U.S. Department
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DOT HS 809 834

December 2004
Technical Report

# Cost and Weight Added by the Federal Motor Vehicle Safety Standards for Model Years 1968-2001 in Passenger Cars and Light Trucks

**Technical Report Documentation Page**

| 1. Report No. | 2. Government Accession No. | 3. Recipient's Catalog No. |
|---|---|---|
| DOT HS 809 834 | | |

| 4. Title and Subtitle | 5. Report Date |
|---|---|
| Cost and Weight Added by the Federal Motor Vehicle Safety Standards for Model Years 1968-2001 in Passenger Cars and Light Trucks | December 2004 |
| | 6. Performing Organization Code |
| 7. Author(s) | 8. Performing Organization Report No. |
| Marcia J. Tarbet | |
| 9. Performing Organization Name and Address | 10. Work Unit No. (TRAIS) |
| Evaluation Division; National Center for Statistics and Analysis<br>National Highway Traffic Safety Administration<br>Washington, DC 20590 | 11. Contract or Grant No. |
| 12. Sponsoring Agency Name and Address | 13. Type of Report and Period Covered |
| Department of Transportation<br>National Highway Traffic Safety Administration<br>Washington, DC 20590 | NHTSA Technical Report |
| | 14. Sponsoring Agency Code |

15. Supplementary Notes

16. Abstract

The National Highway Traffic Safety Administration (NHTSA) began to evaluate the cost of its Federal Motor Vehicle Safety Standards (FMVSS) in 1975. The agency's contractors perform detailed engineering "teardown" analyses, for representative samples of vehicles, to estimate how much specific FMVSS add to the weight and the retail price of a vehicle. This process is also known as "reverse engineering." By July 2004, NHTSA and its contractors had evaluated virtually all the cost-and weight-adding technologies introduced by 2001 in passenger cars and light trucks (including pickup trucks, sport utility vehicles, minivans, and full-size vans) in response to the FMVSS. The agency is now ready to estimate the cost and weight added by all the FMVSS, and by each individual FMVSS, to model year 2001 passenger cars and light trucks, and also in all earlier model years, back to 1968. NHTSA estimates that the FMVSS added an average of $839 (in 2002 dollars) and 125 pounds to the average passenger car in model year 2001. Approximately four percent of the cost and four percent of the weight of a new passenger car could be attributed to the FMVSS. An average of $711 (in 2002 dollars) and 86 pounds was added to the average light truck in model year 2001. Approximately three percent of the cost and two percent of the weight of a new truck could be attributed to the FMVSS.

| 17. Key Words | 18. Distribution Statement |
|---|---|
| FMVSS; cost analysis; teardown; reverse engineering | Document is available to the public through the National Technical Information Service, Springfield, Virginia 22161 |

| 19. Security Classif. (Of this report) | 20. Security Classif. (Of this page) | 21. No. of Pages | 22. Price |
|---|---|---|---|
| Unclassified | Unclassified | 168 | |

**Form DOT F 1700.7** (8-72) **Reproduction of completed page authorized**

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## *ACKNOWLEDGEMENTS*

In 1975, NHTSA proposed to evaluate the costs as well as the benefits of existing Federal Motor Vehicle Safety Standards (FMVSS). Warren LaHeist, under the general direction of Frank Ephraim, planned to estimate costs based on "teardown" or "reverse engineering." The first contract to evaluate costs of specific FMVSS was awarded in 1977 and completed in 1978. During 1978-2001, Robert Lemmer, Bruce Spinney, Gregory Rymarz, or Mr. LaHeist managed the cost-analysis program. Mr. Spinney also developed NHTSA's "macro-analysis" for computing mark-ups from direct costs to final consumer costs.

A report summarizing the cost analyses and estimating the overall consumer cost of the FMVSS was proposed first in NHTSA's 1998-2002 Evaluation Plan and again in the 2004-2007 plan. Mr. LaHeist outlined the report in 1998-1999 and drafted text for some of the FMVSS. After Mr. LaHeist retired, Mr. Rymarz worked up initial spreadsheets and/or text for many of the remaining FMVSS in 1999-2001. I was assigned to the cost-analysis program, as well as this report, when I joined NHTSA in 2002.

## *EXECUTIVE SUMMARY*

The National Highway Traffic Safety Administration (NHTSA) issues Federal Motor Vehicle Safety Standards (FMVSS) for new motor vehicles and equipment to reduce the number of crashes and the risk of deaths and injuries. The 100-series FMVSS are crash avoidance standards, the 200-series regulates crashworthiness, while the 300-, 400- and 500-series address the risk of fires, hazards during normal operation, and certain special vehicles. Manufacturers of new vehicles and equipment must conform and certify compliance to the FMVSS. The initial FMVSS went into effect on January 1, 1968.

NHTSA began to evaluate the cost of the FMVSS in 1975. The agency's contractors perform detailed engineering "teardown" analyses, for representative samples of vehicles, to estimate how much specific FMVSS add to the weight and the retail price of a vehicle. These analyses employ a process known as "reverse engineering." Whereas conventional engineering proceeds from design and raw materials to mass-produced product, reverse engineering includes a step-by-step teardown or disassembly of each finished item into sub-assemblies and finally into individual component parts. The contractor weighs the components, identifies the type, unit cost and amount of raw material needed, and estimates the labor, variable burden, and tooling required to produce individual components and assemble them. In addition to these direct variable costs, the contractor estimates the mark-ups to the consumer's full cost.

By July 2004, NHTSA and its contractors had evaluated virtually all the cost- and weight-adding technologies introduced by 2001 in passenger cars and light trucks (including pickup trucks, sport utility vehicles, minivans, and full-size vans) in response to the FMVSS. The agency is now ready to estimate the cost and weight added by all the FMVSS, and by each individual FMVSS, to model year 2001 passenger cars and light trucks, and also in all earlier model years, back to 1968. All costs are estimated in 2002 dollars. Upon publication of this report, NHTSA will also make available to the public all the contractor studies completed to date.

The cost of a FMVSS, in this report, includes the cost of all equipment added or modified primarily for the purpose of meeting (or even exceeding) the requirements of the standard, provided these modifications took place on or after the effective date, or even before the effective date if NHTSA had a rulemaking process underway and there was a clear anticipation of the standard. (But if safety equipment was already in place well before any rulemaking process, and was not modified in response to any FMVSS, its cost will not be attributed to the FMVSS.) The cost of a FMVSS is the incremental cost over the equipment that was there before the standard and likely would have remained there without the standard. In addition, the cost of a FMVSS may change over time, as a result of more efficient design, new types of materials, or vehicle downsizing (if the weight of the equipment is proportional to the weight of the vehicle).

The report does not include technologies so recent that NHTSA has not yet completed its cost analysis, such as side air bags and head air bags. Furthermore, the report is limited to passenger cars and light trucks; the cost of FMVSS in heavy trucks, buses or motorcycles has not been estimated.

***The Cost and Weight Added by the FMVSS in Model Year 2001***. NHTSA estimates that the FMVSS added an average of $839 (in 2002 dollars) and 125 pounds to the average passenger car in model year 2001. Since passenger cars cost an average of $21,217 (in 2002 dollars) and weighed 3,148 pounds in model year 2001, approximately four percent of the cost and four percent of the weight of a new passenger car could be attributed to the FMVSS. An average of $711 (in 2002 dollars) and 86 pounds was added to the average light truck in model year 2001. With light trucks costing an average of $23,995 (in 2002 dollars) and weighing 4,238 pounds in model year 2001, approximately three percent of the cost and two percent of the weight of a new truck could be attributed to the FMVSS.[1] Table 1 itemizes the cost and weight added by the FMVSS, or by specific safety technologies associated with these FMVSS, to passenger cars and light trucks in model year 2001.

***TABLE 1***
***COST (IN 2002 DOLLARS) AND WEIGHT (IN POUNDS)***
***ADDED BY THE FMVSS IN MODEL YEAR 2001***[2]

| FMVSS | DESCRIPTION | PASSENGER CARS | | LIGHT TRUCKS | |
|---|---|---|---|---|---|
| | | COST | WEIGHT | COST | WEIGHT |
| 104 | Windshield Wipers and Washers | | | | |
| | *Dual speed wipers, washers* | | | $15.05 | 2.10 |
| 105 | Hydraulic Brake System | | | | |
| | *Dual master cylinders* | $10.88 | 0.95 | 11.00 | 0.96 |
| 108 | Lamps | | | | |
| | *Side marker lamps* | 29.37 | 1.95 | 29.37 | 1.95 |
| | *Center high mounted stop lamps* | 9.74 | 0.85 | 9.74 | 0.85 |
| 118 | Power-Operated Window | | | | |
| | *Circuit breaker* | 0.78 | 0.03 | 0.77 | 0.03 |
| 124 | Accelerator Control System | 0.47 | 0.02 | 0.47 | 0.02 |
| 201 | Occupant Protection in Interior Impact (1968/1981 Standard) | | | | |
| | *Seat back padding* | 4.44 | 0.66 | 11.25 | 3.15 |
| 202 | Head Restraints | 30.89 | 5.63 | 30.97 | 3.98 |
| 203/204 | Occupant Protection from the Steering Control System | 27.45 | 1.89 | 27.45 | 1.89 |
| 207 | Seating Systems | | | | |
| | *Seat back locks* | 3.22 | 0.79 | | |
| 208 | Occupant Crash Protection | | | | |
| | *Safety belts* | 124.63 | 18.38 | 137.57 | 18.41 |
| | *Dual air bags* | 396.72 | 26.76 | 382.52 | 26.40 |
| | *On/off switches* | | | 8.75 | 0.20 |
| 214 | Side Impact Protection | | | | |
| | *Static test* | 51.21 | 24.81 | 29.44 | 23.76 |
| | *Dynamic test* | 129.35 | 37.31 | | |
| 216 | Roof Crush Resistance | 3.47 | 2.93 | | |
| 301 | Fuel System Integrity | 16.51 | 2.48 | 16.51 | 2.48 |
| TOTAL | | $839.13 | 125.44 | $710.86 | 86.18 |

[1] The average cost of the 2001 passenger cars and light trucks are based on the Manufacturer's Suggested Retail Price (MSRP). The MSRP cost for the 2001 passenger car and light truck does not include price reductions such as rebates or incentives offered by the dealer and/or the manufacturer, nor does it include price additions such as added charges and optional features.

[2] Average cost and weight per model year 2001 vehicle. For example, if a safety device costs $100 and 50% of the vehicles are equipped with it; the average cost per vehicle is $50.

Those technologies that contributed most significantly to the cost and weight of a passenger car and light truck in 2001 are:

- ***Safety Belts***. The primary component of the occupant protection system is the safety belt. They are highly effective in saving lives and preventing serious injuries in rollovers, frontal crashes, and many types of side impacts. Safety belts evolved from lap belts with manual adjustments to manual 3-point belts that combine the lap belt and shoulder harness into a single device with locking retractors. All front and rear outboard seats are now equipped with manual 3-point belts. These technologies add $124.63 and 18.38 pounds to passenger cars and $137.57 and 18.41 pounds to light trucks.

- ***Frontal Air Bags***. By the late 1990's, passenger cars and light trucks were equipped with a frontal air bag and a manual lap/shoulder belt at both the driver's and right front passenger's seating position. The air bags are designed to save lives and prevent injuries by cushioning occupants as they move forward in a frontal crash, reducing the likelihood of injury to an occupant's head, neck, face, chest, and abdomen. Dual air bags add $396.72 and 26.76 pounds to passenger cars and $382.52 and 26.40 pounds to light trucks.

- ***Side Impact Protection***. Vehicle side structures are substantially reinforced and padded to meet NHTSA's static crush tests and dynamic crash tests and reduce the risk of serious and fatal injury to occupants in side impact crashes. These changes add $180.56 and 62.12 pounds to passenger cars and $29.44 and 23.76 pounds to light trucks.

- ***Lamps***. Side marker lamps and center high mounted stop lamps (CHMSL) are two new lighting systems required by FMVSS 108. Side marker lamps make it easier to see the side of another vehicle in the dark. CHMSL send an additional message to following vehicles that they must slow down. These lamps add a total of $39.11 and 2.80 pounds to passenger cars and light trucks.

- ***Head Restraints***. Adjustable or fixed head restraints are required at the front outboard seat positions to reduce the frequency and severity of neck injuries, specifically "whiplash", in rear-end and other collisions. Implementation of the head restraints adds $30.89 and 5.63 pounds to passenger cars and $30.97 and 3.98 pounds to light trucks.

- ***Energy Absorbing Assemblies.*** FMVSS 203 requires that the steering control systems yield forward to cushion the impact of a front-end crash on the driver's chest and FMVSS 204 limits the rearward displacement of the steering column into the passenger compartment after a frontal impact. These changes add $27.45 and 1.89 pounds to passenger cars and light trucks.

***Historical trend of the cost and weight added by the FMVSS for model years 1968-2001***. The initial FMVSS of 1968 added $169 and 18 pounds to the average passenger car in model year 1968. By model year 2001, the cost had grown to $839 (in constant, 2002 dollars) and the weight to 125 pounds. In light trucks, the cost and weight of the FMVSS grew from $107 and 11 pounds in 1968 to $711 and 86 pounds in 2001. Table 2 shows the cost and weight added by the FMVSS in vehicles of each model year from 1968 to 2001.

***TABLE 2***
***COST (IN 2002 DOLLARS) AND WEIGHT (IN POUNDS) ADDED BY THE FMVSS FOR MODEL YEARS 1968-2001***

| MODEL YEAR | PASSENGER CARS | | LIGHT TRUCKS | |
|---|---|---|---|---|
| | COST | WEIGHT | COST | WEIGHT |
| 1968 | $169.24 | 18.39 | $106.58 | 10.51 |
| 1969 | $216.05 | 33.15 | $106.64 | 10.52 |
| 1970 | $236.02 | 40.21 | $115.95 | 11.07 |
| 1971 | $241.47 | 43.35 | $116.24 | 11.10 |
| 1972 | $268.24 | 49.82 | $142.26 | 15.90 |
| 1973 | $291.23 | 63.09 | $154.61 | 16.75 |
| 1974 | $301.97 | 70.48 | $160.79 | 17.59 |
| 1975 | $299.54 | 68.64 | $160.87 | 17.61 |
| 1976 | $312.58 | 69.07 | $162.27 | 17.71 |
| 1977 | $306.66 | 66.68 | $173.14 | 19.02 |
| 1978 | $302.85 | 64.41 | $189.14 | 21.46 |
| 1979 | $299.58 | 62.33 | $191.06 | 21.59 |
| 1980 | $298.26 | 62.33 | $195.96 | 21.96 |
| 1981 | $297.87 | 61.33 | $196.63 | 22.02 |
| 1982 | $297.25 | 60.72 | $206.92 | 23.68 |
| 1983 | $297.61 | 60.38 | $212.12 | 24.35 |
| 1984 | $297.66 | 60.42 | $214.28 | 24.61 |
| 1985 | $298.29 | 60.24 | $216.33 | 24.88 |
| 1986 | $299.50 | 60.20 | $216.81 | 24.94 |
| 1987 | $338.32 | 63.14 | $233.52 | 27.23 |
| 1988 | $380.42 | 66.84 | $232.58 | 27.12 |
| 1989 | $421.31 | 70.18 | $232.42 | 27.20 |
| 1990 | $596.71 | 82.02 | $236.15 | 27.70 |
| 1991 | $593.10 | 80.13 | $250.26 | 30.45 |
| 1992 | $607.59 | 79.76 | $294.29 | 34.70 |
| 1993 | $650.01 | 82.76 | $308.55 | 36.81 |
| 1994 | $752.09 | 93.66 | $389.49 | 60.69 |
| 1995 | $777.93 | 99.96 | $547.71 | 72.67 |
| 1996 | $782.84 | 104.50 | $612.52 | 77.53 |
| 1997 | $838.81 | 125.34 | $658.58 | 81.79 |
| 1998 | $839.18 | 125.47 | $705.27 | 85.73 |
| 1999 | $839.16 | 125.46 | $708.22 | 85.93 |
| 2000 | $839.29 | 125.51 | $709.39 | 86.04 |
| 2001 | $839.13 | 125.44 | $710.86 | 86.18 |

The safety technologies installed in passenger cars by model year 1968, responding to the initial FMVSS of January 1, 1968, included lap/shoulder or lap belts at all seat positions, energy-absorbing steering assemblies, dual master cylinders, and seat back locks, among others. In addition, model year 1968 passenger cars were equipped with side marker lamps, anticipating a requirement that would take effect on January 1, 1969. These technologies added $169 (in 2002 dollars) and 18 pounds to model year 1968 passenger cars.

By model year 1974, cost had increased to $302 and weight to 70 pounds. Side door beams were installed in response to the original static crush requirement of FMVSS 214. Front-outboard seats were equipped with head restraints. Safety belts were substantially upgraded: drivers and right-front passengers received integral 3-point belts with locking retractors, and rear-outboard lap belts were equipped with retractors.

Cost and weight in passenger cars changed little from 1974 to 1986, as no major new FMVSS went into effect.

Cost increased from $300 in 1986 to $752 in 1994, and weight from 60 to 94 pounds, primarily due to the automatic occupant protection requirements of FMVSS 208. The increase was gradual over that time period. Automatic protection was phased in from model year 1987 to 1990. Then, especially in 1991-94, manufacturers shifted to more effective, but more expensive types of automatic protection: from automatic belts, to driver air bags, to dual frontal air bags.

The dynamic crash test requirement of FMVSS 214 phased in a substantial upgrading and padding of side structures during 1994-97. The total cost of the FMVSS increased to $839, and their weight to 125 pounds by 2001.

Most of the FMVSS were extended from passenger cars to light trucks, but only after they had been in effect on passenger cars for some years. Many safety technologies were installed in light trucks later than in passenger cars, typically after they had been required in passenger cars but before the FMVSS were extended to light trucks. In model year 1968, safety equipment added $107 and 11 pounds to light trucks. However, most of this equipment, including lap belts and dual master cylinders, was not actually required by the FMVSS in trucks at that time, only in passenger cars.

Cost had increased to $189 by 1978 and weight to 21 pounds. By then, most light trucks had been equipped with 3-point belts and retractors at the front-outboard positions and energy-absorbing steering assemblies. Cost continued to increase gradually to $250 in 1991, and weight to 30 pounds, as more of the basic FMVSS were extended to light trucks.

The installation of frontal air bags for drivers in 1992-96, and the addition of passenger air bags in 1994-98 increased the total cost of the FMVSS in light trucks to $711 and their weight to 86 pounds by 2001.

## *FEDERAL MOTOR VEHICLE SAFETY STANDARDS*

## *SECTION 1 – BACKGROUND AND METHODOLOGY*

The National Highway Traffic Safety Administration (NHTSA) has a legislative mandate under Title 49 of the United States Code, Chapter 301, Motor Vehicle Safety, to issue Federal Motor Vehicle Safety Standards (FMVSS) and Regulations to which manufacturers of motor vehicles and equipment must conform and certify compliance. Chapter 301 defines a FMVSS as a "minimum standard for motor vehicle performance or motor vehicle equipment performance that is practicable, meets the need for motor vehicle safety, and provides objective criteria.[1]" The requirements are specified in such a manner "that the public is protected against unreasonable risk of crashes occurring as a result of the design, construction, or performance of motor vehicles and is also protected against unreasonable risk of death or injury in the event crashes do occur.[2]"

NHTSA has a comprehensive program to evaluate existing motor vehicle regulations to determine their effectiveness, benefits, and costs.[3] The program includes evaluation of the weight and initial consumer cost of components that have been modified or added to motor vehicles in order to comply with the performance requirements of existing regulations. Since the late 1970's, NHTSA has sponsored cost studies of automotive safety equipment, and contractors have performed detailed engineering "teardown" analyses to provide definitive cost and weight estimates of this equipment. Results from these various analyses have been scattered among many hard-copy contractor's reports, using different economic years and sometimes-inconsistent methods of averaging costs across models.

The objective of this report is to estimate the overall cost of the FMVSS and the cost of each standard with a uniform methodology. Cost and weight data for the major components of the motor vehicle equipment will be extracted from contractor and NHTSA reports and compiled into a summary report. Care will be taken to determine the economic year used for the cost data in each study. All cost data will then be brought to the most recent full economic year using the gross domestic product implicit price deflator from the Bureau of Economic Analysis. The report will also describe what vehicle modifications were made in response to the various FMVSS and explain how the cost estimates were derived. In addition, the report will estimate the total cost of meeting the FMVSS in passenger cars and light trucks, with the year-by-year breakdown of the cost and weight per passenger car and light truck from 1968 thru 2001. Finally, previously unreleased contractor studies will be made available and accessible to the public.

This report is limited to initial consumer costs of FMVSS, i.e., the likely effect of the FMVSS on the initial purchase price of a vehicle. Lifetime costs for maintaining or, when necessary, replacing components are not included; however, these costs tend to be negligible for most FMVSS.

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[1] Legal citation: *49 Code of Federal Regulations (CFR) 1.50* (2004).
[2] Ibid.
[3] *National Highway Traffic Safety Administration Evaluation Program Plan Calendar Years 2004-2007*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, January 2004 (DOT HS 809 699).

***The Cost of a FMVSS***. The cost of a FMVSS includes the cost of all equipment added or modified primarily for the purpose of complying with the standard, provided these modifications took place on or after the effective date, or even before the effective date if there was a rulemaking process underway and there was a clear anticipation of the standard. The following factors are considered when determining the cost of a FMVSS:

- If a standard essentially did not change vehicles (i.e., if the equipment was already in place well before any rulemaking process was underway and the standard essentially mandated what had already long been there), this standard does not add cost to the vehicle, and the cost of the equipment that was already there will not be attributed to the FMVSS. For example, every passenger vehicle that came under FMVSS 103 had already been equipped with a windshield defrosting and defogging system long before the standard went into effect, nor is there any evidence that these systems were upgraded to meet the standard.

- If manufacturers voluntarily put the equipment in a few years before the effective date, but after NHTSA announced plans to issue a standard, these costs will be attributed to the standard. For example, manufacturers voluntarily installed side door beams from 1969-1972 even though FMVSS 214 did not take effect until January 1973. Nevertheless, because NHTSA announced its intention to regulate side door strength in October 1968, it would appear that these "voluntary" installations were in fact undertaken in response to, or anticipation of, FMVSS 214.

- Even if the equipment or modification exceeded the minimum requirements of the standard, these costs will nevertheless be attributed to the standard. For example, if a model year 1987-1996 passenger car has air bags, the cost of the air bags will be fully attributed to FMVSS 208 even though at that time they could have also complied with the standard using less expensive automatic belts.

- We have only estimated costs of FMVSS that have permanent costs. If a FMVSS causes momentary redesign costs but ultimately does not result in any new equipment, we have not estimated a cost. For example, the requirements of FMVSS 101 resulted in simply relocating and changing the visual appearance of the controls and displays.

The possibility exists that manufacturers could have eventually added some of the safety equipment currently required by FMVSS even if NHTSA had never issued those FMVSS. Similarly, if an existing FMVSS were to be rescinded, manufacturers might well choose not to stop installing the safety equipment previously required by the FMVSS. However, this report will not speculate on what manufacturers might have added to or deleted from their vehicles in these purely hypothetical scenarios. If the safety equipment was originally installed during or immediately after the rulemaking process, this report will continue to attribute to that FMVSS the cost of that safety equipment, or its successors, in subsequent model years.

The cost of a FMVSS is the incremental cost over the equipment that was there before the FMVSS and likely would have remained there without the FMVSS. For example, a cost of FMVSS 105 is the difference between the costs of dual master cylinders and the single master cylinders that existed in pre-standard vehicles.

However, in the special case where a standard puts in an entirely new type of equipment, the cost of the FMVSS is the full cost of the new equipment. For example, the center high mounted stop lamp was an added-on device and little, if any, change was made to any other part of the vehicle to accommodate the lamp.

The cost of a FMVSS may change over time, as a result of more efficient design, new types of materials, or vehicle downsizing (if the weight of the equipment is proportional to the weight of the vehicle). For example, head restraints became less expensive due to more efficient design, and side door beams due to all of these factors, including vehicle downsizing. We are interested in tracking the costs over time when possible, but in doing so we must also keep in mind what might have happened to the vehicle over time if the FMVSS had never been issued. For example, dual master cylinders became less expensive over time, but we should note that single master cylinders might also have become less expensive.

A FMVSS can only result in added cost or no cost, never a savings. If the new equipment is less expensive, manufacturers could presumably have installed it even without the standard.

***Cost and Weight Analysis Methodology***. The "teardown" or "reverse engineering" methodology typically used by a NHTSA contractor for the collection of cost and weight data is described below.

- ***Cost Study Sampling Plan***. An integrated cost sampling plan is developed to provide for the selection of a group of comparable makes and models that are representative of vehicle systems prior to and after the effective date of the standards. The plan is designed to identify a representative cross-section of vehicle sizes and models, plus design and manufacturing cultural approaches, without the need to individually examine every make-model passenger vehicle produced in the affected years. Make-models of passenger vehicles are selected, and system components purchased, for cost analysis. These make-models should:

    - have over 50,000 annual sales volume
    - include matching pre- and post-standard vehicles of the same make-model (unless the FMVSS resulted strictly in add-on equipment, in which case it is only necessary to sample the post-standard vehicles)
    - represent the variety of designs or differences in the types of parts used to meet the FMVSS
    - represent the major domestic and import auto manufacturers
    - represent vehicle weights or sizes ranging from small to large
    - represent the vehicle types (passenger car, SUV, van, or pickup truck)

- ***Teardown Process***. The cost and weight estimates are based on detailed engineering analysis of the individual pieces and assemblies of which the system is composed, employing a process known as "reverse engineering". Whereas conventional engineering proceeds from design to mass-produced product and proceeds back through the various manufacturing processes to the design, this procedure includes a step-by-step teardown or disassembly of each item into sub-assemblies and finally into individual component parts. The teardown sequence is the reverse of the assembly sequence. The components and parts are carefully cataloged and tagged as they are being disassembled. The parts are gauged, measured, manufacturing method determined, and, if possible, the vendor for outsourced parts identified. Even parts that were welded or irreversibly attached are carefully disassembled. The system components are physically torn down into their most elemental parts to identify the process operation by which each elemental part is made in terms of:

    - labor minutes
    - direct materials and scrap
    - machine occupancy hours or station times
    - machinery, equipment, and tooling utilized

The components are laid out on a pegboard, with one-inch squares, and photographed next to appropriate identification labels so the photos can be compared with the cost estimates.

- ***Technical Analysis***. The parts from the comparable vehicle systems are analyzed (in some contractor reports) to determine:

    - changes between the pre- and post-standard make-models
    - reasons for the changes, i.e., differentiate between changes for meeting the FMVSS and changes for unrelated reasons such as:

        - ♣ styling
        - ♣ cost reduction
        - ♣ product improvement (functional improvements not related to the requirements of the FMVSS)

The net result of the analysis is the accurate and complete identification of all changes in the component parts of the selected systems that are attributable to the requirements of the specified FMVSS.

- ***Cost Analysis***. Costs are determined by production decisions, whereas, prices are the results of marketing decisions based on an assessment of what the traffic will bear when faced with a competitive environment of substitutes. To arrive at a price that will "pass in the trade", the vehicle manufacturer engages in a form of cost/price arbitrage across his entire model lineup. At the low end of the pricing scale, competition from other manufacturers may prevent a company from charging a price sufficient to cover the full cost of producing a vehicle line at planned volumes. However, the company can cover this shortfall in other market segments where competition is less intense by charging prices that, on a volume basis, generate sufficient margins to cover the full costs of a vehicle line plus a contribution to overall corporate overhead and profit that offsets the shortfall.

In developing cost estimates for proposed and existing safety standards, all components identified in the technical analysis that changed because of the implementation of the FMVSS are cost analyzed to determine their consumer price. The cost comparison is performed in two stages. The first (micro-analysis) considers the elements of cost that vary from one part to another, and the second (macro-analysis) considers those elements of cost that do not vary.

- ***Micro-analysis***. The micro-analysis consists of the teardown process itself and the identification of the following costs for each elemental part where applicable:

    - ***Variable Manufacturing Costs***

        - ***Direct material cost*** is estimated by judging the weight of the component in the rough state and multiplying that weight by its cost per pound factor appropriate to the material, gauge, grade, etc.

        - ***Direct labor costs*** are determined by time and motion analysis of each labor input per cycle or operation. Each labor input or operation is timed in terms of labor minutes or fraction thereof. The hourly rate is divided by 60 minutes to obtain labor cost per minute. Labor cost is determined by multiplying labor minutes (usually a fraction) by labor cost per minute

        - ***Variable manufacturing burden***. This accounting classification includes all costs that vary directly with production volume but cannot be specifically attached to each unit of end product. Examples would include electric power, indirect labor such as materials handling, and perishable tools.

    - ***Fixed Burden (Fixed Factory Overhead)***

        - Depreciation per Unit (Allocated)
        - Amortization of Special Tooling per Unit (Allocated)

  Using prevailing labor and material costs, the variable manufacturing costs and total manufacturing costs for each elemental part, component, subassembly, and complete assemblies that constitute each system under study are determined. Specific cost elements that must be isolated and identified include the following:

- direct labor dollars per unit
- direct material costs and scrap allowances per unit
- variable burden cost per unit, including indirect labor and other costs that vary with production volume
- fixed burden per unit
- capital investments required at prevailing annual sales volumes – property, plant, equipment, and tooling
- depreciation schedules for property, plant, and equipment
- amortization schedules for special tooling

Cost estimation is performed using operation worksheets, which identify raw materials, labor, and machine utilization for each operation of the manufacturing process. The worksheets are used to record the component, subassembly, and assembly processing methods. A worksheet is prepared for each part and subassembly. The following items of information are collected on each operation worksheet:

- identifying numbers
- material type, gauge, quality, blank size
- finished weight
- rough weight
- percent scrap
- production volume
- tooling cost and amortization
- number of parts per safety system
- operations
- type of equipment pieces per hour
- number of machines
- made in-house or purchased

The manufacturing operations are determined, their operation numbers are listed, and the operations described on the worksheet. Various equipment stations in the manufacturing plan are associated with each operation. Their codes are listed, as well as the pieces per hour, for the equipment. Next the estimator must determine the number of machines required for the operation. There is an interaction between the number of people and the number of machines a person can operate. To determine the labor per part requires estimating this interaction. In addition to estimating the cost of individual parts, the cost of assembling parts into subassemblies and assemblies, where appropriate, is developed by determining the operations necessary to achieve the assemblies. The variable cost includes only those costs associated with the manufacture of the part or assembly, i.e., direct labor and direct material costs associated with making the part or assembly. Also included in the variable cost is the variable burden, which includes such things as set-up costs, inbound freight, perishable production tools, and other miscellaneous costs that vary with production volume changes.

- ***Macro-analysis***. The macro-analysis develops the pricing template used to derive the estimated retail price impact of safety requirements imposed by NHTSA. The teardown process described above does not isolate all of the elements that must be accounted for in order to arrive at a price that covers full cost plus profit margin. Discretionary costs such as Selling, General, and Administration; Research and Development; Taxes Other Than Income; Pension Expense; and Plant Maintenance and Repair must be allocated to each unit of product. Furthermore, after covering Discretionary Costs, there should be sufficient residual for Income Taxes and a bottom line Net Profit.[4]

***Accounting Basis for the Macro-Analysis***[5]

Over the last 30 years, NHTSA has developed and refined a technique for approximating the pricing structure of automotive manufacturers. This technique involves the derivation of markup factors from financial analysis of company income statements and consists of isolating the major corporate cost and expense accounts and rearranging them according to a template that reflects cost behavior rather than Generally Accepted Accounting Principles (GAAP). Under the behavioral approach, costs and expenses are defined as variable, fixed, or discretionary.

Variable costs (or variable manufacturing costs) are defined as costs that are constant per unit of input but vary 6directly in total with changes in production volume. Direct labor, direct material, and variable burden all fit this definition. Fixed costs are constant in total regardless of volume. The only true fixed costs are depreciation and amortization. Most factory and corporate overhead accounts costs have a fixed component and a variable component that can increase or decrease at management's discretion—hence the name discretionary costs.

Variable manufacturing costs are engineered into the production process and cannot be changed to an appreciable degree on a per unit basis at planned production volumes. On the other hand, fixed costs and discretionary costs can be allocated on a per unit basis according to a rationale of management's choosing. It is this allocation process that establishes the pricing structure of the company. In order to approximate this allocation process, variable costs must be isolated to the degree possible from fixed and discretionary costs.

Income statements prepared according to GAAP do not segregate cost and expense accounts based on behavior. The "Cost of Sales" account, for example, includes both variable and discretionary costs. In order to approximate the cost/price arbitrage process, the variable manufacturing costs must be segregated from fixed and discretionary costs. Through analysis of Form 10-K Corporate Annual Reports filed annually with the Securities Exchange Commission by domestic manufacturers, NHTSA has isolated three discretionary cost accounts to be subtracted from "Costs of Sales":

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[4] Spinney, B.C., *Development of Markup Rates for Regulatory Cost Analysis that Approximate Industry Pricing Practices*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration Internal Document, February 1989, 1-2.

[5] Ibid.

- Maintenance and Repairs
- Research and Development
- Taxes Other Than Income

Upon subtraction, the three accounts are reclassified under the general head of Fixed/Discretionary Costs. The remainder of "Costs of Sales" constitutes estimated Variable Manufacturing Costs.

Each manufacturer's income statement is reformatted according to this methodology and the process is called common sizing. The result is a template that enables the analyst to study a company's cost structure and compare it against competitors. The completed template is shown below:

SAMPLE COST/PRICE CORPORATE TEMPLATE

***(Manufacturing Operations Exclusive of Financing Subsidiaries)***

| | | |
|---|---|---|
| Net Sales | $100,000,000 | 100.0% |
| Variable Manufacturing Costs | 74,000,000 | 74.0% |
| Contribution Margin | $ 26,000,000 | 26.0% |
| Fixed/Discretionary Costs: | | |
| Maintenance and Repairs | $ 3,500,000 | 3.5% |
| Research and Development | 3,000,000 | 3.0% |
| Taxes other than Income | 2,000,000 | 2.0% |
| Selling, General, & Administration | 7,000,000 | 7.0% |
| Pension Costs | 2,000,000 | 2.0% |
| Depreciation | 3,500,000 | 3.5% |
| Amortization of Special Tooling | 2,500,000 | 2.5% |
| Amortization of Intangibles | 500,000 | 0.5% |
| Total Fixed/Discretionary Costs | $ 24,000.000 | 24.0% |
| Income from Continuing Operations | $ 2,000,000 | 2.0% |
| Other Income (Expense)-Net | 1,000,000 | 1.0% |
| Income before Interest and Taxes | $ 3,000.000 | 3.0% |
| Interest Income (Expense)-Net | (500,000) | 0.5% |
| Income before Income Taxes | $ 2,500,000 | 2.5% |
| Income Tax Expense (Credit) | 875,000 | 0.9% |
| Net Income | $ 1,625,000 | 1.6% |

(Note: The dollar amounts are hypothetical, however, the percentages of sales for each account reflect long-run weighted averages of the "Big Three")

The key to NHTSA's pricing template lies in the relationship between net sales, variable costs, and contribution margin. Net sales represents total wholesale revenue less returns and allowances. Variable costs have been defined above and account for 74% of net sales. The contribution margin rate of 26% on sales represents the remainder left for fixed/discretionary cost coverage.  Since the template reflects company-wide operations, by definition it reflects the fixed/discretionary cost/price recovery arbitrage process across all product lines whereby a manufacturer meets its profit objectives at expected volumes.

Thus, the pricing formula used by NHTSA to approximate wholesale price for a new safety feature only includes variable costs, which are determined by detailed analysis of the production process, and a markup percentage on variable costs equal to the corporate wide contribution margin rate.  If variable costs account for 74% of sales and contribution margin accounts for 26%, then the markup rate on variable costs to wholesale price would be 35% (26% / 74%).  The markup factor would be 1.35.

To arrive at MSRP, wholesale price needs to be marked up to cover the dealer margin. Currently, dealer margin is about 11% on wholesale on a fleet-wide weighted average basis.  The completed pricing formula is:

Variable costs * 1.35 * 1.11          ***OR***          Variable costs * 1.50

***Inconsistencies and Variations in Contractors' Approaches to Estimating the Cost and Weight of a FMVSS***

- ***Selection of Vehicles/Definition of "Effect of the FMVSS"***
    - The contractor tore down pre-, as well as, post-standard vehicles.  Costs attributed to the standard are allocated based on the following criteria:
        - Without further analysis, the contractor attributed the entire difference in the cost and weight of the pre- and post-standard subsystems to the standard.  For example, with FMVSS 216, some motor vehicles were redesigned in the year the standard took effect.  The cost of styling-related changes was included in the cost of the standard.
        - Only part of the difference is attributed to the standard, while the rest of the difference is attributed to styling, product improvement, or other factors unrelated to the FMVSS.  For example, with FMVSS 201, a comparison of various interior structures in pre- and post-standard passenger cars indicated that costs in some structures might be consistently higher for the post-standard specimens, which probably indicates they were modified because of the standard.  However, costs in other structures went up in some specimens and down in others, which indicates the modifications were merely for styling or production efficient and not needed for meeting the standard.
    - The contractor only performed the physical teardown of post-standard vehicles' subsystems believed to be affected by a FMVSS.  This approach works best for a standard that added on an entire subsystem, with no other change in pre-existing

equipment on other subsystems. However, contractors have also used this approach on other occasions, such as when contract funding was insufficient to study pre-standard vehicles. Costs attributed to the standard are allocated based on the criteria listed below:

- ♣ The full cost of the new equipment is attributed to the FMVSS, because the cost in the pre-standard vehicle is zero. For example, with FMVSS 108, center high mounted stop lamps were added as standard equipment in model year 1986 to reduce rear-impact crashes, but did not result in changes to any other rear lighting system.

- ♣ The contractor does not attribute the full cost of the equipment to the FMVSS, because the contractor asserts or assumes that some of this equipment either already existed in the pre-standard vehicle (although no such vehicles were torn down) or was not added because of the FMVSS, but for some other reason. For example, with the FMVSS 214 upgrade dynamic test requirement, some of the components partially contributed to both pre- and post-revision requirements of FMVSS 214. The contractor used engineering evaluation and judgment to assign a percentage of the identified costs as a contribution towards the additional requirements imposed by the revised standard.

- ♣ The contractor limited the teardowns to post-standard vehicles, even though the equipment was not strictly an add-on, and did not even discuss what parts were there before the standard was implemented, or if the new equipment was safety related. For example, with FMVSS 201, a study of the interior components of 1982 model year trucks was conducted to determine the impact of the standard on light trucks. No pre-standard make-models were studied to serve as a baseline. Since some of the make-models were extensively redesigned in 1982, the contractor was unable to directly compare the components of the pre- and post-standard light trucks and did not estimate the average cost increase.

- ***Teardown Sample Selection***. Some contractors selected a sample of motor vehicles too small to make a meaningful sales-weighted average. To calculate a sales-weighted average, six or more vehicles should be in the sample selection; otherwise, an arithmetic average will be calculated on five vehicles or less. In addition, even a larger sample size can be too small if it does not adequately represent a cross-section of vehicle sizes, body styles, and manufacturers. For example, with FMVSS 214, an analysis of the impact of the dynamic requirements on two-door passenger cars was conducted on only two import cars representing the compact and midsize categories.

- ***Inconsistency in Vehicle Sales Data***. Contractors sales-weighted their data using calendar year production, calendar-year sales, or model-year registrations.

- ***Averaging the Costs Across Make-Models***. Contractors sometimes computed sales-weighted averages of the costs of the make-models they tore down in order to produce a single estimate of the cost of the FMVSS. Sales data by make-model were obtained from various sources, and "makes-models" sometimes, but not always, included vehicles of similar design but with different names (e.g., Ford Taurus and Mercury Sable). In some cases, these sales-weighted averages were based on too few models (e.g., two or three) to be statistically meaningful.

- ***Follow-Up Cost Studies***. NHTSA sometimes awarded follow-up contracts to determine if the cost of safety equipment had changed after a number of model years due to factors such as: more efficient design, vehicle downsizing, availability of new materials. These analyses were limited to teardowns of the recent model year vehicles, and did not include teardowns of pre-standard vehicles for comparison purposes.

- ***Definition of Pre- and Post-FMVSS***. Some contractor reports used the model year immediately before the FMVSS as the "pre-standard" model year. Their rationale was that if manufacturers complied with the standard in that year, their modifications were "voluntary" and should not be attributed to the standard. Other contractors used a model year several years before the standard as the "pre-standard" model year.

- ***Different Economic Years***. All estimated costs were based on specific U.S. model production year economics that, of course, depended on when the contractor did the study.

***Methods Used in This Report to Make the Estimates More Uniform***

- ***Criteria for Averaging Costs Across the Make-Models in the Teardown Sample***

    - If the teardown sample is reasonably large (six or more vehicles) and reasonably representative of the vehicles on the road, we will use only sales-weighted averaging. Otherwise, we will take a simple arithmetic average of the costs in the teardown sample.

    - A sales-weighted average for the cost and weight figures of the make-models studied is calculated to provide a more accurate representation of the average price differentials. This is accomplished by multiplying the cost and weight figures of each make-model by a "weight" relevant to its importance, adding the results, and dividing the total by the sum of the weights. The "weight" in this instance is the volume figures based on the new passenger vehicle registrations for each make-model studied. The volume figures for the 1965-1974 model years were obtained from Ward's Automotive Yearbook[7] and the volume figures for the 1975 model year on up were obtained from the R.L. Polk National Vehicle Population Profile.[8]

[7] Ward's Automotive Yearbook, Annual Publication, Detroit: Ward's Communications.
[8] National Vehicle Population Profile, Annual Publication, Detroit: R.L. Polk & Company.

- If we can reasonably expect the same type of equipment in two make-models of similar design with different names (e.g., Ford Taurus and Mercury Sable), we will do sales-weighted averaging by fundamental car groups. This method was used for the FMVSS 214 side door beams.

  Fundamental car/truck groups are composed of passenger vehicles that have the same automotive manufacturer, belong to the same functional class, and have the same wheelbase. NHTSA staff has defined the fundamental car/truck groups, and have used these classifications in several evaluation reports. The criterion to use the fundamental car/truck group for the volume figures is based on the premise that the make-models from the same manufacturer utilize common structure and mechanisms for all make-models sharing a common body size. However, these vehicles are not necessarily "identical" except for the nameplate and may vary to some extent in weight or appearance.

- If the equipment, however, might not be the same because it is tied into the appearance of the vehicle or for others reasons (consumer preference, vehicle manufacturer design choices), we will sales-weight by sales for the specific make-model in the tear down sample. For example, with FMVSS 202, vehicle manufacturers installed adjustable or nonadjustable (integral or fixed) head restraints in response to the standard.

- If the contractor has looked at a number of pre- and post-standard vehicles, we will take a sales-weighted average of only the make-models where there are matching pre- and post-standard vehicles. We will then weight the difference between the pre- and post-standard costs in each of these matched pairs by the sales of the post-standard vehicles. If we can't do all of this, we will just take the simple arithmetic averages, otherwise we run the risk of getting spurious costs due to shifts in the sales mix.

