVSS 301 required that the entire rear of a test vehicle is to be impacted by a 1,814 kg (4,000 lbs.) moving rigid barrier at speeds up to 48 km/h (30 mph). The proposal required an offset rear crash test procedure specifying that 70 percent of the rear of the vehicle be impacted by a 1,368 kg (3,015 lbs.) moving deformable barrier at 80 km/h (50 mph).

The previous side (lateral) barrier test of FMVSS 301 required the 1,818 kg (4,000 lbs.) moving barrier at 32 km/h (20 mph) to strike the side of the vehicle with the center of the barrier aimed at the driver's seating reference point. This test will be replaced by measuring the amount of fuel spillage in the FMVSS 214 test with a 1,368 kg (3,015 lbs.) crabbed deformable barrier striking the vehicle at a specified point (see FMVSS 214, S6.11) in a 53.6 km/h (33.5 mph) impact. Since the FMVSS 214 test is run anyway by manufacturers whose vehicles weigh less than 2,722 kg (6,000 lbs. GVWR or less), using this test for the lateral barrier test of FMVSS 301 saves the testing cost and the cost of a vehicle.

The current frontal barrier test of FMVSS 301 is a 48 km/h (30 mph) impact into a fixed collision barrier. No changes were proposed for this test.

The agency also requested comments on whether it should require at least one door per row of seats to be openable after a rear impact test.

The Final Rule

The Final rule requires the new rear impact test as proposed in the NPRM. It specifies striking the rear of the test vehicle at 80 km/h (50 mph) ± 1 km/h with a 1,368 kg (3,015 lb) moving deformable barrier (MDB) at a 70 percent overlap with the test vehicle. The MDB face is located 50 mm (2 inches) lower than the face of the FMVSS 214 barrier to simulate pre-crash braking. Regarding the side-impact test procedure, NHTSA is replacing the previous FMVSS 301 lateral crash test with the side impact crash test specified in FMVSS 214. However, it is not requiring one door per row or seat to be openable because the agency has not developed a practical, objective, and repeatable test procedure for door operability.

International Harmonization

There are three other standards concerning fuel system integrity in the world:

1) The Canadian CMVSS No. 301, Fuel System Integrity Standard is identical to the U.S. FMVSS 301.

2) The Economic Commission for Europe (ECE) Regulation No. 34, Uniform Provisions Concerning the Approval of Vehicles with Regard to the Prevention of Fire Risks (01 Series, Amendment 1, January 1, 1979) has been adopted by 13 European countries. This regulation requires a 48 to 53 km/h frontal fixed barrier impact test and a 35 to 38 km/h rear moving flat barrier impact test. The flat barrier weighs 1,100 kg(+ or - 20 kg). A pendulum can be used as the impactor. ECE Reg. No. 34 does not require a rollover test. The regulation does require a hydraulic internal-pressure test for all fuel tanks and special tests (impact resistance, mechanical strength, and fire resistance) for plastic tanks.

3) The Japanese Standard, Technical Standard for Fuel Leakage in Collision. (Amended on August 1, 1989). The Japanese standard requires a 50 km/h (+ or - 2 km/h) frontal fixed barrier impact test and a 35 to 38 km/h rear moving flat barrier impact test. The flat barrier weighs 1,100 kg(+ or - 20 kg). A pendulum can be used as the impactor.

Thus, no other country has a standard with a deformable moving barrier hitting the vehicle in an offset mode with the combined stringency of the test proposed, considering both the weight of the barrier and the speed of the test.

III. Test Results

REAR IMPACT TESTS

The agency conducted 20 rear impact crash tests at 80 km/h (50 mph) with the proposed moving deformable barrier (MDB) to determine what percent of the vehicles met the Final Rule criteria and to demonstrate that the Final Rule procedure can be withstood by even the smallest passenger vehicles in the US market today.

In eleven of the 50 mph (80 km/h) MDB rear impact crash tests, the vehicles met all the FMVSS No. 301 fuel leakage criteria requirements. These tests included a 1993 and 1996 Ford Mustang, a 1996 Plymouth Voyager, a 1996 Chevy Blazer, a 1998 Chevy Metro, a 1999 Mazda Miata, a 1998 Nissan Sentra, three 1998 Honda Civics and a Chevy Cavalier. Two other Cavaliers failed the test, thus for cost/ benefit purposes the Cavalier is considered a failure.

In nine of the 50 mph (80 km/h) MDB rear impact crash tests, the vehicles failed at least one of the FMVSS No. 301 fuel leakage criteria requirements. These tests included two 1993 Ford Mustangs, a 1996 Suzuki Sidekick, a 1996 Dodge Neon, a 1996 Geo Prizm, two 1998 Chevy Cavaliers, a 1998 VW Jetta, and a 1998 Ford Escort.

Table III-1 presents the 13 different models tested (considering only the later Ford Mustang). There are seven passes and six failures of the Final Rule test procedure. The 13 models ranged in weight from 2,198 pounds (997 kg) for the 1998 Chevy Metro to 4,290 pounds (1946 kg) for the 1996 Plymouth Voyager. The pattern of failures did not show a direct relationship to weight (see Table III-1, which are in order by vehicle weight). The two lightest and the three heaviest vehicles passed the Final Rule test and there was no linear pattern among the other eight. However, since larger vehicles have more structure to absorb collision forces, and since the deformable barrier for this test is a fixed weight of 3,015 lbs (1,368 kg) regardless of the size of the tested vehicle, there is a logical reason to expect that larger vehicles are more likely to pass. Although the data show no direct correlation between passing and weight for most of the sample, the 3 heaviest vehicles all passed. This indicates that there may be a weight threshold beyond which failure is unlikely, even at 50 miles per hour (80 km/hr). To understand the implications of this for benefits and compliance costs, three compliance scenarios were examined. These are described in the following models:

Model 1: In Model 1 it was assumed that 60% (6 failures /10 vehicles tested that were lighter than the Mustang) of all vehicles below the weight of the Ford Mustang (1,628 kg or 3,582 lbs.) would require a fix. The Ford Mustang was used as a cutoff because it was the lightest of the three heaviest vehicles which passed the test. Model 1 assumes that had NHTSA tested any other vehicles above that weight, they also would have passed.

Model 2: In Model 2, it is assumed that 46% (6 failures /13 vehicle models tested) of all vehicles at or below the weight of the Plymouth Voyager (1,946 kg or 4,281 lbs.) would require a fix. The Voyager was the heaviest vehicle tested.

Model 3: This model assumes that 46% (6/13) of all vehicles, no matter how heavy, would require a fix. Obviously, it is the most conservative and expensive model.

Table III-2 shows how the vehicle sales are distributed between the weight options and the models.

Under Model 1, 22 percent of the fleet would need improvements to pass the test. Under Model 2, 33 percent of the fleet would need improvements to pass the test. Under Model 3, 46 percent of the fleet would need improvements to pass the test.

Rear Impact Test Impact Energy

The 50 mph (80 km/h) FMVSS 301 rear impact test is significantly more stringent than the present 30 mph (48 km/hr) requirement, since it will increase the barrier's impact kinetic energy (KE) by about 110%. The barrier's initial KE = 1/2 [the barrier's mass (m_b) x test speed (v_b) x test speed (v_b)]. To perform the calculation, the test speeds of 50 and 30 mph are converted to the equivalent metric units 22.35 and 13.4 m/sec.

Table III-1

Test Results Used in the Analysis

Vehicle	Test Speed (km/hr)	Test Mass (KG)	301 Fuel Leakage Requirements			
			Impact	5 min	25 min	Roll
98 Chevy Metro	79.0	997	pass	pass	pass	trace
99 Mazda Miata	82.4	1226	pass	pass	pass	pass
96 Geo Prizm	81.9	1326	trace	pass	pass	fail
98 Nissan Sentra	81.0	1344	pass	pass	pass	pass
98 Honda Civic	80.7	1354	pass	pass	pass	pass
96 Dodge Neon	82.1	1360	fail	fail	fail	na.
96 Suzuki Sidekick	81.6	1370	fail	fail	fail	na.
98 Ford Escort	80.9	1385	trace	pass	pass	fail
98 VW Jetta	81.2	1429	pass	fail	fail	na.
98 Chevy Cavalier	81.0	1468	pass	fail	fail	na.
96 Ford Mustang	80.3	1628	trace	pass	pass	pass
96 Chevy Blazer	81.8	1906	trace	pass	pass	pass
96 Plymouth Voyager	81.5	1946	pass	pass	pass	pass

Table III-2

Estimating the Percent of Sales Needing Improvements

Weight vs. Model Designations

Weight Designation	Model 1	Model 2	Model 3
Lower Weight	36% x 0.60 = 22%	36% x 0.46 = 16.5%	36% x 0.46 = 16.5%
Medium Weight	0	36% x 0.46 = 16.5%	36% x 0.46 = 16.5%
High Weight	0	0	28% x 0.46 = 13%
Percent of Vehicle Sales Needing Improvements	22%	33%	46%

Lower Weight Range = Up to 1,361 kg. or (3,000 lbs.)

Medium Weight Range = From 1,361 to 1,707 kg. or (3,000 to 3,765 lbs.)

High Weight Range = Over 1,707 kg. or (3,765 lbs.)

Thus, the present barrier impact KE is ½[1,814 kg x 13.4 m/sec x 13.4 m/sec] = 162,860 joules, and the Final Rule barrier impact KE is ½[1,368 kg x 22.35 m/sec x 22.35 m/sec] = 341,673 joules.

We can calculate the approximate resultant change of velocity of the moving barrier and test vehicle due to the impact if we ignore the energy absorbed by the aluminum honeycomb on the moving deformable barrier (MDB) and crush deformation of the test vehicle's rear end, by applying the principle of the conservation of linear momentum. Where:

m_b v_b = (test vehicle mass) m_t x (final velocity of the barrier & test vehicle) v_f + m_b v_f

Which can be simplified to: v_f = v_b [m_b) (m_t + m_b)]

Figure III-1 shows the resultant delta V for vehicles between 907 and 2,721 kg (2,000 and 6,000 lbs) when impacted with the present barrier test compared to being impacted with the Final Rule barrier test. With a 2,000 pound (907 kg) vehicle for example, the present barrier test would result in the vehicle experiencing a 20 mph (32 km/hr) delta V, while the Final Rule barrier test will cause the delta V to increase to 30 mph (48 km/hr), which is a 50% increase in delta V. Similarly, the delta V of a 4,000 pound (1,814 kg) vehicle is increased from 15 mph (24 km/hr) to 21.4 mph (34.4 km/hr), which is a 43% increase in delta V, and the delta V of a 6,000 pound (2,722 kg) vehicle is increased from 12 mph (19.3 km/hr) to 16.7 mph (26.9 km/hr), which is a 39% increase in the delta V.

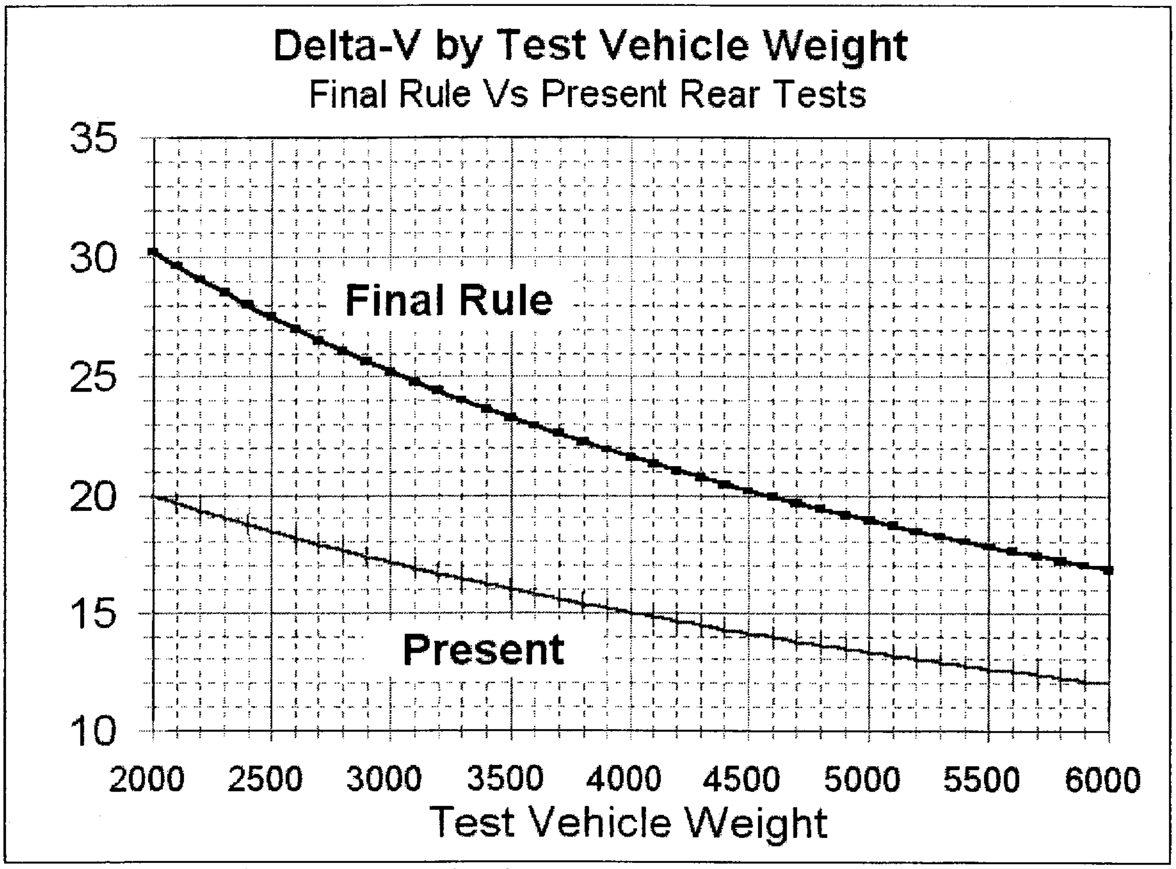

Figure 3. Comparison of Present barrier test and Final Rule barrier test. Delta V in miles per hour by vehicle weight in pounds.

SIDE TESTS

In response to the ANPRM, Chrysler, Ford, GM, Volvo, AAMA, Advocates, and IIHS all supported replacing the current FMVSS 301 side impact test with the current FMVSS 214 test. Most commenters argued that FMVSS 214's test was more stringent and more representative of real world crash conditions than FMVSS 301 lateral impact test.

Responses to the NPRM were likewise supportive. For example, "Volkswagen support making the fuel system integrity side impact test common with the FMVSS 214 occupant protection side impact test." (NHTSA-00-8248-21); "Honda support the proposal to confirm the side-crash requirements of FMVSS 301 with FMVSS 214 because it will reduce cost and development man-hours." (NHTSA-00-8248-22).

Only a few vehicles have failed the fuel leakage requirements of FMVSS 301 in side impact tests. Since 1994, one vehicle out of 43 tested in compliance tests to FMVSS 301 failed. In compliance tests for FMVSS 214, the fuel leakage is routinely measured (although not required), and one out of more than 100 vehicles failed the FMVSS 301 leakage requirement. In side impact NCAP tests, run at 61.6 km/h (38.5 mph), three of 103 vehicles leaked fuel in excess of the FMVSS 301 requirements.

NHTSA has compared the crash test results of a FMVSS 301 lateral impact compliance test condition and a FMVSS 214 compliance test for the same make/model. Our analysis indicates that the fuel system components are exposed to more stringent requirements in the FMVSS 214 test than in the present FMVSS 301 test. The FMVSS 214 test exposes the subject vehicle to higher crash forces, greater changes in velocity, and higher absorbed crush energy than the present FMVSS 301 test. Thus, the agency believes the FMVSS 214 test is stricter, providing a small benefit, and will reduce testing costs at the same time.

Since only one out of more than 100 vehicles failed the fuel leakage requirements in the Final Rule lateral test using the FMVSS 214 procedure, it is assumed that there would be essentially no quantifiable vehicle costs and no quantifiable injury or fatality benefits for the change in the lateral impact test. Changing to the slightly stricter FMVSS 214 procedure will provide some benefit, but with less than 1 percent of the vehicles failing this test, the benefits are not quantifiable. There are quantifiable benefits in terms of cost reduction, which will be discussed later.

Table III-3 provides available information on the ability to open doors after the test. Of the 10 models for which information is available, six passed the proposed requirements and four failed (the Chevrolet Cavalier is considered a failure here since one of the two vehicles tested failed). The purpose of the test is to have at least one door per row of seats that can be opened to let the occupant evacuate the vehicle after a crash. Since the Final Rule is an offset test, we would expect that the doors away from the direct impact would have a higher chance or remaining operable, which occurred in a few cases.

NHTSA believes that a post-crash door operability requirement is a practicable, reasonable safety enhancement. However, the agency has decided not to add a post-crash door operability requirement to FMVSS 301 or FMVSS 206 at this time, because the agency has not developed a practical, objective, and repeatable test procedure for opening doors.