- In general, if the contractor has looked at pre- and post-standard vehicles, we will take the incremental cost difference between the two. However, there are certain cases where this gives too low an estimate, because even the equipment in the "pre-standard" vehicle was added after the rulemaking process began. In those cases, we will use the full cost of the equipment in the post-standard vehicles like we did for FMVSS 214 side door beams in light trucks.

- ***<u>FMVSS Modifications vs. Redesigns Unrelated to FMVSS</u>***

  - If the contractor has attributed to the FMVSS costs that are plainly due to other redesign reasons, we will deduct those costs if that is simple to do. For example, with FMVSS 214, changes in the body pillars of 1973 make-model passenger cars were a result of model redesign and not directly related to the standard; therefore, the weight and consumer cost for them were not included in the side door strength calculations.

- If there is no simple way to do it, we may limit ourselves to the make-models in the contractor's sample that we know were not redesigned in the year the FMVSS went into effect. For example, by singling out only the pre- and post-standard FMVSS 216 make-models that did not receive any overall redesign, it is plausible that any changes were specifically due to standard.

- ***Linear Interpolation When Costs Change Over Time***. If we have two cost estimates for the standard, i.e., $20 in 1980 and $10 in 1990; and, unless we have additional information that pinpoints the time of the cost reduction, we will assume a standard cost of $20 each year until 1980, a declining linear rate (in this case, $1 per year) from 1980 to 1990, and then a cost of $10 each year from 1990 onward.

- ***Adjusting for Inflation***: The labor and material rates used by contractors to estimate the costs were compiled from publicly available sources such as the U.S. Department of Labor, Bureau of Labor (under Employment, Hours, and Earning), and from union contracts. Material costs were determined from the contemporary market price for the appropriate material. These costs are based on U.S. automotive (Detroit, Michigan area) manufacturing practices, labor rates, material costs, and tooling/equipment costs. This information is publicly available in the Commodity Research Bureau (CRB) Commodities Yearbook as well as automotive union contracts. The labor and material rates were updated periodically, and each cost study was based on a given economic year.

  In this report, all cost data have been inflated to 2002 dollars. Even though a particular standard may have been studied in an earlier economic year, using the gross domestic product implicit price deflator adjustments can bring the original cost data to 2002 economics. For example, the first study done for Planning, Evaluation, and Budget was in 1978 economics. The implicit price deflator for 1978 is 45.757 and 103.945 for 2002. To bring the 1978 data to 2002 economics, the original cost estimates are multiplied by the factor of 103.945/45.757 (the ratio of the implicit price deflator for 2002 relative to that of 1978).[9] The indexes for 1976-2002 are listed on the next page:

[9] Bureau of Economic Analysis [online]; available from http://www.bea.doc.gov/bea/dn/nipaweb/AllTables.asp.

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| ***GROSS DOMESTIC PRODUCT IMPLICIT PRICE DEFLATOR (2000 BASE)*** | |
|---|---|
| YEAR | PRICE DEFLATOR |
| 1976 | 40.196 |
| 1977 | 42.752 |
| 1978 | 45.757 |
| 1979 | 49.548 |
| 1980 | 54.043 |
| 1981 | 59.119 |
| 1982 | 62.726 |
| 1983 | 65.207 |
| 1984 | 67.655 |
| 1985 | 69.713 |
| 1986 | 71.250 |
| 1987 | 73.196 |
| 1988 | 75.694 |
| 1989 | 78.556 |
| 1990 | 81.590 |
| 1991 | 84.444 |
| 1992 | 86.385 |
| 1993 | 88.381 |
| 1994 | 90.259 |
| 1995 | 92.106 |
| 1996 | 93.852 |
| 1997 | 95.414 |
| 1998 | 96.472 |
| 1999 | 97.868 |
| 2000 | 100.000 |
| 2001 | 102.373 |
| 2002 | 103.945 |

## *SECTION 2 - FMVSS 100 SERIES*

The FMVSS 100 series specify design and/or performance requirements for vehicles and vehicle subsystems that pertain to crash avoidance. The design-based standards require the presence of certain vehicle subsystems, specify design characteristics (size, shape, color, etc.), and describe how particular subsystems are to function. Thereby, they provide a large degree of uniformity in the operation of all make-models of vehicles. The performance-based standards outline specific capabilities that a vehicle or vehicle subsystem must demonstrate when actively tested. Several of the FMVSS 100 series contain a set of both design-based and performance-based criteria.

### *FMVSS 101 - CONTROLS AND DISPLAYS*

FMVSS 101 became effective on January 1, 1968 and specifies requirements for the location, identification, and illumination of motor vehicle hand-operated controls (steering wheel, horn, ignition, etc.), foot-operated controls (service brake, accelerator, clutch, etc.), and displays (speedometer, turn signal, gear position indicator, etc.). The purpose of this standard is to ensure the accessibility and visibility of motor vehicle controls and displays and to facilitate their selection under daylight and nighttime conditions. The intent of the standard is to reduce the safety hazards caused by the diversion of the driver's attention from the driving task and by mistakes in selecting controls. Furthermore, drivers can more easily operate an unfamiliar vehicle if the controls and displays are in uniform locations with uniform labels. This standard applies to passenger cars, multipurpose passenger vehicles, trucks, and buses.[10]

Most motor vehicles had some form of controls and displays prior to the standard. The requirements resulted in simply relocating and changing the visual appearance of the display. While there may have been a one-time cost in some cases, there is little long-term cost associated with complying with the standard. No cost studies have been performed, and none are planned by the agency.

### *FMVSS 102 - TRANSMISSION SHIFT LEVER SEQUENCE, STARTER INTERLOCK, AND TRANSMISSION BRAKING EFFECT*

FMVSS 102 became effective on January 1, 1968 and specifies the requirements for the transmission shift lever sequence, a starter interlock, and a braking effect of automatic transmissions. The purpose of this standard is to prevent shifting errors in unfamiliar vehicles, or when drivers change from one vehicle to another. It requires a starter interlock to prevent drivers from engaging the starter with the vehicle in a driving gear. It also requires automatic transmissions to have a low gear selection to provide a supplemental braking effect at speeds below 25 miles per hour. For vehicles equipped with manual transmissions, the standard requires a display of the shift pattern that is in the driver's field of view. This standard applies to passenger cars, multipurpose passenger vehicles, trucks, and buses.[11]

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[10] Legal citation: *49 (CFR) 571.101* (2004).
[11] Legal citation: *49 CFR 571.102* (2004).

The standard requires that all shift levers for automatic transmissions have the same clockwise sequence: park, reverse, neutral, drive, and low gear(s). This will reduce the likelihood of shifting errors when drivers change from one vehicle to another. Effective September 23, 1991 the identification of shift lever positions shall be displayed in view of the driver in a single location. Identification of the shift lever pattern for manual transmissions shall be displayed in view of the driver at all times when a driver is present in the driver's seating position. Vehicles with a 3-speed manual transmission that has the standard "H" pattern shift sequence are not required to have a shift pattern display.

While there may have been a one-time cost in some cases, there is little long-term cost associated with complying with the standard. No cost studies have been performed, and none are planned by the agency.

### *FMVSS 103 - WINDSHIELD DEFROSTING AND DEFOGGING SYSTEMS*

FMVSS 103 became effective on January 1, 1968 and specifies requirements for windshield defrosting and defogging systems. The purpose of this standard is to establish minimum capability for all vehicles to assure that windshields will remain clear under conditions in which moisture could adhere to the inside or outside of the windshield. It is based on passenger cars meeting the requirements of the Society of Automotive Engineers (SAE) recommended practices established in 1964. The other vehicle classes under this standard are required to have windshield defrosting and defogging systems; however, no performance requirements are specified. The defrosting and defogging system includes the necessary ducts, baffles, cables, levers, and grilles to direct heated or dehumidified air onto the windshield. This standard applies to passenger cars, multipurpose passenger vehicles, trucks, and buses.[12]

A study of seven pre-standard make-model passenger cars, and their corresponding post-standard systems, revealed minimal design changes resulting in a reduction of average weight and a slight increase of average consumer cost. However, NHTSA has no evidence that these changes were specifically made to meet performance requirements in the standard.[13] Table 103-1 shows the sales-weighted average for the weight and consumer cost of windshield defrosting and defogging systems in pre- and post-standard passenger cars.

***TABLE 103-1***
***AVERAGE WEIGHT AND CONSUMER COST***
***OF WINDSHIELD DEFROSTING AND DEFOGGING SYSTEMS***
***IN PASSENGER CARS***

| MODEL YEAR | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| 1965 (Pre-Standard) | 1.23 | $9.01 |
| 1969 (Post-Standard) | 1.01 | $9.75 |

[12] Legal citation: *49 CFR 571.103* (2004).
[13] Gilmour, J.L., *Consumer Cost Evaluation of Federal Motor Vehicle Safety Standards – FMVSS 103 and 104,* Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, June 1982. (DOT HS 806 205:21-81).

A study of seven 1969 make-model light trucks indicated that the sales-weighted average weight and consumer cost of the defrosting and defogging systems was 3.05 pounds and $10.01 in 2002 dollars.[14] Although not studied, earlier model light trucks were also equipped with these systems.

Since every passenger vehicle that came under the standard was equipped with a windshield defrosting and defogging system before the standard went into effect and NHTSA has no evidence that the minimal design changes between 1965 and 1969 were made to meet the performance tests of the standard, any changes in the weight and consumer cost are not attributed to FMVSS 103.

### *FMVSS 104 - WINDSHIELD WIPING AND WASHING SYSTEMS*

FMVSS 104 became effective on January 1, 1968 and specifies requirements for windshield wiping and washing systems. The standard requires that each vehicle have a power-driven windshield wiping system with two speeds, with the speed of the wiping system independent of the vehicle engine speed and engine load. It essentially mandated electric-powered wiper motors and precluded the early design of wiper systems that were driven by the vehicle's engine vacuum. In addition, each vehicle shall have a windshield washing system that meets the requirements based on SAE recommended practices established in 1965. This standard applies to passenger cars, multipurpose passenger vehicles, trucks, and buses.[15]

## *Passenger Car Studies*

When FMVSS 104 was issued, all passenger cars were equipped with both windshield wiping and washing systems. After studying seven pre-standard 1965 make-model passenger cars, the contractor concluded that the vehicles already complied with the standard.[16] Since every passenger car that came under the standard was equipped with a windshield defrosting and defogging system before the standard went into effect, their weight and consumer cost are not attributed to FMVSS 104.

### *Light Truck Studies*

Seven 1969 make-model light trucks were also studied.[17] The windshield wiping and washing systems, which were not on pre-standard light trucks, were analyzed. The cost of implementing the windshield wiper requirements was determined by comparing the single and multi-speed motors, an additional wire from the switch to the motor, and a switch that was changed from two positions to three positions. In the case of the variable speed motors, a variable switch was substituted for the two-position switch. Table 104-1 shows the sales-weighted average weight

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[14] Gladstone, R., Harvey, M.R., and Lesczhik, J.A., *Estimation of Weight and Consumer Price Relating to the Implementation of FMVSS 201 in Passenger Cars and FMVSS 103 and 104 in Light Trucks,* Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, November 1982. (DOT HS 806 367:2-1 thru 2-6).

[15] Legal citation: *49 CFR 571.104* (2004).

[16] Gilmour, DOT HS 806 205:82-144 (1982).

[17] Gladstone, DOT HS 806 367:3-1 thru 3-23 (1982).

and consumer cost of each system, with the difference being the cost of implementing the windshield wiper requirements.

| ***FMVSS 104-1<br>AVERAGE WEIGHT AND CONSUMER COST<br>OF WINDSHIELD WIPER SYSTEMS IN LIGHT TRUCKS*** | | |
|---|---|---|
| MOTOR TYPE | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
| Single Speed | 2.23 | $19.41 |
| Multi-Speed | 2.72 | $23.43 |
| DIFFERENCE | 0.49 | $ 4.02 |

For the washing systems analysis, the baseline was established as a vehicle without the system, with the components (reservoir, pump, hoses, switch and knob assembly) for the washing system directly related to the implementation of the standard. The sales-weighted average weight and consumer cost was 1.61 pounds and $11.03 in 2002 dollars.

Implementation of the windshield wiper and washer requirements of FMVSS 104 increased the average weight and consumer cost per vehicle. Table 104-2 shows the total weight and consumer cost attributable to FMVSS 104 in light trucks.

| ***FMVSS 104-2<br>AVERAGE WEIGHT AND CONSUMER COST<br>OF WINDSHIELD WIPING AND WASHING SYSTEMS<br>ATTRIBUTABLE TO FMVSS 104 IN LIGHT TRUCKS*** | | |
|---|---|---|
| SYSTEM | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
| Windshield Wiping | 0.49 | $ 4.02 |
| Windshield Washing | 1.61 | $11.03 |
| TOTAL | 2.10 | $15.05 |

## *FMVSS 105 - HYDRAULIC AND ELECTRIC BRAKE SYSTEMS*

FMVSS 105 became effective on January 1, 1968 and specifies requirements for vehicles equipped with hydraulic and electric service brake systems, and associated parking brake systems. The purpose of this standard is to ensure safe braking performance under normal and emergency conditions. This standard applies to:

- hydraulically-braked passenger cars manufactured before September 1, 2000
- hydraulically-braked multipurpose passenger vehicles, trucks, and buses with a Gross Vehicle Weight Rating (GVWR) of 7,716 pounds or less that were manufactured before September 1, 2002
- hydraulically-braked vehicles with a GVWR greater than 7,716 pounds[18]

All hydraulically-braked passenger cars manufactured after September 1, 2000 and hydraulically- braked multipurpose passenger vehicles, trucks, and buses with a GVWR of 7,716 pounds or less that were manufactured after September 1, 2002 are part of FMVSS 135 (Passenger Car Brake Systems).

[18] Legal citation: *49 CFR 571.105* (2004).

## *Passenger Car Studies*

### *Brake System Components*

The brake system components specifically required by FMVSS 105 are a dual or split hydraulic service brake system, parking brake system, and brake system indicator lamp. Particular design characteristics of these components are also governed by this standard. The performance requirements for brake systems consist of a series of stopping tests simulating normal and emergency braking, fade and recovery, water recovery, and partial system failure.

The most important indication of brake performance is the distance in which a brake system can stop a vehicle from a given speed. The performance requirements for the service brake system are expressed in terms of stopping distance and/or deceleration rates from specific vehicle speeds using a specific range of brake pedal apply forces by the vehicle driver. Brake pedal apply force is measured in pounds per foot and is an indication of how hard the vehicle driver's leg pushes against the brake pedal.

Fade and recovery requirements are also included in the standard to assure that a vehicle's braking performance is satisfactory when exposed to the high brake temperatures caused by prolonged or severe use or during the time that the brakes are cooling off after severe use. Fade is the inability of friction material to maintain its normal effectiveness when it is forced to work at elevated temperatures. Recovery is the rate at which the lining returns to its original friction level after having been exposed to a fade condition. Light fade occurs in vehicles even in low speed applications such as in heavy traffic. Moderate to severe fade is a condition that may occur when vehicles are used on hilly or mountainous roads, especially when heavy loads are carried. In addition, water recovery requirements are included in the standard to assure that a vehicle's braking system performs adequately after immersion in water. Finally, partial system failure requirements are included to ensure that a vehicle's brakes are capable of bringing the vehicle to a controlled stop in a reasonable distance if a part of the service brake system should fail.

Each vehicle shall be capable of completing all performance requirements without:

- detachment or fracture of any component of the braking system
- any visible brake fluid or lubricant on the friction surface of the brake or leakage at the master cylinder or brake power unit reservoir cover, seal, and filler openings

FMVSS 105, effective in January 1968, represented the initial Federal effort to specify braking requirements for motor vehicles and required that passenger cars be equipped with a split service brake system and have stopping ability based upon deceleration rates specified in the SAE Recommended Practice J937, June 1966. Requirements for fade and recovery, water recovery, and stability while braking were also included in this standard. These requirements did not represent the full capabilities of modern braking technology; therefore, a new standard (105a) was established in September 1972 specifying requirements for motor vehicle hydraulic brake systems and parking brake systems. Manufacturers had extensive advance knowledge of the upgrade because a Notice of Proposed Rulemaking (NPRM) was issued as early as November 1970. FMVSS 105a was redesignated to 105-75 in February 1974, and with only minor changes in the portion applicable to passenger cars, evolved into the January 1976 requirements.

The principal difference between the 1968 and 1976 standards is that the new regulation specifies the straight-line stopping distances within which a car must stop under good conditions. The older rule merely specified the deceleration rate a car had to attain at some point during braking. Moreover, the stopping distances were set at a level that only half of the 1972 models appeared to be capable of meeting, according to consumer information data submitted to NHTSA by the manufacturers. In other words, it was felt that the new regulation would significantly improve stopping distances over 1972 levels in a large portion of the vehicle fleet. The new regulation requires more stringent partial failure, fade recovery, and water recovery tests than the older rule. In addition, the following requirements for improved handling and stability are added:

- wheel lockup is permitted at a speed below 10 miles per hour
- lockup of only one wheel, not controlled by an antilock system, is permissible at speeds in excess of 10 miles per hour

It is difficult to determine what costs should be attributed to FMVSS 105 because changes in vehicle size, customer preferences, and development of superior materials and designs have all enhanced or changed braking performance, cost, and weight over the years. The four major changes to the braking systems that have occurred during 1965-2001 are dual master cylinders, front disc brakes, brake power assist units, and antilock brake systems (ABS). Only the cost of dual master cylinders is unequivocally attributable to FMVSS 105.

Table 105-1 shows the percentage of domestic cars with these technologies for selected model years.

***TABLE 105–1***
***PERCENT OF DOMESTIC CARS WITH DUAL MASTER CYLINDERS, FRONT DISC BRAKES, POWER BRAKES, AND ABS BY MODEL YEAR***

| MODEL YEAR | PERCENT OF DOMESTIC CARS | | | |
|---|---|---|---|---|
| | DUAL MASTER CYLINDERS | FRONT DISC BRAKES | POWER BRAKES | ABS |
| 1960 | 0 | 0 | 26 | 0 |
| 1962 | 9 | 0 | 26 | 0 |
| 1964 | 7 | 0 | 29 | 0 |
| 1966 | unknown | 3 | 35 | 0 |
| 1967 | 100 | 6 | 41 | 0 |
| 1968 | 100 | 13 | unknown | 0 |
| 1970 | 100 | 41 | unknown | 0 |
| 1972 | 100 | 74 | 68 | 0 |
| 1974 | 100 | 84 | 67 | 0 |
| 1976 | 100 | 99 | 81 | 0 |
| 1978 | 100 | 100 | 88 | 0 |
| 1980 | 100 | 100 | unknown | 0 |
| 1982 | 100 | 100 | 90 | 0 |
| 1984 | 100 | 100 | 96 | 0 |

| TABLE 105–1 (CONTINUED) PERCENT OF DOMESTIC CARS WITH DUAL MASTER CYLINDERS, FRONT DISC BRAKES, POWER BRAKES, AND ABS BY MODEL YEAR | | | | |
|---|---|---|---|---|
| MODEL YEAR | PERCENT OF DOMESTIC CARS | | | |
| | DUAL MASTER CYLINDERS | FRONT DISC BRAKES | POWER BRAKES | ABS |
| 1986 | 100 | 100 | 99 | 1 |
| 1988 | 100 | 100 | 100 | 3 |
| 1990 | 100 | 100 | 100 | 8 |
| 1992 | 100 | 100 | 100 | 32 |
| 1994 | 100 | 100 | 100 | 57 |
| 1996 | 100 | 100 | 100 | 58 |
| 1998 | 100 | 100 | 100 | 59 |
| 2000 | 100 | 100 | 100 | 62 |
| 2001 | 100 | 100 | 100 | 62 |

***Dual Master Cylinders***. Dual master cylinders were explicitly required by FMVSS 105 beginning on January 1, 1968 and were already implemented in all 1967 passenger cars. Dual master cylinders are the chief component of a split or dual brake system. A typical passenger car or light truck has a friction brake at each of its four wheels. These brakes are actuated through hydraulic pressure provided by the master cylinder as the brake pedal is depressed. A single brake system provides hydraulic fluid from one reservoir source to all four wheels. A typical split or dual brake system has two separate hydraulic circuits with a reservoir for the front brakes and one for the rear brakes. There are other dual braking systems that use a diagonal arrangement that has two circuits, each with one front wheel and one rear wheel on the opposite side of the vehicle. Without dual master cylinders, a failure in the brake hydraulic system can lead to a complete loss of braking capability. With dual brakes, however, if one of the circuits fails, the vehicle will retain braking capability with the other circuit. FMVSS 105 requires that vehicles must be able to stop within a specified distance from 60 miles per hour when one of the brake hydraulic circuits is disabled. Furthermore, a brake warning light is required to illuminate whenever there is a gross loss of hydraulic pressure in one of the circuits.

Forty-one make-model passenger cars representing pre-standard, post-standard, and trend systems were studied[19], along with thirteen downsized make-model passenger cars.[20] Table 105-2 shows the sales-weighted average for the weight and consumer cost of master cylinders in 2002 dollars.

[19] Harvey, M.R., Lesczhik, J.A., and McLean, R.F., *Cost Evaluation for Nine Federal Motor Vehicle Standards, Volume 1, FMVSS 105*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, November 1979. (DOT HS 805 315).

[20] Gladstone, R., et.al., *Estimation of Weight and Consumer Price Relating to the Implementation of FMVSS 105, 108, 202, 205, & 216, in Passenger Cars and 201, 203, & 204 in Light Trucks*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, August 1982. (DOT HS 806 769:2-1 thru 2-19).

| TABLE 105-2<br>AVERAGE WEIGHT AND CONSUMER COST<br>OF MASTER CYLINDERS IN PASSENGER CARS | | |
|---|---|---|
| CATEGORY | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
| Single (Pre-Standard) | 4.38 | $26.53 |
| Dual (Post-Standard) | 6.12 | $38.67 |
| Dual (Trend) | 7.97 | $35.95 |
| Dual (Downsized) | 3.33 | $34.66 |

Table 105-2 suggests that master cylinders decreased significantly in weight in the downsized passenger cars. The decrease was the result of a new, smaller cast-iron design and a new two-piece master cylinder unit with an aluminum-alloy bore and either a stamped steel or plastic reservoir.

To accurately allocate the average weight and consumer cost attributable to the standard in any given model year, it is necessary to separate the master cylinders into three time periods. Two conditions exist for the calculations. First, we assume that the average weight and consumer cost decreased at a linear rate from 1976 to 1982 and leveled off after that. Second, it is necessary to calculate what the weight and cost of master cylinders would have been if they had remained single instead of dual (because, presumably, the weight-saving technologies described above could also have been applied to a single master cylinder). The weight and cost figures are calculated using the following formulas.

1. Average Cost of Master Cylinders (1966-1976) =

   Cost of Post-Standard Dual Master Cylinders – Cost of Pre-Standard Single Master Cylinders = $38.67 - $26.53 = $12.14

2. Average Cost of Master Cylinders (if they had remained single) =

   (Cost of Downsized Dual Master Cylinders/Cost of Post-Standard Dual Master Cylinders) * Cost of Pre-Standard Single Master Cylinders = ($34.66/$38.67) * $26.53 = $23.78

3. Average Cost of Master Cylinders (1982-2002) =

   Cost of Downsized Dual Master Cylinders – Cost of Master Cylinders (if they had remained single) = $34.66 – $23.78 = $10.88

4. Average Cost of Master Cylinders (CY), where 1977 $\leq$ CY $\leq$ 1981, =

   [CY –1976] * 10.88 + [1982-CY] * 12.14

5. Average Weight of Master Cylinders (1966-1976) =

Weight of Post-Standard Dual Master Cylinders – Weight of Pre-Standard Single Master Cylinders = 6.12 – 4.38 = 1.74

6. Average Weight of Master Cylinders (if they had remained single) =

(Weight of Downsized Dual Master Cylinders/Weight of Post-Standard Dual Master Cylinders) * Weight of Pre-Standard Single Master Cylinders = (3.33/6.12) * 4.38 = 2.38

7. Average Weight of Master Cylinders (1982-2002) =

Weight of Downsized Dual Master Cylinders – Weight of Master Cylinders (if they had remained single) = 3.33 – 2.38 = 0.95

8. Average Weight of Master Cylinders (CY), where 1977 $\leq$ CY $\leq$ 1981, =

[CY –1976] * 0.95 + [1982-CY] * 1.74

Table 105-3 shows the average weight and consumer cost of master cylinders attributable to FMVSS 105 in passenger cars by model year.

***TABLE 105-3***
***AVERAGE WEIGHT AND CONSUMER COST OF MASTER CYLINDERS ATTRIBUTABLE TO FMVSS 105 IN PASSENGER CARS BY MODEL YEAR***

| MODEL YEAR | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| 1966-1976 | 1.74 | $12.14 |
| 1977 | 1.61 | $11.93 |
| 1978 | 1.48 | $11.72 |
| 1979 | 1.34 | $11.51 |
| 1980 | 1.21 | $11.30 |
| 1981 | 1.08 | $11.09 |
| 1982-2001 | 0.95 | $10.88 |

***Front Disc Brakes***. A change in the brake systems that was encouraged, although not required because of FMVSS 105, was the conversion of front brakes from a drum to a disc design. Disc brakes require less time to recover braking ability after being partially or fully submerged in water, plus they dissipate heat faster and are less likely to fade after repeated applications (e.g., on a long downhill grade). Furthermore, consumers prefer the superior feel of the car's braking power. Disc brakes experience linear relationships between brake pedal apply force and vehicle deceleration, without the tendency to grab like drum brakes. Manufacturers were encouraged by the capability of front disc brakes to meet the fade and recovery and water recovery requirements contained in FMVSS 105. These requirements started in 1976 about the same time as the automotive industry shifted to disc brakes; however, some cars continued to have drum brakes and still met the new requirements of FMVSS 105-75.

The test for fade and recovery involved a repeated series of brake stops from a specific speed where the vehicle had to slow at a specific rate each time falling within minimum and maximum limits for brake pedal apply force. The test for water recovery ability involved driving a vehicle in any combination of forward and reverse directions through a trough having a water depth of six inches and then immediately performing a series of stops from 30 mph at a specified deceleration rate.

The sales-weighted average for the weight and consumer cost of front drum brakes from a sample of 1966 and 1968 model year vehicles was 57.47 pounds and $162.01 in 2002 dollars. The front drum brake system included the brake drum, brake shoes with lining material, hydraulic wheel cylinder, brake adjuster, backing plate, springs, and miscellaneous hardware pieces. Early front disc brake systems (model year 1968 and 1976 passenger cars) weighed 70.99 pounds and cost $147.24 in 2002 dollars. In other words, the early disc brake systems weighed more but cost less than drum brakes. The front disc brake system included the brake disc rotor, caliper, mounting bracket and bolts, backing plate, and brake pads with friction lining material. By 1977-1982, various cost- and weight-reducing technological improvements had significantly lowered the cost of disc brakes. Downsizing of the entire vehicle, resulting in opportunities to use less massive braking systems, also contributed to the cost and weight reduction for brakes. The weight dropped to an average of 50.36 pounds, while the consumer cost dropped to an average of $75.40 in 2002 dollars. The role of FMVSS 105 in the shift to disc brakes is somewhat uncertain, but is a moot point since disc brakes, in the long term, had lower weight and cost than drum brakes.

Table 105-4 shows the overall weight and consumer cost of front brakes for the 1966/1968, 1968/1976, and 1977-1982 make-models years.

***TABLE 105-4***
***AVERAGE WEIGHT AND CONSUMER COST***
***OF FRONT BRAKES IN PASSENGER CARS***

| CATEGORY | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| ***Overall*** | | |
| Drum (1966/68) | 57.47 | $162.01 |
| Disc (1968/76) | 70.99 | $147.24 |
| Disc (1977-1982) | 50.36 | $ 75.40 |

***Power Boosters***. While power boosters are not explicitly required to meet FMVSS 105, power brakes do help vehicles to stop quickly, especially under high speed or hazardous conditions. The stopping distance requirements, in conjunction with the brake pedal apply force requirements of FMVSS 105, encouraged manufacturers to use power boosters. It was difficult to stop cars within the distance and at the pedal pressure specified in FMVSS 105 unless they had power brakes. Furthermore, consumers like power boosters because they amplify the force applied by the driver to the brake pedal and allow even small drivers to achieve high levels of vehicle braking on all sizes of vehicles. Installation of power boosters should not be attributed to the standard because (1) 81% of the passenger cars already had the factory-installed power brakes by 1976, (2) the power brakes were clearly something the consumers wanted, and (3) non-power brakes continued to exist after 1976 and were meeting FMVSS 105.

Table 105-5 shows the sales-weighted average weight and consumer cost of power boosters for the 1966, 1968, 1976, and 1977-1982 make-model passenger cars.

| ***TABLE 105-5 AVERAGE WEIGHT AND CONSUMER COST OF POWER BOOSTERS IN PASSENGER CARS*** | | | | |
|---|---|---|---|---|
| MODEL YEAR | WEIGHT IN POUNDS | CONSUMER COST ($2002) PER POWER BRAKE | % OF CARS WITH POWER BRAKES | CONSUMER COST ($2002) PER CAR |
| 1966 | 7.61 | $45.28 | 35.31 | $46.26 |
| 1968 | 9.27 | $45.46 | 31.50 | $41.89 |
| 1976 | 11.60 | $54.78 | 80.90 | $55.21 |
| 1977-1982 | 7.86 | $40.17 | 84.24 | $39.81 |

***Total Brake System***. The total brake system includes the front and rear brake assembly, master cylinder, foot pedal and linkage, power booster, warning light, proportional valve, and parking brake system. Table 105-6 shows the sales-weighted average weight and consumer cost of the total brake system for the 1966, 1968, 1976, and 1978-1982 make-models. Again, the substantial drop in the weight and consumer cost of 1977-1982 brake systems is the result of specific new weight- and cost-saving brake technologies as well as the downsizing of the overall vehicle. Except for the cost impact of dual master cylinders in 1967, there is little evidence that any of these major cost changes over the years are directly related to FMVSS 105 or that these costs would have been different in the absence of the standard.

| ***TABLE 105-6 AVERAGE WEIGHT AND CONSUMER COST OF THE TOTAL BRAKE SYSTEM IN PASSENGER CARS*** | | |
|---|---|---|
| MODEL YEAR | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
| 1966 | 132.60 | $474.67 |
| 1968 | 147.33 | $504.70 |
| 1976 | 166.69 | $525.25 |
| 1977-1982 | 117.21 | $353.24 |

## *Antilock Brake Systems*

Antilock Brake Systems (ABS) were developed by the motor vehicle industry and voluntarily installed by manufacturers beginning in the mid 1980's on passenger cars and light trucks. They have become accepted by consumers and are standard equipment in most new passenger cars and most light trucks. ABS was developed to prevent wheel lockup during hard braking on wet roads and during combination turning and braking maneuvers. When wheels lock up, the vehicle cannot respond correctly to steering maneuvers. When braking on low friction surfaces, standard brakes are not as effective in stopping the vehicle because the braking force is uniform to all wheels, even the ones that have little or no traction. ABS works by constantly measuring wheel speed; and, when it senses that a wheel is locking up, it decreases the braking force to that wheel. ABS also enables the driver to steer the vehicle in a controlled manner while stopping. Given the potential safety benefits of ABS, the Highway Safety Act of 1991 instructed NHTSA to contemplate requiring ABS in all passenger vehicles. NHTSA published an Advance Notice of Proposed Rulemaking (ANPRM) at the end of 1993. Since many of the light trucks and passenger cars had already been equipped with ABS, the agency and others gathered crash data and evaluated the effectiveness of ABS in light trucks and passenger cars.[21,22] These studies concluded that ABS had mixed effectiveness results, and the agency subsequently decided not to go forth with rulemaking to require ABS for passenger vehicles.

In 1991, NHTSA analyzed the cost of five different ABS systems in make-model passenger cars from 1988-1990.[23] Table 105-7 shows the sales-weighted average weight and consumer cost of ABS in these five models. These are the incremental weights and costs of ABS, above and beyond the pre-ABS hydraulic brake system (see Table 105-6).

***TABLE 105-7***
***AVERAGE WEIGHT AND CONSUMER COST***
***OF ABS IN PASSENGER CARS***

| MODEL YEAR | COMPONENT | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|---|
| 1988-90 Average of five models | Sensors/Rings | 3.83 | $ 45.46 |
| | Control Unit | 2.33 | $166.62 |
| | Modulator Unit | 20.81 | $326.23 |
| | Wiring Harness | 3.95 | $ 59.25 |
| | TOTAL | 30.92 | $597.56 |

The major ABS components shown in Table 105-7 are the wheel speed sensors and rings, the control unit, the modulator unit, and the wiring harness. The wheel speed sensors and rings provide an electrical signal to the ABS controller that is proportional to the wheel speed. The ABS controller is a computer that interprets and compares the signal from all the wheel speed sensors and sends control signals to the ABS modulator. The ABS modulator controls the hydraulic brake fluid pressure for each wheel. When the ABS controller interprets a signal from a wheel speed sensor as a wheel lock-up condition, a signal is sent to the modulator to rapidly pulse the hydraulic pressure at that particular wheel releasing the brake until the proper wheel speed has been restored. The wiring harness provides electrical power to the ABS controller and connects the speed sensors and the modulator to the controller.

In 1994, NHTSA looked at the ABS systems in one 1992 and one 1993 passenger car.[24] Since the analysis was based on only two systems and passenger cars that were not the same make-models as any in the previous study, it is difficult to draw conclusions on cost trends. A review of 2004 make-model passenger vehicles was conducted to determine the cost of ABS as optional equipment. The prices of the ABS systems ranged from $300 to $950, with an average price of $546. Typically in the past, the sales price of performance, convenience, or luxury optional equipment widely desired by consumers has been marked up 200 to 300 percent over what it would be if it were standard equipment (i.e., over the “consumer cost” as computed by the

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[21] Kahane, C.J., *Preliminary Evaluation of the Effectiveness of Rear-Wheel Antilock Brake Systems for Light Trucks,* Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, December 1993. (NHTSA Docket No. 70-27-GR-026).

[22] Kahane, C.J., *Preliminary Evaluation of the Effectiveness of Antilock Brake Systems for Passenger Cars,* Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, December 1994. (DOT HS 808 206).

[23] Fladmark, G.L. and Khadilkar, A.V., *Evaluation of Costs of Antilock Brake Systems, Volumes I and II,* Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, April 1991. (DOT HS 809 794-795: Sections 4,6,8-10).

[24] Fladmark, G.L. and Khadilkar, A.V., *Cost Estimates of Head Restraints in Light Trucks/Vans (Volume I) and Cost Estimates of Lower Cost Antilock Brake Systems (Volume II),* Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, July 1994. (DOT HS 809 797: Sections 13,15)

methods of this report). If the markups for ABS are consistent with these past trends, the average consumer costs of ABS could range from $182 to $273 and possibly indicate that the actual cost of ABS has reduced substantially since 1988-1990.

## *Light Truck Studies*

### ***Brake System Components***

NHTSA extended FMVSS 105, effective in September 1983, for the 1984 model year pickup trucks, vans, sports utility vehicles (SUV), and other vehicle classes equipped with hydraulic brake systems. Essentially the same types of requirements that applied to passenger cars and school buses were now required for these other vehicles with hydraulic brake systems. Since 1975 or earlier, many manufacturers had gradually improved the braking capability of some of their light trucks to FMVSS 105 levels.

***Dual Master Cylinders***. FMVSS 105 explicitly requires a dual braking system – i.e., dual master cylinders – in all vehicles it regulates, including light trucks. For that reason, the cost of dual master cylinders in light trucks will be attributed to FMVSS 105. Even though most light trucks received dual master cylinders well before the September 1983 effective date, quite probably even as early as 1967, the regulatory process for the original FMVSS 105 was getting underway at that time. Since NHTSA has not performed any teardowns of truck master cylinders, we will assume the same cost for dual master cylinders in trucks as in passenger cars (although it is conceivable that truck systems could cost more to the extent that light trucks are usually heavier vehicles than passenger cars). Table 105-8 shows the average weight and consumer cost of dual master cylinders attributable to FMVSS 105 in light trucks.

***TABLE 105-8***
***AVERAGE WEIGHT AND CONSUMER COST***
***OF DUAL MASTER CYLINDERS***
***ATTRIBUTABLE TO FMVSS 105 IN LIGHT TRUCKS***

| MODEL YEAR | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| 1982-2001 | 0.95 | $10.88 |

***Brake Subsystem Components***. A study was conducted on eight pre-standard (1983), and their corresponding post-standard (1984), make-model light trucks from the three-major U.S. Manufacturers.[25] Costs were estimated only for those subsystems of the brake systems of light trucks that were a new or changed design in 1984. The front brake pads, rear brake systems, brake power assist, emergency brake warning switch, and variable proportioning valve subsystems of Dodge, Ford, and GM trucks were studied.

The front brake pads and rear brake shoes on the pre-standard and post-standard light truck make-models were compared. The major change was in the brake pad, shoe lining material, and size. Pre-standard pads or linings were often made from asbestos-based or inorganic materials; whereas, post-standard pads or linings are made of non-asbestos or semi-metallic materials. The

[25] Adams, G.J., Carlson, L.E., and Firth, B.W., *Cost Evaluation of Federal Motor Vehicle Safety Standard 105-83*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, August 1985. (DOT HS 807 016).

elimination of the asbestos-based materials in the post-standard pads or linings was a result of the health hazards associated with its use in the manufacture of friction brake lining material and the maintenance of the brake systems. It was not a requirement of FMVSS 105. The semi-metallic materials were used to improve brake system fade performance and durability characteristics.

Power-booster units became standard in most trucks in 1984 at the latest, largely in response to consumer demand, but conceivably also to meet stopping distance requirements of FMVSS 105 within the allowable pedal pressures. An emergency brake warning switch was added to the Ford trucks in order to comply with the brake system indicator lamp requirements. Vehicle height-sensitive variable rate proportioning valves were employed on the rear brakes to perhaps improve stopping distance performance when the light trucks were tested in a lightly loaded condition.

Table 105-9 shows the sales-weighted average weight and consumer cost of front brake pads, rear brakes, rear shoes, proportioning valves, and emergency brake warning switch for the 1983 and 1984 make-models.

***TABLE 105-9***
***AVERAGE WEIGHT AND CONSUMER COST***
***OF BRAKE SYSTEM COMPONENTS IN LIGHT TRUCKS***

| MAKE/MODEL | COMPONENT | MODEL YEAR | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|---|---|
| Dodge 150 | Front Pads | 1983 | 1.21 | $13.47 |
| | | 1984 | 2.10 | $20.20 |
| | Rear Brakes | 1983 | 50.29 | $85.14 |
| | | 1984 | 64.51 | $96.81 |
| | Servo | 1984 | 8.54 | $36.10 |
| Dodge 350 | Front Pads | 1983 | 1.63 | $18.06 |
| | | 1984 | 2.81 | $27.09 |
| Dodge MPV | Variable Valve | 1984 | 1.50 | $28.45 |
| Ford – All Trucks | Warning Light Emergency Brake | 1984 | 0.03 | $ 0.40 |
| Ford F-150 | Rear Shoes | 1983 | 1.48 | $16.46 |
| | | 1984 | 1.77 | $18.11 |
| Ford F-250 | Front Pads | 1983 | 1.03 | $11.48 |
| | | 1984 | 1.23 | $12.62 |
| | Rear Shoes | 1983 | 1.75 | $19.45 |
| | | 1984 | 1.80 | $19.99 |
| | Variable Valve | 1984 | 2.90 | $11.17 |
| Ford F-350 | Front Pads | 1983 | 2.44 | $27.34 |
| | | 1984 | 2.91 | $30.08 |
| GMC 1500 | Front Pads | 1983 | 1.14 | $12.62 |
| | | 1984 | 1.36 | $18.93 |
| GMC 2500 | Front Pads | 1983 | 1.14 | $12.62 |
| | | 1984 | 1.36 | $18.93 |
| | Variable Valve | 1984 | 3.04 | $15.19 |
| GMC 3500 | Front Pads | 1983 | 1.37 | $15.26 |
| | | 1984 | 1.64 | $22.89 |
| | Variable Valve | 1984 | 3.04 | $12.51 |

Except for the emergency brake warning switch in Ford trucks, NHTSA does not have strong evidence that any of these changes were directly motivated by FMVSS 105, or actually needed to assure compliance with the standard. Therefore, only the cost and weight of the warning light emergency brake switch is attributed to FMVSS 105. Since Ford accounted for 30 percent of truck sales in 1984, the 0.03 pounds and $0.40 in Ford trucks averages out to 0.01 pounds and $0.12 in all trucks. This is added to the cost and weight of dual master cylinders. Table 105-10 shows the average weight and consumer cost of brake system components attributable to FMVSS 105 in light trucks.

***TABLE 105-10***
***AVERAGE WEIGHT AND CONSUMER COST***
***OF BRAKE SYSTEMS COMPONENTS***
***ATTRIBUTABLE TO FMVSS 105 IN LIGHT TRUCKS***

| COMPONENT | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| Dual Master Cylinder | 0.95 | $10.88 |
| Warning Light Emergency Brake Switch | 0.01 | $ 0.12 |
| TOTAL | 0.96 | $11.00 |

*Antilock Brake Systems*

NHTSA analyzed the weight and consumer cost of four-wheel ABS systems in two SUVs.[26,27] During 1987 through 1992, ABS systems controlled only the rear wheels and were typically standard equipment on light trucks. Since 1993, it has become increasingly common for ABS systems to control all four wheels on light trucks, similar to passenger cars. The total weight and consumer cost of an ABS system in a 1990 Jeep Cherokee 4-wheel drive was calculated at 41.17 pounds and $750.88 in 2002 dollars; whereas, the total weight and consumer cost of an ABS in a 1994 Ford Explorer 4-wheel drive was calculated at 20.48 pounds and $426.68 in 2002 dollars. From this study of just two vehicles, it is not possible to compute an industry-wide average or to deduce if the lower cost for the more recent vehicle represents an industry-wide trend.

Table 105-11 shows the average weight and consumer cost of the ABS and its subsystems in these two SUVs.

[26] Fladmark, DOT HS 809 795:Section 7 (1991).
[27] Fladmark, DOT HS 809 797:Section 14 (1994).

| TABLE 105-11 AVERAGE WEIGHT AND CONSUMER COST OF ABS IN TWO SUVs | | | |
|---|---|---|---|
| MODEL YEAR | COMPONENT | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
| 1990 Jeep Cherokee 4-wheel drive | Sensors/Rings | 3.85 | $ 55.02 |
| | Control Unit | 2.10 | $ 95.69 |
| | Hydraulic Unit | 30.72 | $547.16 |
| | Wiring Harness | 4.50 | $ 53.01 |
| | TOTAL | 41.17 | $750.88 |
| 1994 Ford Explorer 4-wheel drive | Sensors/Rings | 2.75 | $ 44.61 |
| | Control Unit | 0.85 | $ 98.50 |
| | Hydraulic Unit | 15.46 | $218.48 |
| | Wiring Harness | 1.41 | $ 65.09 |
| | TOTAL | 20.47 | $426.68 |

The cost of ABS is, of course, not attributable to FMVSS 105 because the standard neither explicitly requires ABS nor implicitly encourages it by including performance tests that are easier to pass with ABS than without it.