NCAP TESTS

The agency has performed fuel leakage tests in its New Car Assessment Program (NCAP). The NCAP program is run at speeds that are 5 mph (8 km/hr) higher than the safety standards. Thus, what are called "failures" regarding NCAP tests below are not compliance failures, but a failure to meet the same performance standards in terms of fuel leakage at a higher impact speed.

In frontal impacts at 35 mph (56 km/hr) into the barrier, there have been 10 failures out of 406 tests, since 1979. On MY 1995 to MY 2000 vehicles, there have been four failures out of 232 vehicles tested (1.7 percent).

Table III-3
Door Opening Test Results

Vehicle	Driver Doors	Passenger Doors	Combined Pass/Fail
96 Ford Mustang	Pass	Pass	Pass
96 Suzuki Sidekick	Fail	Fail	Fail
96 Plymouth Voyager	Pass	Pass	Pass
96 Chevy Blazer	Pass	Pass	Pass
96 Dodge Neon	Fail	Fail	Fail
96 Geo Prizm	Pass	Pass	Pass
98 Ford Escort			
98 Honda Civic at Calspan	Pass	Pass	Pass
98 Honda Civic at TRC	Pass	Fail	Pass
98 VW Jetta			
98 Chevy Cavalier at Calspan	Pass	Fail	Pass
98 Chevy Cavalier at TRC	Fail	Fail	Fail
98 Nissan Sentra			
98 Chevy Metro	Pass	Pass	Pass
99 Mazda Miata	Fail	Fail	Fail

In rear impact tests run at 35 mph (56 km/hr) on MY 1979 to MY 1981 vehicles, there were 14 failures out of 52 vehicles tested (26.9 percent).

In side impacts run at 38.5 mph (62.0 km/hr) on MY 1997 to MY 2000 vehicles, there have been three failures out of 103 vehicles tested (2.9 percent).

IV. Target Population: Real World Crash Data Analysis

REAR IMPACTS

Fatal fires are very rare. The percentage of passenger vehicles with fire in the FARS data has ranged, between 1991 and 2001, from 2.5% (1996 and 1997) to 2.8% (1991, 1999 and 2001). In FARS there is little or no data which would allow us to classify crash energies as 1) below the present standard, 2) between the present and Final Rule standard, or 3) above the Final Rule standard. Only those crashes falling in between the present standard and the Final Rule are in the target population that could show benefits for this upgrade in the rear test.

An Analysis of FARS Data

We searched the Fatality Analysis Reporting System (FARS) for crashes where the change in the rear test for fuel system integrity might reduce fatalities. Table IV-1 shows how we selected the cases.

FARS data do not contain crash estimates of force, aside from "extent of deformation," which in these cases was always at the highest value. Nor do they contain speed estimates, except in rare cases. However, based on data collected in the NASS-CDS, some of the crash speeds were well above the Final Rule test speed. Therefore, the fatalities in Table IV-1 represent a high estimate of the number of lives in the target population that might be affected by the change in the rear 301 test.

The obvious problem with these data is there is no indication of the forces involved, other than each crash was forceful enough to cause a fire and kill an occupant. There is also no evidence of what killed the occupants, or whether the crash was survivable had there been no fire.

An inquiry was made concerning linkage between FARS fatalities and the Medical Examiner data from the National Center for Health Statistics. In the case of fiery crashes, these linkages have been of low quality and lead to no useful conclusions.

An examination of the cases in 2001 FARS provides more information of how these numbers fit together. In 2001 FARS in any type of impact (front, side, rear, rollover, multi-vehicle or single vehicle[1]), there were 1,657 vehicles of any type (passenger car, light truck, heavy truck, motorcycle, bus, others) which had a fire in the vehicle, in which there were 1,621 occupant fatalities. In rear impacts (clock positions 5, 6, or 7, using Principal Impact rather than Initial Impact), there were 145 vehicles of any type which had a fire in the vehicle, in which there were 129 occupant fatalities.

When looking at only passenger cars and light trucks, in 2001 FARS in any type of impact, there were 1,348 vehicles which had a fire in the vehicle, in which there were 1,470 occupant

[1] A rear impact single vehicle crash could include a vehicle which spun out-of-control and struck a tree going backwards, and then caught on fire.

fatalities. In rear impacts, there were 132 vehicles which had a fire in the vehicle, in which there were 125 occupant fatalities.

Taking this one step further, when looking at only passenger cars and light trucks being struck in the rear, in 2001 FARS in multi-vehicle rear impacts in which the striking vehicle was a passenger car or light truck, there were 46 vehicles which had a fire in the vehicle, in which there were 62 occupant fatalities. Thus, by taking out those cases in which a striking vehicle was a heavy truck or bus, those cases in which the fire was in a striking passenger car or light truck, and the single vehicle crashes, the number of occupant fatalities in the target population in 2001 dropped from 118 fatalities to 62 fatalities. [Note that in general the FRE uses the average number of fatalities over the 11 year period (50) and not just for 2001 FARS.] This does not say that there is no chance that improvements made to vehicles to pass the Final Rule test would be beneficial in the other crash modes. The target population analysis is designed to estimate how many fatalities there are in the particular crash mode being simulated by the test. The test uses a 3,000 pound moving deformable barrier (MDB), simulated by a multi-vehicular crash with the striking vehicle being a passenger car or light truck. We took out those cases with large vehicles as striking vehicles because of the greater forces involved. We acknowledge that some of these crashes may be below the test speed, but to be conservative we took out those cases with large vehicles as striking vehicles.

The test only considers fuel leakage in the struck vehicle. Remember that this target population still has not taken into account the possibility that the occupant may have been killed by the impact of the crash. The data only indicate that a fire was present in the vehicle in which the occupant died.

There is a possibility that the real target population is larger due to: (1) the fuel leakage or fire could start in the struck vehicle and spread to the striking vehicle, causing a fatality in the striking vehicle due to fire, (2) as discussed earlier, there could be some heavy truck striking vehicle impacts that the countermeasure could be effective in reducing, and (3) there could be some single-vehicle impacts that the countermeasure could be effective in reducing. An adjustment is made below for situation (1), but not for situations (2) or (3). Thus, the true target population may be higher.

The average number of fatalities over these eleven years is 50 (49.6), with a standard deviation of 10.4. The average number of case vehicles is 35.5, with a standard deviation of 7.8. Note that there are no significant annual trends up or down in either vehicles or fatalities.

We queried the Crashworthiness Data System (CDS) from 1991 through 1998 to get an estimate of the percentage of deaths caused by fire. There were 12 cases involving passenger vehicles being struck in the rear by another passenger vehicle resulting in the death of an occupant in the struck vehicle, where the struck vehicle caught on fire. In 10 of those 12 cases, the deaths were determined to be caused by burn injuries (83 percent). On a weighted basis, you get about the same percentage (132 out of 153 weighted deaths were caused by fire or 86 percent). Therefore, the 50 deaths were multiplied by (132/153), which amounts to an annual estimate of 43 fire-caused deaths in these vehicles under the test conditions. Through personal communication, Ragland (of Ragland and Hsai, 1998) states that eight of the thirty fatalities in rear-end crashes that he studied were in the striking vehicle, and stated that all thirty fatalities were due to burns. Therefore we adjusted the 43 deaths upward by a factor of 30/22 (=1.36), so 1.36*43=58 as the final estimate of burn-related fatalities that could be affected by this Final Rule.

We could have used the most harmful event code from the FARS file to distinguish cases in which the fires was the cause of death. However, the agency does not believe this coding has the best accuracy. There was a study dealing with the FARS coding of fire or explosion as the most harmful event.[2] This study found significant differences between the states for the percent of vehicles for which fire was coded and for which fire or explosion is coded as the most harmful event. The analysis suggests that it is "extremely unlikely" that the states are measuring the same phenomenon. The percent of vehicles experiencing fire ranged from 0.11 percent to 5.30 percent, among the states. The percent of fire or explosion as the most harmful event, given that fire was coded as occurring during the crash, ranged from 0.56 percent to 95.92 percent, among the states. Thus, this was not considered a reliable code without further analysis of the case.

The same study looked at the Multiple Cause of Death file and found inconsistencies between the Multiple Cause of Death file and the FARS Most Harmful Event data. Again, the agency

[2] "An Assessment of the Reliability and Validity of the Information on Vehicle Fires Contained in the Fatal Accident Reporting System (FARS)", Lindsay I. Griffin, III, Safety Division, Texas Transportation Institute, November 1997, Docket No. 1998-3588-40.

determined that it is best to examine the cases individually, with as much data as are available on each case, to get the most useful and correct information.

Table IV-2 provides a breakdown of 2001 FARS data by single vehicle and multi-vehicle collision involving fire and by type of collision. The top of the table provides the number of vehicles with fire and the bottom of the table provides the number of fatalities in those vehicles with fire. The intent of this table is to show why there can be over 1,500 fatalities in FARS crashes involving fire yet have less than 100 be affected by this Final Rule.

Table IV-1 Selected data on passenger vehicles with fire from 1991-2001 FARS

CONDITION	1991 Number (Pct)	1992 Number (Pct)	1993 Number (Pct)	1994 Number (Pct)	1995 Number (Pct)	1996 Number (Pct)	1997 Number (Pct)	1998 Number (Pct)	1999 Number (Pct)	2000 Number (Pct)	2001 Number (Pct)	Average (Standard Deviation)
Total number of passenger vehicles, with and without fire.	46,123 (100.00)	44,465 (100.00)	45,565 (100.00)	46,626 (100.00)	48,527 (100.00)	48,973 (100.00)	48,687 (100.00)	48,403 (100.00)	47,986 (100.00)	48,300 (100.00)	48,151 (100.00)	47,436.9 (1494.0)
Passenger Vehicles with fire and (percentages).	1,307 (2.83)	1,197 (2.69)	1,225 (2.69)	1,272 (2.73)	1,292 (2.66)	1,213 (2.48)	1,217 (2.50)	1,307 (2.70)	1,343 (2.80)	1,348 (2.79)	1,348 (2.80)	1,279.0 (57.7)
Passenger vehicles, struck in the rear, with a fire and an occupant fatality, which were involved in a multiple-vehicle crash where all vehicles were passenger vehicles.	41 (0.089)	34 (0.076)	26 (0.057)	45 (0.097)	26 (0.054)	38 (0.078)	37 (0.076)	26 (0.054)	43 (0.090)	29 (0.060)	46 (0.096)	35.55 (7.81)
The fatalities in these vehicles, and (percentage) of FARS occupant fatalities in passenger vehicles for the year.	57 (0.164)	53 (0.180)	36 (0.120)	64 (0.207)	38 (0.119)	57 (0.176)	50 (0.154)	40 (0.126)	52 (0.162)	36 (0.112)	62 (0.194)	49.55 (10.42)
Fatalities/vehicle ratio	1.39	1.56	1.38	1.42	1.46	1.50	1.35	1.54	1.21	1.24	1.35	1.40 (0.11)

Table IV-2

A Breakdown of 2001 FARS Data

	Number of Vehicles
Vehicles in FARS with Fire	1,657
Passenger Cars and Light Trucks with Fire	1,348
PC and LTV with no heavy trucks involved	1,119

Breakdown of the 1,119	Single Vehicle Crashes	Multi-Vehicle Crashes
Frontal Impacts	403	347
Side Impacts	100	77
Rear Impacts	21	58*
Other/Unknown	99	14
Total	623	496

* This number is higher than the 46 vehicles shown in Table IV-1, because the 46 only include those vehicles with a fatality in the vehicle struck in the rear.

	Number of Fatalities in These Vehicles
Fatalities in Vehicles in FARS with Fire	1,621
Fatalities in Passenger Cars and Light Trucks with Fire	1,448
Fatalities in PC and LTV with no heavy trucks involved	1,195

Breakdown of the 1,195	Single Vehicle Crashes	Multi-Vehicle Crashes
Frontal Impacts	469	273
Side Impacts	131	86
Rear Impacts	33	63**
Other/Unknown	123	17
Total	756	439

** This number is higher than the 62 fatalities shown in Table IV-1, because the 62 only include those fatalities in vehicles struck in the rear.

Non-Fatal Injuries

Based on the 1998 National Automotive Sampling System - General Estimates System (NASS-GES) there were an estimated 4,000 passenger vehicles involved in injury crashes with fire and 5,000 property damage only crashes with fire.

The National Automotive Sampling System - Crashworthiness Data System (NASS-CDS) was used to estimate the number of injuries and the injury levels that presently occur in fire-involved rear passenger vehicle crashes. Eight years of data were examined, from 1991 through 1998. Only one case was found where a non-fatal MAIS was caused by fire in a passenger vehicle struck in the rear. [The Maximum Abbreviated Injury Scale (MAIS) indicates the most serious injury level sustained by the crash victim]. In this one non-fatal case the burn injury was an AIS 5 injury and there was another non-burn related AIS 5 injury. On an annualized basis, this one case represented 2 occupants nationwide. All the other cases in which a burn was the maximum injury to the occupant were MAIS 5 or MAIS 6, and were eventually fatal.

Therefore, the data were re-analyzed to look for any fire-caused injury, not just the worst injury to the occupant. NASS-CDS was analyzed to look directly at the Abbreviated Injury Scale (AIS) rather than the MAIS. As before, only passenger vehicles with fire, struck in the rear by another passenger vehicle were included. There were no cases where the car or truck caught on fire after impact in the rear by a motorcycle. Regarding where the fire started, it is possible for a vehicle to have a motor compartment fire, pull off the roadway, and be struck in the rear by an inattentive driver, without causing a fuel-tank fire. However, no such cases appeared. All cases that met the criteria above originated in the fuel tank. Only four cases (not counting the one case of AIS 5 discussed above) in eight years were found, with an average annualized sampling weight of 117. Adding the annualized estimate of two for MAIS-5 injuries, this gives a total estimate of 119 non-fatal injuries annually due to fire in the target population. The distribution of those injuries in the NASS files is 108 AIS 1 injuries, 9 AIS 3 injuries, and 2 MAIS 5 injuries.

In a comment to the docket (NHTSA 200-8248-21),Volkswagen questions the safety benefits of the increased severity rear impact test. "The accident data base of the Medical University of Hanover in Germany indicates that in the universe of crashes with at least one injured occupant, only 0.58% resulted in after-crash fire and only 0.4% of the injuries in the data base were fire related. In the same sample of crashes, the whiplash injuries were reported in 11% of the cases. Although the vehicle fleet population in Germany is different from that in the U.S., Volkswagen submits that the statistics support the very low incidence of post-crash fires and fire related injuries." We agree that the percentage of injuries due to fires is very low. For 2001, there were an estimated 2,788,000 occupant injuries in passenger cars and light trucks.[3] The estimated percentage of non-fatal injuries affected by this Final Rule in the United States (119/2,788,000 = 0.004%) is extremely small.

Note that in our benefits analysis (Chapter VI) we considered injuries so sparse that we ignored the impact of reduced non-fatal burn injuries (page VI-7).

3 Traffic Safety Facts 2001 – Overview, Table 1. DOT HS 809 476. National Center for Statistics & Analysis, Washington, D.C.

JAMMED DOORS

The agency examined 1991-1999 NASS data to determine how often doors were jammed in crashes in which there was a fire and an AIS 2+ injury. We examined both all crash modes and just rear impacts. When considering all crash modes, which have many more cases than just rear impacts, there usually is a physical reason why the occupant could not quickly get out of the vehicle and keep from being burned. The main reasons include that the occupant was entrapped (physically pinned in the vehicle by compartment intrusion) or that the door next to the occupant, or both doors, were jammed.

Table IV-3 provides 1991-1999 NASS[4] data on victims with AIS 2+ burns, including fatalities. These are average annual estimates, based on 108 victims in all crashes, of which 16 were in non-rollover rear impacts. Since there were so few rear impacts, these data were not further broken down by the size of the striking vehicles. The data are divided to examine several elements of interest, including whether the occupant was physically trapped in the vehicle. This is broken out into cases where the near door was jammed or both doors were jammed. It also examines whether, when the door was jammed, the occupant was physically pinned by compartment intrusion.

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[4] Note: for this data run, we used an extra year of data, 1999 NASS data, which is why the average number of non-fatal fire related injuries changed from 119 to 108.

The "near door" is defined as the door nearest to the occupant. If a person is sitting in the rear seat of a vehicle without back doors (e.g., a two-door coupe), the near door is the nearer front door. "Both doors" is defined as both doors on the same row of seats (the doors an occupant could try to open without climbing over a seat). If the person is sitting in the rear seat of a vehicle without back doors, then both front doors are included.

The results of this analysis are that 52 percent of AIS 2+ burn victims in rear impacts were in vehicles in which both doors were jammed shut and they were not physically pinned in the vehicle by compartment intrusion. This percentage is not that different from the larger sample of burn victims in all types of crashes. There is a difference in both rear impacts and all impacts between whether there is just one door near the occupant that is jammed or whether it is both doors jammed.