### *FMVSS 106 - BRAKE HOSES*

FMVSS 106 became effective on January 1, 1968 and specifies labeling and performance requirements for motor vehicle brake hoses, brake hose assemblies, and brake hose end fittings. The purpose of this standard is to reduce deaths and injuries occurring because of brake system failure from pressure or vacuum loss due to hose or hose assembly rupture. The standard applies to passenger cars, multipurpose passenger vehicles, trucks, buses, trailers, and motorcycles and to hydraulic, air, and vacuum brake hoses, brake hose assemblies, and brake hose end fittings for use in those vehicles.[28] No cost studies of brake hoses have been performed, and none are planned by the agency.

### *FMVSS 107* - [Does not currently exist]

### *FMVSS 108 - LAMPS, REFLECTIVE DEVICES, AND ASSOCIATED EQUIPMENT*

FMVSS 108 became effective on January 1, 1968 for vehicles with 80 or more inches of overall width and January 1, 1969 for all other vehicles. It specifies the requirements for original and replacement lamps, reflective devices, and associated equipment. The purpose of this standard is to reduce traffic accidents, deaths, and injuries by providing adequate illumination of the roadway and by enhancing the conspicuity of motor vehicles on the public roads so that their presence is perceived and their signals understood in daylight, darkness, or other conditions of reduced visibility. The standard applies to:

- passenger cars, multipurpose passenger vehicles, trucks, buses, trailers, and motorcycles

[28] Legal citation: *49 CFR 571.106* (2004).

- retro reflective sheeting and reflex reflectors
- lamps, reflective devices, and associated equipment for replacement of like equipment on vehicles to which this standard applies[29]

FMVSS 108 has been amended many times; however, the most important regulations have been (1) the original standard, (2) the side marker lamp requirement, and (3) the center high mounted stop lamp (CHMSL) requirement. While this standard covers all types of lighting and reflective devices, side marker lamps and CHMSL are the only lighting developments whose cost is readily attributable to FMVSS 108 because they were added to vehicles in anticipation of, or in response to, the standard.

### *Passenger Car Studies*

***Side Marker Lamps***. Prior to 1968, passenger cars did not have side marker lamps. That made it very difficult to see them from the side at night, especially when they crossed into intersections or pulled out of a driveway. Beginning with the 1970 model year, FMVSS 108 required a red lamp (as far to the rear of the vehicle as practicable) and an amber lamp (as far to the front of the vehicle as practicable) on each side of the vehicle. Most 1968 and 1969 model year passenger cars already had lamps or at least reflectors, and SAE Recommended Practice J592 discussed them as early as 1964. Nevertheless, the extent that the lamps were installed within two years of the effective date and while rulemaking was underway, we might judge that the lamps were installed "in anticipation of FMVSS 108" and attribute the full cost of the lamps to FMVSS 108.

A study of the side marker lamps or reflectors was conducted on twenty-six make-model passenger cars representing pre-standard, post-standard, and late-model systems.[30,31] The sales-weighted average for the weight and consumer cost of the pre-standard 1969 model year passenger cars was calculated at 1.46 pounds and $20.90 in 2002 dollars, which is attributed to the standard for model years 1968-69. Implementation of the side marker lamps in the post-standard 1970 model year passenger cars increased the weight to 1.95 pounds and the consumer cost to $29.37 in 2002 dollars, which is attributed to the standard for model years 1970-2001. The late model (1979-1981) passenger cars decreased in weight to 1.30 pounds and increased in consumer cost to $31.13 in 2002 dollars.

***Center High Mounted Stop Lamps***. CHMSL have been standard equipment on all new passenger cars sold in the United States since model year 1986 and all new light trucks since model year 1994, as required by FMVSS 108. The purpose of CHMSL is to safeguard a vehicle from being struck in the rear by another vehicle. When the brakes are applied, the CHMSL sends a conspicuous signal to drivers of following vehicles that they must slow down. Since

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[29] Legal citation: *49 CFR 571.108* (2004).

[30] Harvey, M.R., Lesczhik, J.A., and McLean, R.F., *Cost Evaluation for Nine Federal Motor Vehicle Standards, Volume II, FMVSS 108*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, November 1979. (DOT HS 805 316).

[31] Gladstone, R., Harvey, M.R., and Lesczhik, J.A., *Estimation of the Weight and Consumer Price of Late Model Vehicle Components Relating to the Implementation of FMVSS 108, 202, 208, and 214*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, March 1982. (DOT HS 806 257:5-1 thru 5-21).

nearly two-thirds of all rear impact crashes involve pre-impact braking by the lead vehicle, the CHMSL can be a significant countermeasure to deter rear-impact crashes of all types.

A study was conducted on thirty passenger cars of model years 1986 and 1987 to determine the weight and consumer cost of CHMSL.[32,33] The sales-weighted average for the weight and consumer cost for the 1986 and 1987 model year passenger cars were calculated at 0.85 pounds and $9.74 in 2002 dollars, which are attributed to the standard.

Table 108-1 shows the average weight and consumer cost of lamps attributable to FMVSS 108 in passenger cars.

***TABLE 108-1***
***AVERAGE WEIGHT AND CONSUMER COST***
***OF LAMPS ATTRIBUTABLE TO FMVSS 108***
***IN PASSENGER CARS***

| CATEGORY | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| Side Marker (1968-1969) | 1.46 | $20.90 |
| Side Marker (1970-2001) | 1.95 | $29.37 |
| CHMSL (1986-2001) | 0.85 | $ 9.74 |

***Headlamp Concealment Devices***. Headlamp concealment devices were a popular design feature for passenger cars during the 1960's. These devices were primarily cosmetic; however, an unsafe driving situation could arise if the concealment devices were frozen shut when headlamps were needed. FMVSS 112 became effective on January 1, 1969 and required that the devices remain fully open when there is a power loss or system failure, or they be manually operable without the use of tools. In addition, the device could not be involved in either the mounting or the aiming of the headlamps. FMVSS 112 was canceled on October 24, 1996 and the requirements were incorporated into FMVSS 108 (Lamps, Reflective Devices, and Associated Equipment under Section 12).

A study conducted on four make-model passenger cars, representing pre-standard and post-standard systems, indicated that the headlamp concealment devices met the requirements of the standard before its effective date.[34] None of the changes in the headlamp concealment devices between 1966 and 1969 was related to the standard. The arithmetic average for the weight and consumer cost of headlamp concealment devices for the pre-standard 1966 model year passenger cars was calculated at 12.20 pounds and $114.42 in 2002 dollars. By 1969, the average weight for the post-standard passenger cars had increased to 14.01 pounds while the consumer cost decreased to $98.59 in 2002 dollars. The main reason for the decreased cost was the change in operating system from an electrical system to a vacuum system for reasons unrelated to the

[32] Carlson, L.E. and Leonard, P., *Cost Evaluation of Federal Motor Vehicle Safety Standard 108 and 207,* Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, May 1986. (DOT HS 807 017:15-55).

[33] Khadilkar, A.V. and Fladmark, G.L., *Cost Estimates of Center High Mounted Stop Lamps and Passenger Car Red/Amber Rear Turn Signal Lamps*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, November 1988. (DOT HS 809 793:32-68).

[34] Adams, G.J., et.al., *Cost Evaluation of Federal Motor Vehicle Safety Standards 111, 112, 118, and 124,* Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, November 1983. (DOT HS 806 774:31,124-134).

regulation. No cost is attributed to FMVSS 108 because most concealment devices met the requirements of the standard before its effective date of January 1,1969.

## *Light Truck Studies*

***Side Marker Lamps and CHMSL***. Side marker lamps were required on light trucks at the same time as passenger cars, while CHMSL became effective on September 1, 1993 for light trucks (i.e., model year 1994). Because NHTSA has not performed teardown analyses for these systems on light trucks, and because they are similar to the systems on passenger cars, we will assume the same costs on light trucks as on passenger cars. Table 108-2 shows the average weight and consumer cost of lamps attributable to FMVSS 108 in light trucks.

***TABLE 108-2***
***AVERAGE WEIGHT AND CONSUMER COST***
***OF LAMPS ATTRIBUTABLE TO FMVSS 108***
***IN LIGHT TRUCKS***

| CATEGORY | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| Side Marker (1968-1969) | 1.46 | $20.90 |
| Side Marker (1970-2001) | 1.95 | $29.37 |
| CHMSL (1994-2001) | 0.85 | $ 9.74 |

***Other Lighting System Developments***. Technological advances have resulted in changes to vehicle lighting systems. Manufacturers are offering quartz-halogen headlamps, composite headlamps with replaceable bulbs, high intensity discharge (HID) lights, light-emitting diode (LED) lights, and daytime running lamps (DRL). Since FMVSS 108 did not require these changes, no cost studies have been performed, and none are planned by this agency.

### *FMVSS 109 - NEW PNEUMATIC BIAS PLY AND CERTAIN SPECIALTY TIRES*

FMVSS 109 became effective on January 1, 1968 and specifies tire dimensions and laboratory test requirements for bead unseating resistance, strength, endurance, and high-speed performance; defines tire load rating; and specifies labeling requirements for passenger car tires. This standard applies to new pneumatic tires for use on passenger cars manufactured after 1948. However, it does not apply to any tire that has been altered to render impossible its use, or its repair for use, as motor vehicle equipment.[35] No cost studies of new pneumatic tires have been performed, and none are planned by this agency.

### *FMVSS 110 - TIRE SELECTION AND RIMS FOR MOTOR VEHICLES*

FMVSS 110 became effective on April 1, 1968 and specifies requirements for original equipment tire and rim selection on new cars to prevent tire overloading. These include placard requirements relating to load distribution as well as rim performance requirements under conditions of rapid tire deflation. This standard applies to passenger cars and to non-pneumatic

[35] Legal citation: *49 CFR 571.109* (2004).

spare tire assemblies for use on passenger cars.[36] No cost studies have been performed, and none are planned by this agency.

***FMVSS 111 - REARVIEW MIRRORS***

FMVSS 111 became effective on January 1, 1968 and specifies requirements for the performance and location of inside and outside rearview mirrors. The purpose of this standard is to reduce the number of deaths and injuries that occur when the driver of a motor vehicle does not have a clear and reasonably unobstructed view to the rear. This standard applies to passenger cars, multi-purpose passenger vehicles, trucks, buses, school buses, and motorcycles. Furthermore, FMVSS 111 requires passenger cars to have a mounting system for the inside rearview mirror that would break away upon impact, and an outside rearview mirror. The purpose of breakaway mirrors is to reduce fatalities and injuries in frontal collisions to front seat occupants who contact the rearview mirror.[37]

A study of inside rearview mirrors was conducted on sixteen pre-standard make-model passenger cars and their corresponding post-standard and trend systems.[38] Because most states required outside rearview mirrors before the implementation of FMVSS 111, they were not in the study. The sales-weighted average for the weight and consumer cost of the pre-standard 1966 model year passenger cars was calculated at 0.97 pounds and $7.67 in 2002 dollars. Implementation of the inside rearview mirrors in the post-standard 1968 model year passenger cars increased the weight to 1.12 pounds and the consumer cost to $10.81. However, estimation of the weight and consumer price in the 1982 model year passenger cars indicated a decrease in weight to 0.71 pounds and in consumer cost to $6.70 in 2002 dollars. Since the average weight and consumer cost decreased by 0.26 pounds and $0.97 in 2002 dollars between the pre-standard and long-term trend results, no cost is attributed to FMVSS 111.

***FMVSS 112 –*** [Does not currently exist]

***FMVSS 113 - HOOD LATCH SYSTEM***

FMVSS 113 became effective on January 1, 1969 and specifies the requirement for providing a hood latch system or hood latch systems. Each hood must be provided with a hood latch system, and a front opening hood must be provided with a second latch position on the hood latch system or with a second hood latch system. The purpose of the standard is to prevent the incidence of hoods flying open and partially or completely obstructing the driver’s view through the windshield while the vehicle is moving. This standard applies to passenger cars, multipurpose passenger vehicles, trucks, and buses.[39]

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[36] Legal citation: *49 CFR 571.110* (2004).
[37] Legal citation: *49 CFR 571.111* (2004).
[38] Adams, DOT HS 806 774:23,25-30 (1983).
[39] Legal citation: *49 CFR 571.113* (2004).

A study of thirty-seven make-model passenger cars representing pre-standard, post-standard, and trend systems was conducted. The sales-weighted average for the weight and consumer cost of the pre-standard 1968 model year passenger cars was calculated at 3.19 pounds and $19.05 in 2002 dollars. In 1970, the weight and consumer cost in the post-standard model year passenger cars had decreased to 3.06 pounds and $15.53 in 2002 dollars. By 1971, the weight and consumer cost for the trend systems had increased slightly to 3.37 pounds and $16.90 in 2002 dollars. Since all manufacturers met the requirements of FMVSS 113 by the 1968 model year at the very latest, and likely initiated the development of dual latch systems before the FMVSS 113 rulemaking process, no cost was attributed to the standard. In fact, examination of cars for several years prior to 1968 showed that the safety standard provisions were met in all cases by the domestic industry. It was determined that there were three major reasons for hood latch design changes among the sample:[40]

- the hood lock environment changed due to styling changes or other modifications.
- the trend to inside hood releases, as either an option or standard feature, required a change from a safety catch integral with the latch mechanism to a separate safety catch.
- the designs were revised for cost reduction and simplification.

The Volkswagen Beetle was the only vehicle in the sample whose change in hood latch design was definitely safety related. The Volkswagen Beetle would not have complied with the standard in 1966 because no safety catch was provided; it had dual latch systems. However, a design change was made in 1968, and a push button actuated safety catch was added. Because the safety catch was already included in the 1968 model $1^{1/2}$ years before the effective date, its development may well have been initiated before the FMVSS 113 rulemaking process; therefore, no cost was attributed to the standard.

### *FMVSS 114 - THEFT PROTECTION*

FMVSS 114 became effective on January 1, 1970 and specifies the requirements for a lock system that prevents the activation of the engine ignition and starting systems, movement of the steering wheel, and movement of the automatic transmission gear selector out of the "park" position when the key is removed. The purpose of this standard is to:

- reduce thefts and enhance safety by reducing the incidence of crashes resulting from unauthorized operation of a motor vehicle, and
- prevent the rollaway of parked vehicles because of children moving the automatic shift mechanism out of the "park" position.

This standard applies to passenger cars and to trucks and multipurpose passenger vehicles having a GVWR of 10,000 pounds or less. It does not apply, however, to walk-in van-type vehicles.[41]

[40] McVetty, T.N., Cross, A.J., and Parr, L.W., *Cost Evaluation for Two Federal Motor Vehicle Safety Standards – FMVSS 113 Hood Latch – Passenger Cars – FMVSS 219 Windshield Zone Intrusion – Passenger Cars*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, April 1982. (DOT HS 806 187:9-18).

[41] Legal citation: *49 CFR 571.114* (2004).

While this standard would initially have had some cost implications, no cost studies have been performed, and none are planned by this agency.

***FMVSS 115*** - [Does not currently exist]

### *FMVSS 116 - MOTOR VEHICLE BRAKE FLUIDS*

FMVSS 116 became effective on January 1, 1968 and specifies requirements for fluids for use in hydraulic brake systems of motor vehicles, containers for these fluids, and labeling of the container. The purpose of this standard is to reduce failures in the hydraulic braking systems of motor vehicles that may occur because of the manufacture or use of improper or contaminated fluid. Each passenger car, multipurpose passenger vehicle, truck, bus, trailer, and motorcycle that has a hydraulic brake system shall be equipped with fluid that has been manufactured and packaged in conformity with the requirements of this standard.[42] FMVSS 116 would initially have had some cost implications, along with each time it was updated; however, no cost studies have been performed, and none are planned by this agency.

### *FMVSS 117 - RETREADED PNEUMATIC TIRES*

FMVSS 117 became effective January 1, 1972 and specifies performance, labeling, and certification requirements for retreaded pneumatic passenger car tires. The purpose of this standard is to require retreaded pneumatic passenger car tires to meet safety criteria similar to those for new pneumatic passenger car tires. This standard applies to retreaded pneumatic tires for use on passenger cars manufactured after 1948.[43] Since FMVSS 117 does not regulate components of new passenger cars or light trucks, it is outside the scope of this report. No cost studies have been performed, and none are planned by this agency.

### *FMVSS 118 - POWER-OPERATED WINDOW, PARTITION, AND ROOF PANEL SYSTEMS*

FMVSS 118 became effective on February 1, 1971 (passenger cars and multipurpose vehicles) and on July 25, 1988 (trucks). This standard specifies requirements for power-operated window, partition, and roof panel systems to minimize the likelihood of death or injury from their accidental operation. This standard applies to passenger cars, multipurpose passenger vehicles, and trucks with a GVWR of 10,000 pounds or less. The standard's requirements for power-operated roof panel systems need not be met for vehicles manufactured before September 1, 1993.[44]

Originally, this standard did not allow the power windows to be operational unless a vehicle's ignition or electrical accessory system was energized via the ignition key. In other words, the

[42] Legal citation: *49 CFR 571.116* (2004).
[43] Legal citation: *49 CFR 571.117* (2004).
[44] Legal citation: *49 CFR 571.118* (2004)

opening and closing of the power windows in a parked vehicle without the ignition turned on (potential safety hazard to children or other unsuspecting persons) would not be possible under the standard. In 1975, the standard was amended to add restrictions on the operation of power windows while the passenger doors were ajar.

A study was conducted on six make-model passenger cars from two major domestic manufacturers that represented pre-standard, post-standard, and trend systems.[45] The small sample was due to the limited number of vehicles and the model years affected by the standard for these specialty items.

Implementation of the standard involved moving the window system supply wire to a different location and adding a circuit breaker. Since the block fuse mounting was part of the pre-standard make-models, it was decided to base the weight and consumer cost on the addition of the circuit breaker to the post-standard and trend systems. Due to the small sample size, the simple arithmetic average was used instead of the sales-weighted average.

FMVSS 118 was extended to light trucks effective July 25, 1988, however, voluntary installations of the power windows were appearing in light trucks as early as 1978. Because NHTSA has not performed teardown analyses of the power window components on light trucks, and because they are similar to the components on passenger cars, we will assume the same costs on light trucks as on passenger cars.

Table 118-01 shows the average weight and consumer cost of power window components attributable to FMVSS 118 in passenger cars and light trucks.

***TABLE 118-01***
***AVERAGE WEIGHT AND CONSUMER COST OF POWER WINDOW COMPONENTS ATTRIBUTABLE TO FMVSS 118 IN PASSENGER CARS AND LIGHT TRUCKS***

| COMPONENT | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| Circuit Breaker | 0.04 | $0.92 |

Based on information in the Ward's Automotive Yearbook, approximately 14% of the 1970 model year domestic passenger cars were equipped with power windows. By the 1982 model year, the number had increased to 33%. The popularity of power windows was growing, and the manufacturers had focused more attention on the cost on these systems as they filtered down from luxury cars to the intermediate range.

[45] Adams, DOT HS 806 774:24,32 (1983).

***FMVSS 119 - NEW PNEUMATIC TIRES FOR VEHICLES OTHER THAN PASSENGER CARS***

FMVSS 119 became effective on March 1, 1975 and establishes performance and marking requirements for tires for use on vehicles other than passenger cars. The purpose of this standard is to:

- provide safe operational levels for tires used on motor vehicles other than passenger cars
- place sufficient information on the tires to permit their proper selection and use

This standard applies to new pneumatic tires designed for highway use on multipurpose passenger vehicles, trucks, buses, trailers, and motorcycles manufactured after 1948.[46] Since this standard does not regulate components of new passenger cars or light trucks, it is outside the scope of this report. No cost studies have been performed, and none are planned by this agency.

***FMVSS 120 - TIRE SELECTION AND RIMS FOR MOTOR VEHICLES OTHER THAN PASSENGER CARS***

FMVSS 120 became effective on August 1, 1976 and specifies tire and rim selection requirements and rim marking requirements. The purpose of this standard is to provide safe operational performance by ensuring that vehicles to which it applies are equipped with tires of adequate size and load rating and with rims of appropriate size and type designation. This standard applies to tires, rims, and non-pneumatic spare tire assemblies on multipurpose passenger vehicles, trucks, buses, trailers, and motorcycles.[47] Since this standard does not regulate components of new passenger cars or light trucks, it is outside the scope of this report. No cost studies have been performed, and none are planned by this agency.

***FMVSS 121 - AIR BRAKE SYSTEMS***

FMVSS 121 became effective on January 1, 1975 and establishes performance and equipment requirements for braking systems on vehicles equipped with air brake systems. The purpose of this standard is to insure safe braking performance under normal and emergency conditions.[48]

The Intermodal Surface Transportation Efficiency Act (ITSEA) of 1991 enacted by U.S. Congress required the Department of Transportation to initiate and enact rulemaking to improve braking performance of new commercial motor vehicles. Consequently, FMVSS 121 was amended in March 1997 and 1998 to require ABS systems on new air brake truck-tractors (Class 7 and 8) and new air brake trailers (greater than 10,000 pounds GVWR). It is important to note that even before the standard went into effect, the manufacturers of truck-tractors, trailers, and other heavy vehicles were offering ABS in different configurations as optional equipment.

[46] Legal citation: *49 CFR 571.119* (2004).
[47] Legal citation: *49 CFR 571.120* (2004).
[48] Legal citation: *49 CFR 571.121* (2004).

Since FMVSS 121 does not regulate components of new passenger cars or light trucks, it is outside the scope of this report. However, a study was conducted in 2000 and Table 121-1 shows the arithmetic average weight and consumer cost of two air-braked truck-tractor ABS, two air-braked trailer ABS, and one tractor-trailer connection.[49] The connections between the tractors and the trailers are standardized by industry practice and by applicable standards and guidelines, which allows for interchangeability between various trailers and the towing tractors. (Of course, none of the costs of FMVSS 121 apply to passenger cars or light trucks because they are equipped with hydraulic brakes, not air brakes.)

***TABLE 121-1***
***AVERAGE WEIGHT AND CONSUMER COST***
***OF ABS IN AIR-BRAKED TRUCK-TRACTORS AND TRAILERS***

| ABS | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| ***Truck-Tractor*** | | |
| 2000 Navistar International Class 7 Bendix ABS | 31.71 | $612.45 |
| 2000 Freightliner Class 8 Meritor/Wabco ABS | 18.76 | $496.36 |
| ***Trailer*** | | |
| 2000 Great Dane Meritor/Wabco ABS | 31.74 | $494.85 |
| 2000 Utility International Haldex ABS | 33.19 | $396.06 |
| ***Tractor-Trailer Connection*** | | |
| | 9.54 | $ 96.79 |

## *FMVSS 122 - MOTORCYCLE BRAKE SYSTEMS*

FMVSS 122 became effective on January 1, 1974 and specifies performance requirements for motorcycle brake systems. The purpose of the standard is to insure safe motorcycle braking performance under normal and emergency conditions. This standard only applies to motorcycles.[50] Since this standard does not regulate components of new passenger cars or light trucks, it is outside the scope of this report. No cost studies have been performed, and none are planned by this agency.

[49] Khadilkar, A.V., Fladmark, G.L., and Khadilkar, J., *Teardown Cost Estimates of Automotive Equipment Manufactured to Comply with Motor Vehicle Standards, FMVSS 121 (Air Brake Systems) and FMVSS 105 (Hydraulic Brake Systems), Antilock Brake Features*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, November 2002. (DOT HS 809 808).

[50] Legal citation: *49 CFR 571.122* (2004).

### *FMVSS 123 - MOTORCYCLE CONTROLS AND DISPLAYS*

FMVSS 123 became effective on September 1, 1974 and specifies requirements for the location, operation, identification, and illumination of motorcycle controls and displays and requirements for motorcycle stands and footrests. The purpose of this standard is to minimize accidents caused by operator error in responding to the motoring environment by standardizing certain motorcycle controls and displays. This standard applies to motorcycles equipped with handlebars, except for motorcycles that are designed and sold exclusively for use by law enforcement agencies.[51] Since this standard does not regulate components of new passenger cars or light trucks, it is outside the scope of this report. No cost studies have been performed, and none are planned by this agency.

### *FMVSS 124 - ACCELERATOR CONTROL SYSTEMS*

FMVSS 124 became effective on September 1, 1973 and establishes requirements for the return of a vehicle's throttle to the idle position when the driver removes his or her foot from the accelerator control or in the event of a severance or disconnection in the accelerator control system. The purpose of this standard is to reduce deaths and injuries resulting from engine over-speed when the accelerator fails to return to the up position. This standard applies to passenger cars, multipurpose passenger vehicles, trucks, and buses.[52]

Accelerator control systems were difficult to analyze because changes were being made to the carburetor systems to meet EPA fuel conservation and emissions systems standards at the same time FMVSS 124 went into effect. However, the standard was met by having two energy sources, an inner and outer accelerator return spring, which were capable of returning the throttle to the idle position.

A study was conducted on eighteen make-model passenger cars from four major manufacturers that represented pre-standard, post-standard, and trend systems.[53] Analysis of each system identified an increase in the weight and consumer cost from the six pre-standard make-models to the six post-standard make-models. While a comparison of the post-standard and trend systems indicated that four out of the six make-models decreased in cost, three out of those four make-models were from the same manufacturer (GMC). The lack of evidence to support a significant trend, therefore, justifies the use of the simple arithmetic average instead of the sales-weighted average for the weight and consumer cost. The arithmetic average for the weight and consumer cost of the pre-standard make-models was calculated at 0.02 pounds and $0.45 in 2002 dollars; the post-standard was calculated at 0.04 pounds and $0.91; the trend systems were calculated at 0.03 pounds and $0.74.

NHTSA has not performed teardown analyses of the accelerator control systems on light trucks; however, because they are similar to the systems on passenger cars, we will assume the same costs on light trucks as on passenger cars.

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[51] Legal citation: *49 CFR 571.123* (2004).
[52] Legal citation: *49 CFR 571.124* (2004).
[53] Adams, DOT HS 806 774:24,33-38 (1983).

Table 124-1 shows the actual weight and cost increments of accelerator control systems attributable to FMVSS 124 in passenger cars and light trucks.

| ***TABLE 124-1 AVERAGE WEIGHT AND CONSUMER COST OF ACCELERATOR CONTROL SYSTEMS ATTRIBUTABLE TO FMVSS 124 IN PASSENGER CARS AND LIGHT TRUCKS*** | | |
|---|---|---|
| CATEGORY | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
| Pre-Standard | 0.02 | $0.45 |
| Post-Standard | 0.04 | $0.91 |
| DIFFERENCE | 0.02 | $0.47 |

### *FMVSS 125 - WARNING DEVICES*

FMVSS 125 became effective on January 1, 1974 and establishes shape, size, and performance requirements for reusable day and night warning devices that can be erected on or near the roadway to warn approaching motorists of the presence of a stopped vehicle. The purpose of this standard is to reduce deaths and injuries due to rear-end collisions between moving traffic and disabled vehicles. This standard applies to devices that do not have self-contained energy sources and are designed to be carried in buses and trucks that have a GVWR greater than 10,000 pounds.[54] Since this standard does not regulate components of new passenger cars or light trucks, it is outside the scope of this report. No cost studies have been performed, and none are planned by this agency.

### *FMVSS 129 - NEW NON-PNEUMATIC TIRES FOR PASSENGER CARS*

FMVSS 129 became effective on August 20, 1990 and specifies tire dimensions and laboratory test requirements for lateral strength, endurance, and high-speed performance; defines the tire load rating; and defines labeling requirements for non-pneumatic spare tires. This standard applies to new temporary spare non-pneumatic tires for use on passenger cars.[55] Since this standard does not require new passenger cars or light trucks to have the optional non-pneumatic tires, no cost studies have been performed, and none are planned by this agency.

### *FMVSS 131 - SCHOOL BUS PEDESTRIAN SAFETY DEVICES*

FMVSS 131 became effective on May 3, 1991 and establishes requirements for devices (stop signal arms) that can be installed on school buses to improve the safety of pedestrians near stopped school buses. The purpose of this standard is to reduce deaths and injuries by minimizing the likelihood of vehicles passing a stopped school bus and striking pedestrians near the bus.[56] Since this standard does not regulate components of new passenger cars or light

[54] Legal citation: *49 CFR 571.125* (2004).
[55] Legal citation: *49 CFR 571.129* (2004).
[56] Legal citation: *49 CFR 571.131* (2004).

trucks, it is outside the scope of this report. No cost studies have been performed, and none are planned by this agency.

### *FMVSS 135 – LIGHT VEHICLE BRAKE SYSTEMS*

This standard specifies requirements for vehicles equipped with hydraulic and electric service brakes and parking brake systems. The purpose of the standard is to ensure safe braking performance under normal conditions and emergency conditions. This standard applies to passenger cars manufactured on or after September 1, 2000 and to multipurpose passenger vehicles, trucks, and buses with a GVWR of 7,716 pounds or less, manufactured on or after September 1, 2002. In addition, at the option of the manufacturer, passenger cars manufactured before September 1, 2000 and multipurpose passenger vehicles, trucks, and buses with a GVWR of 7,716 pounds or less manufactured before September 1, 2002, may meet the requirements of this standard instead of FMVSS 105.[57] No cost studies have been performed.

### *FMVSS 138 – TIRE PRESSURE MONITORING SYSTEMS*

FMVSS 138 became effective on August 5, 2002 and specifies performance requirements for tire pressure monitoring systems. The purpose of the standard is to prevent significant under-inflation of tires and the resulting safety problems by warning the driver when a tire is significantly under-inflated. This standard applies to passenger cars, multipurpose passenger vehicles, trucks, and buses with a GVWR of 10,000 pounds or less, except those vehicles with dual wheels on an axle.[58] No cost studies have been performed.

### *FMVSS 139 – NEW PNEUMATIC RADIAL TIRES FOR LIGHT VEHICLES*

FMVSS 139 became effective on June 5, 2003 and specifies tire dimensions, test requirements, labeling requirements, and defines load ratings. The purpose of the standard is to create more stringent tire performance requirements and require improved labeling of tires to assist consumers in identifying tires that may be the subject of a safety recall. This standard applies to new pneumatic tires for use on motor vehicles (other than motorcycles and low speed vehicles) that have a GVWR of 10,000 pounds or less and that were manufactured after 1975.[59] No cost studies have been performed.

[57] Legal citation: *49 CFR 571.135* (2004).
[58] Legal citation: *49 CFR 571.138* (2004).
[59] Legal citation: *49 CFR 571.139* (2004).

## *SECTION 3 – FMVSS 200 SERIES*

The FMVSS 200 series of “crashworthiness” standards specify performance requirements for motor vehicles intended to reduce the fatality risk or injury severity of people involved in crashes. Performance specifications are more easily related to specific hardware modifications than in the FMVSS 100 series of standards. Furthermore, most crashworthiness standards result in modification to equipment that requires no action by the driver or passenger. A noted exception of this condition is the use of safety belts that often requires the occupant to “buckle up”.

### *FMVSS 201 - OCCUPANT PROTECTION IN INTERIOR IMPACT*

***Original Standard***. FMVSS 201 became effective on January 1, 1968 (passenger cars) and on September 1, 1981 (multipurpose passenger vehicles, trucks, and buses) and specifies requirements on the design and performance of instrument panels, seat backs, interior compartment doors, sun visors, and armrests. The purpose of this standard is to afford head impact protection for occupants. Therefore, in order to meet the requirements, certain parts of the vehicle interior have to be padded, and no sharp or pointed parts can be placed in the vehicle interior that an occupant can come in contact with during a frontal crash. This standard applies to passenger cars, multipurpose passenger vehicles, trucks, and buses with a GVWR of 10,000 pounds or less.[60]

Unlike some of the FMVSS 200-series standards, there are few specific, self-contained vehicle modifications (i.e., head restraints or air bags) associated with the 1968 version of FMVSS 201. Instead, the standard established impact test requirements for various interior surfaces, which may or may not have required some degree of modification to meet the tests. As a result, the cost analysis for FMVSS 201 was sometimes exploratory in nature. Since we did not know in advance if anything was changed to meet FMVSS 201, we had to discover this during the analysis.

Several pre- and post-standard specimens were compared for each of the various interior structures addressed by the standard. In some structures, costs might be consistently higher for the post-standard specimens, as evidenced by a statistically significant average cost increase for the study sample. That probably indicates they were modified because of the standard. In other structures, costs went up in some specimens and down in others, and the average change in cost was not statistically significant. That probably indicates the modifications were merely for styling or production efficiency, and not needed for meeting the standard. Of course, in those cases where a specific modification was already known to be associated with FMVSS 201 (e.g., the change from friction to mechanical latches on glove compartment doors), the exploratory approach was unnecessary and we were able to cost those modifications directly.

In general, few costs are attributed to FMVSS 201 because manufacturers began padding interior surfaces well before the rulemaking process, as early as 1956. By 1964, padding that presumably could have met FMVSS 201 was already standard equipment on most cars. The

[60] Legal citation: *49 CFR 571.201* (2004).

practical effect of the standard was at most a selective improvement or an extension of earlier developments.

Actually, the most important development from 1967 through 1971 (i.e., during and after the FMVSS 201 rulemaking period) was the reduction in the rigidity of the middle and lower instrument panels. The middle and lower panels were redesigned to deform at a controlled rate during an impact to reduce peak loads on an occupant's chest and legs. Coincidentally, the availability of plastics, coupled with the desire to substitute them for steel to lighten vehicles, also led to less rigid panels. These improvements significantly reduced fatality and injury risk of right-front passengers in crashes.[61] Since none of these modifications were necessitated or even addressed by FMVSS 201, their costs were not studied by NHTSA.

## *Passenger Car Studies*

Thirty make-model passenger cars representing pre-standard (1967), standard (1968), and post-standard (1969) systems were studied to determine the weight and consumer cost impact of FMVSS 201.[62] The following items were studied:

<u>Glove Compartment Doors</u>. These were required by FMVSS 201 to remain in the closed position when subjected to an inertial load of 10g in the lateral and vertical directions, 30g in the longitudinal direction, or a head-on vehicle impact into a fixed barrier at 30 mph. A mechanical latch and striker with a release knob/button and mechanism was employed by the vehicle manufacturers to keep the door closed. Most vehicles were already in compliance in the pre-standard 1967 model year, and their door locks were identical in design and manufacturing processing for the pre-standard, implementation, and post-standard model years. Those vehicles not in compliance in 1967 used a friction latch, which was nothing more than a tab or tang mount to the inside of the door that pressed against an indentation on the inside of the glove compartment. The friction force was enough to keep the door closed during normal operation of the vehicle but not during a crash. Those vehicles with the friction latch in 1967 switched to a positive mechanical latch in 1968. The arithmetic average weight and consumer cost increase from the pre-standard to the post-standard vehicles was 0.05 pounds and $0.72 in 2002 dollars in the cars that changed from friction to mechanical latches. When these amounts are averaged with the rest of the fleet (unchanged), the average weight and consumer cost increases for the entire fleet are 0.01 pounds and $0.12 in 2002 dollars and are attributed to the standard.

<u>Protruding Components (Interior Door Release Handles, Window Regulators, and Vent Window Locks and Regulators)</u>. These were considered "protrusions" according to the original proposed FMVSS 201. The underlying concept of the proposed requirement was to re-contour, soften (change material or add padding), recess, or move the interior items that protruded into possible head, knee, or leg impact areas. This requirement was later removed in an amendment in the summer of 1967. Even though the protrusion requirement was dropped, vehicle manufacturers made changes to comply with the proposed requirements. 1968 was a transitional stage that

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[61] Kahane, C.J., *An Evaluation of Occupant Protection in Frontal Interior Impact for Unrestrained Front Seat Occupants of Cars and Lights Trucks*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1988. (DOT HS 807 203)

[62] Gladstone, DOT HS 806 367:4-1 thru 4-88 (1982).

reflected some uncertainty on design changes. By 1969, the average cost of these systems was, on the average, lower (but not significantly lower) than in 1966. Window regulators were re-contoured with larger radii, using more pliable plastic or rubber knobs in place of the smaller metal knobs. This resulted in a decrease in consumer cost of $1.46 in 2002 dollars. Interior door release handles were reshaped with fewer sharp edges and corners and built into either the armrest or flush with the door inner trim panel, which decreased the consumer cost by $0.83 in 2002 dollars. Vent window locks were either eliminated or reshaped to be smaller and rounder, with many vehicles eliminating the vent window on the 1968 and 1969 make-models. Since the changes to the protruding components were not required, the weight and consumer cost difference is not attributed to the standard. Even if FMVSS 201 had required this modification, this report would not have credited the cost reduction to the standard because the same cost-saving modifications could presumably have been implemented without it.

Armrests. These were required to deflect or collapse laterally upon impact at least 2 inches without contacting any underlying rigid material or have no unpadded areas that a passenger could contact in a collision. Many armrests were redesigned to be longer and shallower in order to protrude less into the pelvic impact area. Additional padding, support structure, and softer cover materials were also employed for the 1968 and 1969 model years. However, the cost of these additions was in some cases more than offset by the reduction in the overall size of the armrest. The average change in weight and consumer cost from the pre-standard to the post-standard vehicles was an increase of 0.06 pounds and a decrease of $0.33 in 2002 dollars. These weight and cost changes were not statistically significant since half of the armrests studied increased and half decreased. Since no consistent trend was demonstrated, the changes in the weight and cost of armrests are not attributed to the standard.

Sun Visors. FMVSS 201 required two sun visors be provided that were constructed of, or covered with, energy absorbing materials. No rigid material edge radii less than 0.125 inches would be present on the sun visor mounting. The manufacturers made the required design and material changes, but these did not necessarily lead to increased costs. In fact, the average weight and consumer cost decreased from the pre-standard to the post-standard vehicles by 0.15 pounds and $0.46 in 2002 dollars. Since approximately half of the sun visors studied decreased in weight and cost while the other half increased, the difference between the 1967 and 1969 model years is not statistically significant. Since no consistent trend was demonstrated, the changes in the weight and cost of sun visors are not attributed to the standard.

Instrument Panels. These were required to have adequate energy absorption capabilities in head impact areas (primarily the top surface and edges of the panel) so that when a 15-pound, 6.5-inch diameter head form is impacted at a velocity of 15 miles per hour the deceleration rate does not exceed 80g continuously for more than 3 milliseconds. Changes to the padding and the instrument panel cover were made for the 1968 and 1969 model years. The average weight increased from the pre-standard to the post-standard vehicles by 0.87 pounds while the consumer cost decreased by $0.83 in 2002 dollars. Just over half of the instrument panels studied increased in weight and decreased in cost. The average weight and consumer cost difference between the 1967 and 1969 model years are not statistically significant. Since no consistent trend was demonstrated, the changes in the weight and cost of instrument panels are not attributed to the standard.

Seat Back Padding. Similar to instrument panels, the head impact areas of the front seat backs are required to pass a headform impact test. The requirement applies to the top and backside of the front seatback, which are impact areas for the back-seat occupant in a frontal crash. The upper six inches of the front seat back padding was studied. The average weight and consumer cost increased in the ten specimen make-models from 1967 to 1968 and in seven specimen make-models from 1968 to 1969. The average weight and consumer cost increase from 1967 to 1969 was 0.65 pounds and $4.32 in 2002 dollars and is attributed to the standard.

Table 201-1 shows the total average weight and cost increase of occupant protection attributable to FMVSS 201 in passenger cars.

***TABLE 201-1***
***AVERAGE WEIGHT AND CONSUMER COST***
***OF OCCUPANT PROTECTION***
***ATTRIBUTABLE TO FMVSS 201 IN PASSENGER CARS***

| COMPONENT | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| Glove Box Door Latch | 0.01 | $0.12 |
| Seat Back Padding | 0.65 | $4.32 |
| TOTAL | 0.66 | $4.44 |

An additional study was conducted in the 1980s to determine the cost effect (trend cost) that FMVSS 201 had on 1983 passenger cars plus the effect that downsizing, weight reduction, and front-wheel drive may have had on the cost of implementing the standard.[63] The basis for the price determinations was the teardown and analysis of system components from selected vehicles representing comparable make-models prior to and after the effective date of the standard. Since the trend-system sample did not measure the same items or car designs as the pre- and post-standard sample, the costs cannot be used for comparison.

## *Light Truck Studies*

A study was conducted in the late 1970's to determine the effects of extending the passenger car requirements of FMVSS 201 to light trucks and vans.[64] An estimate of the additional weight and consumer cost imposed by the standard on light trucks was calculated in 1979 to support the regulatory analysis process; however, these estimates were not based on a "teardown" analysis. All 1978 model year U.S. light trucks were inspected to determine their state of compliance. Cost and weight estimates were prepared for all items that were in noncompliance.

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[63] Osen, W.R and Ludtke, N.F., *Cost Evaluation of Federal Motor Vehicle Safety Standard 210 – Passenger Cars and Evaluation of Cost and Weight Trends for Standards 201, 203, and 204 – Passenger Cars, Volume I* , Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, April 1985. (DOT HS 806 770),

[64] McLean, R.F., *Study of the Effects of Applying Federal Motor Vehicle Safety Standard 201 to Light Trucks and Vans*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, May 1979. (DOT HS 805 162).

Additional padding was required on some instrument panels and on all seat backs. Pickups equipped to carry rear passengers would require added seat back padding on the front seat. Passenger vans, fitted with one or more seats behind the front seats, would require the forward-most seat backs to be padded. Table 201-2 shows the arithmetic average weight and consumer cost increase of padding for light trucks. These figures are the best estimates, based on the contractor's judgment. The increases in interior impact protection are attributable to FMVSS 201 in light trucks.

***TABLE 201-2***
***AVERAGE WEIGHT AND CONSUMER COST***
***OF OCCUPANT PROTECTION***
***ATTRIBUTABLE TO FMVSS 201 IN LIGHT TRUCKS***
***WITH TWO OR MORE ROWS OF SEATS***

| COMPONENT | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| Padding | 3.78 | $13.48 |

A study of the interior components on seven 1982 model year light trucks was conducted to determine the consumer cost and weight of the glove box latches, dashboard padding, armrests, and sun visors.[65] No pre-standard make-models were studied to serve as a baseline. The 1982 specimen vehicles were leased for visual inspection, detailed measurements, and photographic documentation, but components were not removed and torn down. A review of the prior year models and parts books indicated that the components related to interior impact protection were being used in advance of the implementation date. However, because some of the make-models were extensively redesigned in 1982, the contractor was unable to directly compare the components of pre- and post-standard light trucks and did not estimate the average cost increase.

***<u>Head Impact Protection Upgrade</u>***. FMVSS 201 was substantially upgraded in the 1990's. In August 1995, a final rule was issued requiring passenger cars and light trucks to provide protection when an occupant's head strikes upper interior components during a crash, including pillars, side rails, headers, and the roof. The rule significantly expanded the scope of the standard. Previously, the standard applied mainly to the portion of the vehicle interior in front of the front seat occupants, i.e., the instrument panel. By September 1998, the standard was amended to permit, but not require, the installation of dynamically deploying upper interior head protection systems that provide added head protection in lateral crashes.[66]

Specific areas of the upper interior are required to absorb energy to protect the occupant's head in an impact. A free motion head form is impacted into target locations on the A-pillar, B-pillar, side headers, front windshield header, and other potential interior locations. The additional upper interior protection requirements can be met with either head air bag or non air bag head protection systems or both, which are being phased in starting with the 1999 model year and concluding with the 2003 model year.