Table IV-3
1991-1999 NASS data
AIS 2+ Burn Injuries, includes Fatalities
Annualized Estimates

	All Crashes Near Door	All Crashes Both Doors	Rear Impacts Near Door	Rear Impacts Both Doors
Of those burned in fires				
Trapped	476	356	40	35
Not Trapped	80	103	16	17
Percent trapped = A	86%	78%	71%	67%
Of those trapped				
Door jammed	383	263	32	27
Door not jammed	74	76	0	8
Percent jammed = B	84%	78%	100%	78%
Of those trapped with door jammed				
Not physically pinned	279	167	32	27
Physically pinned	81	81	0	0
Percent not pinned = C	77%	67%	100%	100%
Might have escaped with an operable door = A * B * C	56%	41%	71%	52%

Note: Unknowns regarding door jammed and physically pinned are not included in the numbers, thus percentages were used in the calculations of A*B*C.

V. Costs and Lead Time

The agency believes that most of these fuel leak test failures could be eliminated with minor design revisions. The agency believes these minor design changes will not translate into significant consumer cost increases. The changes would include improvements in the fuel filler neck in cases like the Geo Prizm and Ford Escort; an additional weld to the suspension component failing on the Chevy Cavalier; and rerouting of the fuel lines on the Dodge Neon. The failure mode of the tested 1996 Suzuki Sidekick was not determined. However, the 1996 Geo Tracker (which is the same design as the Suzuki Sidekick) failed the FMVSS 301 compliance test due to a deformed gusset plate puncturing the fuel tank wall. The 1997 vehicles were redesigned and the 1997 Suzuki Sidekick passed the FMVSS 301 compliance test.

The improved performance of the redesigned 1996 Ford Mustang vs. the 1993 Ford Mustang is an example of how vehicles that have failed the Final Rule upgraded requirements can be redesigned to meet the upgraded rear impact fuel system performance. The agency believes that most current vehicles that would fail the Final Rule requirements would only require minor design changes and given adequate lead time, the costs to comply could be minimized.

Per-vehicle costs for those that currently fail the rear-impact test depend on the type of failure. *Cost, Weight, and Lead Time Analysis* (Contract No.DTNH22-96-12003, Task Order 004) studied three types of failure that appeared in NHTSA's series of crash tests using the moving deformable barrier. The contractors looked at the failure modes of a 1993 Ford Mustang, a 1996 Geo Prizm, and a 1996 Dodge Neon. All three of these cases were fixed by redesigns. Thus, we investigated failing and passing vehicles. The Mustang failed due to a fuel tank rupture, which the researchers decided could be fixed by a fuel tank guard. The 1999 Mustang has such a guard, and was the basis for the first set of cost and lead-time estimates. The Geo Prizm fractured at the junction of the filler neck and the fuel tank. The 1999 Geo Prizm has a filler neck that is flexible and compressible, allowing more deformation between the rear fender and the fuel tank before rupturing. It was the basis for the second set of cost and lead-time estimates. A flexible filler neck should fix problems on the Geo Prizm and Ford Escort test vehicles. The Neon failed when the sending unit and fuel lines, located on the bottom of the fuel tank, were ruptured. The solution here was to place the sending unit on top of the fuel tank and re-route the fuel lines.

The contractors cost estimates are dependent upon the size of the vehicle. The fix for the first failure type (guard and strap for fuel tank), is estimated to be $4.15 for a lower weight vehicle (e.g., Geo Prizm), $5.14 for a medium weight vehicle (e.g., Ford Mustang), and $5.33 for a heavy weight vehicle (e.g., Mercury Marquis). The fix for the second failure type (flexible filler neck) is estimated to be $3.40 for a lower weight vehicle, $4.90 for a medium weight vehicle, and $6.41 for a heavy weight vehicle. Thus, the per-vehicle consumer cost would range from \$3.40 to \$6.41, depending on the nature of the required modification. Note also that this is not an average across the entire vehicle fleet. That figure and others are presented in Table V-1, which estimates consumer cost[1]. The fix for the third failure (relocation of sending unit and fuel line) is estimated to add zero retail cost.

Variation of Cost by Make/Model Weight: The only information available on cost by weight was for the three cars described in *Cost, Weight, and Lead Time Analysis*, namely a Geo Prizm, a Ford Mustang, and a Mercury Marquis. Although the relationship between part cost and vehicle weight was linear for the filler tube, it was not very linear for the tank guard. Therefore, a simpler rule was used to assign cost to each make/model. Two cut-off points (1,361 and 1,707 kg) were used, midway between the weights of the Prizm and the Mustang, and midway between the weights of the Mustang and the Marquis. Below the first cut-off weight, the averaged cost estimated for the Prizm was applied for the lower weight vehicles. Between the two cut-off weights, the averaged cost estimated for the Mustang was applied for the medium weight vehicles. Above the second cut-off weight the averaged cost estimated for the Marquis was applied for the heavy weight vehicles. Light trucks and vans were also classified by their weight.

[1] Contractors' costs were presented as variable costs. These were multiplied by 1.51 to take into account fixed costs and manufacturer and dealer profit. They were also adjusted from 1999 dollars to 2002 dollars.

Costs are estimated using three weight groups. These weight groups are different than those used in Table III-2 for determining the percent of the fleet that needed improvements, since the cost breakdowns were based on the specific models estimated in the cost contract for which specific fixes had been developed. The cost weight breakdowns, which were based on the vehicles identified in the cost contract, are defined as:

Low Weight - up to 1,361 kg (3,000 lbs.)
Medium Weight - 1,361 kg to 1,707 kg.
High Weight - over 1,707 kg (3,765 lbs.)

Cost Averaging: Since there was no way to tell for vehicles not tested, which vehicle make/model would require which fix (or for that matter, some other fix), the two fixes (tank guard and filler neck) which had per-vehicle costs were summed and divided by two for each of the three weight categories. This resulted in consumer cost estimates of $3.78 for the low weight vehicles, $5.02 for medium weight vehicles, and $5.87 for heavy weight vehicles. This assumption ignores a no-cost fix (e.g., the Dodge Neon), but is also ignores potentially more expensive fixes that might be needed for some other vehicles.

Once the cost was applied appropriately for each make/model, it was multiplied by the number of vehicles sold. Sales figures for the 1998 calendar year (15,179,501 passenger cars and light trucks) were used (see **Automotive Weekly,** January 11,1999) and then adjusted upward for 2001 sales figures. Passenger Car figures were increased by 3% and

Light Truck figures were increased by 17%. Weights were from **Ward's Automotive Yearbook 1999**, with a few weights coming from the 1997 edition for models which were sold in 1999 but not in Ward's 1999 table. Some models with few sales and no longer manufactured were omitted.

Inflation: Total cost estimates are summarized in Table V-1. These figures have been increased compared to the Preliminary Regulatory Analysis by a factor of 1.057 which is the increase between the Implicit Price Deflator[2] for 2002 (110.66) divided by the Implicit Price Deflator for 1999 (104.69).

Cost estimates:

Model 1: In model one it was assumed that 22 % of all vehicles (which includes 60% of all vehicles lighter than the Mustang) would require a fix. This model resulted in a total cost to consumers of $15.7 million or an average or $4.53 per vehicle affected, or $0.94 over all vehicles.

Model 2: This model is similar, except that it assumes that 33% of all vehicles (which includes 46% of all vehicles at or below the weight of the Plymouth Voyager) would require a fix. This model resulted in a total cost to consumers of $27.5 million or an average or $5.08 per vehicle affected, or $1.64 over all vehicles.

Model 3: This model assumes that 46% of all vehicles, no matter how heavy, would require a fix. Obviously, it is the most conservative and expensive model. This model resulted in a total cost to consumers of $41.1 million or an average or $5.31 per vehicle affected, or $2.45 over all vehicles.

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[2] Bureau of Economic Analysis website, Table 7.1 Quantity and Price Indexes for Gross Domestic Product, Line 4: Implicit price deflator. As of January 31, 2003.

Total costs are estimated to be $16 million to $41 million depending on whether the changes are only required for the smallest vehicles or are applied to all vehicles, including pick-ups, vans, and sport-utility vehicles.

At this time, the agency believes that the test failures are more the result of differences in design than they are related to the weight of the struck vehicle. Thus, for the cost effectiveness analysis, the agency believes the estimate of 46 percent of the fleet needing improvements at $5.31 per vehicle is more likely than the other cost models and estimates.

Table V-1

Cost estimates by model

	Model 1 (60% of vehicles lighter than Mustang)	Model 2 (46% of vehicles lighter than Voyager)	Model 3 (46% of ALL vehicles)
Number of vehicles in affected weight class	5,789,416	11,743,891	16,746,053
Number of vehicles expected to be affected	3,473,650	5,420,258	7,728,948
Weight Category			
Under 3,000 lbs.	1,359,042 x $3.77	1,045,417 x $3.77	1,045,417 x $3.77
3,000 to 3,765 lbs.	2,114,608 x $5.02	2,463,563 x $5.02	2,463,563 x $5.02
Over 3,765 lbs.	0	1,911,277 x $5.87	4,219,967 x $5.87
Total cost to public	$15,744,934*	$27,523,712*	$41,065,792*
Cost per affected vehicle	$4.53	$5.08	$5.31
Cost per vehicle (denominator is ALL vehicles: 16,746,053)	$0.94	$1.64	$2.45

* The total cost is based on a computer algorithm that does not round estimates. The cost estimates in the previous row are rounded to the nearest cent. Thus, when they are multiplied by vehicle sales and added, they do not exactly match the total cost.

Docket Comments on Costs

There were two docket comments indicating that the agency had underestimated the costs of complying with the final rule. DaimlerChrysler stated "The proposal is likely to require significant changes to vehicle structure and design, which are yet to be fully defined and realized." They argued that the proposed upgrade is a "major rulemaking effort which will present many challenges to the industry that may not yet be fully identified." Honda stated "The cost of managing all the accompanying issues is at least 10 times greater than NHTSA's cost estimation." Honda also claimed "It will be necessary to change the thickness of the vehicle's rear structure ..." However, neither company provided any real cost estimates and the 1998 Honda Civic passed the test (See Table III-1) . On the other hand, the agency's cost estimates pertain to particular changes that have been used to remedy noncompliant vehicles or are believed necessary to remedy noncompliant vehicles based on our engineering judgment.

Items not included in the cost estimates: The agency has no cost estimates related to assuring that doors can open after the test. This test may cause some designs to address the load path of a rear impact and how that load affects the side door latch area. This issue will be discussed in the future when NHTSA begins to develop a door-opening test.

Fuel costs: Fuel costs for added weight were considered inconsequential, given that the heaviest fix, the fuel-tank guard, was less than seven pounds, the added weight for the flexible filler neck was less that 4 ounces, and the relocation of the sending unit and fuel lines added no weight.

Cost Savings from Testing

Replacing the side test for FMVSS 301, with the FMVSS 214 (side impact protection) test, would eliminate the cost to conduct the FMVSS 301 test, as well as the cost of a test vehicle. Based on contractor testing costs for NHTSA, the average lateral test for FMVSS 301 costs roughly $4,300 in the year 2002, not counting the costs of the vehicle. An average test vehicle costs about $21,000. Total savings would be about $25,300 per vehicle model (roughly $4,300 to conduct the test and $21,000 for an average vehicle).

The agency believes the cost for the proposed procedure will be essentially the same as the current rear impact test, with one exception. The Final Rule includes a deformable barrier. The deformable face, which costs $1,085 each, is destroyed with each test. Current rear impact tests for FMVSS 301 cost $6,660, but include instrumenting the driver dummy for research purposes at a cost of about $1,375 per test. Under the proposal, the tests will cost about $7,745 ($6,660 + $1,085).

Lead Time

Factors that affect the amount of lead time necessary for the rear impact test include:

1) All vehicles must be tested with the new test, which is at a higher speed than currently used by most manufacturers in their testing. Thus, most all make/models must be tested to determine current compliance.

2) For all non-complying vehicles (6 of 13 vehicles tested did not comply) a remedy must be determined, a prototype solution fabricated and installed in the vehicle and the vehicle retested.

3) Finally, the changes must be implemented on the production line.

In the NPRM, the agency proposed a three-year lead time after issuance of the Final Rule for the new rear impact test procedure and a one-year lead time after the Final Rule for implementing the FMVSS 214 test requirement for the lateral test. Since this is a different test than the current FMVSS 301 test, it is not known how many manufacturers have experience with this test procedure. After reviewing comments to the docket, in which most manufacturers recommended more lead time. NHTSA has increased these times to a six-year implementation schedule comprised of a three-year lead time after the publication of this Final Rule plus a three-year phase-in (40%, 70%, 100%) for the rear impact test upgrade. See Table V-2 on the next page.

Table V-2
Final Rule Lead Time

Vehicles Manufactured	Percent of Vehicles That Must Comply
On or After September 1, 2006 and before September 1, 2007	40 %
On or After September 1, 2007 and before September 1, 2008	70 %
On or After September 1, 2008	100 %
Vehicles Manufactured in two or more stages	
On or After September 1, 2008	100 %

VI. Benefits Analysis

Rear Impacts

Estimating the effectiveness of countermeasures in reducing the fire-caused fatality and injury problem is very difficult. First, while the rear impact crash scenario represented by the test is typical of fire-causing crashes, one test cannot represent the continuum of crashes, angles and speeds that the rear of light passenger vehicles is exposed to. Thus, while the countermeasure chosen could solve the problem shown in the compliance test, it may not expose other potential problems that could occur in the variety of real world crashes. On the other hand, there might be cases where improvements made to comply with the proposed offset rear impact test could provide benefits in other crash modes (frontal, side, or rollover). Second, there are not many cases available with fire, injury, and known delta V to distribute the cases between those represented by the test procedure and those cases not represented.

The agency examined fire data on a make/model basis and compared it to the test results for the 13 vehicles it tested against the proposed standards. This was an attempt to determine whether there was a correlation between test performance and the probability of fire and burn injuries. Unfortunately, there were not enough data to draw any conclusions in this regard.

In this analysis, we have severely limited the target population to just those rear impact fatalities in which the striking vehicle is representative of the barrier being used in the test (striking vehicles under 10,000 pounds GVWR) and in which the fire was the cause of the fatality. In addition, the Final Rule is a relatively severe test, imparting over twice as much energy at impact than the current test. Given these factors, the agency believes that there should be a relatively high effectiveness against fuel leakage and fires for vehicles designed to meet the final rule requirements.

In the special study of FARS cases,[1] the agency examined the 10 cases of light vehicles being struck in the rear by light vehicles, and in which a fatality was believed to be caused by fire, to determine how many of these cases were similar to the test procedure in the impact mode, the percentage overlap, and in the speed of impact. Of these 10 cases, four cases were very similar to the test setup. All four were estimated to be 50 to 55 mph (80 to 88 km/hr) impact speeds, with three of the four being 70 to 80 percent offset crashes; the fourth was 50 percent offset. Regarding the other six cases, two of the 10 cases are not really represented by the test; one because the impact mode was not right (more of a rear/side slap than an offset test), and one because the tongue of a trailer was pushed into the fuel tank. A third case had an impact speed somewhat higher than the test speed (estimated at 60 mph [97 km/hr]), and the countermeasure might have been effective given that the struck vehicle was one that we tested and failed at the test speed. The remaining three cases had unknown delta V and unknown percent offset.

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[1] "A Case Study of 214 Fatal Crashes Involving Fire" by Carl Ragland and Hsi-Sheng Hsia, Paper No. 98-S4-O-08, The Sixteenth International Technical Conference on the Enhanced Safety of Vehicles, Windsor, Canada, June 1998.

The agency also examined the 1981-1993 NASS and FARS cases investigated in the GESAC, Inc. study[2]. In this study there were 21 rear impact cases where the fire started in the struck vehicle. Eight of these cases resulted in occupant deaths. One case was the same crash as one of the 10 cases studied above. In two of these cases, death occurred from the trauma of the impact, not from the fire. In the remaining five cases, death occurred from burn injuries. This study used delta V rather than impact speed as the parameter to discuss the force of the impact. As shown in Figure III-1, the test represents a delta V of about 20-30 mph (32-48 km/hr), depending upon the mass of the struck vehicle. Of those five fatal cases, one had a very high delta V of 42 mph (68 km/hr). One case had a delta V slightly higher than the test speed (estimated at 32.1 mph [51.7 km/hr]), and the countermeasure might have been effective. Two cases had delta V's similar to the Final Rule condition of 21.2 mph (34.1 km/hr) and 24.3 mph (39.1 km/hr). One case had a lower delta V of 15 mph (24 km/hr), but the left wheel had come off the vehicle allowing it to skid across the road tearing the fuel line. This case is not well represented by our test.

We also examined 1993-2000 NASS-CDS cases and found five rear impact cases in which a light vehicle was struck by a light vehicle with a fire and a fatality. None of these cases matched the previous cases examined. In all five cases, the occupant died from burns. In two of the cases, the delta V was much higher than the test speed (36 mph [58 km/hr] into a Crown Victoria, and 74 mph [119 km/hr]). In three cases, the delta V was unknown.

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[2] A Fuel System Integrity Upgrade - NASS & FARS Case Study, March 1994.