A study was conducted in 2003 to determine the changes made by the automotive industry to meet the standard's non air bag criteria. Ten make-model pre-standard passenger vehicles (six passenger cars, one pickup, one SUV, and two vans), and their corresponding post-standard systems, were studied to determine the weight and consumer cost impact of adding non air bag

[65] Gladstone, DOT HS 806 769:4-1 thru 4-41 (1982).
[66] *Federal Register*, Vol.67, No. 117, pg. 41348.

components.[67] The type of approaches used to meet the standard consist of foam padding, ridges molded from composite materials, injection molded "egg-crate" or honeycomb parts, and injection molded ribs in parallel on the interior side of trim pieces. All these approaches are used in the A and B pillar trim, header, and headliner locations.

Table 201-3 shows the sales-weighted average weight and consumer cost of the non air bag protection systems. Passenger cars and light trucks were combined to identify the preliminary costs for head impact protection. With the automotive manufacturers transitioning to head air bag protection systems, a study on head air bags is currently being conducted. When completed, NHTSA will have a more comprehensive estimate of the costs.

***TABLE 201-3***
***AVERAGE WEIGHT AND CONSUMER COST OF HEAD IMPACT PROTECTION SYSTEMS WITHOUT AIR BAGS IN PASSENGER VEHICLES***

| SYSTEM | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| Without Air Bags | 1.89 | $11.99 |

This cost is inherently attributable to FMVSS 201. However, because NHTSA's cost analysis of the head impact protection upgrade, including head air bags, has not been completed, we will not include it at this time in our accounting of the total costs of the FMVSS (Section 5 of this report).

### *FMVSS 202 – HEAD RESTRAINTS*

FMVSS 202 became effective on January 1, 1969 (passenger cars) and September 1, 1991 (multipurpose passenger vehicles, trucks, and buses) and specifies requirements for head restraints at the front outboard seat positions. The purpose of this standard is to reduce the frequency and severity of neck injuries in rear-end and other collisions, specifically "whiplash", a painful and sometimes disabling syndrome that is all too common in these crashes. This standard applies to passenger cars, multipurpose passenger vehicles, trucks, and buses with a GVWR of 10,000 pounds or less.[68]

Vehicle manufacturers installed adjustable or nonadjustable (integral or fixed) head restraints in response to FMVSS 202. Adjustable head restraints can be added to bench as well as bucket seats. They can be shifted up and down through a finite range to suit the occupant, and some can also be rotated about their lateral axis to change the distance from the face of the restraint to the back of the occupant's head. Integral head restraints are built into a bucket seat, or in rare cases, a bench seat. They are not adjustable. Essentially the seat back is raised high enough to act as a head restraint, and seats with integral head restraints are commonly referred to as "high-back" seats. They require additional framing, padding, and seat covering as compared to a pre-standard seat back without a head restraint. Fixed head restraints are rigidly attached to the seat back, are

[67] Ludtke, N.F., et.al., *Perform Cost and Weight Analysis, Non Air Bag Head Protection Systems, FMVSS 201,* Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, December 2003. (DOT HS 809 810).
[68] Legal citation: *49 CFR 571.202* (2004).

not adjustable, and are typically composed of a metal frame that is covered with padding that allows the vehicle operator to see through the open areas of the framework.

The advantage of adjustable restraints is that short drivers can push them down to avoid vision obstructions; the disadvantage is that taller occupants may neglect to adjust them up to an adequate height.  Integral restraints avoid the problem of improper adjustment and sometimes cost less than adjustable restraints; however, they have been criticized because they might obstruct a driver's vision or create a "wall" that makes rear-seat passengers feel isolated from the people in front of them.  Fixed "see-through" restraints try to avoid the shortcomings of the adjustable and the integral types, although not all consumers, researchers, or manufacturers would agree they are successful.  Fixed head restraints have similar bulk and costs as adjustable head restraints.

FMVSS 202 requires a head restraint be provided at each front outboard seating position.  The performance requirements of the standard can be met in either of two ways.  The first option is to undergo a dynamic test where a $95^{th}$ percentile male test dummy is belted into the subject seat and subjected to a forward acceleration of 8g.  If the dummy's head is displaced angularly rearward no greater than 45 degrees during the acceleration, the requirements are met.  The second option outlines specific dimensional requirements such as the extended restraint height from the seat reference point and the restraint width.  It also requires that the head restraint withstand a force, applied with a head form, 2.5 inches below the top of the restraint that produces a moment of 275 pound feet at the seating reference point until the seat back fails or the apply force reaches 200 pounds.  To date, manufacturers have always certified compliance by the second option.

Head restraints are an addition to vehicles; therefore, a baseline was not used to determine the additional consumer cost and weight.  The head restraint portion of the integral "high-back" seats was estimated by considering only the additional material and labor necessary to provide the increase in seat-back height necessary to meet the requirements for a head restraint.  For the purposes of analysis, head restraints were divided into adjustable and nonadjustable categories.  The nonadjustable restraints include integral and fixed head restraints.

## *Passenger Car Studies*

The vast majority of American passenger cars were fitted with adjustable head restraints in 1969.  During the 1970's, nonadjustable head restraints reached their peak market share.  Starting in 1983, the percentage of nonadjustable head restraints started to drop dramatically.  Table 202-1 shows the average percentage of nonadjustable and adjustable head restraints from 1969-2001.

***TABLE 202-1***
***AVERAGE PERCENTAGE OF NONADJUSTABLE/ADJUSTABLE HEAD RESTRAINTS IN PASSENGER CARS FROM 1969 TO 2001***

| MODEL YEAR | % NONADJUSTABLE | % ADJUSTABLE |
|---|---|---|
| 1969-1981 | 31 | 69 |
| 1982-2001 | 13 | 87 |

Three separate studies of nonadjustable and adjustable headrests were conducted to determine the weight and consumer cost of the head restraint systems in 1969-1981 model-year passenger cars.[69,70,71] There were a total of eight nonadjustable (integral or fixed) head restraints in various model year passenger cars, eleven adjustable head restraints in 1969 model year passenger cars, and five adjustable head restraints in 1979-1981 model year passenger cars. Table 202-2 shows the sales-weighted average weight and consumer cost of head restraints per passenger car (i.e., the cost of two head restraints) in 2002 dollars.

***TABLE 202-2***
***AVERAGE WEIGHT AND CONSUMER COST***
***OF HEAD RESTRAINTS IN PASSENGER CARS***

| CATEGORY | MODEL YEAR | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|---|
| Nonadjustable | 1969-1981 | 6.18 | $27.57 |
| Adjustable | 1969 | 9.94 | $43.07 |
| Adjustable | 1979-1981 | 5.55 | $31.39 |

Table 202-2 suggests that adjustable head restraints decreased significantly in weight and consumer cost between 1969 and 1979-1981. NHTSA believes the reductions are due to two factors:

- initial "over design" (extra wide and bulky restraints)
- vehicle downsizing that resulted in smaller, narrower seats and elimination of full-bench seats

For simplicity, let us assume that the average consumer cost decreased at a linear rate from 1969 to 1981 and leveled off after that (since no further downsizing has occurred). Therefore, the average weight and consumer cost of passenger car head restraints attributable to the standard in any given model year is calculated using the following formulas:

1. Average Cost of Head Restraints (1969-1981) =

a. For MY 1969
(% 1969-1981 Nonadjustable HR/100 * Cost of Nonadjustable HR) +
(% 1969-1981 Adjustable HR/100 * Cost of 1969 Adjustable HR)

b. For MY 1970 through 1980
(% 1969-1981 Nonadjustable HR/100*Cost of Nonadjustable HR) +
% 1969-1981 Adjustable HR/100*((Cost of 1979-81 Adjustable HR*(MY-1969))/12 +
(Cost of 1969 Adjustable HR*(1981-MY))/12))

c. For MY 1981
(% 1969-1981 Nonadjustable HR/100 * Cost of Nonadjustable HR) +
(% 1969-1981 Adjustable HR/100 * Cost of 1979-1981 Adjustable HR))

[69] Harvey, M.R., Lesczhik, J.A., and McLean, R.F., *Cost Evaluation for Nine Federal Motor Vehicle Standards Volume IV, FMVSS 202 & 207*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, November 1979. (DOT HS 805 318:12-15).
[70] Gladstone, DOT HS 806 257:2-1 thru 2-14 (1982).
[71] Gladstone, DOT HS 806 769:6-1 thru 6-2 (1982).

2. Average Cost of Head Restraints (1982-2001) =
   (% 1982-2001 Nonadjustable HR/100 * Cost of Nonadjustable HR) +
   (% 1982-2001 Adjustable HR/100 * Cost of 1979-1981 Adjustable HR)

3. Average Weight of Head Restraints (1969-1981) =

   a. For MY 1969
   (% 1969-1981 Nonadjustable HR/100 * Weight of Nonadjustable HR) +
   (% 1969-1981 Adjustable HR/100 * Weight of 1969 Adjustable HR)

   b. For MY 1970 through 1980
   (% 1969-1981 Nonadjustable HR/100*Weight of Nonadjustable HR) +
   % 1969-1981 Adjustable HR/100*((Weight of 1979-81 Adjustable HR*(MY-1969))/12 +
   (Weight of 1969 Adjustable HR*(1981-MY))/12))

   c. For MY 1981
   (% 1969-1981 Nonadjustable HR/100 * Weight of Nonadjustable HR) +
   (% 1969-1981 Adjustable HR/100 * Weight of 1979-1981 Adjustable HR)

4. Average Weight of Head Restraints (1982-2001) =
   (% 1982-2001 Nonadjustable HR/100 * Weight of Nonadjustable HR) +
   (% 1982-2001 Adjustable HR/100 * Weight of 1979-1981 Adjustable HR)

Table 202-3 shows the results of equations 1-4, the average weight and consumer cost of head restraints attributable to FMVSS 202 in passenger cars by model year.

***TABLE 202-3***
***AVERAGE WEIGHT AND CONSUMER COST OF HEAD RESTRAINTS ATTRIBUTABLE TO FMVSS 202 IN PASSENGER CARS BY MODEL YEAR***

| MODEL YEAR | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| 1969 | 8.77 | $38.27 |
| 1970 | 8.52 | $37.59 |
| 1971 | 8.27 | $36.92 |
| 1972 | 8.02 | $36.25 |
| 1973 | 7.76 | $35.58 |
| 1974 | 7.51 | $34.91 |
| 1975 | 7.26 | $34.24 |
| 1976 | 7.01 | $33.56 |
| 1977 | 6.76 | $32.89 |
| 1978 | 6.50 | $32.22 |
| 1979 | 6.25 | $31.55 |
| 1980 | 6.00 | $30.88 |
| 1981 | 5.75 | $30.21 |
| 1982-2001 | 5.63 | $30.89 |

### *Light Truck Studies*

Head restraints have been required since September 1, 1991 (model year 1992) in pickup trucks, vans, and SUVs with a GVWR of 10,000 pounds or less. Nevertheless, head restraints or other devices capable of meeting FMVSS 202 (e.g., high-backed "captain's chairs") were already installed in most vans, SUVs, and some pickup trucks well before 1992, even before the rulemaking process that extended the standard to light trucks. That raises a question whether the full cost of head restraints in light trucks is attributable to FMVSS 202. To the extent that the standard for cars set an example for light trucks (e.g., in product liability litigation); and, since there was much discussion of extending the standard as early as the mid-1970's, it seems appropriate to attribute all costs of head restraints in light trucks to FMVSS 202.

Table 202-4 shows the average percentage of nonadjustable and adjustable light truck head restraints between 1992 and 2001.

***TABLE 202-4***
***AVERAGE PERCENTAGE OF NONADJUSTABLE/ADJUSTABLE HEAD RESTRAINTS IN LIGHT TRUCKS FROM 1992 TO 2001***

| MODEL YEAR | % NONADJUSTABLE | % ADJUSTABLE |
|---|---|---|
| 1992-2001 | 55 | 45 |

A study of nine light truck head restraints was conducted to determine the weight and consumer cost of the head restraint systems in 1992-1994 make-model light trucks and vans.[72] Four of the head restraints were nonadjustable while five were adjustable. Table 202-5 shows the sales-weighted average weight and consumer cost of the head restraint systems.

***TABLE 202-5***
***AVERAGE WEIGHT AND CONSUMER COST OF HEAD RESTRAINTS IN LIGHT TRUCKS***

| CATEGORY | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| Nonadjustable | 4.40 | $29.83 |
| Adjustable | 3.47 | $32.36 |

The average weight and consumer cost of light truck head restraints attributable to the standard was calculated using the following formulas:

1. Average Cost of Head Restraints (1992-2001) =
   (% 1992-2001 Nonadjustable HR/100 * Cost of Nonadjustable HR) +
   (% 1992-2001 Adjustable HR/100 * Cost of Adjustable HR)

2. Average Weight of Head Restraints (1992-2001) =
   (% 1992-2001 Nonadjustable HR/100 * Weight of Nonadjustable HR) +
   (% 1992-2001 Adjustable HR/100 * Weight of Adjustable HR)

[72] Fladmark, DOT HS 809 796 (1994).

Table 202-6 shows the average weight and consumer cost of head restraints attributable to FMVSS 202 in light trucks.

| ***TABLE 202-6***<br>***AVERAGE WEIGHT AND CONSUMER COST***<br>***OF HEAD RESTRAINTS***<br>***ATTRIBUTABLE TO FMVSS 202 IN LIGHT TRUCKS*** | | |
|---|---|---|
| MODEL YEAR | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
| 1992-2001 | 3.98 | $30.97 |

## *FMVSS 203 – IMPACT PROTECTION FOR THE DRIVER FROM THE STEERING CONTROL SYSTEM*
## *FMVSS 204 – STEERING CONTROL REARWARD DISPLACEMENT*

### *Passenger Car Studies*

FMVSS 203/204 became effective on January 1, 1968 (passenger cars) and September 1, 1981 (multipurpose passenger vehicles, trucks, and buses). FMVSS 203 specifies requirements for steering control systems that yield forward, cushioning the impact of the driver's chest by absorbing much of his or her impact energy in front-end crashes. FMVSS 204 specifies requirements limiting the rearward displacement of the steering column into the passenger compartment. The purpose of these standards is to provide basic occupant protection for the unbelted or lap-belted driver in a frontal crash and minimize chest, neck, head, or facial injuries from an impact. This standard applies to passenger cars, multipurpose passenger vehicles, trucks, and buses with a GVWR of 10,000 pounds or less.[73] Since the changes made to steering columns typically satisfied both of these standards, this analysis is combined into one section.

The requirements of FMVSS 203 and 204 address the hazards of a steering column in two different ways. FMVSS 203 requires that the impact force developed on the chest not to exceed a safe level of 2500 pounds from the steering column during an impact of 15 mph. This is accomplished by designing the column to collapse at a controlled rate upon impact. FMVSS 204 specifies a limit of 5 inches horizontal steering column intrusion toward the driver during a head-on crash into a fixed barrier at 30 mph. Essentially, FMVSS 203 addresses the driver impacting the steering wheel/column and FMVSS 204 is concerned with the steering column being driven into the interior as the front of the vehicle is crushed during a crash. A collapsible steering column typically satisfied both requirements. It should be noted that FMVSS 203 does not apply as a separate requirement to vehicles that conform to the barrier crash standards of FMVSS 208 by means of air bags. Nevertheless, today's vehicles equipped with air bags still have collapsible steering columns since this device is an important component of the safety system that makes air bags effective.

Manufacturers replaced the rigid steering columns with different collapsible designs. American Motors, Chrysler, and General Motors had installed steering columns with the energy absorbing features on their 1967 models; whereas Ford, Toyota, Volkswagen, and, probably other foreign-based manufacturers introduced them in 1968. Three main components were modified to create

[73] Legal citation: *49 CFR 571.203/204* (2004).

a collapsible column:  the outer jacket tube, the shift tube, and the steering shaft.  The outer jacket is the visible external tube mounted to the firewall and instrument panel that contains the shift tube, the steering shaft, a wiring harness, and any internal energy absorbing components. The shift tube transfers the rotational input from the column mounted shift lever to the bottom of the steering column where linkage from the transmission is connected.  The shift tube is oriented concentrically inside the outer jacket tube.  The steering shaft transfers the rotational input from the steering wheel to the bottom of the steering column where it connects with the steering gearbox or an intermediate shaft.  The steering shaft typically passes through the center of the column.

The outer jackets were weakened by cutting longitudinal slots in them (Ford), or by replacing a lower part of the jacket with a tube-shaped, basket-weave section of metal mesh (GM, Chrysler, AMC, VW, and Toyota).  Later in 1969, AMC and GM started using an outer jacket composed of two concentric tubes, with the lower tube of a smaller diameter like a telescope.  Between the outer diameter of the smaller tube and the inner diameter of the larger tube was a bearing sleeve that contained small hardened steel balls.  During an impact, this outer jacket would collapse and absorb energy at a controlled rate as the steel balls cut grooves into the tubes.  Chrysler maintained the basket-weave mesh design until the mid 1970's when they started placing a tapered collar/mandrel at the base of the outer jacket.  As the column was loaded, the outer jacket would peel apart as it was pressed against the outer diameter of the collar and collapse at a controlled rate.  Chrysler also introduced a wheel canister absorption device starting with the 1970 Dodge Challenger and Plymouth Barracuda in place of the energy-absorbing column. Volvo has also used wheel canisters.  In 1973, Ford started installing an internally grooved column that uses friction between the column tubes to absorb energy.

The shift tube and the steering shaft were redesigned to collapse under impact.  The shift tubes were designed to telescopically collapse with the outer jacket.  The steering shaft was changed from a single rigid shaft to a two or three-piece shaft.  The lower section on the two-piece shaft and the middle section on the three-piece shaft were hollow to allow the upper shaft to collapse into it.

One modification that could be attributed to FMVSS 204 was the change to the steering gearbox's intermediate shafts from a rigid to a collapsible design.  These intermediate shafts span the distance from the lower end of the steering shaft to the steering gearbox mounted on the front sub-frame.  Initially, a coaxial design where a smaller shaft slides into a larger hollow shaft was used to create a collapsible intermediate shaft.  With the advent of rack and pinion steering, when the intermediate shaft usually became too short and too vertical to accommodate the coaxial design, two or more universal joints were used on the intermediate shaft to allow it to fold upon impact.  The manufacturers of the vehicles studied, in order to comply with FMVSS 204, made no major front structural changes.

The shear capsule, which is a bracket designed to prevent rearward movement of the column but to allow forward movement, is a vital partner to the steering column energy-absorbing device (EAD).  When the lower part of the column is forced backward due to vehicle damage, the shear capsule holds the upper column in place while the column EAD collapses.  On the other hand, when the driver contacts the steering wheel, the shear capsule freely allows the upper part of the column to move forward while the EAD collapses.[74]

The steering assemblies and front structures of 1969-1976 post-standard passenger cars and their corresponding 1966 pre-standard make-models were examined to determine the weight and consumer cost of equipment changes in response to FMVSS 203/204.[75] Examination of the front structures indicated that the post-standard structures and their pre-standard counterparts were identical; no structural changes were made in response to the standard. Therefore, the weight and consumer cost estimates were based on the steering column assemblies. Three of the make-model passenger cars in the study (Rambler American, Volkswagen Beetle, and Toyota Corona) were not included in these estimates because there were no corresponding pre-standard model by the same manufacturer, so the weight and consumer cost added by the standard could not be accurately estimated. Furthermore, the steering column assembly of the 1968 Volkswagen Beetle used a simple mesh design that was soon modified and not a "typical" mesh-type column.

The cost analysis is subdivided into two sections:

- the steering assembly within the passenger compartment
- the steering assembly within the engine compartment

The best estimate of the weight and consumer cost changes within the passenger compartment are obtained by subtracting the weight and consumer cost of the corresponding pre-standard steering column assembly from the weight and consumer cost of the post-standard steering column assembly. This cost analysis is based on six make-models where teardowns were performed on the 1969 and 1966 steering assemblies. The average incremental weight and consumer cost attributed to the standard is 1.89 pounds and $24.00 in 2002 dollars.

Within the engine compartment, an intermediate shaft is used between the steering column assembly and the steering gearbox in some cars with a forward-mounted steering gearbox. The engine compartment telescoping device, which was installed for the purpose of complying with FMVSS 204, was sometimes located on the intermediate shaft. Telescoping post-standard and rigid pre-standard intermediate shafts were examined. The post-standard shaft was found to cost $8.85 more in 2002 dollars and weigh about the same as the pre-standard design. This device is used in 39 percent of all passenger cars[76], so the average cost per car is $3.45 in 2002 dollars. Table 203/204-1 shows the average weight and consumer cost of steering assemblies attributable to FMVSS 203/204 in passenger cars.

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[74] Kahane, C.J., *An Evaluation of Federal Motor Vehicle Safety Standards for Passenger Car Steering Assemblies, Standard 203 – Impact Protection for the Driver, Standard 204 – Rearward Column Displacement,* Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, January 1981. (DOT HS 805 705:90).

[75] McLean, R.F., Eckel, C.E.B., and Lesczhik, J.A., *Cost Evaluation for Three Federal Motor Vehicle Standards FMVSS 203, 204, and 212*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, May 1980. (DOT HS 805 602:5-32).

[76] Kahane, DOT HS 805 705:90 (1981).

| *TABLE 203/204-1*<br>*AVERAGE WEIGHT AND CONSUMER COST*<br>*OF STEERING ASSEMBLIES IN PASSENGER CARS*<br>*ATTRIBUTABLE TO FMVSS 203/204* | | |
|---|---|---|
| CATEGORY | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
| Passenger | 1.89 | $24.00 |
| Engine | 0.00 | $ 3.45 |
| TOTAL | 1.89 | $27.45 |

An additional study was conducted on model-year 1983 passenger cars to determine the trend in weight and consumer cost of their steering column systems.[77] The entire sample of passenger cars studied had made extensive changes since the original post-standard vehicles. Unlike the 1968 and 1969 vehicles studied, every 1983 model-year passenger car studied used an intermediate steering shaft and two universal joints, which are necessary components of a rack and pinion steering system.

The design of the trend steering columns was affected in several ways by "downsizing". Eight of the twelve 1983 vehicles studied used rack and pinion steering in place of the traditional worm and re-circulating ball gearbox type steering system. The downsized cars of 1983 were shorter in length from the windshield base to the front of the car; consequently, they had less room to package a steering system. Rack and pinion steering systems were mounted much closer to the firewall than the older systems with the steering gearbox located ahead of the front axle centerline. A steep angle resulted when the intermediate shaft was linked from the end of the steering column to the drive flange on the steering rack. This steep angle necessitated the use of universal joints on the ends of the intermediate shafts to allow the intermediate shaft to fold under impact. The universal joints added considerable cost to the intermediate shaft. A cheaper coaxial shaft would not function at these steep angles. The cost of the trend steering column was also affected by the increased use of floor shifts. Four of the vehicles studied used a floor shift for the transmission, eliminating the column shift tube altogether. The modest net overall decrease in weight and consumer cost of the trend steering columns, as compared to those of the standard year, are primarily the result of the trend steering columns being simpler and smaller. The various cost increasing and cost-savings factors essentially cancelled each other out, resulting in about the same net cost as in earlier years.

Table 203/204-2 shows the sales-weighted average weight and consumer cost of steering column assemblies for the pre-standard, standard, post-standard, and trend system passenger cars. It is important to note that there has been relatively little change to the weight and consumer cost between 1967 and 1983. Unlike Table 203/204-1, Table 203/204-2 computes the average total weight and consumer cost for all specimen vehicles in each model year group rather than the average incremental weight and consumer cost for matching make-models only (because the 1983 specimens did not match the earlier make-models).

[77] Osen, DOT HS 806 771 (1985).

| ***TABLE 203/204-2 AVERAGE TOTAL WEIGHT AND CONSUMER COST OF STEERING COLUMN ASSEMBLIES IN PASSENGER CARS BY MODEL YEAR*** | | |
|---|---|---|
| MODEL YEAR | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
| 1966 (Pre-Standard) | 9.94 | $24.37 |
| 1967-1968 (Standard) | 10.90 | $43.49 |
| 1969-1976 (Post-Standard) | 12.41 | $47.16 |
| 1983 (Trend) | 11.90 | $44.42 |

Table 203/204-3 shows the breakout of the weight and consumer cost of the different steering column designs. All six major energy absorbing design types are represented, as are the three largest U.S. auto manufacturers (Chrysler, Ford, and GM). Furthermore, there are multiple data points for the three most common energy absorbing design types (mesh, ball, and slotted columns)[78]. Based on limited study samples, it appears that the costs of the various alternative collapsible column designs were fairly similar.

| ***TABLE 203/204-3 AVERAGE INCREMENTAL WEIGHT AND CONSUMER COST BY STEERING COLUMN DESIGN FOR STEERING COLUMN ASSEMBLIES IN PASSENGER CARS (INCREASE RELATIVE TO MATCHING 1966 PRE-STANDARD ASSEMBLIES)*** | | |
|---|---|---|
| DESIGN TYPE | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
| Mesh | 1.59 | $23.27 |
| Ball | 1.06 | $16.27 |
| Slotted | 1.30 | $17.01 |
| Grooved | 0.53 | $19.92 |
| Slotted/Mandrel | 0.62 | $24.12 |
| Wheel Canister | 1.52 | $21.24 |

### *Light Truck Studies*

FMVSS 203 and 204 were effective for light trucks on September 1, 1981. However, collapsible steering columns had already been installed in pickup trucks and multipurpose passenger vehicles from AMC, Chrysler, and GM at least three years before the standard was effective (as early as 1973 in Jeeps and GM pickup trucks). Collapsible steering columns were lacking mostly in full-sized vans with "forward control" steering systems where the more vertical angle of the column made it difficult to implement an energy-absorbing system.

Unlike passenger cars, NHTSA has not performed teardowns of complete steering assemblies in post-standard and matching pre-standard make-models of light trucks. However, steering columns with intermediate shafts from seven 1982 post-standard make-model light trucks and vans were torn down to determine their weight and consumer cost.[79] The contractor also

[78] Kahane, DOT HS 805 705:90 (1981).
[79] Gladstone, DOT HS 806 769:5-1 thru 5-13 (1982).

estimated (without actual teardown) how much these columns would have cost if they had been rigid one-piece designs typical of pre-standard vehicles.

Table 203/204-4 shows the sales-weighted average weight and consumer cost of a steering column without energy absorbing columns (hypothetical estimate) and one with energy absorbing columns (actual teardown). The figures include the complete steering column and intermediate shaft, but not the steering wheel.

| ***TABLE 203/204-4<br>ESTIMATED AVERAGE WEIGHT AND CONSUMER COST<br>OF STEERING COLUMNS IN LIGHT TRUCKS*** | | |
|---|---|---|
| CATEGORY | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
| Without Energy Absorbing Columns | 10.13 | $24.86 |
| With Energy Absorbing Columns | 10.76 | $35.25 |
| Estimated Incremental Weight & Cost | 0.63 | $10.39 |

The estimate in Table 203/204-4 is lower than the estimate for passenger cars (1.89 pounds and $27.45 in Table 203/204-1). The estimate for passenger cars is based on actual teardowns of matching pre- and post-standard specimens and considers the entire steering assembly; therefore, we believe it to be a more reliable estimate than Table 203/204-4, and we shall use it as our estimate for light trucks as well.

Even though collapsible steering columns and intermediate shafts had been in some pickup trucks and SUVs well before model year 1982, it is appropriate to attribute their weight and consumer cost to FMVSS 203 and 204 because the installation of these components took place after the standards became effective for passenger cars. With light truck steering columns being very similar to those of passenger cars, some of the manufacturers went ahead with the installation of these components to increase the safety of their light trucks. Therefore, one impetus for installing collapsible columns and intermediate shafts in light trucks was the earlier requirement of FMVSS 203 and 204 for passenger cars. Table 203/204-5 shows the sales-weighted average weight and consumer cost of steering column assemblies attributable to FMVSS 203 and 204 in light trucks.

| ***TABLE 203/204-5<br>AVERAGE WEIGHT AND CONSUMER COST<br>OF STEERING COLUMN ASSEMBLIES<br>ATTRIBUTABLE TO FMVSS 203/204 IN LIGHT TRUCKS*** | | |
|---|---|---|
| MODEL YEAR | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
| 1982-2001 | 1.89 | $27.45 |

### *FMVSS 205 – GLAZING MATERIALS*

FMVSS 205 became effective on January 1, 1968 and specifies requirements for glazing materials for use in motor vehicles and motor vehicle equipment. The purpose of this standard is to:

- reduce injuries resulting from impact to glazing surfaces
- ensure a necessary degree of transparency in motor vehicle windows for driver visibility

- minimize the possibility of occupants being thrown through the vehicle windows in collisions.

This standard applies to glazing materials for use in passenger cars, multipurpose passenger vehicles, trucks, buses, motorcycles, slide-in campers, and pickup covers designed to carry persons while in motion.[80]

Essentially, FMVSS 205 required that glazing materials used for windshields, windows, and interior partitions meet the requirements outlined in the industry's American National Standard Institute (ANSI) *Safety Code for Safety Glazing Materials for Glazing Motor Vehicles Operating on Land Highways*, Z-26.1 as issued in 1966. (The requirements were subsequently revised in Z26.1-1977, January 26, 1977, as supplemented by Z26.1a, July 3, 1980.) ANSI Z26.1 outlines the requirements for all vehicle safety glazing materials, which include safety glass, safety plastic, multiple glazed units (two or more sheets of glazing separated by an air space), and bullet-resistant glazing. The standard specifies which type of glazing material can be in vehicle locations where driving visibility is required and not required. For passenger cars and light trucks, the industry used tempered glass for side and rear windows and laminated glass for windshields, although the standard allowed the use of other glazing materials in these locations as long as they met the material test requirements described in the standard.

ANSI Z26.1 defines tempered glass as a single sheet of specially treated (heat or chemically treated) plate, sheet, or float glass. It cannot be cut, drilled, or polished after treatment. When it is broken at any point, the entire piece immediately breaks into innumerable small pieces, which may be described as granular, usually with no large jagged edges. Tempered glass for use in locations other than windshields must pass tests for light stability, luminous transmittance, humidity, boil, ball impact, fracture, shot bag impact, and abrasion resistance. Tempered glass had been in use for many years before FMVSS 205, and the standard has not imposed any cost increases with its use.

ANSI Z26.1 defines laminated glass as two or more sheets of glass held together by a layer(s) of plastic material. Under impact, laminated glass will crack or break but the pieces do not fly and the edges of holes are less jagged than ordinary glass. In addition to the tests required of tempered glass, laminated glass must also pass tests for deviation/distortion and penetration resistance.

Before model year 1966, the standard windshield for domestic cars was composed of a 0.015-inch layer of polyvinyl butyral tightly bonded between two 0.125-inch layers of plate glass. Tests in the industry indicated that the plastic interlayer did not stretch more than the glass before the tight bond between the plastic and the glass caused tearing. Consequently, the plastic interlayer was easily torn by broken glass, allowing an occupant's head to tear through the windshield in low speed crashes causing disfiguring or disabling head injuries associated with windshield contact. In the early 1960's, it was discovered that a looser bond between the plastic and glass layers could be obtained by increasing the moisture content of the polyvinyl butyral, which set the stage for the development of improved windshields. In 1962, SAE requested glass companies develop a safer windshield, and the High Penetration Resistant (HPR) windshield was

[80] Legal citation: *49 CFR 571.205* (2004).

the response to that request.[81] The penetration resistance requirement was SAE standard J938, and first published in October 1965. FMVSS 205, effective in January 1968, was based largely on earlier SAE and ANSI standards; the installation of HPR windshields was the primary vehicle modification associated with those standards.

High Penetration Resistant Windshield (HPR). The new HPR windshield consisted of a 0.030-inch advanced plastic interlayer bonded to two glass plies by a special adhesive that permitted the plastic to slide along the glass and not delaminate or discolor. In 1965, the domestic manufacturers installed HPR windshields, on an experimental basis, in a few models. By 1966, every automobile manufacturer in the United States and Canada adopted the new HPR windshield with the 1966 model-year passenger car. These windshields remained unchanged until 1977 when thinner lights of glass (0.105-0.115 inch) were used to support vehicle downsizing.[82]

A study was conducted to determine the weight and consumer price differential between the pre-1966 glazing and the FMVSS 205 HPR windshield and tempered side and rear windows of 1969 model-year passenger cars. The only variance in the windshield between the pre-standard and the HPR standard was the increase in thickness of the plastic interlayer from 0.015-inch to 0.030-inch and the use of an improved adhesive bonding material.[83] A representative sample of major domestic and foreign manufacturers was examined, and the sales-weighted average weight and consumer cost increase of an HPR windshield was calculated at 1.07 pounds and $7.57 in 2002 dollars. It is understood that the increase in weight and consumer cost is proportional with the surface area of the windshield; i.e., as vehicle size increases, the weight and consumer cost of the HPR windshield increases.

HPR windshields were installed in all domestic vehicles for the 1966 model year in response to industry and SAE initiatives that preceded any Federal regulatory process, plus the majority of imported cars used an HPR windshield starting with the 1967 model year. Therefore, the added weight and consumer cost is not attributed to FMVSS 205. The Federal standard essentially codified existing industry practices, and these practices were developed before the Federal government began to regulate motor vehicle safety.

Glass-Plastic Windshields. FMVSS 205 was amended in 1983 to permit, but not require, the use of glass-plastic glazing material at the option of the motor vehicle manufacturer. Glass-plastic windshields were thought to further reduce (over HPR windshields) occupant lacerations from impact with the windshield. This new windshield was essentially an HPR windshield with a layer of polyurethane bonded to the glass surface that faces the vehicle interior. This layer would provide a barrier that would prevent an occupant from contacting the broken shards of glass

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[81] Kahane, C.J., *An Evaluation of Windshield Glazing and Installation Methods for Passenger Cars*, Washington: Department of Transportation, National Highway Traffic Safety Administration, 1985. (DOT HS 806 693).

[82] Gladstone, DOT HS 806 769:7-1 thru 7-14 (1982).

[83] Ibid.

during an impact.[84] At the time of the amendment, the potential drawbacks of a glass-plastic windshield were thought to be:

- The lower abrasion resistance of the inside plastic layer could lead to degraded visibility and a shorter windshield "lifespan", which would increase vehicle operation cost.
- The windshield is stiffer (four plies) and could contribute to a higher incidence of blunt impact injuries.
- The additional cost of a glass-plastic windshield on a new vehicle was estimated to be between $38 and $45 as compared to an HPR windshield.[85]
- Attachment of the rearview mirror to the plastic with adhesive was not practical. Other mounting schemes were needed.
- Attachments and removal of decals to the inside of the windshield may result in localized scratches and haze.

In the early 1980's, Ford and GM installed glass-plastic windshields in rental vehicles for field-testing; however, the durability of these windshields in the real world was less than expected. The plastic inner liner was susceptible to damage (i.e., cuts, scratches) from the everyday operating environment. In 1984, GM installed the glass-plastic windshields as standard equipment in one of its luxury car models, the Cadillac Seville Elegante. By model years 1986 and 1987, GM had made these windshields standard equipment on approximately 210,000 cars.[86]

The actual cost of glass-plastic windshields in use was greater than estimated in the 1983 amendment. The estimated cost increase of a glass-plastic windshield in 1983 was between $63 and $75 in 2002 economics. This estimate was from the sole supplier of glass-plastic glazing at the time and was based on a production volume of 500,000 to 1,000,000 units annually. In reality, much lower production volumes resulted in higher costs. After the 1987 model year, GM no longer installed glass-plastic windshields in any vehicles due to high warranty and replacement costs, and no other domestic or import automaker has used them in their U.S. market vehicles since.

### *FMVSS 206 – DOOR LOCKS AND DOOR RETENTION COMPONENTS*

FMVSS 206 became effective on January 1, 1968 (passenger cars), January 1, 1970 (multipurpose passenger vehicles), and January 1, 1972 (trucks) and specifies requirements for door locks and door retention components including latches, hinges, and other supporting means. The purpose of this standard is to minimize the likelihood of occupants being thrown from the vehicle as a result of impact. This standard applies to passenger cars, multipurpose passenger vehicles, and trucks.[87]

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[84] Parsons, G.G., *An Evaluation of the Effects of Glass-Plastic Windshield Glazing in Passenger Cars*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, November 1993. (DOT HS 808 062).

[85] *Final Regulatory Evaluation Anti-Lacerative Glazing FMVSS 205*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, September 1983, pg. IV-2.

[86] Parsons, DOT HS 808 062, (1983).

[87] Legal citation: *49 CFR 571.206* (2004).

***Side Door Components***. Door latches were required to have a fully latched position and a secondary latched position, which were required to withstand a 2,500-pound longitudinal load in the fully latched position and 1,000 pounds in the secondary latched position. In the transverse direction, the latch must withstand a 2,000-pound load when fully engaged and a 1.000-pound load in the secondary latched position. Door latches were also required not to move from the fully engaged position when a longitudinal or transverse inertial load of 30g was applied to the door latch system. Similarly, door hinges were required to sustain loads of 2,500 pounds longitudinal and 2,000 pounds transverse without failure.

FMVSS 206 had a regulatory history that began before NHTSA was founded. Specifically, it incorporated two SAE standards developed by the domestic auto industry. The standard gradually evolved and became stronger throughout 1962-1969. The manufacturers who often anticipated the regulations and steadily improved their door locks throughout 1956-1969 voluntarily implemented most of these improvements.[88] Therefore, no cost studies have been performed on door latches, hinges, and other retention components for side doors, and none are planned by the agency.

***Back Door Components***. In 1995, a final rule amending FMVSS 206 was published that extended the side door requirements to the back doors of passenger cars and multipurpose passenger vehicles. This ruling affected hatchbacks, stations wagons, SUVs, and passenger vans with a GVWR of 10,000 pounds or less. Sixty percent of the affected vehicles were required to comply by September 1, 1997, with 100 percent by September 1, 1998. The intent of the amendment is to prevent occupant ejections from vehicles equipped with back doors.

In March 1994, NHTSA published a press release warning owners of minivans and other vehicles with hatchbacks that these doors can open unexpectedly in a crash and unbelted occupants can be ejected. A cost and weight analysis was performed on latch/striker assemblies from the back doors of two 1993 (pre-standard) minivans.[89] One of the assemblies met the side door latch strength requirements of FVMSS 206 while the other did not. The latch/striker assembly that passed the 206 testing weighed 0.86 pounds and cost an estimated $3.31 in 2002 dollars, while the latch/striker assembly that failed weighed 0.90 pounds and cost an estimated $4.56 in 2002 dollars. A comparison of the test results and cost analysis leads to the conclusion that a latch/striker that meets the requirements of FMVSS 206 in this case did not cost more than a latch/striker that does not meet the standard. Therefore, an increase in the weight and consumer cost of back door latches has not been attributed to the standard. However, a more detailed teardown analysis of a representative sample of pre- and post-standard make-models would be needed to confirm this initial “no-cost” estimate.

[88] Kahane, C.J., *An Evaluation of Door Locks and Roof Crush Resistance of Passenger Cars – Federal Motor Vehicle Safety Standards 206 and 216*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, November 1989. (DOT HS 807 489:3-4).

[89] Rutland, K.W. and Spinney, B.C., *A Cost and Weight Analysis of MY93 Minivan Rear Door Latch and Striker Sets*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, May 1994.

***FMVSS 207 – SEATING SYSTEMS***

FMVSS 207 became effective on January 1, 1968 (passenger cars) and January 1, 1972 (multipurpose passenger vehicles, trucks, buses) and specifies requirements for seats, their attachment assemblies, and their installation. The purpose of this standard is to minimize the possibility of their failure by forces acting on them as a result of vehicle impact. This standard applies to passenger cars, multipurpose passenger vehicles, trucks, and buses.[90]

The standard requires that each occupant seat installation, except for folding auxiliary jump seats and side-facing seats, shall withstand a load of twenty times the weight of the seat in a forward and rearward longitudinal direction and withstand a 3,300 inch pound moment about the seat's "H" point (location, when viewed from the side, where an occupant's hips would reside when sitting in the seat). Folding and hinged seats are required to have a self-locking restraining device for the seatback with a release control to allow the seatback to be folded forward. The restraining device must preclude inertial release when subjected to a 20g longitudinal load. Additionally, the restraining device must withstand a forward longitudinal load of twenty times the weight of the seatback applied to the center of gravity of the seatback without failing or releasing.

FMVSS 207 is essentially associated with one tangible vehicle modification: the introduction of seat back locks in the folding front seatbacks of passenger cars with two doors. Folding and hinged seats were not necessary in four-door vehicles. On average, 41 percent of the vehicles sold in the United States from 1968 to 2001 were two-door vehicles. On a model year basis, the percentage of two-door cars sold has ranged from a high of 66 percent in 1974 to a low of 19.5 percent in 2001.

Seat mounting assemblies and floor panels on twelve 1969 model year U.S. manufactured passenger cars were examined to determine the impact of FMVSS 207. There were no apparent modifications to the seat mounting assemblies or the floor panels under the seats on any of the vehicles examined. The manual seat back locks from four 1969 model year two-door passenger cars (Ford Mustang, Ford Thunderbird, Chevrolet Nova, and Pontiac Firebird) were examined to determine their cost and weight.[91] The results of the first three cars were reasonable and consistent, especially since the Mustang had a simpler lever for operating the seat back lock than did the Thunderbird and Nova. The much lower results for the Firebird were anomalous, especially since the photographs suggested it had almost the same hardware as the Mustang. In addition, the report gave two conflicting values for added weight intimating that the cost estimates for the Firebird were incorrectly calculated or transcribed in several categories. Only the results for the first three vehicles were used for computing the average. Automatic (inertial) seat back locks from three 1986 model year passenger cars (Chevrolet Camaro, Dodge 400, and Ford Tempo) were also studied.[92]

Seat back locks were implemented at General Motors in 1967 and at Ford and Chrysler in 1968. In addition, Volkswagen and Opel contained seat back locks by 1966 and Fiat, Renault, Datsun,

[90] Legal citation: *49 CFR 571.207* (2004).
[91] Harvey, DOT HS 805 318:16-19 (1979).
[92] Carlson, DOT HS 807 017:56-67 (1986).

and Sunbeam by 1967.[93] Initially all seat back locks were the manual type. Persons desiring to enter the back seat of a two-door car could not fold over the front seatback until they disengaged the lock by operating a lever or pressing a button. Around 1980, the domestic manufacturers switched to automatic inertial seatback locks, which operate much like inertial safety belt retractors. The front seatback folds over freely except during the moments when the car is subjected to decelerations by impacts, road bumps, or emergency braking. During a frontal crash, an inertial mechanism automatically locks the seatback in place.