Thus, we have retrieved as much information as possible on a total of 20 fatal cases in our target population. Of those 20, six are represented very well by our test, two have slightly higher speeds, 6 have unknown speeds, 3 have much higher speeds than our test and 3 have different crash circumstances that are not represented by out test. Our best estimate is that 8 to 14 (40 to 70 percent) of the 20 cases we have detailed information on will be well represented by the new test. Assuming these 20 cases are representative of the 58 fatalities that occur per year in which a light vehicle is struck in the rear by another light vehicle, resulting in a fire that causes the death, then 40 to 70 percent of the fatality cases could be like the test setup.

We also examined the non-fatal fire cases in the GESAC and later NASS files to determine how many of them were like the test setup. Of the 18 non-fatal fire cases, 7 cases resulted in non-fatal burn injuries, 9 cases had no burn injuries, and in 2 cases the struck vehicles were parked cars with no occupants. The burn injuries were one MAIS 5 injury, one MAIS 2 injury (a case not represented by our test because a trailer hitch ruptured the fuel tank), one AIS 3 injury where the occupant had another AIS 3 head injury, three AIS 1 injuries where the occupant had other AIS 1 injuries, and one AIS 1 where the occupant had another AIS 2 head injury. Of these 18 cases, 8 had delta V much higher than the test condition (33.4 mph [53.8 km/hr], 34.8 mph [56.0 km/hr], 41 mph [66 km/hr], 41 mph [66 km/hr], 42 mph [68 km/hr], 45.3 mph [72.9 km/hr], 53 mph [85 km/hr] and 54 mph [87 km/hr]). The delta V of the other 10 cases varied from 10 mph (16.1 km/hr) to 25.8 mph (41.5 km/hr), with two unusual cases occurring at low speeds when (1) an electrical fire started in the rear lights and (2) a trailer hitch ruptured a fuel tank. Thus, for these non-fatal fire cases, our test procedure would represent 8 of 18 cases or 44.4 percent.

The next question is, what percent of the fatalities are represented by the vehicles that do not currently pass the Final Rule and thereby would make improvements to the fleet? Some of the 58 fatalities in the target population undoubtedly occur in vehicles that already pass the proposed test. A look at the FARS fatalities found a few in vehicles that had passed the test and a few in vehicles that did not pass the test. Out of the 13 make/models tested, 6 failed the test and would need modifications to certify compliance (46 percent).

If fatalities were evenly distributed over both passing and failing vehicles (46 percent of all vehicles tested failed) and if the effectiveness were 100 percent in those cases with similar crash conditions to the test setup in which the striking vehicle were less than 10,000 pounds GVWR, the number of fatalities reduced by the test would be 10 to 15 (58 fatalities x 0.375 to 0.563 like the test setup x .46 vehicles modified). However, there are two factors that would raise or lower these estimates. Given the narrow target population utilized in this analysis, and the conservative assumptions taken, the agency believes it is reasonable to expect a very high overall effectiveness for these cases, although not 100 percent. For this analysis, we assume an effectiveness of 50 to 75 percent. The test should do a better job of determining those vehicles that are more likely to be involved in fires than an even distribution. In other words, we would expect vehicles that failed the performance test would more likely be over reported in the real world fire population. In addition, once you have a test procedure with engineers trying to determine how to assure compliance, they are likely to find many small changes that can reduce the risk of fires, even in vehicles that originally pass the test. Thus, we would expect that if 46 percent of the vehicles did not pass the proposal, that more than 46 percent of the fires would be in these vehicles. A reasonable expectation would be that the fire risk of the worst performers might be 50 percent higher than the average vehicle or 0.46 x 1.5 = 0.69. Putting together our engineering judgment and assumptions, the range of benefits from meeting the proposed tests are 8 to 21 lives saved (58 fatalities x 0.40 to 0.70 like the test setup x 0.50 to 0.75 effectiveness x 0.69 distribution of fires for failing vehicles). These calculations are summarized in Table VI-1 on the next page.

Table VI-1

Summary of Benefits Estimate

Step	Estimate and/or Adjustment		Fatalities*
1	Average number of fatalities in passenger vehicles struck in the rear by passengers vehicles, 1991-2001 (Table IV-1)		50
2	Adjustment for deaths not due to fire (86%)		43
3	Adjustment for fatalities in striking vehicle (136%)		58
4	Probability that real-world crashes will be like the test setup in the Final Rule:	Low estimate: 40% High Estimate: 70%	23 41
5	Estimated effectiveness of Final Rule	Low estimate: 50% High Estimate: 75%	12 31
6	Probability that fires will occur in vehicles that presently fail the Final Rule and therefore will save lives because of the Final Rule: 69%		8 21

*Calculations were performed on unrounded data and then rounded when placed in the table.

Side Impacts

NHTSA has compared the crash test results of a FMVSS 301 lateral impact compliance test condition and a FMVSS 214 compliance test for the same make/model. Our analysis indicates that the fuel system components are exposed to more stringent requirements in the FMVSS 214 test than in the present FMVSS 301 test. Thus, the agency believes the FMVSS 214 test is stricter and will provide a small benefit.

Since only one out of more than 100 vehicles failed the fuel leakage requirements in the proposed lateral test using the FMVSS 214 procedure, it is assumed that there would be essentially no quantifiable injury or fatality benefits for the change in the lateral impact test. Changing to the slightly stricter FMVSS 214 procedure will provide some benefit, but more exact testing is required to quantify the improvement.

VII. Cost Effectiveness

To be conservative, this analysis will be based on the highest cost estimate from Table V-1, which is about $41 million. We have also not included a value for the difference in property damage that would result between a crash with a fire and a crash without a fire. The estimated fatality benefits for this rulemaking are 8 to 21 lives saved per year once all vehicles in the on-the-road fleet meet the proposal.

The cost per life saved is estimated to be $1.96 million to $5.13 million ($41 million/21 lives to $41 million/8 lives).

Injuries

Although there are non-fatal burn injuries that result from rear impact fires, our data sources (1991 to 1998 NASS-CDS) estimated an average of only 2 cases per year resulted in the burn injury being the most serious injury or tied for the most serious injury suffered by the injured person. This was based on weighting one case and dividing by 8 years. This victim also had another non-burn AIS 5 injury at the same injury level. Eliminating the burn injury, although desirable, in itself would not eliminate the most serious injury experienced by the crash victim in any of the cases we examined. For the cost effectiveness analysis, we have chosen to ignore the impact of reduced non-fatal burn injuries.

VIII. Small Business Impacts

Regulatory Flexibility Act

The Regulatory Flexibility Act of 1980 (5 USC Sec. 601 et seq.) requires agencies to evaluate the potential effects of their proposed and final rules on small businesses, small organizations and small governmental jurisdictions.

The only types of business impacted by this Final Rule are believed to be vehicle manufacturers, since the types of failures found in testing relate to the surrounding environment of fuel tanks, how the fuel filler necks are attached to the body and how fuel tanks and lines are installed in the vehicle.

Currently, there are about 4 small motor vehicle manufacturers in the United States. This is not a substantial number. It is unknown how many of their vehicle models currently meet the new requirements. No comments on the impact of this proposal on small vehicle manufacturers were received after the PRE was published.

There are a large number of second-stage manufacturers that could be affected by this new requirement. Second-stage manufacturers buy a chassis from a first-stage manufacturer and finish it to the consumer's specifications. Many of these manufacturers that put a work-related body on a pickup truck chassis (like a small tow truck) get involved with the fuel system, both in the structure around the fuel tank and where the fuel filler neck attaches to the body. Other second-stage manufacturers use a van chassis or an incomplete vehicle for ambulances, small mobile homes, small school buses, etc. Typically, the first-stage manufacturer provides the second-stage manufacturer with a body builder's guide, which tells the second-stage manufacturer what they can do and still pass along the original equipment manufacturer's certification for compliance with FMVSS 301. To the extent that a second-stage manufacturer deviates from the guide, they have to certify compliance on their own. The agency does not know how often this occurs. This final rule would make a stricter test for those certifying compliance on their own. However, the agency tentatively concludes that this will not result in a significant economic impact on these companies.

The National Truck Equipment Association (NTEA)[1] disagreed with this tentative conclusion. The NTEA commented:

> It is not inconceivable that a major upgrade of the standard could force a chassis manufacturer to forbid the completion of certain chassis with certain body types or equipment in order to reduce their liability to an acceptable level. In any event, it will be impossible for the chassis manufacturers to test or even envision all types of multi-stage vehicles and will likely allow no modifications of any sort while leaving as much liability with the final stage manufacturer as possible, even when no fuel system modifications are made by the final stage manufacturer.

[1] The NTEA represents second-stage manufacturers, most of whom are small businesses.

The NTEA stated that the proposed upgrade of FMVSS 301 could require second-stage manufacturers to conduct compliance testing, and that since most second-stage manufacturers are small businesses, such testing would be an unreasonable burden.[2]

The agency notes that it is currently involved in a negotiated rulemaking process with the NTEA, first-stage manufacturers, and other stakeholders regarding the certification process for vehicles manufactured in two or more stages. The agency intends to develop changes to the regulations governing the certification of such vehicles through this process.

The agency believes that there will be no change to the certification responsibilities of second-stage and final-stage manufacturers as a result of this rulemaking. The agency tentatively concludes that this Final Rule would not have a significant economic impact on a substantial number of small entities.

[2] The NTEA submitted several conformity statements from first-stage manufacturers as evidence that the certification responsibilities of second-stage manufacturers would change as a result of this rulemaking.

IX. Cumulative Impacts

Section 1(b) II of Executive Order 12866 Regulatory Planning and Review requires the agencies to take into account to the extent practicable "the costs of cumulative regulations". To adhere to this requirement, the agency has decided to examine both the costs and benefits by vehicle type of all substantial final rules with a cost or benefit impact effective from MY 1990 or later. In addition, proposed rules should also be identified and preliminary cost and benefit estimates provided. A this time, there are no major outstanding proposals that have quantified costs and benefits.

Costs include primary cost, secondary weight costs and the lifetime discounted fuel costs for both primary and secondary weight. Costs will be presented in two ways, the cost per affected vehicle and the average cost over all vehicles. The cost per affected vehicle includes the range of costs that any vehicle might incur. For example, if two different vehicles need different countermeasures to meet the standard, a range will show the cost for both vehicles. The average cost over all vehicles takes into account voluntary compliance before the rule was promulgated or planned voluntary compliance before the rule was effective and the percent of the fleet for which the rule is applicable. Costs are provided in 1997 dollars, using the implicit GNP deflator to inflate previous estimates to 1997 dollars.

Benefits are provided on an annual basis for the fleet once all vehicles in the fleet meet the rule. Benefit and cost per average vehicle estimates take into account voluntary compliance.

Table IX-1

COSTS OF RECENT PASSENGER CAR RULEMAKINGS
(Includes Secondary Weight and Fuel Impacts)
(1997 Dollars)

Description	Effective Model Year	Cost Per Affected Vehicle $	Cost Per Average Vehicle $
FMVSS 114, Key Locking System to Prevent Child-Caused Rollaway	1993	$8.99 - 18.65	$0.50 - 1.03
FMVSS 214, Dynamic Side Impact Test	1994 - 10% phase-in 1995 - 25% 1996 - 40% 1997 - 100%	$65.77 - 640.56	$59.54
FMVSS 208, Locking Latch Plate for Child Restraints	1996	$0.85 - 17.07	$2.29
FMVSS 208, Belt Fit	1998	$3.25 - 16.28	$1.20 - 1.73
FMVSS 208, Air Bags Required	1997 - 95% 1998 - 100	$479.52 - 579.42	$479.52 - 579.42
FMVSS 201, Upper Interior Head Protection	1999 - 10% 2000 - 25% 2001 - 40% 2002 - 70% 2003 - 100%	$35.96	$35.96
FMVSS 225, Child Restraint Anchorage Systems	2001 - 20% 2002 - 50% 2003 - 100%	$2.87 - $6.74	$5.78
FMVSS 208, Advanced Air Bags	two phases 2003 to 2001	$23 to 128	Depends on method chosen to comply

Table IX-2

BENEFITS OF RECENT PASSENGER CAR RULEMAKINGS
(Annual benefits when all vehicles meet the standard)

Description	**Fatalities Prevented**	**Injuries Reduced**	**Property Damage Savings $**
FMVSS 114, Key Locking System to Prevent Child Caused Rollaway	None	50-99 Injuries	Not Estimated
FMVSS 214, Dynamic Side Impact Test	512	2,626 AIS 2-5	None
FMVSS 208, Locking Latch Plate for Child Restraints	Not estimated	Not estimated	None
FMVSS 208, Air Bags Required		AIS 2-5	None
Compared to 12.5% Usage in 1983	4,570 - 9,110	85,930 - 155,090	
Compared to 46.1% Usage in 1991	2,842 - 4,505	63,000 - 105,000	
FMVSS 201, Upper Interior Head Protection	575 - 711	251 - 465 AIS 2-5	None
FMVSS 225, Child Restraint Anchorage Systems B Benefits include changes to Child Restraints in FMVSS 213	36 to 50*	1,231 to 2,929*	None
FMVSS 208, Advanced Air Bags	117 to 215**	584 to 1,043 AIS 2-5**	Up to $85 per vehicle*

* Total benefits for passenger cars and light trucks

** Total benefits for passenger cars and light trucks, does not count potential loss in benefits if air bags are significantly depowered.

Table IX-3

COSTS OF RECENT LIGHT TRUCK RULEMAKINGS
(Includes Secondary Weight and Fuel Impacts)
(1997 Dollars)

Description	Effective Model Year	Cost Per Affected Vehicle $	Cost Per Average Vehicle $
FMVSS 202, Head Restraints	1992	$44.64 - 108.29	$5.28
FMVSS 204, Steering Wheel Rearward Displacement for 4,000 to 5,500 lbs. unloaded	1992	$5.76 - 28.52	$1.02 - 1.93
FMVSS 208, Rear Seat Lap/Shoulder Belts	1992	$65.95	$0.39
FMVSS 114, Key Locking System to Prevent Child-Caused Rollaway	1993	$8.99 - 18.65	$0.01 - 0.03
FMVSS 208, Locking Latch Plate for Child Restraints	1996	$0.85 - 17.07	$2.29
FMVSS 108, Center High-Mounted Stop Lamp	1994	$14.34 - 21.68	$14.79
FMVSS 214, Quasi-Static Test (side door beams)	1994 - 90% 1995 - 100	$64.17 - 80.48	$59.48 - 74.71
FMVSS 216, Roof Crush for 6,000 lbs. GVWR or less	1995	$23.63 - 212.05	$0.85 - 8.40
FMVSS 208, Belt Fit	1998	$3.59 - 16.98	$6.13 - 8.27
FMVSS 208, Air Bags Required	1998 - 90% 1999 - 100	$479.52 - 579.42 dual air bags	$478.52 - 597.42 dual air bags
FMVSS 201, Upper Interior Head Protection	1999 - 10% 2000 - 25% 2002 - 70% 2003 - 100%	$35.62 - 78.00	$54.97
FMVSS 225, Child Restraint Anchorage Systems	2001 - 20% 2002 - 50% 2003 - 100%	$2.87 - $6.74	$5.78
FMVSS 208, Advanced Air Bags	two phases 2003 to 2001	$23 to 128	Depends on method chosen to comply

Table IX-4
BENEFITS OF RECENT LIGHT TRUCK RULEMAKINGS
(Annual benefits when all vehicles meet the standard)

Description	Fatalities Prevented	Injuries Reduced	Property Damage Savings $
FMVSS 202, Head Restraints	None	470 - 835 AIS 1 20 - 35 AIS 2	None
FMVSS 204, Steering Wheel Rearward Displacement for 4,000 to 5,500 lbs. unloaded	12 - 23	146 - 275 AIS 2-5	None
FMVSS 208, Rear Seat Lap/Shoulder Belts	None	2 AIS 2-5	None
FMVSS 114, Key Locking System to Prevent Child Caused Rollaway	None	1 Injury	Not Estimated
FMVSS 208, Locking Latch Plate for Child Restraint	Not estimated	Not estimated	None
FMVSS 108, Center High Mounted Stop Lamp	None	19,200 to 27,400 Any AIS Level	$119 to 164 Million
FMVSS 214, Quasi-Static Test (side door beams)	58 - 82	1,569 to 1,889 hospitalizations	None
FMVSS 216, Roof Crush for 6,000 lbs. GVWR or less	2 - 5	25-54 AIS 2-5	None
FMVSS 208, Belt Fit	9	102 AIS 2-5	None
FMVSS 208, Air Bags Required Compared to 27.3% Usage in 1991	1,082 - 2,000	21,000 - 29,000 AIS 2-5	None
FMVSS 201, Upper Interior Head Protection	298 - 334	303 - 424	None
FMVSS 225, Child Restraint Anchorage Systems B Benefits include changes to Child Restraints in FMVSS 213	36 to 50*	1,231 to 2,929*	None
FMVSS 208, Advanced Air Bags	117 to 215**	584 to 1,043 AIS 2-5**	Up to $85 per vehicle*

* Total benefits for passenger cars and light trucks

** Total benefits for passenger cars and light trucks, does not count potential loss in benefits if air bags are significantly depowered.