Table 207-1 shows the arithmetic average weight and consumer cost of manual and automatic seat back locks for two-door passenger cars. On average, the automatic seat back locks weighed more than, and cost about the same as, the manual locks. Since seat back locks were an addition to the seat, their weight and consumer cost is attributed to FMVSS 207 but only in two-door passenger cars. The cost of manual seat back locks will be used for model years 1968-1979, while the cost of automatic seat back locks will be used for model years 1980-2001.

***TABLE 207-1***
***AVERAGE WEIGHT AND CONSUMER COST***
***OF SEAT BACK LOCKS IN TWO-DOOR PASSENGER CARS***
***ATTRIBUTABLE TO FMVSS 207***

| CATEGORY | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| Manual (1968-1979) | 3.07 | $16.53 |
| Automatic (1980-2001) | 3.96 | $16.13 |

### *FMVSS 208 – OCCUPANT CRASH PROTECTION*
### *FMVSS 209 – SEAT BELT ASSEMBLIES*
### *FMVSS 210 – SEAT BELT ASSEMBLY ANCHORAGES*

FMVSS 208 became effective on January 1, 1968 (passenger cars) and July 1, 1971 (multipurpose passenger vehicles, trucks, buses). It was the basic crash protection standard and initially defined the requirements for the installation of safety belts in passenger cars. The standard was amended to specify performance requirements for anthropomorphic test dummies seated in the front, outboard seats of passenger cars and certain multipurpose passenger vehicles, trucks, and buses for manual and automatic restraint systems. It subsequently required and set performance levels for automatic crash protection, especially air bags.

FMVSS 209 became effective on January 1, 1968 and specifies requirements for safety belt assemblies. The requirements apply to:

- straps, webbing, or similar material,
- all necessary buckles and other fasteners,
- all hardware designed for installing the assembly in a motor vehicle, and
- installation, usage, and maintenance instructions for the assembly.

[93] Costenoble, K. and Northrop, G.M., *Review of Nine Federal Motor Vehicle Safety Standards*. Report No. 4238/4239-601. Hartford: Center for the Environment and Man, 1978, pp.49-50.

FMVSS 210 became effective on January 1, 1968 (passenger cars) and July 1, 1971 (multipurpose passenger vehicles, trucks, and buses) and establishes requirements for safety belt assembly anchorages. The purpose of this standard is to ensure proper location for effective occupant restraint and to reduce the likelihood of failure. The requirements apply to any component, other than the webbing or straps, involved in transferring safety belt loads to the vehicle structure.

The purpose of FMVSS 208/209/210 is to reduce the number of fatalities and the number and severity of injuries to occupants involved in frontal crashes. These standards apply to passenger cars, multipurpose passenger vehicles, trucks, and buses.[94] Since FMVSS 209 and 210 support the hardware requirements of FMVSS 208, these standards have been combined into this analysis with FMVSS 208.

The following technologies have been employed over the years to meet the requirements of FMVSS 208:

- ***Manual belts*** are safety belts that will provide protection in a crash if occupants buckle up.[95] Manual belts can be lap belts that fit around the pelvic region or combined/separate lap and shoulder belts. Manual lap/shoulder belts are now equipped with inertia reels that allow the belt webbing to play out so that the occupant can reach forward freely in the occupant compartment under normal conditions, but lock the belt in place in a crash. To remind occupants to use their belts, FMVSS 208 requires the installation of a brief (4-8 seconds) audible and visible reminder. The following are types of manual belts:

    - Manual lap belts with manual adjustment (airline style), simple retractors, or locking retractors
    - Separate manual lap belts and shoulder harnesses, with manual adjustment or simple retractors on the lap belt, and manual adjustment on the shoulder harness
    - Manual 3-point belts, combining the lap belt and shoulder harness into a single device, with locking retractors

- ***Automatic belts*** are similar in many respects to manual belts but differ in that they are attached at one end between the seats in a two front-seat car and at the other end to the interior of the door, or in the case of a belt with a motorized anchorage, to the doorframe. The belt moves out of the way when the door is opened and automatically moves into place around the occupant when the door is closed. Thus, the occupant need take no action to gain the protective benefits of the belt. The following are types of automatic belts:

    - Motorized torso belts with manual lap belts
    - Non-motorized automatic torso belts with manual lap belts and/or knee bolsters
    - Door-mounted, automatic 3-point belts

[94] Legal citation: *49 CFR 571.208/209/210* (2004).
[95] In some of the earlier literature, manual belts are called "active" restraints, while automatic belts and air bags are called "passive" restraints.

- ***Frontal air bags*** are fabric cushions that are very rapidly filled with gas to cushion the occupants against colliding with the vehicle interior when a crash occurs that has a frontal deceleration strong enough to register on a sensor device in the vehicle. When such a crash is sensed, there is rapid generation or release of gas to inflate the bag. After the crash, the bag quickly deflates to permit emergency egress. Beginning in 1996, other types of air bags such as side air bags or head curtains have been installed, but FMVSS 208 regulates only frontal air bags. Frontal air bags are broken down into two categories:

    - Driver air bags
    - Dual air bags (driver and right-front passenger)

The weight and consumer cost of the various safety belt systems, along with safety belt assembly anchorages, in passenger cars were studied and are presented in the following sections.

***Passenger Car Studies***

***Safety Belts***

***Manual Front Outboard Safety Belts Without Retractors***. Passenger cars employed lap belts as the occupant protection system for many years prior to the implementation of FMVSS 208. Safety belt systems prior to 1968 were manually adjusted, airline style. Manual lap belts were believed to be highly effective not only for preventing occupant ejection from the vehicle in crashes but also for preventing harmful occupant contacts with interior vehicle components. They were installed initially at the front-outboard positions.

Crash investigation and biomechanics research demonstrated that a lap belt alone was insufficient for restraining an occupant's head and upper torso from injurious contact with the vehicle's interior, especially in frontal crashes, and might even result in a harmful concentration of force on the abdomen. A shoulder harness was needed in addition to the lap belt to limit the forward motion of the upper body.

The original FMVSS 208 required a lap (Type 1) safety belt at all designated seating positions and a lap/shoulder safety belt at the front outboard seating positions if the windshield header was a potential head impact area for a lap-belted dummy. Vehicle manufacturers began installing lap/shoulder belts in the front outboard positions by January 1, 1968 or earlier. The domestic and Japanese manufacturers largely used separate lap belts and torso belts for these front outboard positions. Crash data and observational surveys soon indicated that few occupants fastened both belts, and most did not bother using the shoulder harness. This shortcoming was remedied with the development of integral 3-point (Type 2) belts, which were used primarily by the European manufacturers. These safety belts were manually adjustable. The integral 3-point belts became, and are still today, the primary component of the occupant protection system. They are highly effective in saving lives and preventing serious injuries in rollovers, frontal crashes, and many types of side impacts.

A cost and weight analysis was performed on three lap belt systems and one separate lap/shoulder belt without retractors.[96] NHTSA did not cost analyze any of the early European integral 3-point belt systems, which were present in fewer than ten percent of new cars in the United States. They are assumed to have approximately the same weight and consumer cost as the early separate lap/shoulder belts. Since the lap belt systems studied ranged over several model years, we took the arithmetic average of their weights and costs.

A cost and weight analysis was also performed on safety belt assembly anchorages in passenger cars.[97] Table 208-1 shows the average weight and consumer cost per seat for the manual front outboard safety belts without retractors, plus the seat belt assembly anchorages.

***TABLE 208-1***
***AVERAGE WEIGHT AND CONSUMER COST PER SEAT OF MANUAL FRONT OUTBOARD SAFETY BELTS WITHOUT RETRACTORS IN PASSENGER CARS***

| BELT ASSEMBLIES | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| Lap Belt Only | 2.38 | $20.99 |
| Separate Lap/Shoulder Belt | 2.95 | $22.61 |
| 3-Point Belt (1966-1971) | 2.95 | $22.61 |

***<u>Manual Front Outboard Safety Belts With Retractors</u>***. Manually adjusting the belt systems was considered inconvenient, especially when people of different sizes took turns driving the same car. The belt was not adjusted to fit the size of the person driving, which in many cases resulted in a loose-fitting belt making it less effective. In order to eliminate the loose fit and the inconvenience of manual adjustment, retractors were added to the safety belt systems. Retractors are a device for storing part or all of the webbing in a safety belt assembly. However, the belts became uncomfortably tight and restricted the freedom of motion needed for driving. A major improvement was the inertia reel or emergency locking retractor. It allowed the belt to spool out freely and retract when an occupant moved forward and backward in the seat during normal vehicle operation, but it locked the belt in place upon sensing a crash.

Beginning in January 1972, FMVSS 208 offered three options to meet its requirements for an occupant restraint system.[98]

- ***Option 1*** – Meet the injury protection criteria of the standard by automatic means in frontal and front angular crash test, <u>or</u> provide either (1) automatic crash protection in a lateral and rollover crash test or (2) manual lap belt or combination of a manual lap/shoulder belt at each seating position.

- ***Option 2*** – Meet the injury protection criteria of the standard by automatic means in a frontal crash test, <u>and</u> provide a manual lap belt or a combination of a manual lap/shoulder belt for each seating position.

[96] McLean, R.F., Eckel, C.E., and Cowan, D., *Cost Evaluation of Four Federal Motor Vehicle Standards, Volume I,* Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, October 1978. (DOT HS 803 871:88-103)
[97] Osen, DOT HS 806 772 (1985).
[98] *Federal Register*, Vol. 36, No. 47, pg. 4600.

- ***Option 3*** **–** Provide, at each front outboard-designated seating position, a Type 2 belt and at other seating positions either a Type 1 or Type 2 belt.

In addition, each belt system must have a belt warning system that operates a continuous or flashing light and a buzzer for 4-8 seconds when the car is started and the driver's belt is not used.[99] All belts must have an emergency release mechanism that is readily accessible to an occupant. Manual belts must be equipped with a push button release.

Vehicle manufacturers chose the third option by employing Type 2 belts in the front outboard positions and Type 1 belts in the other positions. The domestic and Japanese manufacturers kept the lap/detachable torso belts for the front outboard positions and added retractors. The European manufacturers stayed with the integral lap/shoulder belts for the front outboard positions and added retractors.

Starting with model year 1974, the detachable torso belt was no longer allowed for the front outboard seating positions under the third option. Only a Type 2 belt, with integral lap and shoulder belt was allowed.[100] By model year 1978, features like dual retractors (one for the lap belt and one for the torso belt) were introduced to improve the ease-of-use and performance of front safety belts.

A series of cost and weight analyses were performed on two separate lap/shoulder belts and 20 integral 3-point safety belts used to satisfy the third option in FMVSS 208.[101,102,103,104,105]

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[99] From January 1, 1972 to August 31, 1973, a continuous light and buzzer were required. From September 1, 1973 to October 29, 1974, an ignition interlock system was required, whereby front outboard belts had to be buckled before a car could be started. The ignition interlock requirement was revoked on October 29, 1974, and the 4-8 second warning system replaced the persistent warning system. We did not obtain a cost estimate for the ignition interlock system.

[100] Under the first two options, a Type 1 belt was permissible if the vehicle could meet the frontal crash test requirement.

[101] McLean, DOT HS 803 871:88-103 (1978).

[102] Gladstone, DOT HS 806 257:3-1 thru 3-59 (1982).

[103] Fladmark, G.L. and Khadilkar, A.V., *Cost Estimates of Manual & Automatic Crash Protection Systems (CPs) in Selected 1988-1992 Model Year Passenger Cars Brake Systems, Volumes I-IV*. Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, September 1992. (DOT HS 807 949-952).

[104] Fladmark, G.L. and Khadilkar, A.V., *Cost Estimates of (1) Side Impact Crash Protection of 1994-95 vs. 1993-94 Model Year Passenger Cars; (2) Automatic Crash Protection of 1995 Model Year Pickup Trucks, Vans, and Multipurpose Passenger Vehicles; and (3) Automatic Crash Protection of Two 1995 Model Year Passenger Cars, Volume I*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, September 1996. (DOT HS 809 798).

[105] Fladmark, G.L. and Khadilkar, A.V., *Cost Estimates of (1) Side Impact Crash Protection of 1993-95 vs. 1996 Model Year Passenger Cars; (2) Automatic Crash Protection of 1996 Model Year Pickup Trucks, Vans, and Multipurpose Passenger Vehicles; and (3) Automatic Crash Protection of Two 1996 Model Year Passenger Cars, Volumes I-II*, Washington: Department of Transportation, National Highway Traffic Safety Administration, September 1997. (DOT HS 809 801: Section 4 and DOT HS 809 802: Section 6).

Table 208-2 shows the arithmetic average weight and consumer cost per seat for the manual front outboard safety belts with retractors.

| ***TABLE 208-2***<br>***AVERAGE WEIGHT AND CONSUMER COST PER SEAT***<br>***OF MANUAL FRONT OUTBOARD SAFETY BELTS***<br>***WITH RETRACTORS IN PASSENGER CARS*** | | |
|---|---|---|
| MODEL YEAR | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
| ***Separate Lap/Shoulder Belt*** | | |
| 1972-1973 | 4.52 | $32.42 |
| ***Integral 3-Point Belt*** | | |
| 1974 | 4.60 | $36.60 |
| 1979-1981 | 5.82 | $36.50 |
| 1988-1996 | 4.99 | $31.68 |
| GRAND AVERAGE OF INTEGRAL 3-POINT BELT | 5.18 | $33.35 |

The sample of integral 3-point safety belts represented different eras in passenger cars. The weight and consumer cost has remained fairly steady over the years. Consequently, a grand average of the weight and consumer costs of the integral 3-point safety belts in the five studies of 1974-1996 passenger cars has been calculated and used for the integral 3-point safety belts from 1972-2001.

***<u>Automatic Front Outboard Safety Belts With Retractors</u>***. The requirements for automatic restraints in the front seating positions of passenger cars were issued in 1984 in response to the persistent low usage rate of manual belts. Two systems that qualified as automatic restraints were air cushion restraints (air bags) and automatic safety belts (belts that automatically move into place around the occupant when the door is closed).

The 1984 rule required that some type of automatic restraint be installed in passenger cars, but provided the manufacturers the choice of a variety of methods of providing automatic protection, including automatic safety belts and air bags, as long as certain specified performance requirements were met. The final rule required automatic occupant protection in all passenger automobiles based on a phased-in schedule beginning September 1986, with full implementation being required by September 1989. The front center seat of passenger cars was exempt from, and rear seats were not covered by, the requirements.

Most vehicle manufacturers initially chose to comply with the requirements by installing automatic belts in many of their vehicles. The fact that the rule did not include design specifications gave them broad flexibility in selecting the design and performance characteristics of their automatic belts. For example, the motorized two-point torso belts required the occupant to manually fasten the lap belt for full protection, while the door-mounted non-motorized 3-point belts were often detached by occupants from their anchorage in the middle of the car and subsequently used in the same manner as manual 3-point belts. And, one of the non-motorized 2-point torso belt systems had an automatic shoulder belt used in combination with a knee bolster. This was the only shoulder belt system specifically designed for use without a lap belt because the knee bolster took the place of the lap belt.

A series of cost and weight analyses were performed on automatic motorized and non-motorized safety belts.[106,107,108] Table 208-3 shows the average weight and consumer cost per seat for the automatic front outboard safety belts with retractors and anchors. Since these estimates are based on at most nine systems, arithmetic averages of the costs and weights were used.

| ***TABLE 208-3<br>AVERAGE WEIGHT AND CONSUMER COST PER SEAT<br>OF AUTOMATIC FRONT OUTBOARD SAFETY BELTS<br>IN PASSENGER CARS*** | | |
|---|---|---|
| BELT ASSEMBLIES | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
| ***Non-Motorized*** | | |
| 2-point (1975-1984) | 11.88 | $ 72.19 |
| 2-point (1987-1990) | 17.72 | $128.50 |
| 2-point (1991-1995) | 5.34 | $ 51.08 |
| 3-point | 15.12 | $164.92 |
| ***Motorized*** | | |
| 2-point | 16.01 | $182.10 |

The estimate for 1987-1990 non-motorized 2-point belts is substantially higher than the estimates for the 1975-1984 and 1991-1995 systems primarily because structural modifications were made to the existing vehicle. The costs would probably be lower if the 2-point belts had been built in as an overall redesign of the vehicle like it was in the 1975-1984 and 1991-1995 systems. NHTSA does not know if these extra costs were characteristic of most of the systems in the first years of the automatic protection requirement, or only of the one system we analyzed. Similarly, we do not know if the low cost of the 1991-1995 system relative to 1987-1990 represents typical across-the-board savings as manufacturers gain experience with new technologies, or merely the difference between the two systems we selected for analysis. Likewise, we do not know if the costs for the non-motorized 3-point belts and the motorized 2-point belts, each based on analyses of three 1987 systems, were reduced in subsequent years. Since all automatic belts were phased out by the mid 1990's, NHTSA is not planning any further cost analyses.

Successful enactment of buckle-up laws in most of the states, and the demonstrated superior performance and customer preference for manual 3-point belts with air bags, soon eliminated interest in the various types of automatic belts. FMVSS 208 was subsequently modified to require dual air bags plus manual 3-point belts effective September 1, 1997 in passenger cars. In 1986-1996, vehicles equipped with air bags usually had manual belts, but some had automatic belts at one or both of the front outboard positions.

***Rear Outboard Safety Belts***. From January 1, 1968 to December 10, 1989, FMVSS 208 only required Type 1 (lap) belts at the rear-outboard positions of passenger cars. In model years 1966-1970, 100 percent of rear-outboard seats were equipped with Type 1 belts. Type 2 (integral

[106] McLean, DOT HS 803 871:88-103 (1978).

[107] Khadilkar, A.V., Fladmark, G.L.L., and Firth, B.W., *Cost Estimates of Automatic Crash Protection in 1987 Model Year Passenger Cars – Volumes I-IV*, Washington: Department of Transportation, National Highway Traffic Safety Administration, June 1988. (DOT HS 807 319-322).

[108] Fladmark, DOT HS 807 950:Section 8 (1992).

3-point) belts were voluntarily installed in a small number of European make-models starting in 1971, and subsequently in a gradually increasing list of models. Retractors were added in 1972.

Three-point belts are more effective than lap only belts because they are highly effective in saving lives and preventing serious injuries in rollovers, frontal crashes, and many types of side impacts. In June 1989, the agency issued a final rule mandating lap/shoulder belts for forward-facing rear outboard seating positions in all passenger cars, other than convertibles, with a GVWR of 10,000 pounds or less.

A series of cost and weight analyses were performed on rear outboard safety belts with and without retractors.[109,110,111] NHTSA did not cost analyze any of the early European integral 3-point belt systems without retractors, which were present in fewer than one percent of new cars in the United States. They are assumed to have approximately the same weight and consumer cost as the lap belt only. Table 208-4 shows the average weight and consumer cost per seat for the rear outboard safety belts.

***TABLE 208-4***
***AVERAGE WEIGHT AND CONSUMER COST PER SEAT OF REAR OUTBOARD SAFETY BELTS IN PASSENGER CARS***

| BELT ASSEMBLIES | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| ***Without Retractors*** | | |
| Lap Only (1968) | 1.83 | $16.45 |
| 3-Point Belt | 1.83 | $16.45 |
| ***With Retractors*** | | |
| Lap Only (1972-1974) | 2.73 | $18.29 |
| Lap Only (1979-1981) | 3.09 | $26.46 |
| Lap Only (1988-1989) | 2.84 | $19.41 |
| ***Lap Only Average (1972-74 & 1988-89)*** | 2.61 | $18.57 |
| 3-Point Belt | 3.56 | $22.00 |

The sample of the lap only safety belts represented three different eras in passenger cars. The average weight and consumer costs of the 1972-1974 samples and the 1988-1989 samples are nearly equal. There is no obvious explanation why the 1979-1981 costs are substantially higher, in fact, even higher than the cost estimate for 3-point belts. It is perhaps a consequence of the specific make-models selected. At all the other seat positions, the 1979-1981 estimates were consistent with the earlier and later estimates. We will use the arithmetic average over the 1972-1974 and 1988-1989 samples as our estimate for the weight and consumer cost of lap belts. There appears to be a reasonable cost and weight increase from this average to the estimated cost and weight of 3-point belts.

[109] McLean, DOT HS 803 871:88-103 (1978).
[110] Gladstone, DOT HS 806 257:3-1 thru 3-59 (1982).
[111] Fladmark, DOT HS 807 952:Sections 12-15 (1992).

***Front and Rear Center Safety Belts***. From January 1, 1968 through 2003, FMVSS 208 has only required Type 1 (lap) belts at the front and rear center seat positions. They are airline-style belts without retractors.

"Anton's Law", signed on December 4, 2002, directs NHTSA to issue a final rule, no later than December 2004, requiring a lap/shoulder belt assembly for each rear designated seating position in a passenger motor vehicle with a GVWR of 10,000 pounds or less including the center rear position. It further specifies that the final rule be implemented in stages, starting no later than September 1, 2005 and be fully implemented no later than September 1, 2007. This rule will extend the superior protection of 3-point belts to the rear center seat.

Since the late 1980s, manufacturers have begun voluntarily installing lap/shoulder belts in the rear center seating position. By model year 2002, approximately 120 vehicle models were equipped with rear center lap/shoulder belts.

A series of cost and weight analyses were performed on front and rear center lap belts.[112,113,114] Table 208-5 shows the average weight and consumer cost per seat for the front and rear center belts.

***TABLE 208-5***
***AVERAGE WEIGHT AND CONSUMER COST PER SEAT***
***OF FRONT AND REAR CENTER LAP BELTS***
***WITHOUT RETRACTORS IN PASSENGER CARS***

| BELT ASSEMBLIES | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| ***Front Center*** | | |
| Lap Only (1968-1974) | 0.90 | $14.42 |
| Lap Only (1979-1981) | 0.79 | $13.35 |
| AVERAGE | 0.85 | $13.95 |
| ***Rear Center*** | | |
| Lap Only (1968-1974) | 1.02 | $14.10 |
| Lap Only (1979-1981) | 0.75 | $12.46 |
| Lap Only (1992-1993) | 1.09 | $11.34 |
| AVERAGE | 0.92 | $12.96 |

While it appears that the costs are becoming slightly lower for the rear center safety belts without retractors, we do not see a similar trend in the front center belts or in other seat positions. Consequently, the difference for the rear center seats may be attributed to the vehicle sample or the estimation methods. Therefore, we are using a simple arithmetic average of all the samples at each position.

A preliminary weight and consumer cost estimate of rear center 3-point safety belts of 3.03 pounds and $22.28 in 2002 dollars was calculated on the teardown of three existing systems.[115]

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[112] McLean, DOT HS 803 871:88-103 (1978).
[113] Gladstone, DOT HS 806 257:3-1 thru 3-59 (1982).
[114] Khadilkar, A.V., Fladmark, G.L., and Khadilkar, J., *Teardown Cost Estimates of Automotive Equipment Manufactured to Comply with Motor Vehicle Standards, FMVSS 208 – Occupant Protection, Volume II*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, January 2001. (DOT HS 809 807:Sections 20,23).
[115] Ibid.

The cost of the shoulder belt upper anchor was not included. These figures may not necessarily be representative of the true cost of 3-point belts.

***Summary Calculations for Safety Belts***. The total weight and consumer cost of safety belt assemblies and anchorages for model years 1966-2001 were calculated. The calculations were based on the weight and consumer cost per seat and the percent market share of safety belt assemblies per number of seating positions in a passenger car by model year (average "N"). The model years were divided into four groups, i.e., 1966-1976, 1977-1984, 1985-1994, and 1995-2001. The percent market share for each group was based on data from the following sources:

1. 1966-1976 – National Crash Severity Study (NCSS), which was a 1976-1978 predecessor of the National Automotive Sampling System (NASS) file. NCSS had a variable indicating how many seats were in the vehicle.

2. 1977-1984 – NASS file. In 1982-1986, NASS had a variable indicating how many seats were in a car.

3. 1985-1994 – 1990 Polk registration file and Branham Automobile Reference Book.[116] The Polk file provides the sales figures of all 1990 passenger vehicles broken out by make and model, while the Branham book identifies the number of seating positions in each of the 1990 make-models. The sales figures for each seating position are divided by the overall sales figures to determine the percent market share per position. For example, 170,491 two-seat passenger cars were sold in 1990, with overall passenger car sales of 8,669,395. Therefore, the percent market share for two seating positions = 170,491 / 8,669,395 or 0.0197.

4. 1995-2001 – 1999 Polk registration file and Branham Automobile Reference Book.

The summary calculations were determined through a series of steps.

- Step 1. Determine the average N of front-outboard, rear-outboard, rear-outboard third row, front-center, and rear- or third-row center seats per car.

    - Multiply the percent market share per position (Column A) for the number of seating positions per car by the number of safety belt assemblies required for each seating location (Columns B,C,D,E,F). For example, a car from 1966-1976 with five seating positions has a percent market share of 0.1344. Five safety belt assemblies are required (two at the front outboard, two at the rear outboard, and one at the rear center locations). The percent market share would be 0.2688 (0.1344 * 2) for each front and rear outboard location and 0.1344 (0.1344 * 1) for the rear center location.

    - Sum the individual market share calculations in each seating location to arrive at the total percent market share for each seating location. Table 208-6A shows that the average car had 2.000 front-outboard seats, 1.9508 rear-outboard seats, 0.0336 rear outboard third row seats, 0.4718 front-center seats, and 0.6166 rear- or third-

[116] Branham Automobile Reference Book, Branham Publishing Company, Santa, Monica, CA, 1985-2001.

row center seats.

- Tables 208-6A thru D show the breakout of the possible number of seating positions in passenger cars, the percent market share for those seating positions, the number of safety belt assemblies required at each seating location, the corresponding percent market share at each seating location for the number of seating positions per car, and the total percent market share for each seating location for the four year groups.

***TABLE 208-6A***
***PERCENT MARKET SHARE (AVERAGE N) FOR SEATING POSITIONS***
***IN PASSENGER CARS FROM 1966-1976***

| # OF SEATING POSITIONS PER CAR | % MARKET SHARE PER POSITION (A) | FRONT OUTBOARD | | REAR OUTBOARD | | REAR OUTBOARD THIRD ROW | | FRONT CENTER | | REAR OR THIRD ROW CENTER | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | # OF BELTS (B) | % MKT SHARE (A*B) | # OF BELTS (C) | % MKT SHARE (A*C) | # OF BELTS (D) | % MKT SHARE (A*D) | # OF BELTS (E) | % MKT SHARE (A*E) | # OF BELTS (F) | % MKT SHARE (A*F) |
| 2 | 0.0246 | 2 | 0.0492 | 0 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 |
| 4 | 0.3692 | 2 | 0.7384 | 2 | 0.7384 | 0 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 |
| 5 | 0.1344 | 2 | 0.2688 | 2 | 0.2688 | 0 | 0.0000 | 0 | 0.0000 | 1 | 0.1344 |
| 6 | 0.4550 | 2 | 0.9100 | 2 | 0.9100 | 0 | 0.0000 | 1 | 0.4550 | 1 | 0.4550 |
| 8 | 0.0064 | 2 | 0.0128 | 2 | 0.0128 | 2 | 0.0128 | 1 | 0.0064 | 1 | 0.0064 |
| 9 | 0.0104 | 2 | 0.0208 | 2 | 0.0208 | 2 | 0.0128 | 1 | 0.0104 | 2 | 0.0208 |
| TOTAL | 1.0000 | | 2.0000 | | 1.9508 | | 0.0336 | | 0.4718 | | 0.6166 |

***TABLE 208-6B***
***PERCENT MARKET SHARE (AVERAGE N) FOR SEATING POSITIONS***
***IN PASSENGER CARS FROM 1977-1984***

| # OF SEATING POSITIONS PER CAR | % MARKET SHARE PER POSITION (A) | FRONT OUTBOARD | | REAR OUTBOARD | | REAR OUTBOARD THIRD ROW | | FRONT CENTER | | REAR OR THIRD ROW CENTER | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | # OF BELTS (B) | % MKT SHARE (A*B) | # OF BELTS (C) | % MKT SHARE (A*C) | # OF BELTS (D) | % MKT SHARE (A*D) | # OF BELTS (E) | % MKT SHARE (A*E) | # OF BELTS (F) | % MKT SHARE (A*F) |
| 2 | 0.0237 | 2 | 0.0474 | 0 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 |
| 4 | 0.3614 | 2 | 0.7228 | 2 | 0.7228 | 0 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 |
| 5 | 0.2826 | 2 | 0.5652 | 2 | 0.5652 | 0 | 0.0000 | 0 | 0.0000 | 1 | 0.2826 |
| 6 | 0.3262 | 2 | 0.6524 | 2 | 0.6524 | 0 | 0.0000 | 1 | 0.3262 | 1 | 0.3262 |
| 8 | 0.0039 | 2 | 0.0078 | 2 | 0.0078 | 2 | 0.0078 | 1 | 0.0039 | 1 | 0.0039 |
| 9 | 0.0022 | 2 | 0.0044 | 2 | 0.0044 | 2 | 0.0044 | 1 | 0.0022 | 2 | 0.0044 |
| TOTAL | 1.0000 | | 2.0000 | | 1.9526 | | 0.0122 | | 0.3323 | | 0.6171 |

| TABLE 208-6C<br>PERCENT MARKET SHARE (AVERAGE N) FOR SEATING POSITIONS<br>IN PASSENGER CARS FROM 1987-1994 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| # OF SEATING POSITIONS PER CAR | % MARKET SHARE PER POSITION (A) | FRONT OUTBOARD | | REAR OUTBOARD | | REAR OUTBOARD THIRD ROW | | FRONT CENTER | | REAR OR THIRD ROW CENTER | |
| | | # OF BELTS (B) | % MKT SHARE (A*B) | # OF BELTS (C) | % MKT SHARE (A*C) | # OF BELTS (D) | % MKT SHARE (A*D) | # OF BELTS (E) | % MKT SHARE (A*E) | # OF BELTS (F) | % MKT SHARE (A*F) |
| 2 | 0.0197 | 2 | 0.0394 | 0 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 |
| 4 | 0.1236 | 2 | 0.2472 | 2 | 0.2472 | 0 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 |
| 5 | 0.6260 | 2 | 1.2520 | 2 | 1.2520 | 0 | 0.0000 | 0 | 0.0000 | 1 | 0.6260 |
| 6 | 0.2265 | 2 | 0.4530 | 2 | 0.4530 | 0 | 0.0000 | 1 | 0.2265 | 1 | 0.2265 |
| 8 | 0.0003 | 2 | 0.0006 | 2 | 0.0006 | 2 | 0.0006 | 1 | 0.0003 | 1 | 0.0003 |
| 9 | 0.0039 | 2 | 0.0078 | 2 | 0.0078 | 2 | 0.0078 | 1 | 0.0039 | 2 | 0.0078 |
| TOTAL | 1.0000 | | 2.0000 | | 1.9606 | | 0.0084 | | 0.2307 | | 0.8606 |

| TABLE 208-6D<br>PERCENT MARKET SHARE (AVERAGE N) FOR SEATING POSITIONS<br>IN PASSENGER CARS FROM 1995-2001 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| # OF SEATING POSITIONS PER CAR | % MARKET SHARE PER POSITION (A) | FRONT OUTBOARD | | REAR OUTBOARD | | REAR OUTBOARD THIRD ROW | | FRONT CENTER | | REAR OR THIRD ROW CENTER | |
| | | # OF BELTS (B) | % MKT SHARE (A*B) | # OF BELTS (C) | % MKT SHARE (A*C) | # OF BELTS (D) | % MKT SHARE (A*D) | # OF BELTS (E) | % MKT SHARE (A*E) | # OF BELTS (F) | % MKT SHARE (A*F) |
| 2 | 0.0161 | 2 | 0.0322 | 0 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 |
| 4 | 0.0894 | 2 | 0.1788 | 2 | 0.1788 | 0 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 |
| 5 | 0.6808 | 2 | 1.3616 | 2 | 1.3616 | 0 | 0.0000 | 0 | 0.0000 | 1 | 0.6808 |
| 6 | 0.2068 | 2 | 0.4136 | 2 | 0.4136 | 0 | 0.0000 | 1 | 0.2068 | 1 | 0.2068 |
| 8 | 0.0007 | 2 | 0.0014 | 2 | 0.0014 | 2 | 0.0014 | 1 | 0.0007 | 1 | 0.0007 |
| 9 | 0.0062 | 2 | 0.0124 | 2 | 0.0124 | 2 | 0.0124 | 1 | 0.0062 | 2 | 0.0124 |
| TOTAL | 1.0000 | | 2.0000 | | 1.9678 | | 0.0138 | | 0.2137 | | 0.9007 |

- Step 2. When more than one technology is used, determine the percent distribution of the safety belt types at the front and rear outboard seating locations for each model year. For example, in 1968 the distribution of front outboard safety belts in passenger cars was 50% for lap belts only, 45.5% for separate lap/shoulder belts, and 5.5% for 3-point belts.

- Step 3. Determine the “n” of belts of each type of safety belt technology per car. Multiply the average N from Step 1 by the percent distribution from Step 2. For example, the “n” of belts for a front outboard lap only belt in 1968 would be 1.00 (2 * 0.50).

- Step 4. Calculate the cost and weight per seat for each safety belt assembly. Multiply the “n” of belts by the cost or weight (from Tables 208-1 thru 5) of each type of safety belt.

- Step 5. Calculate the total cost and weight per car of safety belt assemblies and anchorages for model years 1966-2001. Sum the individual market share calculations in each seating location to arrive at the total percent market share for each seating location. Table 208-7 shows the calculations of the total cost for model year 1968.

| ***TABLE 208-7*** ***TOTAL CONSUMER COST PER PASSENGER CAR*** ***OF SAFETY BELT ASSEMBLIES AND ANCHORAGES*** ***FOR MODEL YEAR 1968*** | | | |
|---|---|---|---|
| SAFETY BELT ASSEMBLY | COST PER SEAT (A) | "n" OF BELTS PER CAR (B) | TOTAL COST PER SAFETY BELT ASSEMBLY (A * B) |
| ***Manual Front Outboard Without Retractor*** | | | |
| Lap Belt Only | $20.99 | 1.00 | $20.99 |
| Separate Lap/Shoulder Belt | $22.61 | 0.89 | $20.12 |
| 3-Point Belt | $22.61 | 0.11 | $ 2.49 |
| ***Rear Outboard Without Retractor*** | | | |
| Lap Belt Only | $16.45 | 1.95 | $32.08 |
| ***Rear Outboard Third Row Without Retractor*** | | | |
| Lap Belt Only | $16.45 | 0.03 | $ 0.49 |
| ***Front Center*** | | | |
| Lap Belt Only | $13.95 | 0.47 | $ 6.56 |
| ***Rear/Third Row Center*** | | | |
| Lap Belt Only | $12.96 | 0.62 | $ 8.03 |
| TOTAL CONSUMER COST | | | $90.76 |

Summary calculations of the total consumer cost per car of safety belt assemblies and anchorages for model year 1966-2001 are provided in Tables 208-8A thru 8E with the calculations for the total weight provided in Tables 208-9A thru 9E.

| TABLE 208-8A AVERAGE CONSUMER COST (IN 2002 DOLLARS) PER PASSENGER CAR OF SAFETY BELT ASSEMBLIES AND ANCHORAGES FOR MODEL YEARS 1966-1973 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SAFETY BELT ASSEMBLY | COST PER SEAT | "n" OF BELTS PER CAR | | | | | | |
| | | '66-67 | '68 | '69 | '70 | '71 | '72 | '73 |
| ***FRONT OUTBOARD*** | | | | | | | | |
| ***Manual Without Retractor*** | | | | | | | | |
| Lap Belt Only | $ 20.99 | 1.99 | 1.00 | | | | | |
| Separate Lap/Shoulder Belt | $ 22.61 | 0.01 | 0.89 | 1.80 | 1.82 | 1.81 | | |
| 3-Point Belt | $ 22.61 | | 0.11 | 0.20 | 0.18 | 0.19 | | |
| ***Manual With Retractor*** | | | | | | | | |
| Separate Lap/Shoulder Belt | $ 32.42 | | | | | | 1.86 | 1.85 |
| 3-Point Belt | $ 33.35 | | | | | | 0.14 | 0.15 |
| ***Automatic*** | | | | | | | | |
| 2-Point Non-Motorized (1975-1984) | $ 72.19 | | | | | | | |
| 2-Point Non-Motorized (1987-1990) | $128.50 | | | | | | | |
| 2-Point Non-Motorized (1991-1995) | $ 51.08 | | | | | | | |
| 3-Point Non-Motorized | $164.92 | | | | | | | |
| 2-Point Motorized | $182.10 | | | | | | | |
| ***REAR OUTBOARD*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | $ 16.45 | 1.95 | 1.95 | 1.95 | 1.95 | 1.94 | | |
| 3-Point Belt | $ 16.45 | | | | | 0.01 | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | $ 18.57 | | | | | | 1.94 | 1.94 |
| 3-Point Belt | $ 22.00 | | | | | | 0.01 | 0.01 |
| ***REAR OUTBOARD THIRD ROW*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | $ 16.45 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | $ 18.57 | | | | | | 0.03 | 0.03 |
| ***CENTER*** | | | | | | | | |
| Front (lap) | $ 13.95 | 0.47 | 0.47 | 0.47 | 0.47 | 0.47 | 0.47 | 0.47 |
| Rear/Third Row (lap) | $ 12.96 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 |
| TOTAL COST PER CAR | | $89.16 | $90.76 | $92.38 | $92.38 | $92.38 | $116.41 | $116.37 |

| TABLE 208-8B<br>AVERAGE CONSUMER COST PER PASSENGER CAR<br>OF SAFETY BELT ASSEMBLIES AND ANCHORAGES<br>FOR MODEL YEARS 1974-1980 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SAFETY BELT ASSEMBLY | COST PER SEAT | "n" OF BELTS PER CAR | | | | | | |
| | | '74 | '75 | '76 | '77 | '78 | '79 | '80 |
| ***FRONT OUTBOARD*** | | | | | | | | |
| ***Manual Without Retractor*** | | | | | | | | |
| Lap Belt Only | $ 20.99 | | | | | | | |
| Separate Lap/Shoulder Belt | $ 22.61 | | | | | | | |
| 3-Point Belt | $ 22.61 | | | | | | | |
| ***Manual With Retractor*** | | | | | | | | |
| Separate Lap/Shoulder Belt | $ 32.42 | | | | | | | |
| 3-Point Belt | $ 33.35 | 2.00 | 1.99 | 1.99 | 1.99 | 1.99 | 1.98 | 1.98 |
| ***Automatic*** | | | | | | | | |
| 2-Point Non-Motorized (1975-1984) | $ 72.19 | | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 |
| 2-Point Non-Motorized (1987-1990) | $128.50 | | | | | | | |
| 2-Point Non-Motorized (1991-1995) | $ 51.08 | | | | | | | |
| 3-Point Non-Motorized | $164.92 | | | | | | | |
| 2-Point Motorized | $182.10 | | | | | | | |
| ***REAR OUTBOARD*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | $ 16.45 | | | | | | | |
| 3-Point Belt | $ 16.45 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | $ 18.57 | 1.94 | 1.93 | 1.94 | 1.94 | 1.94 | 1.94 | 1.94 |
| 3-Point Belt | $ 22.00 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| ***REAR OUTBOARD THIRD ROW*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | $ 16.45 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | $ 18.57 | 0.03 | 0.03 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 |
| ***CENTER*** | | | | | | | | |
| Front (lap) | $ 13.95 | 0.47 | 0.47 | 0.47 | 0.33 | 0.33 | 0.33 | 0.33 |
| Rear/Third Row (lap) | $ 12.96 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 |
| TOTAL COST PER CAR | | $118.09* | $118.52* | $118.48 | $116.16 | $116.16 | $116.55 | $116.55 |

* Does not include additional cost of ignition interlock system for front-outboard seats.

| TABLE 208-8C<br>AVERAGE CONSUMER COST PER PASSENGER CAR<br>OF SAFETY BELT ASSEMBLIES AND ANCHORAGES<br>FOR MODEL YEARS 1981-1987 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SAFETY BELT ASSEMBLY | COST PER SEAT | "n" OF BELTS PER CAR | | | | | | |
| | | '81 | '82 | '83 | '84 | '85 | '86 | '87 |
| ***FRONT OUTBOARD*** | | | | | | | | |
| ***Manual Without Retractor*** | | | | | | | | |
| Lap Belt Only | $ 20.99 | | | | | | | |
| Separate Lap/Shoulder Belt | $ 22.61 | | | | | | | |
| 3-Point Belt | $ 22.61 | | | | | | | |
| ***Manual With Retractor*** | | | | | | | | |
| Separate Lap/Shoulder Belt | $ 32.42 | | | | | | | |
| 3-Point Belt | $ 33.35 | 1.98 | 1.99 | 1.99 | 1.99 | 1.99 | 1.99 | 1.80 |
| ***Automatic*** | | | | | | | | |
| 2-Point Non-Motorized (1975-1984) | $ 72.19 | 0.01 | 0.005 | | | | | |
| 2-Point Non-Motorized (1987-1990) | $128.50 | | | | | | | 0.02 |
| 2-Point Non-Motorized (1991-1995) | $ 51.08 | | | | | | | |
| 3-Point Non-Motorized | $164.92 | | | | | | | 0.08 |
| 2-Point Motorized | $182.10 | 0.01 | 0.005 | 0.01 | 0.01 | 0.01 | 0.01 | 0.10 |
| ***REAR OUTBOARD*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | $ 16.45 | | | | | | | |
| 3-Point Belt | $ 16.45 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | $ 18.57 | 1.92 | 1.88 | 1.85 | 1.85 | 1.85 | 1.84 | 1.80 |
| 3-Point Belt | $ 22.00 | 0.03 | 0.07 | 0.10 | 0.10 | 0.10 | 0.11 | 0.16 |
| ***REAR OUTBOARD THIRD ROW*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | $ 16.45 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | $ 18.57 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| ***CENTER*** | | | | | | | | |
| Front (lap) | $ 13.95 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.23 |
| Rear/Third Row (lap) | $ 12.96 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 | 0.86 |
| TOTAL COST PER CAR | | $117.71 | $116.91 | $117.57 | $117.57 | $117.57 | $117.60 | $145.49 |

| ***TABLE 208-8D*** ***AVERAGE CONSUMER COST PER PASSENGER CAR*** ***OF SAFETY BELT ASSEMBLIES AND ANCHORAGES*** ***FOR MODEL YEARS 1988-1994*** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SAFETY BELT ASSEMBLY | COST PER SEAT | "n" OF BELTS PER CAR | | | | | | |
| | | '88 | '89 | '90 | '91 | '92 | '93 | '94 |
| ***FRONT OUTBOARD*** | | | | | | | | |
| ***Manual Without Retractor*** | | | | | | | | |
| Lap Belt Only | $ 20.99 | | | | | | | |
| Separate Lap/Shoulder Belt | $ 22.61 | | | | | | | |
| 3-Point Belt | $ 22.61 | | | | | | | |
| ***Manual With Retractor*** | | | | | | | | |
| Separate Lap/Shoulder Belt | $ 32.42 | | | | | | | |
| 3-Point Belt | $ 33.35 | 1.51 | 1.30 | 0.53 | 0.61 | 0.86 | 0.95 | 1.07 |
| ***Automatic*** | | | | | | | | |
| 2-Point Non-Motorized (1975-1984) | $ 72.19 | | | | | | | |
| 2-Point Non-Motorized (1987-1990) | $128.50 | 0.04 | 0.02 | 0.13 | | | | |
| 2-Point Non-Motorized (1991-1995) | $ 51.08 | | | | 0.15 | 0.18 | 0.06 | 0.06 |
| 3-Point Non-Motorized | $164.92 | 0.25 | 0.39 | 0.68 | 0.55 | 0.49 | 0.45 | 0.46 |
| 2-Point Motorized | $182.10 | 0.20 | 0.29 | 0.66 | 0.69 | 0.47 | 0.54 | 0.41 |
| ***REAR OUTBOARD*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | $ 16.45 | | | | | | | |
| 3-Point Belt | $ 16.45 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | $ 18.57 | 1.39 | 0.64 | | | | | |
| 3-Point Belt | $ 22.00 | 0.57 | 1.32 | 1.96 | 1.96 | 1.96 | 1.96 | 1.96 |
| ***REAR OUTBOARD THIRD ROW*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | $ 16.45 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | $ 18.57 | 0.01 | 0.01 | | | | | |
| ***CENTER*** | | | | | | | | |
| Front (lap) | $ 13.95 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 |
| Rear/Third Row (lap) | $ 12.96 | 0.86 | 0.86 | 0.86 | 0.86 | 0.86 | 0.86 | 0.86 |
| TOTAL COST PER CAR | | $186.04 | $218.52 | $324.19 | $301.83 | $261.75 | $264.77 | $246.75 |

| TABLE 208-8E<br>AVERAGE CONSUMER COST PER PASSENGER CAR<br>OF SAFETY BELT ASSEMBLIES AND ANCHORAGES<br>FOR MODEL YEARS 1995-2001 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SAFETY BELT ASSEMBLY | COST PER SEAT | "n" OF BELTS PER CAR | | | | | | |
| | | '95 | '96 | '97 | '98 | '99 | '00 | '01 |
| ***FRONT OUTBOARD*** | | | | | | | | |
| ***Manual Without Retractor*** | | | | | | | | |
| Lap Belt Only | $ 20.99 | | | | | | | |
| Separate Lap/Shoulder Belt | $ 22.61 | | | | | | | |
| 3-Point Belt | $ 22.61 | | | | | | | |
| ***Manual With Retractor*** | | | | | | | | |
| Separate Lap/Shoulder Belt | $ 32.42 | | | | | | | |
| 3-Point Belt | $ 33.35 | 1.62 | 1.79 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| ***Automatic*** | | | | | | | | |
| 2-Point Non-Motorized (1975-1984) | $ 72.19 | | | | | | | |
| 2-Point Non-Motorized (1987-1990) | $128.50 | | | | | | | |
| 2-Point Non-Motorized (1991-1995) | $ 51.08 | 0.01 | | | | | | |
| 3-Point Non-Motorized | $164.92 | 0.22 | 0.14 | | | | | |
| 2-Point Motorized | $182.10 | 0.15 | 0.07 | | | | | |
| ***REAR OUTBOARD*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | $ 16.45 | | | | | | | |
| 3-Point Belt | $ 16.45 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | $ 18.57 | | | | | | | |
| 3-Point Belt | $ 22.00 | 1.97 | 1.97 | 1.97 | 1.97 | 1.97 | 1.97 | 1.97 |
| ***REAR OUTBOARD THIRD ROW*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | $ 16.45 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | $ 18.57 | | | | | | | |
| ***CENTER*** | | | | | | | | |
| Front (lap) | $ 13.95 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 |
| Rear/Third Row (lap) | $ 12.96 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| TOTAL COST PER CAR | | $176.07 | $153.47 | $124.63 | $124.63 | $124.63 | $124.63 | $124.63 |

| TABLE 208-9A<br>AVERAGE WEIGHT (IN POUNRDS) PER PASSENGER CAR<br>OF SAFETY BELT ASSEMBLIES AND ANCHORAGES<br>FOR MODEL YEARS 1966-1973 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SAFETY BELT ASSEMBLY | WEIGHT PER SEAT | "n" OF BELTS PER CAR | | | | | | |
| | | '66-67 | '68 | '69 | '70 | '71 | '72 | '73 |
| ***FRONT OUTBOARD*** | | | | | | | | |
| ***Manual Without Retractor*** | | | | | | | | |
| Lap Belt Only | 2.38 | 1.99 | 1.00 | | | | | |
| Separate Lap/Shoulder Belt | 2.95 | 0.01 | 0.89 | 1.80 | 1.82 | 1.81 | | |
| 3-Point Belt | 2.95 | | 0.11 | 0.20 | 0.18 | 0.19 | | |
| ***Manual With Retractor*** | | | | | | | | |
| Separate Lap/Shoulder Belt | 4.52 | | | | | | 1.86 | 1.85 |
| 3-Point Belt | 5.18 | | | | | | 0.14 | 0.15 |
| ***Automatic*** | | | | | | | | |
| 2-Point Non-Motorized (1975-1984) | 11.88 | | | | | | | |
| 2-Point Non-Motorized (1987-1990) | 17.72 | | | | | | | |
| 2-Point Non-Motorized (1991-1995) | 5.34 | | | | | | | |
| 3-Point Non-Motorized | 15.12 | | | | | | | |
| 2-Point Motorized | 16.01 | | | | | | | |
| ***REAR OUTBOARD*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | 1.83 | 1.95 | 1.95 | 1.95 | 1.95 | 1.94 | | |
| 3-Point Belt | 1.83 | | | | | 0.01 | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | 2.61 | | | | | | 1.94 | 1.94 |
| 3-Point Belt | 3.56 | | | | | | 0.01 | 0.01 |
| ***REAR OUTBOARD THIRD ROW*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | 1.83 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | 2.61 | | | | | | 0.03 | 0.03 |
| ***CENTER*** | | | | | | | | |
| Front (lap) | 0.85 | 0.47 | 0.47 | 0.47 | 0.47 | 0.47 | 0.47 | 0.47 |
| Rear/Third Row (lap) | 0.92 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 |
| TOTAL WEIGHT PER CAR | | 9.36 | 9.92 | 10.49 | 10.49 | 10.49 | 15.28 | 15.29 |

| TABLE 208-9B<br>AVERAGE WEIGHT PER PASSENGER CAR<br>OF SAFETY BELT ASSEMBLIES AND ANCHORAGES<br>FOR MODEL YEARS 1974-1980 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SAFETY BELT ASSEMBLY | WEIGHT PER SEAT | "n" OF BELTS PER CAR | | | | | | |
| | | '74 | '75 | '76 | '77 | '78 | '79 | '80 |
| ***FRONT OUTBOARD*** | | | | | | | | |
| ***Manual Without Retractor*** | | | | | | | | |
| Lap Belt Only | 2.38 | | | | | | | |
| Separate Lap/Shoulder Belt | 2.95 | | | | | | | |
| 3-Point Belt | 2.95 | | | | | | | |
| ***Manual With Retractor*** | | | | | | | | |
| Separate Lap/Shoulder Belt | 4.52 | | | | | | | |
| 3-Point Belt | 5.18 | 2.00 | 1.99 | 1.99 | 1.99 | 1.99 | 1.98 | 1.98 |
| ***Automatic*** | | | | | | | | |
| 2-Point Non-Motorized (1975-1984) | 11.88 | | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 |
| 2-Point Non-Motorized (1987-1990) | 17.72 | | | | | | | |
| 2-Point Non-Motorized (1991-1995) | 5.34 | | | | | | | |
| 3-Point Non-Motorized | 15.12 | | | | | | | |
| 2-Point Motorized | 16.01 | | | | | | | |
| ***REAR OUTBOARD*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | 1.83 | | | | | | | |
| 3-Point Belt | 1.83 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | 2.61 | 1.94 | 1.93 | 1.94 | 1.94 | 1.94 | 1.94 | 1.94 |
| 3-Point Belt | 3.56 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| ***REAR OUTBOARD THIRD ROW*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | 1.83 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | 2.61 | 0.03 | 0.03 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 |
| ***CENTER*** | | | | | | | | |
| Front (lap) | 0.85 | 0.47 | 0.47 | 0.47 | 0.33 | 0.33 | 0.33 | 0.33 |
| Rear/Third Row (lap) | 0.92 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 |
| TOTAL WEIGHT PER CAR | | 16.51 | 16.58 | 16.57 | 16.40 | 16.40 | 16.47 | 16.47 |

| TABLE 208-9C<br>AVERAGE WEIGHT PER PASSENGER CAR<br>OF SAFETY BELT ASSEMBLIES AND ANCHORAGES<br>FOR MODEL YEARS 1981-1987 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SAFETY BELT ASSEMBLY | WEIGHT PER SEAT | "n" OF BELTS PER CAR | | | | | | |
| | | '81 | '82 | '83 | '84 | '85 | '86 | '87 |
| ***FRONT OUTBOARD*** | | | | | | | | |
| ***Manual Without Retractor*** | | | | | | | | |
| Lap Belt Only | 2.38 | | | | | | | |
| Separate Lap/Shoulder Belt | 2.95 | | | | | | | |
| 3-Point Belt | 2.95 | | | | | | | |
| ***Manual With Retractor*** | | | | | | | | |
| Separate Lap/Shoulder Belt | 4.52 | | | | | | | |
| 3-Point Belt | 5.18 | 1.98 | 1.99 | 1.99 | 1.99 | 1.99 | 1.99 | 1.80 |
| ***Automatic*** | | | | | | | | |
| 2-Point Non-Motorized (1975-1984) | 11.88 | 0.01 | 0.005 | | | | | |
| 2-Point Non-Motorized (1987-1990) | 17.72 | | | | | | | 0.02 |
| 2-Point Non-Motorized (1991-1995) | 5.34 | | | | | | | |
| 3-Point Non-Motorized | 15.12 | | | | | | | 0.08 |
| 2-Point Motorized | 16.01 | 0.01 | 0.005 | 0.01 | 0.01 | 0.01 | 0.01 | 0.10 |
| ***REAR OUTBOARD*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | 1.83 | | | | | | | |
| 3-Point Belt | 1.83 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | 2.61 | 1.92 | 1.88 | 1.85 | 1.85 | 1.85 | 1.84 | 1.80 |
| 3-Point Belt | 3.56 | 0.03 | 0.07 | 0.10 | 0.10 | 0.10 | 0.11 | 0.16 |
| ***REAR OUTBOARD THIRD ROW*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | 1.83 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | 2.61 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| ***CENTER*** | | | | | | | | |
| Front (lap) | 0.85 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.23 |
| Rear/Third Row (lap) | 0.92 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 | 0.86 |
| TOTAL WEIGHT PER CAR | | 16.53 | 16.48 | 16.53 | 16.53 | 16.53 | 16.54 | 18.77 |

| TABLE 208-9D AVERAGE WEIGHT PER PASSENGER CAR SAFETY BELT ASSEMBLIES AND ANCHORAGES FOR MODEL YEARS 1988-1994 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SAFETY BELT ASSEMBLY | WEIGHT PER SEAT | "n" OF BELTS PER CAR | | | | | | |
| | | '88 | '89 | '90 | '91 | '92 | '93 | '94 |
| ***FRONT OUTBOARD*** | | | | | | | | |
| ***Manual Without Retractor*** | | | | | | | | |
| Lap Belt Only | 2.38 | | | | | | | |
| Separate Lap/Shoulder Belt | 2.95 | | | | | | | |
| 3-Point Belt | 2.95 | | | | | | | |
| ***Manual With Retractor*** | | | | | | | | |
| Separate Lap/Shoulder Belt | 4.52 | | | | | | | |
| 3-Point Belt | 5.18 | 1.51 | 1.30 | 0.53 | 0.61 | 0.86 | 0.95 | 1.07 |
| ***Automatic*** | | | | | | | | |
| 2-Point Non-Motorized (1975-1984) | 11.88 | | | | | | | |
| 2-Point Non-Motorized (1987-1990) | 17.72 | 0.04 | 0.02 | 0.13 | | | | |
| 2-Point Non-Motorized (1991-1995) | 5.34 | | | | 0.15 | 0.18 | 0.06 | 0.06 |
| 3-Point Non-Motorized | 15.12 | 0.25 | 0.39 | 0.68 | 0.55 | 0.49 | 0.45 | 0.46 |
| 2-Point Motorized | 16.01 | 0.20 | 0.29 | 0.66 | 0.69 | 0.47 | 0.54 | 0.41 |
| ***REAR OUTBOARD*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | 1.83 | | | | | | | |
| 3-Point Belt | 1.83 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | 2.61 | 1.39 | 0.64 | | | | | |
| 3-Point Belt | 3.56 | 0.57 | 1.32 | 1.96 | 1.96 | 1.96 | 1.96 | 1.96 |
| ***REAR OUTBOARD THIRD ROW*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | 1.83 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | 2.61 | 0.01 | 0.01 | | | | | |
| ***CENTER*** | | | | | | | | |
| Front (lap) | 0.85 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 |
| Rear/Third Row (lap) | 0.82 | 0.86 | 0.86 | 0.86 | 0.86 | 0.86 | 0.86 | 0.86 |
| TOTAL WEIGHT PER CAR | | 22.18 | 25.01 | 33.86 | 31.29 | 28.31 | 28.66 | 27.35 |

| *TABLE 208-9E*<br>*AVERAGE WEIGHT PER PASSENGER CAR*<br>*SAFETY BELT ASSEMBLIES AND ANCHORAGES*<br>*FOR MODEL YEARS 1995-2001* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SAFETY BELT ASSEMBLY | WEIGHT PER SEAT | "n" OF BELTS PER CAR | | | | | | |
| | | '95 | '96 | '97 | '98 | '99 | '00 | '01 |
| ***FRONT OUTBOARD*** | | | | | | | | |
| ***Manual Without Retractor*** | | | | | | | | |
| Lap Belt Only | 2.38 | | | | | | | |
| Separate Lap/Shoulder Belt | 2.95 | | | | | | | |
| 3-Point Belt | 2.95 | | | | | | | |
| ***Manual With Retractor*** | | | | | | | | |
| Separate Lap/Shoulder Belt | 4.52 | | | | | | | |
| 3-Point Belt | 5.18 | 1.62 | 1.79 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| ***Automatic*** | | | | | | | | |
| 2-Point Non-Motorized (1975-1984) | 11.88 | | | | | | | |
| 2-Point Non-Motorized (1987-1990) | 17.72 | | | | | | | |
| 2-Point Non-Motorized (1991-1995) | 5.34 | 0.01 | | | | | | |
| 3-Point Non-Motorized | 15.12 | 0.22 | 0.14 | | | | | |
| 2-Point Motorized | 16.01 | 0.15 | 0.07 | | | | | |
| ***REAR OUTBOARD*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | 1.83 | | | | | | | |
| 3-Point Belt | 1.83 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | 2.61 | | | | | | | |
| 3-Point Belt | 3.56 | 1.97 | 1.97 | 1.97 | 1.97 | 1.97 | 1.97 | 1.97 |
| ***REAR OUTBOARD THIRD ROW*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | 1.83 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | 2.61 | | | | | | | |
| ***CENTER*** | | | | | | | | |
| Front (lap) | 0.85 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 |
| Rear/Third Row (lap) | 0.92 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| TOTAL WEIGHT PER CAR | | 22.19 | 20.53 | 18.38 | 18.38 | 18.38 | 18.38 | 18.38 |

### *Pretensioners, Load Limiters, and Adjustable Anchors*

While safety belts reduce the risk of fatal and serious injuries, rib and abdominal injuries may be suffered in high-speed collisions especially if the safety belt is not correctly positioned. These risks are minimized with safety belt pretensioners, load limiters, and adjustable anchors. Although they are not mandatory for meeting NHTSA standards, the agency regards them with favor and provides consumer information on their availability.

Pretensioners. In a crash, pretensioners retract the safety belt almost instantly to remove excess slack and keep the occupant restrained. Whereas the conventional locking mechanism in a retractor keeps the belt from extending any farther, the pretensioner actually pulls in on the belt and reduces the risk of "submarining" (where the car occupant slips under a loosely tightened safety belt). This force helps move the passenger into the optimum crash position in his or her seat so that the air bag can more effectively deploy.

The three types of pretensioners in use today are mechanical, electrical, and pyrotechnic. Mechanical pretensioners use an inertial wheel with a pendulum device that moves under the rapid deceleration of the crash to lock the belt into place and prevent excessive safety belt slack. Excessive slack allows too much occupant motion during a crash, thus increasing the chance of contact with components such as the steering wheel, dashboard, or windshield and the possibility of increased potential of injury in an accident. Electrical pretensioners replace the mechanical means of sensing the deceleration with an electrical device that may or may not be tied into the airbag ignition circuits. Pyrotechnic pretensioners use electrically triggered pyrotechnics that tighten the safety belt a prescribed amount upon sensing a crash event. This keeps the occupant travel to a minimum and also helps optimize occupant position for effective use of the restraint capabilities of the airbag systems.

Load Limiters. In severe crashes where a car collides with an obstacle at extremely high speed, a safety belt can inflict serious damage. As a passenger's inertial speed increases, it takes a greater force to bring the passenger to a stop, i.e., the faster you are going on impact, the harder the safety belt will push on you. The purpose of a load limiter is to limit the forces imparted to the occupant by the safety belt during the crash event. The forces are prevented from exceeding a predetermined level by allowing the safety belt webbing to yield when the forces reach this level.

Adjustable Anchors. An adjustable upper belt anchorage improves the safety belts' protective effect by letting the occupant change the position of the shoulder strap to accommodate that person's size, which increases the ease and comfort of safety belt use for car occupants of above or below average height.

A study was conducted in 2000 on fourteen 1992-1999 make-model passenger vehicles, including nine vehicles equipped with pretensioners, load limiters, adjustable anchors, or a combination of these technologies and five baseline vehicles, to determine the weight and consumer cost of pretensioners, load limiters, and adjustable anchors.[117] Table 208-10 shows the arithmetic average weight and consumer cost of the pretensioners, the load limiters and adjustable anchors (the contractor did not break these out), and all three technologies. Since these technologies are voluntarily installed in passenger vehicles by the automotive

[117] Khadilkar, DOT HS 809 806-807 (2001).

manufacturers and not required by NHTSA, their costs are not attributed to FMVSS 208.

| ***TABLE 208-10 AVERAGE WEIGHT AND CONSUMER COST PER SEAT OF PRETENSIONERS, LOAD LIMITERS, AND ADJUSTABLE ANCHORS*** | | |
|---|---|---|
| COMPONENT | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
| Pretensioners | 0.22 | $10.94 |
| Load Limiters & Adjustable Anchors | 0.98 | $ 8.88 |
| TOTAL FOR ALL THREE | 1.20 | $19.82 |

Since conventional 3-point belts in passenger cars cost $33.35 per seat (Table 208-2), the addition of pretensioners, load limiters, and adjustable anchors increases the total cost by $19.82 or 59 percent.

### *Frontal Air Bags*

Air bags are designed to save lives and prevent injuries by cushioning occupants as they move forward in a frontal crash. Air bags reduce the likelihood of injury to an occupant's head, neck, face, chest, and abdomen. It is important to note, however, that the air bags are supplemental restraints. The presence of an air bag does not mean it is less important for occupants to use their safety belts. The safety belt, which provides protection in all kinds of crashes, is the primary means of occupant restraint. Air bags provide significant supplemental protection in frontal crashes. Today's air bag requirements have been evolving for more than 30 years. NHTSA issued its first public notice concerning air bags in 1969. Starting in 1972, vehicle manufacturers had the option of installing air bags in passenger cars as a means of complying with FMVSS 208. General Motors installed driver and passenger air bags in approximately 10,000 passenger cars in the mid 1970s.

A final rule, issued in July 1984, required automatic restraint systems for the front outboard seats in passenger cars in response to the persistent low usage rate of manual belts. The requirement was phased in starting September 1, 1986 with full implementation by September 1, 1989. The front center seat of passenger cars was exempt from, and rear seats were not covered by, the requirements.

To encourage the development and introduction of non-belt automatic restraint systems, the requirement also provided that manufacturers that installed a non-belt system, such as an air bag, at the driver's seating position could install a manual lap/shoulder belt rather than an automatic system at the front right seating position. A further amendment in March 1987 extended this option until September 1, 1993 to expedite the introduction of driver air bags while allowing adequate lead-time for introduction of passenger bags.

In 1991, Congress directed NHTSA to issue a final rule requiring that automatic crash protection must be provided by an inflatable restraint (i.e., an air bag) in passenger cars, light trucks, multipurpose vehicles, and buses with a GVWR of 8,500 pounds or less. In addition, the seating positions protected by an air bag must also be equipped with a manual lap/shoulder belt. The final rule was published in the Federal Register on September 2, 1993[118] requiring at least 95

[118] *Federal Register*, Vol. 58, No. 169, pg. 46551.

percent of each manufacturer's passenger cars manufactured on or after September 1, 1996 and before September 1, 1997 must be equipped with an air bag and a manual lap/shoulder belt at both the driver's and right front passenger's seating position. Every passenger car manufactured on or after September 1, 1997 must be so equipped. The vehicle manufacturers, however, were ahead of the implementation schedule. Nearly every 1996 model year passenger car was equipped with both driver- and passenger-side air bags as standard equipment.

Like the automatic restraint requirements issued in 1984, the air bag requirements were performance requirements that did not specify the design of an air bag system. Instead, vehicles must meet specified injury criteria, including criteria for the head and chest, measured on test dummies during a barrier crash test at speeds up to 30 mph. These criteria must be met for air bag equipped vehicles both when the dummies are belted and when they are unbelted. These requirements apply to the performance of the vehicle as a whole, and not to the air bags as a separate item of motor vehicle equipment. This permits vehicle manufacturers to "tune" the performance of the air bag to the crash pulse and other specific attributes of each of their vehicles and leaves them free to select specific attributes for their air bags, such as dimensions, actuation time, etc.

A series of cost and weight analyses were performed on air bags from twelve passenger cars.[119,120,121,122] Table 208-11 shows the arithmetic average weight and consumer cost for driver air bags and dual air bags.

***TABLE 208-11***
***AVERAGE WEIGHT AND CONSUMER COST***
***OF AIR BAGS IN PASSENGER CARS***

| MODEL YEAR | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| ***Driver Air Bags*** | | |
| 1988 | 25.93 | $414.38 |
| 1992 | 13.46 | $284.09 |
| ***Dual Air Bags*** | | |
| 1992-1996 | 26.76 | $396.72 |

The high estimate of driver air bags in 1988 probably reflects the inefficiencies of initial implementation, while the 1992 estimate is a more reasonable long-term cost. Consequently, the $284.09 estimate for driver air bags will be used for the consumer cost for model years 1985-1996, while the $396.72 estimate for dual air bags will be used for the consumer cost from 1987-2001.

[119] Khadilkar, DOT HS 807 321-322 (1988).
[120] Fladmark, DOT HS 949-951 (1992).
[121] Fladmark, DOT HS 809 798 (1996).
[122] Fladmark, DOT HS 809 801-802 (1997).

The main components of an air bag system are the:

- Air Bag Module. The air bag module contains both an inflator unit and the lightweight fabric air bag. The driver air bag module is located in the steering wheel hub, and the passenger air bag module is located in the instrument panel.

- Igniter/Inflator. The igniter assemblies are electrical devices that ignite a chemical gas generator that uses a sodium azide/sodium nitrate generant. Upon ignition, the generant produces nitrogen gas that fills the bag assemblies, creating a "cushion" effect. Some vehicles use a cylinder of compressed Argon gas rather than/in addition to an ignitable propellant.

- Control Module/Sensors. The control module is usually installed in the middle of the car between the passenger and engine compartment. The sensors continuously monitor the acceleration and deceleration of the vehicle and send this information to a microprocessor where the "crash pulse" of a vehicle is stored. When the microprocessor "recognizes" the crash pulse from the sensor, an electrical current is sent to the inflator of the airbag(s) that should be deployed.

- Clock Spring. The clock spring, or SIR coil, is located in the steering column and has several wraps of wire that look much like the spring in a clock. This assembly allows for one end to be connected to the wiring harness for the air bag system and the other end to be connected to the air bag in the steering wheel. The wraps of wire wind in and out as the steering wheel is turned, which allows the steering wheel to move while maintaining the electrical connection to the airbag module.

- Wiring Harness. The wiring harness is a collection of wires that is designed to control electrical functions in one section of a vehicle. Most wiring harnesses feature simple plug-in connectors, so components can be changed without the need to splice wires.

- Knee Bolster. The knee bolster is a padded bar on the lower part of the dashboard that is deployed in conjunction with frontal air bags to reduce lower limb injury and the risk of gliding under the safety belt during a crash.

Table 208-12 shows the arithmetic average weight and consumer cost of the principal components of dual air bags for 1992-1996.

| TABLE 208-12<br>AVERAGE WEIGHT AND CONSUMER COST<br>OF PRINCIPAL COMPONENTS IN DUAL AIR BAGS<br>IN PASSENGER CARS FROM 1992-1996 | | |
|---|---|---|
| PRINCIPAL COMPONENTS | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
| Driver Air Bag and Inflator Assembly | 3.60 | $ 65.03 |
| Passenger Air Bag and Inflator Assembly | 11.58 | $128.14 |
| Knee Bolster | 7.37 | $ 29.55 |
| Control Module and Sensors | 2.87 | $133.88 |
| Clock Spring Assembly | 0.41 | $ 13.52 |
| Wiring Harness | 0.93 | $ 26.60 |
| TOTAL | 26.76 | $396.72 |

In 1998, Congress directed NHTSA to issue a final rule mandating the use of advanced air bags to improve occupant protection for occupants of different sizes, belted and unbelted, while minimizing the risk to infants, children, and other occupants from injuries and deaths caused by air bags. The issuance of this rule will ensure that advanced air bag technologies are installed across the full spectrum of future fleets of motor vehicles. As a result, the air bags in those vehicles will be even more effective in saving lives and reducing serious injuries. NHTSA will analyze advanced air bags in future cost studies.

### *Light Truck Studies*

### *Safety Belts*

***Manual Front Outboard Safety Belts Without Retractors***. FMVSS 208/209/210 were effective for light trucks on January 1, 1968. Prior to 1976, light trucks were equipped with lap belts. Manual 3-point belts were equipped in low volumes on light trucks as well. From 1966 through 1971, the proportion of light trucks installed with 3-point belts averaged two percent based on data from NASS and other crash files. The remaining 98 percent were equipped with lap belts in the front outboard positions.

It is assumed that manually adjusted lap belts without retractors were installed through December 31, 1971. Although no cost or weight analysis was performed on manual front outboard safety belts in light trucks for this time period, the safety belts used in light trucks are assumed to be very similar to those in passenger cars for the same time frame. Consequently, the weight and cost numbers from the passenger car study are used to determine the light truck figures[123]. The safety belt and shoulder belt anchorages in light trucks, however, differed from those in the passenger cars. Therefore, the figures from a study of belt assembly anchorages in light trucks are used.[124] Table 208-13 shows the arithmetic average weight and consumer cost per seat for the manual front outboard safety belts without retractors, including the safety belt and shoulder belt assembly anchorages.

[123] McLean, DOT HS 803 871 (1978).
[124] Osen, DOT HS 806 772 (1985).

| TABLE 208-13<br>AVERAGE WEIGHT AND CONSUMER COST PER SEAT<br>OF MANUAL FRONT OUTBOARD SAFETY BELTS<br>WITHOUT RETRACTORS IN LIGHT TRUCKS | | |
|---|---|---|
| BELT ASSEMBLIES | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
| Lap Belt Only | 2.25 | $20.67 |
| 3-Point Belt (1966-1971) | 2.54 | $22.03 |

***Manual Front Outboard Safety Belts With Retractors***. Beginning January 1, 1972, front lap/shoulder safety belts, safety belt retractors, and safety belt warning systems were required on passenger cars. It is assumed that the safety belt retractors and safety belt warning systems were added to the light truck outboard safety belt assemblies at this time. The figures for the 3-point belts were derived from a cost and weight analysis performed on six light trucks,[125,126] however, there was no analysis performed on the lap belts. Since there was little difference in the cost and weight of the lap belt and 3-point belts without retractors (Table 208-13), the cost of the lap belt with retractor was determined by subtracting 0.29 from the weight and $1.36 from the cost of the 3-point belts with retractors. Table 208-14 shows the average weight and consumer cost per seat for the manual front outboard safety belts with retractors. These figures include the safety belt and shoulder belt assembly anchorages.

| TABLE 208-14<br>AVERAGE WEIGHT AND CONSUMER COST PER SEAT<br>OF MANUAL FRONT OUTBOARD SAFETY BELTS<br>WITH RETRACTORS IN LIGHT TRUCKS | | |
|---|---|---|
| BELT ASSEMBLIES | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
| Lap Belt Only | 4.49 | $33.46 |
| 3-Point Belt (1972-2001) | 4.78 | $34.82 |

After January 1, 1976, the FMVSS 208 requirements for light trucks were similar to those for passenger cars, offering three possible options that were discussed earlier in this paper. Manufacturers avoided the automatic protection options. However, certain types of trucks were still exempt from 3-point belts. The proportion of light trucks installed with 3-point belts increased over the years until 1981 when 100 percent of light trucks were equipped with 3-point belts in the front outboard seating positions.

***Rear Outboard Safety Belts***. From 1966 to 1986 rear-outboard seats were equipped with lap only belts. Integral 3-point belts were voluntarily installed in light trucks starting in 1987, and subsequently in a gradually increasing list of models. In November 1989, NHTSA published a final rule that extended the requirements for rear lap/shoulder belts to convertibles, light trucks, multipurpose vehicles, and small buses other than school buses. As in the earlier final rule, center seating positions and non forward-facing seating positions were excluded from the requirements. By 1992, 100 percent of light trucks were equipped with integral 3-point belts in all forward-facing rear outboard-seating positions. Rear seat lap/shoulder belts are estimated to

[125] Fladmark, DOT HS 809 798 (1996).
[126] Fladmark, DOT HS 809 801-802 (1997).

be even more effective than rear-seat lap only belts in reducing fatalities and moderate-to-severe injuries.

Although no cost or weight analysis was performed on manual rear outboard safety belts in light trucks for this time period, the safety belts used in light trucks are assumed to be very similar to those in passenger cars for the same time frame. Consequently, the weight and cost numbers from the passenger car study are used to determine the light truck figures.[127,128] The safety belt and shoulder belt anchorages in light trucks, however, differed from those in the passenger cars. Therefore, the figures from a study of belt assembly anchorages in light trucks are used.[129] Table 208-15 shows the arithmetic average weight and consumer cost per seat for the manual rear outboard safety belts with and without retractors, plus the safety belt and shoulder belt assembly anchorages.

***TABLE 208-15***
***AVERAGE WEIGHT AND CONSUMER COST PER SEAT***
***OF REAR OUTBOARD SAFETY BELTS IN LIGHT TRUCKS***

| BELT ASSEMBLIES | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| ***Without Retractors*** | | |
| Lap Only | 1.35 | $15.97 |
| ***With Retractors*** | | |
| Lap Only | 2.24 | $18.29 |
| 3-Point Belt | 3.45 | $22.34 |

***Front and Rear Center Safety Belts***. From January 1, 1968 through 2003, FMVSS 208 has only required lap only belts at the front and rear center seat positions. They are airline-style belts without retractor. Again, no cost or weight analysis was performed on front and rear center lap belts in light trucks for this time period; consequently, the weight and cost numbers from the passenger car studies are used to determine the light truck figures.[130,131] Table 208-16 shows the arithmetic average weight and consumer cost per seat for the front and rear center lap belts without retractors. No cost is included for anchorages, since they are shared with the outboard seats.

***TABLE 208-16***
***AVERAGE WEIGHT AND CONSUMER COST PER SEAT***
***OF FRONT AND REAR CENTER LAP BELTS***
***WITHOUT RETRACTORS IN LIGHT TRUCKS***

| BELT ASSEMBLIES | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| Front Center | 0.85 | $13.95 |
| Rear Center | 0.92 | $12.96 |

***Summary Calculations for Safety Belts***. The total weight and consumer cost of safety belt assemblies and anchorages for model years 1966-2001 were calculated. The calculations were based on the weight and consumer cost per seat and the percent market share of safety belt assemblies per number of seating positions in a passenger car by model year (average "N"). The

[127] McLean DOT HS 803 871 (1978).
[128] Khadilkar, DOT 807 952 (1992).
[129] Osen, DOT HS 806 772 (1985).
[130] McLean, DOT HS 803 871 (1978).
[131] Gladstone, DOT HS 803 871 (1982).

summary calculations were determined through the same series of steps as the passenger cars. The model years were divided into four groups, i.e., 1966-1976, 1977-1984, 1985-1994, and 1995-2001. The percent market share for each group was based on data from the following sources:

1. 1966-1976 – National Crash Severity Study (NCSS), which was a 1976-1978 predecessor of the National Automotive Sampling System (NASS) file. NCSS had a variable indicating how many seats were in the vehicle.

2. 1977-1984 – 1985 Polk registration file and Branham Automobile Reference Book. The Polk file provides the sales figures of all 1985 light trucks broken out by make and model, while the Branham book identifies the number of seating positions in each of the 1985 make/models. In cases where the Branham book did not provide the number of seating positions, certain assumptions based on body type were used to determine the number of seating positions, i.e., pickups with no backseats had three, pickups with king cab had five, and pickups with crew cab had six. The sales figures for each seating position are divided by the overall sales figures to determine the percent market share per position. For example, 927,833 two-seat light trucks were sold in 1985, with overall light truck sales of 3,925,577. Therefore, the percent market share for two seating positions = 927,833 / 3,925,577 or 0.2364.

3. 1985-1994 – 1990 Polk registration file and Branham Automobile Reference Book.

4. 1995-2001 – 1999 Polk registration file and Branham Automobile Reference Book.

Tables 208-17A thru D show the breakout of the possible number of seating positions in light trucks, the percent market share for those seating positions, the number of safety belt assemblies required at each seating location, the corresponding percent market share at each seating location for the number of seating positions per light truck, and the total percent market share for each seating location for 1966-2001.

| *TABLE 208-17A PERCENT MARKET SHARE (AVERAGE N) FOR SEATING POSITIONS IN LIGHT TRUCKS FROM 1966-1976* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | FRONT OUTBOARD | | REAR OUTBOARD | | FRONT CENTER | | REAR CENTER | |
| # OF SEATING POSITIONS PER LIGHT TRUCK | % MARKET SHARE PER POSITION (A) | # OF BELTS (B) | % MARKET SHARE (A*B) | # OF BELTS (C) | % MARKET SHARE (A*C) | # OF BELTS (D) | % MARKET SHARE (A*D) | # OF BELTS (E) | % MARKET SHARE (A*E) |
| 2 | 0.3272 | 2 | 0.6544 | 0 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 |
| 3 | 0.4959 | 2 | 0.9918 | 0 | 0.0000 | 1 | 0.4959 | 0 | 0.0000 |
| 4 | 0.0488 | 2 | 0.0976 | 2 | 0.0976 | 0 | 0.0000 | 0 | 0.0000 |
| 5 | 0.1057 | 2 | 0.2114 | 2 | 0.2114 | 0.5 | 0.0529 | 0.5 | 0.0529 |
| 6 | 0.0081 | 2 | 0.0162 | 2 | 0.0162 | 1 | 0.0081 | 1 | 0.0081 |
| 7 | 0.0041 | 2 | 0.0082 | 4 | 0.0164 | 0 | 0.0000 | 1 | 0.0041 |
| 8 | 0.0081 | 2 | 0.0162 | 4 | 0.0324 | 0 | 0.0000 | 2 | 0.0162 |
| 12 | 0.0021 | 2 | 0.0042 | 6 | 0.0126 | 1 | 0.0021 | 3 | 0.0063 |
| TOTAL | 1.0000 | | 2.0000 | | 0.3866 | | 0.5590 | | 0.0876 |

| *TABLE 208-17B PERCENT MARKET SHARE (AVERAGE N) FOR SEATING POSITIONS IN LIGHT TRUCKS FROM 1977-1986* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | FRONT OUTBOARD | | REAR OUTBOARD | | FRONT CENTER | | REAR CENTER | |
| # OF SEATING POSITIONS PER LIGHT TRUCK | % MARKET SHARE PER POSITION (A) | # OF BELTS (B) | % MARKET SHARE (A*B) | # OF BELTS (C) | % MARKET SHARE (A*C) | # OF BELTS (D) | % MARKET SHARE (A*D) | # OF BELTS (E) | % MARKET SHARE (A*E) |
| 2 | 0.2364 | 2 | 0.4728 | 0 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 |
| 3 | 0.4310 | 2 | 0.8620 | 0 | 0.0000 | 1 | 0.4310 | 0 | 0.0000 |
| 4 | 0.1105 | 2 | 0.2210 | 2 | 0.2210 | 0 | 0.0000 | 0 | 0.0000 |
| 5 PU[132] | 0.1245 | 2 | 0.2490 | 2 | 0.2490 | 1 | 0.1245 | 0 | 0.0000 |
| 5 S/V[133] | 0.0014 | 2 | 0.0028 | 2 | 0.0028 | 1 | 0.0014 | 0 | 0.0000 |
| 6 | 0.0227 | 2 | 0.0454 | 2 | 0.0454 | 1 | 0.0227 | 1 | 0.0227 |
| 7 | 0.0378 | 2 | 0.0756 | 4 | 0.1512 | 0 | 0.0000 | 1 | 0.0378 |
| 8 | 0.0103 | 2 | 0.0206 | 4 | 0.0412 | 0 | 0.0000 | 2 | 0.0206 |
| 9 | 0.0189 | 2 | 0.0378 | 4 | 0.0756 | 1 | 0.0189 | 2 | 0.0378 |
| 12 | 0.0043 | 2 | 0.0086 | 6 | 0.0258 | 1 | 0.0043 | 3 | 0.0129 |
| 15 | 0.0022 | 2 | 0.0044 | 8 | 0.0176 | 1 | 0.0022 | 4 | 0.0088 |
| TOTAL | 1.0000 | | 2.0000 | | 0.8296 | | 0.6050 | | 0.1406 |

[132] PU = pickup
[133] S/V = SUV or Van

| TABLE 208-17C PERCENT MARKET SHARE (AVERAGE N) FOR SEATING POSITIONS IN LIGHT TRUCKS FROM 1987-1994 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | FRONT OUTBOARD | | REAR OUTBOARD | | FRONT CENTER | | REAR CENTER | |
| # OF SEATING POSITIONS PER LIGHT TRUCK | % MARKET SHARE PER POSITION (A) | # OF BELTS (B) | % MARKET SHARE (A*B) | # OF BELTS (C) | % MARKET SHARE (A*C) | # OF BELTS (D) | % MARKET SHARE (A*D) | # OF BELTS (E) | % MARKET SHARE (A*E) |
| 2 | 0.1393 | 2 | 0.2786 | 0 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 |
| 3 | 0.3501 | 2 | 0.7002 | 0 | 0.0000 | 1 | 0.3501 | 0 | 0.0000 |
| 4 | 0.0656 | 2 | 0.1312 | 2 | 0.1312 | 0 | 0.0000 | 0 | 0.0000 |
| 5 PU | 0.1933 | 2 | 0.3866 | 2 | 0.3866 | 1 | 0.1933 | 0 | 0.0000 |
| 5 S/V | 0.0313 | 2 | 0.0626 | 2 | 0.0626 | 1 | 0.0313 | 0 | 0.0000 |
| 6 | 0.0843 | 2 | 0.1686 | 2 | 0.1686 | 1 | 0.0843 | 1 | 0.0843 |
| 7 | 0.1052 | 2 | 0.2104 | 4 | 0.4208 | 0 | 0.0000 | 1 | 0.1052 |
| 8 | 0.0036 | 2 | 0.0072 | 4 | 0.0144 | 0 | 0.0000 | 2 | 0.0072 |
| 9 | 0.0210 | 2 | 0.0420 | 4 | 0.0840 | 1 | 0.0210 | 2 | 0.0420 |
| 12 | 0.0039 | 2 | 0.0078 | 6 | 0.0234 | 1 | 0.0039 | 3 | 0.0117 |
| 15 | 0.0024 | 2 | 0.0048 | 8 | 0.0192 | 1 | 0.0024 | 4 | 0.0096 |
| TOTAL | 1.0000 | | 2.0000 | | 1.3108 | | 0.6863 | | 0.2600 |

| TABLE 208-17D PERCENT MARKET SHARE (AVERAGE N) FOR SEATING POSITIONS IN LIGHT TRUCKS FROM 1995-2001 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | FRONT OUTBOARD | | REAR OUTBOARD | | FRONT CENTER | | REAR CENTER | |
| # OF SEATING POSITIONS PER LIGHT TRUCK | % MARKET SHARE PER POSITION (A) | # OF BELTS (B) | % MARKET SHARE (A*B) | # OF BELTS (C) | % MARKET SHARE (A*C) | # OF BELTS (D) | % MARKET SHARE (A*D) | # OF BELTS (E) | % MARKET SHARE (A*E) |
| 2 | 0.0466 | 2 | 0.0932 | 0 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 |
| 3 | 0.1188 | 2 | 0.2376 | 0 | 0.0000 | 1 | 0.1188 | 0 | 0.0000 |
| 4 | 0.0636 | 2 | 0.1272 | 2 | 0.1272 | 0 | 0.0000 | 0 | 0.0000 |
| 5 PU | 0.0388 | 2 | 0.0776 | 2 | 0.0776 | 1 | 0.0388 | 0 | 0.0000 |
| 5 S/V | 0.1735 | 2 | 0.3470 | 2 | 0.3470 | 1 | 0.1735 | 0 | 0.0000 |
| 6 | 0.2975 | 2 | 0.5950 | 2 | 0.5950 | 1 | 0.2975 | 1 | 0.2975 |
| 7 | 0.1340 | 2 | 0.2680 | 4 | 0.5360 | 0 | 0.0000 | 1 | 0.1340 |
| 8 | 0.0802 | 2 | 0.1604 | 4 | 0.3208 | 0 | 0.0000 | 2 | 0.1604 |
| 9 | 0.0404 | 2 | 0.0808 | 4 | 0.1616 | 1 | 0.0404 | 2 | 0.0808 |
| 12 | 0.0021 | 2 | 0.0042 | 6 | 0.0126 | 1 | 0.0021 | 3 | 0.0063 |
| 15 | 0.0045 | 2 | 0.0090 | 8 | 0.0360 | 1 | 0.0045 | 4 | 0.0180 |
| TOTAL | 1.0000 | | 2.0000 | | 2.2138 | | 0.6756 | | 0.6970 |

The calculations of the total cost for LTVs in model year 1969 are shown in Table 208-18.

| ***TABLE 208-18*** ***TOTAL CONSUMER COST PER LIGHT TRUCK OF SAFETY BELT ASSEMBLIES AND ANCHORAGES FOR MODEL YEAR 1969*** | | | |
|---|---|---|---|
| SAFETY BELT ASSEMBLY | COST PER SEAT (A) | "n" OF BELTS PER LIGHT TRUCK (B) | WEIGHTED COST PER SAFETY BELT ASSEMBLY (A * B) |
| ***Manual Front Outboard Without Retractor*** | | | |
| Lap Belt Only | $20.67 | 1.95 | $40.31 |
| 3-Point Belt | $22.03 | 0.05 | $ 1.10 |
| ***Rear Outboard Without Retractor*** | | | |
| Lap Belt Only | $15.97 | 0.39 | $ 6.23 |
| ***Front Center*** | | | |
| Lap Belt Only | $13.95 | 0.56 | $ 7.81 |
| ***Rear Center*** | | | |
| Lap Belt Only | $12.96 | 0.09 | $ 1.16 |
| TOTAL CONSUMER COST | | | $56.61 |

Summary calculations of the total consumer cost per light truck of safety belt assemblies and anchorages for models 1966-2001 are provided in Tables 208-19A thru E with the calculations for the total weight provided in Tables 208-20A thru E.

| ***TABLE 208-19A*** ***AVERAGE CONSUMER COST PER LIGHT TRUCK OF SAFETY BELT ASSEMBLIES AND ANCHORAGES FOR MODEL YEARS 1966-1973*** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SAFETY BELT ASSEMBLY | COST PER SEAT | "n" OF BELTS PER LIGHT TRUCK | | | | | | |
| | | '66-67 | '68 | '69 | '70 | '71 | '72 | '73 |
| ***FRONT OUTBOARD*** | | | | | | | | |
| ***Manual Without Retractor*** | | | | | | | | |
| Lap Belt Only | $20.67 | 2.00 | 2.00 | 1.95 | 1.94 | 1.93 | | |
| 3-Point Belt | $22.03 | | | 0.05 | 0.06 | 0.07 | | |
| ***Manual With Retractor*** | | | | | | | | |
| Lap Belt Only | $33.46 | | | | | | 1.87 | 1.87 |
| 3-Point Belt | $34.82 | | | | | | 0.13 | 0.13 |
| ***REAR OUTBOARD*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | $15.97 | 0.39 | 0.39 | 0.39 | 0.39 | 0.39 | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | $18.29 | | | | | | 0.39 | 0.39 |
| 3-Point Belt | $22.34 | | | | | | | |
| ***CENTER*** | | | | | | | | |
| Front (lap) | $13.95 | 0.56 | 0.56 | 0.56 | 0.56 | 0.56 | 0.56 | 0.56 |
| Rear (lap) | $12.96 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| TOTAL COST PER LIGHT TRUCK | | $56.55 | $56.55 | $56.61 | $56.63 | $56.64 | $83.21 | $83.21 |

| TABLE 208-19B<br>AVERAGE CONSUMER COST PER LIGHT TRUCK<br>OF SAFETY BELT ASSEMBLIES AND ANCHORAGES<br>FOR MODEL YEARS 1974-1980 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SAFETY BELT ASSEMBLY | COST PER SEAT | "n" OF BELTS PER LIGHT TRUCK | | | | | | |
| | | '74 | '75 | '76 | '77 | '78 | '79 | '80 |
| ***FRONT OUTBOARD*** | | | | | | | | |
| ***Manual Without Retractor*** | | | | | | | | |
| Lap Belt Only | $20.67 | | | | | | | |
| 3-Point Belt | $22.03 | | | | | | | |
| ***Manual With Retractor*** | | | | | | | | |
| Lap Belt Only | $33.46 | 1.00 | 0.94 | 0.92 | 0.24 | 0.23 | 0.24 | 0.08 |
| 3-Point Belt | $34.82 | 1.00 | 1.06 | 1.08 | 1.76 | 1.77 | 1.76 | 1.92 |
| ***REAR OUTBOARD*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | $15.97 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | $18.29 | 0.39 | 0.39 | 0.39 | 0.83 | 0.83 | 0.83 | 0.83 |
| 3-Point Belt | $22.34 | | | | | | | |
| ***CENTER*** | | | | | | | | |
| Front (lap) | $13.95 | 0.56 | 0.56 | 0.56 | 0.61 | 0.61 | 0.61 | 0.61 |
| Rear (lap) | $12.96 | 0.09 | 0.09 | 0.09 | 0.14 | 0.14 | 0.14 | 0.14 |
| TOTAL COST PER LIGHT TRUCK | | $84.39 | $84.47 | $84.50 | $94.82 | $94.83 | $94.82 | $95.04 |

| TABLE 208-19C<br>AVERAGE CONSUMER COST PER LIGHT TRUCK<br>OF SAFETY BELT ASSEMBLIES AND ANCHORAGES<br>FOR MODEL YEARS 1981-1987 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SAFETY BELT ASSEMBLY | COST PER SEAT | "n" OF BELTS PER LIGHT TRUCK | | | | | | |
| | | '81 | '82 | '83 | '84 | '85 | '86 | '87 |
| ***FRONT OUTBOARD*** | | | | | | | | |
| ***Manual Without Retractor*** | | | | | | | | |
| Lap Belt Only | $20.67 | | | | | | | |
| 3-Point Belt | $22.03 | | | | | | | |
| ***Manual With Retractor*** | | | | | | | | |
| Lap Belt Only | $33.46 | | | | | | | |
| 3-Point Belt | $34.82 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| ***REAR OUTBOARD*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | $15.97 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | $18.29 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 1.308 |
| 3-Point Belt | $22.34 | | | | | | | 0.003 |
| ***CENTER*** | | | | | | | | |
| Front (lap) | $13.95 | 0.61 | 0.61 | 0.61 | 0.61 | 0.61 | 0.61 | 0.69 |
| Rear (lap) | $12.96 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.26 |
| TOTAL COST PER LIGHT TRUCK | | $95.14 | $95.14 | $95.14 | $95.14 | $95.14 | $95.14 | $106.63 |

| ***TABLE 208-19D***<br>***AVERAGE CONSUMER COST PER LIGHT TRUCK***<br>***OF SAFETY BELT ASSEMBLIES AND ANCHORAGES***<br>***FOR MODEL YEARS 1988-1994*** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SAFETY BELT ASSEMBLY | COST PER SEAT | "n" OF BELTS PER LIGHT TRUCK | | | | | | |
| | | '88 | '89 | '90 | '91 | '92 | '93 | '94 |
| ***FRONT OUTBOARD*** | | | | | | | | |
| ***Manual Without Retractor*** | | | | | | | | |
| Lap Belt Only | $20.67 | | | | | | | |
| 3-Point Belt | $22.03 | | | | | | | |
| ***Manual With Retractor*** | | | | | | | | |
| Lap Belt Only | $33.46 | | | | | | | |
| 3-Point Belt | $34.82 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| ***REAR OUTBOARD*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | $15.97 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | $18.29 | 1.28 | 1.13 | 1.09 | 0.99 | | | |
| 3-Point Belt | $22.34 | 0.03 | 0.18 | 0.22 | 0.32 | 1.31 | 1.31 | 1.31 |
| ***CENTER*** | | | | | | | | |
| Front (lap) | $13.95 | 0.69 | 0.69 | 0.69 | 0.69 | 0.69 | 0.69 | 0.69 |
| Rear (lap) | $12.96 | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 |
| TOTAL COST PER LIGHT TRUCK | | $106.72 | $107.32 | $107.49 | $107.89 | $111.90 | $111.90 | $111.90 |

| ***TABLE 208-19E***<br>***AVERAGE CONSUMER COST PER LIGHT TRUCK***<br>***OF SAFETY BELT ASSEMBLIES AND ANCHORAGES***<br>***FOR MODEL YEARS 1995-2001*** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SAFETY BELT ASSEMBLY | COST PER SEAT | "n" OF BELTS PER LIGHT TRUCK | | | | | | |
| | | '95 | '96 | '97 | '98 | '99 | '00 | '01 |
| ***FRONT OUTBOARD*** | | | | | | | | |
| ***Manual Without Retractor*** | | | | | | | | |
| Lap Belt Only | $20.67 | | | | | | | |
| 3-Point Belt | $22.03 | | | | | | | |
| ***Manual With Retractor*** | | | | | | | | |
| Lap Belt Only | $33.46 | | | | | | | |
| 3-Point Belt | $34.82 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| ***REAR OUTBOARD*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | $15.97 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | $18.29 | | | | | | | |
| 3-Point Belt | $22.34 | 2.21 | 2.21 | 2.21 | 2.21 | 2.21 | 2.21 | 2.21 |
| ***CENTER*** | | | | | | | | |
| Front (lap) | $13.95 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 |
| Rear (lap) | $12.96 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |
| TOTAL COST PER LIGHT TRUCK | | $137.57 | $137.57 | $137.57 | $137.57 | $137.57 | $137.57 | $137.57 |

| TABLE 208-20A<br>AVERAGE WEIGHT PER LIGHT TRUCK<br>OF SAFETY BELT ASSEMBLIES AND ANCHORAGES<br>FOR MODEL YEARS 1974-1980 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SAFETY BELT ASSEMBLY | WEIGHT PER SEAT | "n" OF BELTS PER LIGHT TRUCK | | | | | | |
| | | '66-67 | '68 | '69 | '70 | '71 | '72 | '73 |
| ***FRONT OUTBOARD*** | | | | | | | | |
| ***Manual Without Retractor*** | | | | | | | | |
| Lap Belt Only | 2.25 | 2.00 | 2.00 | 1.95 | 1.94 | 1.93 | | |
| 3-Point Belt | 2.54 | | | 0.05 | 0.06 | 0.07 | | |
| ***Manual With Retractor*** | | | | | | | | |
| Lap Belt Only | 4.49 | | | | | | 1.87 | 1.87 |
| 3-Point Belt | 4.78 | | | | | | 0.13 | 0.13 |
| ***REAR OUTBOARD*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | 1.35 | 0.39 | 0.39 | 0.39 | 0.39 | 0.39 | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | 2.24 | | | | | | 0.39 | 0.39 |
| 3-Point Belt | 3.45 | | | | | | | |
| ***CENTER*** | | | | | | | | |
| Front (lap) | 0.85 | 0.56 | 0.56 | 0.56 | 0.56 | 0.56 | 0.56 | 0.56 |
| Rear (lap) | 0.92 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| TOTAL WEIGHT PER LIGHT TRUCK | | 5.59 | 5.59 | 5.60 | 5.60 | 5.61 | 10.45 | 10.45 |

| TABLE 208-20B<br>AVERAGE WEIGHT PER LIGHT TRUCK<br>OF SAFETY BELT ASSEMBLIES AND ANCHORAGES<br>FOR MODEL YEARS 1974-1980 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SAFETY BELT ASSEMBLY | WEIGHT PER SEAT | "n" OF BELTS PER LIGHT TRUCK | | | | | | |
| | | '74 | '75 | '76 | '77 | '78 | '79 | '80 |
| ***FRONT OUTBOARD*** | | | | | | | | |
| ***Manual Without Retractor*** | | | | | | | | |
| Lap Belt Only | 2.25 | | | | | | | |
| 3-Point Belt | 2.54 | | | | | | | |
| ***Manual With Retractor*** | | | | | | | | |
| Lap Belt Only | 4.49 | 1.00 | 0.94 | 0.92 | 0.24 | 0.23 | 0.24 | 0.08 |
| 3-Point Belt | 4.78 | 1.00 | 1.06 | 1.08 | 1.76 | 1.77 | 1.76 | 1.92 |
| ***REAR OUTBOARD*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | 1.35 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | 2.24 | 0.39 | 0.39 | 0.39 | 0.83 | 0.83 | 0.83 | 0.83 |
| 3-Point Belt | 3.45 | | | | | | | |
| ***CENTER*** | | | | | | | | |
| Front (lap) | 0.85 | 0.56 | 0.56 | 0.56 | 0.61 | 0.61 | 0.61 | 0.61 |
| Rear (lap) | 0.92 | 0.09 | 0.09 | 0.09 | 0.14 | 0.14 | 0.14 | 0.14 |
| TOTAL WEIGHT PER LIGHT TRUCK | | 10.70 | 10.72 | 10.73 | 12.00 | 12.00 | 12.00 | 12.04 |

| TABLE 208-20C<br>AVERAGE WEIGHT PER LIGHT TRUCK<br>OF SAFETY BELT ASSEMBLIES AND ANCHORAGES<br>FOR MODEL YEARS 1981-1987 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SAFETY BELT ASSEMBLY | WEIGHT PER SEAT | "n" OF BELTS PER LIGHT TRUCK | | | | | | |
| | | '81 | '82 | '83 | '84 | '85 | '86 | '87 |
| ***FRONT OUTBOARD*** | | | | | | | | |
| ***Manual Without Retractor*** | | | | | | | | |
| Lap Belt Only | 2.25 | | | | | | | |
| 3-Point Belt | 2.54 | | | | | | | |
| ***Manual With Retractor*** | | | | | | | | |
| Lap Belt Only | 4.49 | | | | | | | |
| 3-Point Belt | 4.78 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| ***REAR OUTBOARD*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | 1.35 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | 2.24 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 1.308 |
| 3-Point Belt | 3.45 | | | | | | | 0.003 |
| ***CENTER*** | | | | | | | | |
| Front (lap) | 0.85 | 0.61 | 0.61 | 0.61 | 0.61 | 0.61 | 0.61 | 0.69 |
| Rear (lap) | 0.92 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.26 |
| TOTAL WEIGHT PER LIGHT TRUCK | | 12.07 | 12.07 | 12.07 | 12.07 | 12.07 | 12.07 | 13.33 |

| TABLE 208-20D<br>AVERAGE WEIGHT PER LIGHT TRUCK<br>OF SAFETY BELT ASSEMBLIES AND ANCHORAGES<br>FOR MODEL YEARS 1988-1994 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SAFETY BELT ASSEMBLY | WEIGHT PER SEAT | "n" OF BELTS PER LIGHT TRUCK | | | | | | |
| | | '88 | '89 | '90 | '91 | '92 | '93 | '94 |
| ***FRONT OUTBOARD*** | | | | | | | | |
| ***Manual Without Retractor*** | | | | | | | | |
| Lap Belt Only | 2.25 | | | | | | | |
| 3-Point Belt | 2.54 | | | | | | | |
| ***Manual With Retractor*** | | | | | | | | |
| Lap Belt Only | 4.49 | | | | | | | |
| 3-Point Belt | 4.78 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| ***REAR OUTBOARD*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | 1.35 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | 2.24 | 1.28 | 1.13 | 1.09 | 0.99 | | | |
| 3-Point Belt | 3.45 | 0.03 | 0.18 | 0.22 | 0.32 | 1.31 | 1.31 | 1.31 |
| ***CENTER*** | | | | | | | | |
| Front (lap) | 0.85 | 0.69 | 0.69 | 0.69 | 0.69 | 0.69 | 0.69 | 0.69 |
| Rear (lap) | 0.92 | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 |
| TOTAL WEIGHT PER LIGHT TRUCK | | 13.36 | 13.54 | 13.59 | 13.71 | 14.91 | 14.91 | 14.91 |

| TABLE 208-20E AVERAGE WEIGHT PER LIGHT TRUCK OF SAFETY BELT ASSEMBLIES AND ANCHORAGES FOR MODEL YEARS 1995-2001 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SAFETY BELT ASSEMBLY | WEIGHT PER SEAT | "n" OF BELTS PER LIGHT TRUCK | | | | | | |
| | | '95 | '96 | '97 | '98 | '99 | '00 | '01 |
| ***FRONT OUTBOARD*** | | | | | | | | |
| ***Manual Without Retractor*** | | | | | | | | |
| Lap Belt Only | 2.25 | | | | | | | |
| 3-Point Belt | 2.54 | | | | | | | |
| ***Manual With Retractor*** | | | | | | | | |
| Lap Belt Only | 4.49 | | | | | | | |
| 3-Point Belt | 4.78 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| ***REAR OUTBOARD*** | | | | | | | | |
| ***Without Retractor*** | | | | | | | | |
| Lap Belt Only | 1.35 | | | | | | | |
| ***With Retractor*** | | | | | | | | |
| Lap Belt Only | 2.24 | | | | | | | |
| 3-Point Belt | 3.45 | 2.21 | 2.21 | 2.21 | 2.21 | 2.21 | 2.21 | 2.21 |
| ***CENTER*** | | | | | | | | |
| Front (lap) | 0.85 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 |
| Rear (lap) | 0.92 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |
| TOTAL WEIGHT PER LIGHT TRUCK | | 18.41 | 18.41 | 18.41 | 18.41 | 18.41 | 18.41 | 18.41 |

## *Frontal Air Bags*

Although FMVSS 208 has long required the installation of safety belts at all designated seating positions in light trucks, it did not originally require those vehicles to provide automatic crash protection. A final rule issued in September 1991 extended the requirements for automatic crash protection, which currently applied to front outboard seats in passenger cars, to front outboard seats in trucks and multipurpose passenger vehicles with a GVWR of 8,500 pounds or less. The rule provided that the automatic restraint requirement would be phased into light trucks over a three-year period starting on September 1, 1994. The two types of automatic crash protection available to manufacturers for installation in their vehicles were air bags and automatic belts. However, in September 1993, NHTSA amended FMVSS 208 to require that all passenger cars and light trucks provide automatic protection by means of air bags. Every light truck (with a GVWR of 8,500 pounds or less) manufactured on or after September 1, 1998 would have to be equipped with an air bag and a manual lap/shoulder belt at both the driver's and right front passenger's seating positions. The vehicle manufacturers were far ahead of the implementation schedule, and a large number of model year 1996 light trucks were equipped with air bags.

A series of cost and weight analyses were performed on air bags from six light trucks.[134,135] Table 208-21 shows the arithmetic average weight and consumer cost for driver air bags and dual air bags.

[134] Fladmark, DOT HS 809 799 (1996).
[135] Fladmark, DOT HS 809 801:Section 5 and DOT HS 809 802:Sections 7,8 (1997).

| ***TABLE 208-21*** ***AVERAGE WEIGHT AND CONSUMER COST*** ***OF AIRBAGS IN LIGHT TRUCKS*** | | |
|---|---|---|
| MODEL YEAR | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
| ***Driver Air Bags*** | | |
| 1996 | 14.31 | $265.78 |
| ***Dual Air Bags*** | | |
| 1995-1996 | 26.48 | $383.75 |

The main components of an air bag system are the air bag module, igniter/inflator, control module/sensors, clock spring, wiring harness, and knee bolster. Table 208-22 shows the average costs of the principal components of dual air bags for 1995-1996. The total cost and weight of air bags, and the cost of the main components, is about the same as in passenger cars.

| ***TABLE 208-22*** ***AVERAGE WEIGHT AND CONSUMER COST*** ***OF PRINCIPAL COMPONENTS IN DUAL AIR BAGS*** ***IN LIGHT TRUCKS FROM 1995-1996*** | | |
|---|---|---|
| PRINCIPAL COMPONENTS | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
| Driver Air Bag and Inflator Assembly | 3.50 | $ 57.11 |
| Passenger Air Bag and Inflator Assembly | 10.39 | $105.41 |
| Knee Bolster | 7.82 | $ 31.36 |
| Control Module and Sensors | 3.00 | $137.42 |
| Clock Spring Assembly | 0.43 | $ 13.62 |
| Wiring Harness | 1.34 | $ 38.83 |
| TOTAL | 26.48 | $383.75 |

### *On-Off Switches*

While air bags were providing significant overall safety benefits, NHTSA was very concerned that current designs had adverse effects, especially on children in rear-facing child seats installed in front passenger positions. To address this dilemma, NHTSA published a final rule in May 1995 allowing manufacturers the option of installing a manual device that motorists could use to deactivate the front passenger-side air bag in vehicles manufactured on or after June 22, 1995, that cannot accommodate rear-facing child seats anywhere except in the front seat. The manual on/off switch had to use an ignition key to turn off the passenger air bag and to turn on the air bag. In addition, the manufacturer had to install a warning light that was separate from the air bag readiness indicator, which would indicate when the air bag was turned off. The light had to be visible to both the driver and the passenger. By model year 1998, switches for the passenger bag had become standard equipment in all pickup trucks with a GVWR of 8,500 pounds or less that could not accommodate a rear-facing infant seat in the rear seat. That basically includes all conventional cabs (no rear seats) and extended cabs (small rear seats) and only excludes certain full crew cabs.

A cost and weight analysis was performed on air bag on/off switch systems.[136] The sample vehicles each had two switches that were independent of each other; consequently, the cost of the two switches was double the cost of one switch. Table 208-23 shows the arithmetic average weight and consumer cost of one on/off switch for a pickup truck.

***TABLE 208-23***
***AVERAGE WEIGHT AND CONSUMER COST PER SWITCH OF PASSENGER SIDE ON/OFF SWITCHES***

| COMPONENT | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| On/Off Switches | 0.65 | $28.12 |

In 1998, Congress directed NHTSA to issue a final rule mandating the use of advanced air bags to improve occupant protection for occupants of different sizes, belted and unbelted, while minimizing the risk to infants, children, and other occupants from injuries and deaths caused by air bags. The issuance of this rule will ensure that advanced air bag technologies are installed across the full spectrum of future fleets of motor vehicles. As a result, the air bags in those vehicles will be even more effective in saving lives and reducing serious injuries. NHTSA will analyze advanced air bags in future cost studies.

***<u>Summary Tables for FMVSS 208/209/210</u>***

Tables 208-24A and 24B summarize the total consumer cost and weight of the occupant protection systems installed in passenger cars for model years 1966-2001. In general, all these weights and costs should be attributed directly to the standards because installation of occupant protection systems was in response to, or in anticipation of, the regulatory requirements of these standards. The summary calculations are a compilation of the total cost and weight per vehicle of safety belts, driver air bags, and dual bags. An explanation of the tables follows:

- <u>Column (a)</u>: The total cost of safety belts was obtained from Tables 208-8A thru E, with its corresponding total weight obtained from Tables 208-9A thru E.

- <u>Column (b)</u>: The unit cost/weight of driver air bags was obtained from Table 208-11.

- <u>Column (c)</u>: The percent of passenger cars that had driver air bags in a specific model year was obtained from NHTSA crash data files and Polk registration files.

- <u>Column (d)</u>: The total cost/weight per vehicle for driver air bags was calculated by multiplying column (b) by column (c).

- <u>Column (e)</u>: The unit cost/weight of dual air bags was obtained from Table 208-11.

- <u>Column (f)</u>: The percent of passenger cars that had dual air bags in a specific model year was obtained from NHTSA crash data files and Polk registration files.

[136] Fladmark, G.L. and Khadilkar, A.V., *Cost Estimates of One (1) Side Impact Crash Protection for 1998 Model Year Passenger Car and Two (2) Automatic Crash Protection On/Off Switches for 1998 Model Year Passenger Car*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, December 1998. (DOT HS 809 805).

- Column (g): The total cost/weight per vehicle for dual air bags was calculated by multiplying column (e) by column (f).

- Column (h): The total cost/weight per vehicle of FMSVSS 208/209/210 in passenger cars was calculated by adding column (a) plus column (d) plus column (g).

| TABLE 208-24A<br>SUMMARY TABLE FOR THE TOTAL CONSUMER COST<br>ATTRIBUTABLE TO FMVSS 208/209/210<br>IN PASSENGER CARS BY MODEL YEAR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | SAFETY BELTS | AIR BAGS | | | | | | FMVSS 208-210 |
| | | DRIVER | | | DUAL | | | |
| | (a) | (b) | (c) | (d) | (e) | (f) | (g) | (h) |
| MODEL YEAR | TOTAL COST | UNIT COST | % OF CARS | TOTAL COST PER CAR | UNIT COST | % OF CARS | TOTAL COST PER CAR | TOTAL COST PER CAR |
| 1966-67 | $ 89.16 | | | | | | | $ 89.16 |
| 1968 | $ 90.76 | | | | | | | $ 90.76 |
| 1969 | $ 92.38 | | | | | | | $ 92.38 |
| 1970 | $ 92.38 | | | | | | | $ 92.38 |
| 1971 | $ 92.38 | | | | | | | $ 92.38 |
| 1972 | $116.41 | | | | | | | $116.41 |
| 1973 | $116.37 | | | | | | | $116.37 |
| 1974 | $118.09 | | | | | | | $118.09 |
| 1975 | $118.52 | | | | | | | $118.52 |
| 1976 | $118.48 | | | | | | | $118.48 |
| 1977 | $116.16 | | | | | | | $116.16 |
| 1978 | $116.16 | | | | | | | $116.16 |
| 1979 | $116.55 | | | | | | | $116.55 |
| 1980 | $116.55 | | | | | | | $116.55 |
| 1981 | $117.71 | | | | | | | $117.71 |
| 1982 | $116.91 | | | | | | | $116.91 |
| 1983 | $117.57 | | | | | | | $117.57 |
| 1984 | $117.57 | | | | | | | $117.57 |
| 1985 | $117.57 | $284.09 | 0.13 | $ 0.37 | | | | $117.94 |
| 1986 | $117.60 | $284.09 | 0.75 | $ 2.13 | | | | $119.73 |
| 1987 | $145.49 | $284.09 | 1.17 | $ 3.32 | $396.72 | 0.05 | $ 0.20 | $149.01 |
| 1988 | $186.04 | $284.09 | 1.66 | $ 4.72 | $396.72 | 0.02 | $ 0.08 | $190.84 |
| 1989 | $218.52 | $284.09 | 3.62 | $ 10.28 | $396.72 | 0.72 | $ 2.86 | $231.66 |
| 1990 | $324.19 | $284.09 | 26.51 | $ 75.31 | $396.72 | 2.00 | $ 7.93 | $407.43 |
| 1991 | $301.83 | $284.09 | 35.18 | $ 99.94 | $396.72 | 0.55 | $ 2.18 | $403.95 |
| 1992 | $261.75 | $284.09 | 48.42 | $137.56 | $396.72 | 4.89 | $ 19.40 | $418.71 |
| 1993 | $264.77 | $284.09 | 49.42 | $140.40 | $396.72 | 14.08 | $ 55.86 | $461.03 |
| 1994 | $246.75 | $284.09 | 25.38 | $ 72.10 | $396.72 | 58.36 | $231.53 | $550.38 |
| 1995 | $176.07 | $284.09 | 9.14 | $ 25.97 | $396.72 | 89.51 | $355.10 | $557.14 |
| 1996 | $153.47 | $284.09 | 4.93 | $ 14.01 | $396.72 | 94.60 | $375.30 | $542.78 |
| 1997 | $124.63 | | | | $396.72 | 100.00 | $396.72 | $521.35 |
| 1998 | $124.63 | | | | $396.72 | 100.00 | $396.72 | $521.35 |
| 1999 | $124.63 | | | | $396.72 | 100.00 | $396.72 | $521.35 |
| 2000 | $124.63 | | | | $396.72 | 100.00 | $396.72 | $521.35 |
| 2001 | $124.63 | | | | $396.72 | 100.00 | $396.72 | $521.35 |

| TABLE 208-24B<br>SUMMARY TABLE FOR THE TOTAL WEIGHT<br>ATTRIBUTABLE TO FMVSS 208/209/210<br>IN PASSENGER CARS BY MODEL YEAR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | SAFETY BELTS | AIR BAGS | | | | | | FMVSS 208-210 |
| | | DRIVER | | | DUAL | | | |
| | (a) | (b) | (c) | (d) | (e) | (f) | (g) | (h) |
| MODEL YEAR | TOTAL WEIGHT | UNIT WEIGHT | % OF CARS | TOTAL WEIGHT PER CAR | UNIT WEIGHT | % OF CARS | TOTAL WEIGHT PER CAR | TOTAL WEIGHT PER CAR |
| 1966-67 | 9.36 | | | | | | | 9.36 |
| 1968 | 9.92 | | | | | | | 9.92 |
| 1969 | 10.49 | | | | | | | 10.49 |
| 1970 | 10.49 | | | | | | | 10.49 |
| 1971 | 10.49 | | | | | | | 10.49 |
| 1972 | 15.28 | | | | | | | 15.28 |
| 1973 | 15.29 | | | | | | | 15.29 |
| 1974 | 16.51 | | | | | | | 16.51 |
| 1975 | 16.58 | | | | | | | 16.58 |
| 1976 | 16.57 | | | | | | | 16.57 |
| 1977 | 16.40 | | | | | | | 16.40 |
| 1978 | 16.40 | | | | | | | 16.40 |
| 1979 | 16.47 | | | | | | | 16.47 |
| 1980 | 16.47 | | | | | | | 16.47 |
| 1981 | 16.53 | | | | | | | 16.53 |
| 1982 | 16.48 | | | | | | | 16.48 |
| 1983 | 16.53 | | | | | | | 16.53 |
| 1984 | 16.53 | | | | | | | 16.53 |
| 1985 | 16.53 | 13.46 | 0.13 | 0.02 | | | | 16.55 |
| 1986 | 16.54 | 13.46 | 0.75 | 0.10 | | | | 16.64 |
| 1987 | 18.77 | 13.46 | 1.17 | 0.16 | 26.76 | 0.05 | 0.01 | 18.94 |
| 1988 | 22.18 | 13.46 | 1.66 | 0.22 | 26.76 | 0.02 | 0.005 | 22.41 |
| 1989 | 25.01 | 13.46 | 3.62 | 0.49 | 26.76 | 0.72 | 0.19 | 25.69 |
| 1990 | 33.86 | 13.46 | 26.51 | 3.57 | 26.76 | 2.00 | 0.54 | 37.97 |
| 1991 | 31.29 | 13.46 | 35.18 | 4.74 | 26.76 | 0.55 | 0.15 | 36.18 |
| 1992 | 28.31 | 13.46 | 48.42 | 6.52 | 26.76 | 4.89 | 1.31 | 36.14 |
| 1993 | 28.66 | 13.46 | 49.42 | 6.65 | 26.76 | 14.08 | 3.77 | 39.08 |
| 1994 | 27.35 | 13.46 | 25.38 | 3.42 | 26.76 | 58.36 | 15.62 | 46.39 |
| 1995 | 22.19 | 13.46 | 9.14 | 1.23 | 26.76 | 89.51 | 23.95 | 47.37 |
| 1996 | 20.53 | 13.46 | 4.93 | 0.66 | 26.76 | 94.60 | 25.31 | 46.50 |
| 1997 | 18.38 | | | | 26.76 | 100.00 | 26.76 | 45.14 |
| 1998 | 18.38 | | | | 26.76 | 100.00 | 26.76 | 45.14 |
| 1999 | 18.38 | | | | 26.76 | 100.00 | 26.76 | 45.14 |
| 2000 | 18.38 | | | | 26.76 | 100.00 | 26.76 | 45.14 |
| 2001 | 18.38 | | | | 26.76 | 100.00 | 26.76 | 45.14 |

Tables 208-25A and 25B summarize the total consumer cost and weight of the occupant protection systems installed in light trucks for model years 1966-2001. The summary calculations are a compilation of the total cost and weight per vehicle of safety belts, driver air bags, dual air bags, and on/off switches. An explanation of the tables follows:

- Column (a): The total cost of safety belts was obtained from Tables 208-19A thru E, with its corresponding total weight obtained from Tables 208-20A thru E.
- Column (b): The unit cost/weight of driver air bags was obtained from Table 208-21.
- Column (c): The percent of light trucks that had driver air bags in a specific model year was obtained from NHTSA crash data files and Polk registration files.
- Column (d): The total cost/weight per vehicle for driver air bags was calculated by multiplying column (b) by column (c).
- Column (e): The unit cost/weight of dual air bags was obtained from Table 208-21.
- Column (f): The percent of light trucks that had dual air bags in a specific model year was obtained from NHTSA crash data files and Polk registration files.
- Column (g): The total cost/weight per vehicle for dual air bags was calculated by multiplying column (e) by column (f).
- Column (h): The unit cost/weight of passenger side on/off switches was obtained from Table 208-23.
- Column (i): The percent of light trucks that had passenger side on/off switches in a specific model year was obtained from NHTSA crash data files and Polk registration files.
- Column (j): The total cost/weight per vehicle for passenger side on/off switches was calculated by multiplying column (h) by column (i).
- Column (k): The total cost/weight per vehicle of FMSVSS 208/209/210 in light trucks was calculated by adding column (a) plus column (d) plus column (g) plus column (j).

***TABLE 208-25A***
***SUMMARY TABLE FOR THE TOTAL CONSUMER COST***
***ATTRIBUTABLE TO FMVSS 208/209/210***
***IN LIGHT TRUCKS (LTVs) BY MODEL YEAR***

| MODEL YEAR | SAFETY BELTS | AIR BAGS | | | | | | ON/OFF SWITCHES | | | FMVSS 208-210 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DRIVER | | | DUAL | | | | | | |
| | (a) TOTAL COST | (b) UNIT COST | (c) % OF LTVS | (d) TOTAL COST PER LTV | (e) UNIT COST | (f) % OF LTVS | (g) TOTAL COST PER LTV | (h) UNIT COST | (i) % OF LTVS | (j) TOTAL COST PER LTV | (k) TOTAL COST PER LTV |
| 1966-67 | $ 56.55 | | | | | | | | | | $ 56.55 |
| 1968 | $ 56.55 | | | | | | | | | | $ 56.55 |
| 1969 | $ 56.61 | | | | | | | | | | $ 56.61 |
| 1970 | $ 56.63 | | | | | | | | | | $ 56.63 |
| 1971 | $ 56.64 | | | | | | | | | | $ 56.64 |
| 1972 | $ 83.21 | | | | | | | | | | $ 83.21 |
| 1973 | $ 83.21 | | | | | | | | | | $ 83.21 |
| 1974 | $ 84.39 | | | | | | | | | | $ 84.39 |
| 1975 | $ 84.47 | | | | | | | | | | $ 84.47 |
| 1976 | $ 84.50 | | | | | | | | | | $ 84.50 |
| 1977 | $ 94.82 | | | | | | | | | | $ 94.82 |
| 1978 | $ 94.83 | | | | | | | | | | $ 94.83 |
| 1979 | $ 94.82 | | | | | | | | | | $ 94.82 |
| 1980 | $ 95.04 | | | | | | | | | | $ 95.04 |
| 1981 | $ 95.14 | | | | | | | | | | $ 95.14 |
| 1982 | $ 95.14 | | | | | | | | | | $ 95.14 |
| 1983 | $ 95.14 | | | | | | | | | | $ 95.14 |
| 1984 | $ 95.14 | | | | | | | | | | $ 95.14 |
| 1985 | $ 95.14 | | | | | | | | | | $ 95.14 |
| 1986 | $ 95.14 | | | | | | | | | | $ 95.14 |
| 1987 | $106.63 | | | | | | | | | | $106.63 |
| 1988 | $106.72 | | | | | | | | | | $106.72 |
| 1989 | $107.32 | | | | | | | | | | $107.32 |
| 1990 | $107.49 | | | | | | | | | | $107.49 |
| 1991 | $107.89 | 265.78 | 3.08 | $ 8.19 | | | | | | | $116.08 |
| 1992 | $111.90 | 265.78 | 14.75 | $ 39.20 | | | | | | | $151.10 |
| 1993 | $111.90 | 265.78 | 19.30 | $ 51.30 | | | | | | | $163.20 |
| 1994 | $111.90 | 265.78 | 26.78 | $ 71.18 | 383.75 | 7.56 | $ 29.01 | | | | $212.09 |
| 1995 | $137.57 | 265.78 | 66.30 | $176.21 | 383.75 | 13.58 | $ 52.11 | | | | $365.89 |
| 1996 | $137.57 | 265.78 | 55.56 | $147.67 | 383.75 | 37.69 | $144.64 | 28.12 | 2.80 | $ 0.79 | $430.67 |
| 1997 | $137.57 | 265.78 | 22.25 | $ 59.14 | 383.75 | 71.34 | $273.77 | 28.12 | 22.14 | $ 6.23 | $476.71` |
| 1998 | $137.57 | | | | 383.75 | 97.84 | $375.46 | 28.12 | 36.64 | $10.30 | $523.33 |
| 1999 | $137.57 | | | | 383.75 | 98.61 | $378.42 | 28.12 | 36.52 | $10.27 | $526.26 |
| 2000 | $137.57 | | | | 383.75 | 99.08 | $380.22 | 28.12 | 34.23 | $ 9.63 | $527.42 |
| 2001 | $137.57 | | | | 383.75 | 99.68 | $382.52 | 28.12 | 31.10 | $ 8.75 | $528.84 |

***TABLE 208-25A***
***SUMMARY TABLE FOR THE TOTAL WEIGHT***
***ATTRIBUTABLE TO FMVSS 208/209/210***
***IN LIGHT TRUCKS (LTVs) BY MODEL YEAR***

| | SAFETY BELTS | AIR BAGS | | | | | | ON/OFF SWITCHES | | | FMVSS 208-210 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DRIVER | | | DUAL | | | | | | |
| MODEL YEAR | (a) TOTAL WEIGHT | (b) UNIT WEIGHT | (c) % OF LTVS | (d) TOTAL WEIGHT PER LTV | (e) UNIT WEIGHT | (f) % OF LTVS | (g) TOTAL WEIGHT PER LTV | (h) UNIT WEIGHT | (i) % OF LTVS | (j) TOTAL WEIGHT PER LTV | (k) TOTAL WEIGHT PER LTV |
| 1966-67 | 5.59 | | | | | | | | | | 5.59 |
| 1968 | 5.59 | | | | | | | | | | 5.59 |
| 1969 | 5.60 | | | | | | | | | | 5.60 |
| 1970 | 5.60 | | | | | | | | | | 5.60 |
| 1971 | 5.61 | | | | | | | | | | 5.61 |
| 1972 | 10.45 | | | | | | | | | | 10.45 |
| 1973 | 10.45 | | | | | | | | | | 10.45 |
| 1974 | 10.70 | | | | | | | | | | 10.70 |
| 1975 | 10.72 | | | | | | | | | | 10.72 |
| 1976 | 10.73 | | | | | | | | | | 10.73 |
| 1977 | 12.00 | | | | | | | | | | 12.00 |
| 1978 | 12.00 | | | | | | | | | | 12.00 |
| 1979 | 12.00 | | | | | | | | | | 12.00 |
| 1980 | 12.04 | | | | | | | | | | 12.04 |
| 1981 | 12.07 | | | | | | | | | | 12.07 |
| 1982 | 12.07 | | | | | | | | | | 12.07 |
| 1983 | 12.07 | | | | | | | | | | 12.07 |
| 1984 | 12.07 | | | | | | | | | | 12.07 |
| 1985 | 12.07 | | | | | | | | | | 12.07 |
| 1986 | 12.07 | | | | | | | | | | 12.07 |
| 1987 | 13.33 | | | | | | | | | | 13.33 |
| 1988 | 13.36 | | | | | | | | | | 13.36 |
| 1989 | 13.54 | | | | | | | | | | 13.54 |
| 1990 | 13.59 | | | | | | | | | | 13.59 |
| 1991 | 13.71 | 14.31 | 3.08 | 0.44 | | | | | | | 14.15 |
| 1992 | 14.91 | 14.31 | 14.75 | 2.11 | | | | | | | 17.02 |
| 1993 | 14.91 | 14.31 | 19.30 | 2.76 | | | | | | | 17.67 |
| 1994 | 14.91 | 14.31 | 26.78 | 3.83 | 26.48 | 7.56 | 2.00 | | | | 20.74 |
| 1995 | 18.41 | 14.31 | 66.30 | 9.49 | 26.48 | 13.58 | 3.60 | | | | 31.50 |
| 1996 | 18.41 | 14.31 | 55.56 | 7.95 | 26.48 | 37.69 | 9.98 | 0.65 | 2.80 | 0.02 | 36.36 |
| 1997 | 18.41 | 14.31 | 22.25 | 3.18 | 26.48 | 71.34 | 18.89 | 0.65 | 22.14 | 0.14 | 40.62 |
| 1998 | 18.41 | | | | 26.48 | 97.84 | 25.91 | 0.65 | 36.64 | 0.24 | 44.56 |
| 1999 | 18.41 | | | | 26.48 | 98.61 | 26.11 | 0.65 | 36.52 | 0.24 | 44.76 |
| 2000 | 18.41 | | | | 26.48 | 99.08 | 26.24 | 0.65 | 34.23 | 0.22 | 44.87 |
| 2001 | 18.41 | | | | 26.48 | 99.68 | 26.40 | 0.65 | 31.10 | 0.20 | 45.01 |

***FMVSS 211*** **–** [Does not currently exist]

***FMVSS 212 – WINDSHIELD MOUNTING***

FMVSS 212 became effective on January 1, 1970 (passenger cars) and September 1, 1978 (multipurpose passenger vehicles, trucks, buses) and establishes windshield retention requirements for motor vehicles during crashes. The purpose of this standard is to reduce crash injuries and fatalities by providing for retention of the vehicle windshield during a crash, thereby utilizing fully the penetration-resistance and injury-avoidance properties of the windshield glazing material and preventing the ejection of occupants from the vehicle. This standard applies to passenger cars, multipurpose passenger vehicles, trucks, and buses having a GVWR of 10,000 pounds or less. However, it does not apply to forward control vehicles, walk-in van-type vehicles, or to open-body type vehicles with fold-down or removable windshields.[137]

The standard requires that a vehicle traveling longitudinally forward at any speed up to and including 30 miles per hour impacts a fixed collision barrier that is perpendicular to the line of travel of the vehicle, the windshield mounting of the vehicle shall retain not less than the minimum portion of the windshield periphery specified in the following:

- Vehicles equipped with automatic restraint systems shall retain not less than 50 percent of the portion of the windshield periphery on each side of the vehicle longitudinal centerline.
- Vehicles not equipped with automatic restraint systems shall retain not less than 75 percent of the windshield periphery.

Before 1963, windshields were sealed inside a rubber gasket or molding that in turn was attached and sealed to the frame. It was a relatively loose attachment. In low speed impacts, the rubber gasket had some energy absorbing "give". At higher speeds, the gasket could partly or completely tear away from the frame, beginning during the initial vehicle collision and deformation and continuing as occupants impacted the windshield.

Bonding of the windshield directly to its frame with adhesives gradually (1963-1985) superseded the earlier method of first enclosing the windshield in a rubber gasket and then attaching the gasket to the frame. Adhesive bonding resembles HPR windshields in that it is primarily a technical advance, the synthesis of resilient sealing materials, than an addition of hardware to the car. The new bonding materials allowed the elimination of rubber gaskets in return for an inexpensive sealant and a minor increase in labor costs. Thus, the shift to adhesive bonding began in some vehicles well before anybody anticipated FMVSS 212, but rubber gaskets persisted in other make-models for quite a few years after the standard. Although rubber gaskets are generally a looser installation than adhesive bonding, they can readily be designed to meet FMVSS 212. Each installation method has advantages, and the gradual shift from one to the other was motivated by various factors, sometimes including FMVSS 212. However, vehicle manufacturers could meet the standard with either method.

Pickup trucks, vans, and SUVs also kept rubber gaskets during most of the 1970's, and in many cases after FMVSS 212 was extended to light trucks (September 1, 1978). Manufacturers may

[137] Legal citation: *49 CFR 571.212* (2004).

have been especially concerned that operation on rough roads could accelerate deterioration of adhesive bonds, as compared to rubber gaskets. Adhesive bonding was gradually phased in from 1978 to approximately 1985. The final transition to adhesive bonding may have been spurred by anticipation of safety benefits, cost advantages with the second-generation sealants, and a 1976 rule allowing NHTSA to conduct the FMVSS 212 test in a wider range of temperatures, from 15 to 110 degrees Fahrenheit.

A 1980 study compared rubber gaskets to adhesive bonding in one passenger car and three light trucks.[138] Table 212-1 shows the arithmetic average weight and consumer cost for the windshield mountings.

***TABLE 212-1***
***AVERAGE WEIGHT AND CONSUMER COST***
***FOR WINDSHIELD MOUNTINGS IN PASSENGER VEHICLES***

| MATERIAL | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| Rubber Gasket | 5.92 | $35.51 |
| Adhesive Bonding | 0.69 | $12.61 |

The substantial decrease in weight and consumer cost, when using adhesive bonding, cannot be attributed to the standard. Manufacturers could have moved to the use of the less costly adhesive bonding even without the standard. Furthermore, adhesive bonding was in common use on windshields long before the standard was proposed and rubber gaskets continued to be used for some years after the standard took effect.

Ford Motor Company in comments on the NHTSA evaluation report of FMVSS 205/212 questioned whether the preceding cost analysis realistically accounted for the full cost of adhesive bonding. Ford stated "to achieve an acceptable appearance with adhesive bonding, interior and exterior moldings must be added to hide the bond area. In addition, a blackout paint band is generally added to the periphery of the glazing to block vision of the bond area and the underside of the trim moldings. As a result, adhesive bonding results in a cost and weight penalty, except on some luxury models and convertibles that have interior and exterior trim moldings installed for other reasons."[139]

## *FMVSS 213 – CHILD RESTRAINT SYSTEMS*

FMVSS 213 became effective on April 1, 1971 and specifies requirements for child restraint systems used in motor vehicles and aircraft. The purpose of this standard is to reduce the number of children killed or injured in motor vehicle crashes and in aircraft. This standard applies primarily to equipment that may be purchased for use in a vehicle, rather than to the vehicle itself.[140] No cost studies of this standard have been done, and none are planned by the agency.

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[138] McLean, DOT HS 805 602:33-40 (1980).

[139] Ford Motor Company Letter, *Request for Comment on Evaluation Report on Federal Motor Vehicle Safety Standards 205/212*, July 23, 1985.

[140] Legal citation: *49 CFR 571.213* (2004).

## *FMVSS 214 – SIDE IMPACT PROTECTION*

FMVSS 214 became effective on January 1, 1973 and specified performance requirements for protection of occupants in side impact crashes. The purpose of this standard is to reduce the risk of serious and fatal injury to occupants of passenger cars, multipurpose passenger vehicles, trucks, and buses in side impact crashes by:

- specifying vehicle crashworthiness requirements in terms of accelerations measured on anthropomorphic dummies in test crashes,
- specifying strength requirements for side doors, and
- other means[141]

### *Passenger Car Studies*

***<u>Side Door Beams</u>***. FMVSS 214 originally specified performance requirements, effective January 1, 1973, for each side door in a passenger car to mitigate occupant injuries in side impacts by reducing the extent to which the side structure of a car is pushed into the passenger compartment during a side impact. The standard initially specified three-stage static crush test (initial, intermediate, and peak) to measure the crush resistance of the side doors, and required each door to resist crush forces that are applied by a piston pressing a 12-inch diameter steel cylinder inward against the door's outside surface in a laboratory test.

Early studies concerning side impact protection demonstrated that in fatal side collisions most occupants die because of the door structures collapsing inward on them. The static crush tests were intended to ensure that there were strong door structures to limit this intrusion. Under the peak crush test, the vehicle door may not be deformed more than 18 inches inward when the door is subjected to a force of 7,000 pounds or two times the curb weight of the vehicle, whichever is less.[142] The standard, however, does not attempt to regulate directly the level of crash forces on an occupant who strikes or is struck by the car's interior during a side impact crash. Since the standard became effective on January 1, 1973, vehicle manufacturers have generally chosen to meet its performance requirements by reinforcing the side doors with metal beams. The added side door beam helps to make a pole, tree, guardrail, or other fixed object slide by the occupant's position, thus reducing intrusion into the passenger compartment.

Three cost and weight analyses were performed on side door beams and body pillars from twenty-three make-model two-door passenger cars and fourteen make-model four-door passenger cars representing implementation and trend systems from 1973 to 1981.[143,144,145]

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[141] Legal citation: *49 CFR 571.214* (2004).

[142] The standard was amended on March 17, 1980 to add a new door crush test (a 3-stage crush test) allowing the seats to be installed during the test. In this test, the peak force is 3.5 times the curb weight or 12,000 pounds, whichever is smaller.

[143] McLean, DOT HS 803 871:22-37 (1978).

[144] Harvey, M.R. and Eckel, C.E., *Cost Evaluation for Nine Federal Motor Vehicle Safety Standards, Task IX: Side Door Strength, Identification and Cost Evaluation of Design and Manufacturing Changes*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, November 1979. (DOT HS 805 450).

[145] Gladstone, DOT HS 806 257:4-1 thru 4-4 (1982).

(Changes in the body pillars discussed in the October 1978 study were a result of model redesign and not directly related to the standard, therefore, the weight and consumer cost for them were not included in the side door strength calculations.) Table 214-1 shows the sales-weighted average weight and consumer cost for the side door beams in two- and four-door passenger cars.

***TABLE 214-1***
***AVERAGE WEIGHT AND CONSUMER COST PER VEHICLE OF SIDE DOOR BEAMS IN TWO- AND FOUR-DOOR PASSENGER CARS***

| MODEL YEAR | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| ***Two-Door*** | | |
| 1973 | 33.39 | $49.50 |
| 1975-1978 | 23.90 | $38.45 |
| 1979-1981 | 28.17 | $45.02 |
| ***Four-Door*** | | |
| 1973 | 43.53 | $88.55 |
| 1975-1979 | 26.60 | $73.02 |
| 1979-1981 | 23.98 | $52.76 |

For model years 1975-1979, some design refinement had occurred with the door beams for the four-door models, with more refinement occurring with the 1980 models. All through the late 1970's and early 1980's, downsizing was occurring and vehicle designs were incorporating design features into the vehicle bodies to cope with requirements and relying less on just door beams, consequently, door beams were becoming lighter and less costly.

In the four-door passenger cars, the refinements and downsizing resulted in a 45 percent decrease in weight from 1973 to 1979-1981, with the 1979-1981 weight less than the weight for the two-door models. The cost for the four-door models decreased 40 percent in the same time period; however, the 1979-1981 costs were still greater than the two-door models. The costs and weights of the 1975-1979 models are lower than in 1973 and higher than in 1979-1981.

While the two-door models saw a decrease of 28 percent in weight and 22 percent in cost from 1973 to 1975-1978, there was in increase of 18 percent in weight and 17 percent in cost from 1975-1978 to 1979-1981. This may be an artifact of the specific make-models selected for the 1975-1978 study. Notwithstanding this exception, there appears to be a general downward trend from 1972 to 1979-1981 in both the two- and four-door passenger cars.

Assuming that the average consumer cost decreased at a linear rate from 1973 to 1979-81 and leveled off after that, the average weight and consumer cost of the side impact protection attributable to the static requirements of the standard in any given model year are shown in Table 214-2.

| TABLE 214-2<br>AVERAGE WEIGHT AND CONSUMER COST<br>OF SIDE IMPACT PROTECTION<br>ATTRIBUTABLE TO STATIC REQUIREMENTS<br>IN PASSENGER CARS BY MODEL YEAR | | |
|---|---|---|
| MODEL YEAR | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
| ***Two-Door*** | | |
| 1973 | 33.39 | $49.50 |
| 1974 | 32.52 | $48.75 |
| 1975 | 31.65 | $48.01 |
| 1976 | 30.78 | $47.26 |
| 1977 | 29.91 | $46.51 |
| 1978 | 29.04 | $45.77 |
| 1979-2001 | 28.17 | $45.02 |
| ***Four-Door*** | | |
| 1973 | 43.53 | $88.55 |
| 1974 | 40.27 | $82.59 |
| 1975 | 37.01 | $76.62 |
| 1976 | 33.76 | $70.66 |
| 1977 | 30.50 | $64.69 |
| 1978 | 27.24 | $58.73 |
| 1979-2001 | 23.98 | $52.76 |

***FMVSS 214 Upgrade – Dynamic Test Requirement***. NHTSA's analysis of real-world crash data showed that strengthening the side doors with metal beams was indeed effective in single car side impacts but had little effect on reducing fatalities in multi-car crashes. Consequently, FMVSS 214 was amended in October 1990 to upgrade its test procedures and performance requirements for passenger cars.

The amendments required that each passenger car, in addition to the static crush performance requirements, must protect its occupants in a full-scale dynamic crash test in which the passenger car is struck on either side by a moving deformable barrier simulating another vehicle. Instrumented test dummies are positioned in the target car to measure the potential for injuries to an occupant's thorax and pelvis. Accelerations at the dummy's upper rib, lower rib, and lower spine are measured, and a Thoracic Trauma Index, TTI(d) is calculated from these accelerations. Four-door passenger cars must score 85 or less, while two-door passenger cars must score 90 or less. In addition, the pelvis acceleration must be less than 130 g's. However, the safety benefits are mainly from chest injury reduction. The requirements were phased in with 10% of new passenger cars in model year 1994, 25% in 1995, 40% in 1996, and 100% in 1997 (i.e., after September 1, 1996).

Manufacturers initially relied on one or more of the following strategies to ensure their vehicles met the dynamic test:

- No changes necessary to meet the dynamic test
- Major structure changes applied to the A-pillars, the front and rear door or rear panel (two-door models), the B-pillar, the C-pillar, or other components

- Minor structure changes such as additional or strengthened door beams and some additional steel plates
- Padding added to inside of door skin or inner door structure

NHTSA sent information requests to vehicle manufacturers asking them to identify any components that were added or redesigned to meet the dynamic performance requirements. The requests were reviewed to determine which alternative the vehicle manufacturers chose, and it is our belief that an estimated 56% of the vehicles certified to comply with this requirement had substantial structural reinforcement changes and added padding, 21% had minor structural changes and added padding, 6% just added padding to comply, while 17% of the vehicles had no structural changes or added padding.[146] Of course, all vehicles continued to have side door beams and other equipment previously installed to meet the original, static requirement of FMVSS 214.

Since our teardown cost analysis was limited to a sample of vehicles that all had major structure changes, a simple average of these teardowns would be a substantial overestimate of the cost of FMVSS 214. Therefore, to calculate a realistic cost of the standard, it was necessary to generate estimates for the vehicles that did not have major structure changes, append those estimates to the contractor's costs, and average the results.

Here is a more detailed discussion of the cost implications of the alternative methods to secure compliance with FMVSS 214.

- No Structural Changes or Padding. Some vehicles did not have to incorporate any structural changes or added padding to their vehicles to meet the dynamic standard. Of course, even in these vehicles, the equipment used to meet the static requirement would continue to be in place. Therefore, the full cost and weight of FMVSS 214 would be equal to the weight and consumer cost from the study of the two- and four-door passenger cars from 1979-1981. These results for these static requirements are shown in Table 214-3.

***TABLE 214-3***
***AVERAGE WEIGHT AND CONSUMER COST***
***OF FMVSS 214 IN TWO- AND FOUR-DOOR***
***PASSENGER CARS THAT REMAINED UNCHANGED***

| CAR TYPE | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| Two-Door | 28.17 | $45.02 |
| Four-Door | 23.98 | $52.76 |

- Major Structure Changes with Padding. Substantial structural changes were applied to the A-pillars, the front and rear door or rear panel (two-door models), the B-pillar, and the C-pillar. The changes to the pillars were to help support the loads on the door hinges and latches and provide additional structural rigidity so that impact loads could be transferred to the rest of the vehicle body without buckling. In some cases, a dashboard

[146] Kahane, C.J., *Evaluation of FMVSS 214 Side Impact Protection, Dynamic Performance Requirement,* Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, October 1999. (DOT HS 809 004:141-142).

level cross-member between left and right A-pillars was added. Floor cross-members linking the left and right B-pillars were added or strengthened and the same was done for the C-pillars. Changes to the doors and rear panels (two-door models) typically consisted of additional door beams and energy absorbing designs in the inner door structure. Three cost and weight analyses comprised two make-model two-door passenger cars and seven make-model four-door passenger cars representing systems from 1994-1998.[147,148,149] These contractor reports attempted to estimate separately the cost and weight of equipment needed only to meet the dynamic standard versus equipment needed to meet the static requirement. However, we have added these costs and weights to produce a single, more reliable estimate of the total cost and weight of FMVSS 214. Table 214-4 shows the arithmetic average total weight and consumer cost of the side impact protection system (dynamic and static requirements) in two- and four-door passenger cars.

***TABLE 214-4***
***AVERAGE WEIGHT AND CONSUMER COST***
***OF FMVSS 214 (DYNAMIC PLUS STATIC REQUIREMENTS)***
***IN TWO- AND FOUR-DOOR PASSENGER CARS***
***WITH MAJOR STRUCTURE CHANGES***

| CAR TYPE | WEIGHT IN POUNDS | CONSUMER COST $2002 |
|---|---|---|
| Two-Door | 70.33 | $222.58 |
| Four-Door | 90.59 | $271.58 |

- Cost and Weight of Padding. Padding was typically affixed to the inside of the door skin or inner door structure. The foam padding was strategically placed with one piece to protect the upper and lower rib cage of the occupant and other piece located to protect the pelvis. As stated above, the contractor did not tear down any vehicles whose modifications were limited to padding. Therefore, we reviewed the contractor's nine teardowns of vehicles that received padding plus major structure and isolated the costs specifically related to padding. Next, we compared the padding in these vehicles to padding in vehicles that did not receive major structure, and found them quite similar in size and shape. The component cost summaries, with corresponding photographs from the sample vehicles in the teardown cost studies, were analyzed and the padding information was extracted. The arithmetic average for the padding incorporated into the front door, rear door, and in some cases the B pillar was calculated from the three cost and weight analyses for the 1994-1998 model year passenger cars. Table 214-5 shows the average weight and consumer cost of just the padding in the two- and four-door passenger cars.

[147] Fladmark, DOT HS 809 800 (1996).
[148] Fladmark, DOT HS 809 803 (1997).
[149] Fladmark, DOT HS 809 805:Section 6 (1998).

| TABLE 214-5<br>AVERAGE WEIGHT AND CONSUMER COST<br>OF PADDING IN TWO- AND FOUR-DOOR PASSENGER CARS | | |
|---|---|---|
| CAR TYPE | WEIGHT IN POUNDS | CONSUMER COST $2002 |
| Two-Door | 0.91 | $ 9.85 |
| Four-Door | 1.27 | $13.94 |

- Cost and Weight of Minor Structure Changes. Minor structure changes usually consisted of additional or strengthened door beams and some additional steel plates added to strengthen areas on the pillars around the door latches and hinges. As stated above, teardowns were limited to vehicles with major structure changes. In order to estimate the cost of new structure in the 21 percent of vehicles that had only minor changes, we needed to: (1) establish some kind of ratio of the cost of "minor" to "major" structural changes; (2) isolate in the teardown sample the FMVSS 214 costs specifically associated with major structural changes, as opposed to, padding or continuation of the equipment needed to meet the static requirement; and (3) multiply the ratio of "minor" to "major" structure by the cost of major structure.

    1) In the seven teardown vehicles for which we also had clear diagrams or enumerations of the new structure, we found an average of 4.43 relatively massive and costly new structural components per vehicle, such as large-size pillar stiffeners, cross members, beams, and sill reinforcements. Information requests to the manufacturers furnished detailed diagrams or enumerations of new structure in six make-models that we described above as receiving only "minor" structure. For the most part, these new structures were limited to a few very low-cost items such as small, localized beams and sills, but some models received one or even two massive and costly components. In all, these six make-models received an average of 0.83 massive and costly components per vehicle. Therefore, we estimate that the cost ratio of "minor" to "major" structure must have been close to 0.83/4.43 = 19 percent.

    2) The top section of Table 214-6 shows the average cost and weight of major new structure in the teardown vehicles. From the total cost or weight of FMVSS 214 (e.g., $271.58 in four-door passenger cars from Table 214-4), deduct the cost or weight of padding (e.g., $13.94 from Table 214-5) and the cost or weight of the existing structures used for meeting the static requirements of FMVSS 214 (e.g., $52.76 from Table 214-3). Whatever remains (e.g., $204.88 in the four-door passenger cars) is the cost of the added structures.

    3) Multiply the cost or weight of added "major" structures in the teardown sample by 19 percent to obtain an estimate of the cost or weight of added "minor" structures, as shown in the lower section of Table 214-6.

| | TABLE 214-6<br>DETERMINATION OF THE<br>AVERAGE WEIGHT AND CONSUMER COST<br>OF MINOR STRUCTURE CHANGES<br>IN TWO- AND FOUR-DOOR PASSENGER CARS | | | | |
|---|---|---|---|---|---|
| | CATEGORY | TWO-DOOR | | FOUR-DOOR | |
| | | WEIGHT | COST | WEIGHT | COST |
| | 214 Teardown Studies | 70.33 | $222.58 | 90.59 | $271.58 |
| - | Padding | 0.91 | $ 9.85 | 1.27 | $ 13.94 |
| - | Static Requirements | 28.17 | $ 45.02 | 23.98 | $ 52.76 |
| = | Major Structure | 41.25 | $167.71 | 65.34 | $204.88 |
| * | Percentage Change | 0.19 | 0.19 | 0.19 | 0.19 |
| = | Minor Structure | 7.84 | $ 31.86 | 12.41 | $ 38.93 |

Table 214-7 shows the average weight and consumer cost of the side impact protection system in two- and four-door passenger cars, broken out by the changes incorporated by the vehicle manufacturers. It is necessary to <u>add</u> the cost of static protection, padding, and or minor structures in the vehicles that have more than one of those items.

| TABLE 214-7<br>AVERAGE WEIGHT AND CONSUMER COST<br>OF FMVSS 214 (DYNAMIC PLUS STATIC REQUIREMENTS)<br>IN ALL PASSENGER CARS | | | |
|---|---|---|---|
| CHANGED TO MEET DYNAMIC STANDARD | WEIGHT IN POUNDS | CONSUMER COST ($2002) | PERCENT OF CARS |
| ***Two-Door*** | | | |
| Major Structure Changes + Padding + Static | 70.33 | $222.58 | 56 |
| Minor Structure Changes + Padding + Static | 36.92 | $ 86.73 | 21 |
| Padding + Static | 29.08 | $ 54.87 | 6 |
| Static Only | 28.17 | $ 45.02 | 17 |
| WEIGHTED AVERAGE | 53.67 | $153.80 | |
| ***Four-Door*** | | | |
| Major Structure Changes + Padding + Static | 90.59 | $271.58 | 56 |
| Minor Structure Changes + Padding + Static | 37.66 | $105.63 | 21 |
| Padding + Static | 25.25 | $ 66.70 | 6 |
| Static Only | 23.98 | $ 52.76 | 17 |
| WEIGHTED AVERAGE | 64.23 | $187.24 | |

## ***<u>Summary Tables for FMVSS 214</u>***

Tables 214-8A and 8B summarize the total weight and cost of the side impact protection systems installed in passenger cars for model years 1969-2001. That includes the cost of side door beams installed by manufacturers voluntarily before the effective date of January 1, 1973. Even though these installations predated FMVSS 214, their weights and costs should be attributed to the standard because installation of side door beams was in response to, or in anticipation of, the regulatory requirements of this standard. NHTSA announced its intention to regulate side door strength with an ANPRM in October 1968, followed by several NPRMs. The Final Rule, issued in October 1970, became effective on January 1, 1973. The summary calculations are a compilation of the total cost and weight per vehicle of static and dynamic requirements in two- and four-door passenger cars. An explanation of the tables follows:

- Column (a): The unit cost/weight of side impact protection for two-door passenger cars were determined as follows:
  - Model Years 1969-1993 – Cost/Weight Attributable to Static Requirements from Table 214-2
  - Model Years 1994-1996 – Phase in of Dynamic Requirements
    - 90% * 1993 Unit Cost/Weight + 10% * 1997 Unit Cost/Weight = 1994 Unit Cost/Weight
    - 75% * 1993 Unit Cost/Weight + 25% * 1997 Unit Cost/Weight = 1995 Unit Cost/Weight
    - 60% * 1993 Unit Cost/Weight + 40% * 1997 Unit Cost/Weight = 1996 Unit Cost/Weight
  - Model Years 1997-2001 – Cost/Weight Attributable to Dynamic Requirements from Table 214-7

- Column (b): The percent of two-door passenger cars in a specific model year was obtained from NHTSA crash data files and Polk registration files. The percents for model years 1969-1973 were determined by multiplying the proportion of two-door passenger cars that met FMVSS 214 in 1969-1973 by the percent of two-door passenger cars in 1969-1973.

- Column (c): The unit cost/weight of side impact protection for four-door passenger cars were determined as follows:
  - Model Years 1969-1993 – Cost/Weight Attributable to Static Requirements from Table 214-2
  - Model Years 1994-1996 – Phase in of Dynamic Requirements
    - 90% * 1993 Unit Cost/Weight + 10% * 1997 Unit Cost/Weight = 1994 Unit Cost/Weight
    - 75% * 1993 Unit Cost/Weight + 25% * 1997 Unit Cost/Weight = 1995 Unit Cost/Weight
    - 60% * 1993 Unit Cost/Weight + 40% * 1997 Unit Cost/Weight = 1996 Unit Cost/Weight
  - Model Years 1997-2001 – Cost/Weight Attributable to Dynamic Requirements from Table 214-7

- Column (d): The percent of four-door passenger cars in a specific model year was obtained from NHTSA crash data files and Polk registration files. The percents for model years 1969-1973 were determined by multiplying the proportion of four-door passenger cars that met FMVSS 214 in 1969-1973 by the percent of four-door passenger cars in 1969-1973.

- Column (e): The total cost/weight per vehicle of FMVSS 214 in passenger cars = (a * b) + (c *d)

| *TABLE 214-8A*<br>*SUMMARY TABLE FOR THE TOTAL CONSUMER COST*<br>*OF SIDE IMPACT PROTECTION*<br>*ATTRIBUTABLE TO FMVSS 214*<br>*PER PASSENGER CAR BY MODEL YEAR* | | | | | |
|---|---|---|---|---|---|
| | TWO-DOOR | | FOUR-DOOR | | |
| | (a) | (b) | (c) | (d) | (e) |
| MODEL YEAR | UNIT COST | % OF CARS | UNIT COST | % OF CARS | TOTAL COST PER VEHICLE |
| 1969 | $ 49.50 | 9.32 | $ 88.55 | 7.68 | $ 11.41 |
| 1970 | $ 49.50 | 20.28 | $ 88.55 | 14.72 | $ 23.07 |
| 1971 | $ 49.50 | 25.71 | $ 88.55 | 18.29 | $ 28.92 |
| 1972 | $ 49.50 | 27.51 | $ 88.55 | 21.49 | $ 32.65 |
| 1973 | $ 49.50 | 49.12 | $ 88.55 | 35.88 | $ 56.09 |
| 1974 | $ 48.75 | 64.32 | $ 82.59 | 35.68 | $ 60.82 |
| 1975 | $ 48.01 | 61.32 | $ 76.62 | 38.68 | $ 59.08 |
| 1976 | $ 47.26 | 60.91 | $ 70.66 | 39.09 | $ 56.41 |
| 1977 | $ 46.51 | 59.15 | $ 64.69 | 40.85 | $ 53.94 |
| 1978 | $ 45.77 | 58.51 | $ 58.73 | 41.49 | $ 51.15 |
| 1979 | $ 45.02 | 59.96 | $ 52.76 | 40.04 | $ 48.12 |
| 1980 | $ 45.02 | 58.06 | $ 52.76 | 41.94 | $ 48.27 |
| 1981 | $ 45.02 | 49.72 | $ 52.76 | 50.28 | $ 48.91 |
| 1982 | $ 45.02 | 45.83 | $ 52.76 | 54.17 | $ 49.21 |
| 1983 | $ 45.02 | 41.07 | $ 52.76 | 58.93 | $ 49.58 |
| 1984 | $ 45.02 | 41.56 | $ 52.76 | 58.44 | $ 49.54 |
| 1985 | $ 45.02 | 38.59 | $ 52.76 | 61.41 | $ 49.77 |
| 1986 | $ 45.02 | 37.42 | $ 52.76 | 62.58 | $ 49.86 |
| 1987 | $ 45.02 | 34.93 | $ 52.76 | 65.07 | $ 50.06 |
| 1988 | $ 45.02 | 37.78 | $ 52.76 | 62.22 | $ 49.84 |
| 1989 | $ 45.02 | 38.32 | $ 52.76 | 61.68 | $ 49.79 |
| 1990 | $ 45.02 | 32.97 | $ 52.76 | 67.03 | $ 50.21 |
| 1991 | $ 45.02 | 31.77 | $ 52.76 | 68.23 | $ 50.30 |
| 1992 | $ 45.02 | 27.78 | $ 52.76 | 72.22 | $ 50.61 |
| 1993 | $ 45.02 | 28.35 | $ 52.76 | 71.65 | $ 50.57 |
| 1994 | $ 55.90 | 27.95 | $ 66.21 | 72.05 | $ 63.31 |
| 1995 | $ 72.22 | 26.03 | $ 86.38 | 73.97 | $ 82.69 |
| 1996 | $ 88.53 | 23.50 | $106.55 | 76.50 | $102.32 |
| 1997 | $153.80 | 21.57 | $187.24 | 78.43 | $180.03 |
| 1998 | $153.80 | 19.61 | $187.24 | 80.39 | $180.68 |
| 1999 | $153.80 | 19.73 | $187.24 | 80.27 | $180.64 |
| 2000 | $153.80 | 19.08 | $187.24 | 80.92 | $180.86 |
| 2001 | $153.80 | 19.99 | $187.24 | 80.01 | $180.56 |

| TABLE 214-8B<br>SUMMARY TABLE FOR THE TOTAL WEIGHT<br>OF SIDE IMPACT PROTECTION<br>ATTRIBUTABLE TO FMVSS 214<br>PER PASSENGER CAR BY MODEL YEAR | | | | | |
|---|---|---|---|---|---|
| | TWO-DOOR | | FOUR-DOOR | | |
| MODEL YEAR | (a) UNIT WEIGHT | (b) % OF CARS | (c) UNIT WEIGHT | (d) % OF CARS | (e) TOTAL WEIGHT PER VEHICLE |
| 1969 | 33.39 | 9.32 | 43.53 | 7.68 | 6.46 |
| 1970 | 33.39 | 20.28 | 43.53 | 14.72 | 13.18 |
| 1971 | 33.39 | 25.71 | 43.53 | 18.29 | 16.55 |
| 1972 | 33.39 | 27.51 | 43.53 | 21.49 | 18.54 |
| 1973 | 33.39 | 49.12 | 43.53 | 35.88 | 32.02 |
| 1974 | 32.52 | 64.32 | 40.27 | 35.68 | 35.29 |
| 1975 | 31.65 | 61.32 | 37.01 | 38.68 | 33.72 |
| 1976 | 30.78 | 60.91 | 33.76 | 39.09 | 31.94 |
| 1977 | 29.91 | 59.15 | 30.50 | 40.85 | 30.15 |
| 1978 | 29.04 | 58.51 | 27.24 | 41.49 | 28.29 |
| 1979 | 28.17 | 59.96 | 23.98 | 40.04 | 26.49 |
| 1980 | 28.17 | 58.06 | 23.98 | 41.94 | 26.41 |
| 1981 | 28.17 | 49.72 | 23.98 | 50.28 | 26.06 |
| 1982 | 28.17 | 45.83 | 23.98 | 54.17 | 25.90 |
| 1983 | 28.17 | 41.07 | 23.98 | 58.93 | 25.70 |
| 1984 | 28.17 | 41.56 | 23.98 | 58.44 | 25.72 |
| 1985 | 28.17 | 38.59 | 23.98 | 61.41 | 25.60 |
| 1986 | 28.17 | 37.42 | 23.98 | 62.58 | 25.55 |
| 1987 | 28.17 | 34.93 | 23.98 | 65.07 | 25.44 |
| 1988 | 28.17 | 37.78 | 23.98 | 62.22 | 25.56 |
| 1989 | 28.17 | 38.32 | 23.98 | 61.68 | 25.59 |
| 1990 | 28.17 | 32.97 | 23.98 | 67.03 | 25.36 |
| 1991 | 28.17 | 31.77 | 23.98 | 68.23 | 25.31 |
| 1992 | 28.17 | 27.78 | 23.98 | 72.22 | 25.14 |
| 1993 | 28.17 | 28.35 | 23.98 | 71.65 | 25.17 |
| 1994 | 30.72 | 27.95 | 28.01 | 72.05 | 28.77 |
| 1995 | 34.55 | 26.03 | 34.04 | 73.97 | 34.17 |
| 1996 | 38.37 | 23.50 | 40.08 | 76.50 | 39.68 |
| 1997 | 53.67 | 21.57 | 64.23 | 78.43 | 61.95 |
| 1998 | 53.67 | 19.61 | 64.23 | 80.39 | 62.16 |
| 1999 | 53.67 | 19.73 | 64.23 | 80.27 | 62.15 |
| 2000 | 53.67 | 19.08 | 64.23 | 80.92 | 62.22 |
| 2001 | 53.67 | 19.99 | 64.23 | 80.01 | 62.12 |

Having calculated the total cost and weight of the standard for two- and four-door passenger cars, a breakout by static and dynamic requirements is presented in Tables 214-9A and B. It is important to note that the mix of two- and four-door passenger cars is changing every year. With the trend toward more four-door passenger cars, costs are rising very slightly.

***TABLE 214-9A***
***SUMMARY TABLE FOR THE TOTAL CONSUMER COST OF SIDE IMPACT PROTECTION ATTRIBUTABLE TO FMVSS 214 PER PASSENGER CAR BY MODEL YEAR***

| MODEL YEAR | STATIC | | | DYNAMIC | | | TOTAL COST |
|---|---|---|---|---|---|---|---|
| | UNIT COST | % OF CARS | STATIC COST | UNIT COST | % OF CARS | DYNAMIC COST | |
| 1969 | $67.12 | 17 | $11.41 | | | | $11.41 |
| 1970 | $65.91 | 35 | $23.07 | | | | $23.07 |
| 1971 | $65.73 | 44 | $28.92 | | | | $28.92 |
| 1972 | $66.63 | 49 | $32.65 | | | | $32.65 |
| 1973 | $65.99 | 85 | $56.09 | | | | $56.09 |
| 1974 | $60.82 | 100 | $60.82 | | | | $60.82 |
| 1975 | $59.08 | 100 | $59.08 | | | | $59.08 |
| 1976 | $56.41 | 100 | $56.41 | | | | $56.41 |
| 1977 | $53.94 | 100 | $53.94 | | | | $53.94 |
| 1978 | $51.15 | 100 | $51.15 | | | | $51.15 |
| 1979 | $48.12 | 100 | $48.12 | | | | $48.12 |
| 1980 | $48.27 | 100 | $48.27 | | | | $48.27 |
| 1981 | $48.91 | 100 | $48.91 | | | | $48.91 |
| 1982 | $49.21 | 100 | $49.21 | | | | $49.21 |
| 1983 | $49.58 | 100 | $49.58 | | | | $49.58 |
| 1984 | $49.54 | 100 | $49.54 | | | | $49.54 |
| 1985 | $49.77 | 100 | $49.77 | | | | $49.77 |
| 1986 | $49.86 | 100 | $49.86 | | | | $49.86 |
| 1987 | $50.06 | 100 | $50.06 | | | | $50.06 |
| 1988 | $49.84 | 100 | $49.84 | | | | $49.84 |
| 1989 | $49.79 | 100 | $49.79 | | | | $49.79 |
| 1990 | $50.21 | 100 | $50.21 | | | | $50.21 |
| 1991 | $50.30 | 100 | $50.30 | | | | $50.30 |
| 1992 | $50.61 | 100 | $50.61 | | | | $50.61 |
| 1993 | $50.57 | 100 | $50.57 | | | | $50.57 |
| 1994 | $50.60 | 100 | $50.60 | $127.10 | 10 | $ 12.71 | $63.31 |
| 1995 | $50.75 | 100 | $50.75 | $127.76 | 25 | $ 31.94 | $82.69 |
| 1996 | $50.94 | 100 | $50.94 | $128.45 | 40 | $ 51.38 | $102.32 |
| 1997 | $51.09 | 100 | $51.09 | $128.94 | 100 | $128.94 | $180.03 |
| 1998 | $51.24 | 100 | $51.24 | $129.44 | 100 | $129.44 | $180.68 |
| 1999 | $51.23 | 100 | $51.23 | $129.41 | 100 | $129.41 | $180.64 |
| 2000 | $51.28 | 100 | $51.28 | $129.58 | 100 | $129.58 | $180.86 |
| 2001 | $51.21 | 100 | $51.21 | $129.35 | 100 | $129.35 | $180.56 |

| ***TABLE 214-9B SUMMARY TABLE FOR THE TOTAL WEIGHT OF SIDE IMPACT PROTECTION ATTRIBUTABLE TO FMVSS 214 PER PASSENGER CAR BY MODEL YEAR*** | | | | | | | |
|---|---|---|---|---|---|---|---|
| | STATIC | | | DYNAMIC | | | |
| MODEL YEAR | UNIT WEIGHT | % OF CARS | STATIC WEIGHT | UNIT WEIGHT | % OF CARS | DYNAMIC WEIGHT | TOTAL WEIGHT |
| 1969 | 38.00 | 17 | 6.46 | | | | 6.46 |
| 1970 | 37.66 | 35 | 13.18 | | | | 13.18 |
| 1971 | 37.61 | 44 | 16.55 | | | | 16.55 |
| 1972 | 37.84 | 49 | 18.54 | | | | 18.54 |
| 1973 | 37.67 | 85 | 32.02 | | | | 32.02 |
| 1974 | 35.29 | 100 | 35.29 | | | | 35.29 |
| 1975 | 33.72 | 100 | 33.72 | | | | 33.72 |
| 1976 | 31.94 | 100 | 31.94 | | | | 31.94 |
| 1977 | 30.15 | 100 | 30.15 | | | | 30.15 |
| 1978 | 28.29 | 100 | 28.29 | | | | 28.29 |
| 1979 | 26.49 | 100 | 26.49 | | | | 26.49 |
| 1980 | 26.41 | 100 | 26.41 | | | | 26.41 |
| 1981 | 26.06 | 100 | 26.06 | | | | 26.06 |
| 1982 | 25.90 | 100 | 25.90 | | | | 25.90 |
| 1983 | 25.70 | 100 | 25.70 | | | | 25.70 |
| 1984 | 25.72 | 100 | 25.72 | | | | 25.72 |
| 1985 | 25.60 | 100 | 25.60 | | | | 25.60 |
| 1986 | 25.55 | 100 | 25.55 | | | | 25.55 |
| 1987 | 25.44 | 100 | 25.44 | | | | 25.44 |
| 1988 | 25.56 | 100 | 25.56 | | | | 25.56 |
| 1989 | 25.59 | 100 | 25.59 | | | | 25.59 |
| 1990 | 25.36 | 100 | 25.36 | | | | 25.36 |
| 1991 | 25.31 | 100 | 25.31 | | | | 25.31 |
| 1992 | 25.14 | 100 | 25.14 | | | | 25.14 |
| 1993 | 25.17 | 100 | 25.17 | | | | 25.17 |
| 1994 | 25.15 | 100 | 25.15 | 36.20 | 10 | 3.62 | 28.77 |
| 1995 | 25.06 | 100 | 25.06 | 36.44 | 25 | 9.11 | 34.17 |
| 1996 | 24.96 | 100 | 24.96 | 36.80 | 40 | 14.72 | 39.68 |
| 1997 | 24.88 | 100 | 24.88 | 37.07 | 100 | 37.07 | 61.95 |
| 1998 | 24.79 | 100 | 24.79 | 37.37 | 100 | 37.37 | 62.16 |
| 1999 | 24.80 | 100 | 24.80 | 37.35 | 100 | 37.35 | 62.15 |
| 2000 | 24.77 | 100 | 24.77 | 37.45 | 100 | 37.45 | 62.22 |
| 2001 | 24.81 | 100 | 24.81 | 37.31 | 100 | 37.31 | 62.12 |

***Side Air Bags***. Some of the dangers of motor vehicle side-impact collisions are injuries to the head, neck, and upper extremities; ejection through the door; and ejection through windows. To help reduce occupant injuries and fatalities, side air bags were introduced in an increasing number of new vehicles in the late 1990's. Side air bags are designed to deploy from either the doors or the outboard side of the seat to reduce the risk of injury in moderate to severe side impact crashes. Seat- and door-mounted air bags all provide upper thorax protection, with some also extending upwards to provide head protection.

Unlike frontal air bags, side air bags are neither required nor regulated by NHTSA as of February 2004. At NHTSA's request, a Technical Working Group representing automakers, air bag suppliers, and independent safety organizations has developed comprehensive uniform test procedures related to out-of-position occupant testing for side air bags. All vehicle manufacturers have agreed to utilize these tests when designing future side air bag systems.

A study conducted in 2003 looked at the side air bag safety systems of five make-model passenger vehicles, including two passenger cars and three LTVs.[150] Four of these systems were designed to provide torso protection only, while one also extends to provide head protection.[151] One passenger car and three LTVs had driver-side and passenger-side air bags, while one passenger car had the driver-side and passenger side air bags plus side air bag modules in the rear on the left and right side. Table 214-10 shows the arithmetic average weight and consumer cost of the principal components of side impact air bags for the 2001 passenger vehicles.[152]

***TABLE 214-10***
***AVERAGE WEIGHT AND CONSUMER COST PER VEHICLE OF SIDE IMPACT AIR BAGS IN 2001 PASSENGER VEHICLES***

| COMPONENT | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| Sensors | 0.73 | $ 77.90 |
| Air Bags | 3.60 | $ 68.69 |
| Wire Harness (Sensor)[153] | 0.44 | $ 15.07 |
| TOTAL | 4.77 | $161.66 |

Two types of separate head air bags, known as inflatable tubular structures and inflatable curtains, are specifically designed to reduce the risk of head injury and/or help keep the head and upper body inside the vehicle. Additional studies on head air bags, some of which combine side and head air bags, will be conducted by NHTSA. After these studies are completed, NHTSA will have more comprehensive estimates of the cost of side and head air bags.

[150] Khadilkar, A.V., Fladmark, G.L., and Khadilkar, J., *Teardown Cost Estimates of Automotive Equipment Manufactured to Comply with Motor Vehicle Standard – FMVSS 214(D) – Side Impact Protection, Side Air Bag Features*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, April 2003. (DOT HS 809 809)

[151] 2001 Used Car Reviews, Head and Side Airbag Safety Features, (accessed 5 March 2004) available from http://www.edmunds.com; Internet.

[152] The contractor's report also included an electronic control module (ECM) pro-rated at 30% of total cost, which has not been included with the side impact airbags. This cost, in its entirety, would be needed for the frontal air bags in FMVSS 208.

[153] Only the wire harness for the sensors was included in the weight and consumer cost of the side impact air bags. The wire harness for the control module was excluded because appears to be shared with the frontal air bag.

***Light Truck Studies***

The number of light truck occupant fatalities increased during the 1980's primarily due to the greatly increasing sales of these vehicles and their use for passenger transportation. Side impacts were a significant cause of these fatalities. Consequently, NHTSA extended the side door strength requirements of FMVSS 214 to light trucks with a GVWR of 10,000 pounds or less starting September 1, 1993.

***<u>Side Door Beams</u>***. Prior to this time, some door reinforcement was already present. However, manufacturers responded by adding reinforcement beams to the doors along with very minor strengthening of the A and B pillars around the door hinge and door latch areas. A study conducted in 1998 looked at the side safety systems from five pre-standard (1987) make models and five corresponding post-standard (1994) make-model light trucks.[154] The cost teardown analysis determined that the A and B pillar in both the pre- and post-standard light trucks had the same weight and cost; consequently, changes made to meet the standard were incorporated into the door only.

Table 214-11 shows the arithmetic average weight and consumer cost of the safety equipment such as side door beams and supporting structures contained in pre- and post-standard side doors. Other functional and cosmetic components of the doors, such as sheet metal, window systems, and interior decoration are not included. Our customary methodology would be to attribute only the difference between pre- and post-standard, 15 pounds and $14.70, to FMVSS 214. However, in this case, we prefer to attribute the full weight and cost of the safety equipment in the post-standard vehicles, 23.76 pounds and $29.44, to FMVSS 214. Because FMVSS 214 was already in effect for passenger cars (1973) long before the 1987 model year of the pre-standard trucks, it could be argued that manufacturers were already anticipating the extension of the standard to light trucks when they were installing safety equipment in the side doors of pre-standard trucks.

***TABLE 214-11***
***AVERAGE WEIGHT AND CONSUMER COST***
***OF SIDE IMPACT PROTECTION***
***ATTRIBUTABLE TO FMVSS 214 IN LIGHT TRUCKS***

| COMPONENT | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| Front Side Door | 23.76 | $29.44 |

Starting September 1, 1998, light trucks with a GVWR of 6,000 pounds or less were subject to the same dynamic requirements as the passenger cars. No teardown studies have been performed on the changes made as a result of this requirement. These light trucks would have a much greater probability than passenger cars of meeting the dynamic requirement without any changes.

***FMVSS 215 –*** [Does not currently exist]

[154] Fladmark, G.L. and Khadilkar, A.V., *Cost Estimates of Side Impact Crash Protection of 1994 vs. Pre-Standard 214 (Static Test – Side Impact) Light Trucks*, Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, September 1998. (DOT HS 809 804).

*FMVSS 216 – ROOF CRUSH RESISTANCE*

FMVSS 216 became effective on September 1, 1973 (passenger cars) and September 1, 1994 (multipurpose passenger vehicles, trucks, and buses) and establishes strength requirements for the passenger compartment roof. The purpose of this standard is to reduce deaths and injuries due to the crushing of the roof into the occupant compartment in rollover crashes. This standard applies to passenger cars, multipurpose passenger vehicles, trucks, and buses with a GVWR of 6,000 pounds or less. It does not apply to school buses, vehicles that conform to the rollover test requirements of FMVSS 208 by means that require no action by vehicle occupants, and convertibles (except for optional compliance with the standard as an alternative to the rollover test requirements of FMVSS 208).[155]

Most passenger cars built since September 1, 1973 have easily complied with FMVSS 216, and it is also believed most cars built before that date could have met the standard.[156] It was primarily full-sized hardtops of the late 1960's and early 1970's that had typically borderline or worse performance. This body style was phased out (redesigned as a pillared hardtop or sedan) a few years before or after FMVSS 216 took effect. Although some true hardtops were built after 1973 and did meet FMVSS 216, they were pretty much gone by the late 1970's. These changes did not have any direct cost because it was cheaper to build a sedan than a hardtop. However, there is an indirect cost of lost sales. Hardtops were attractive for sales, which meant higher prices. Unfortunately, these intangible costs cannot be determined by cost teardown analysis.

Whereas the phasing out of true hardtops was the most visible design change, it is also possible that pillars or roof structure were strengthened, without major redesign, in selected vehicles. A study was conducted in 1982 to determine the implementation consumer price and weight variance of FMVSS 216 in 1974 model year vehicles from a baseline of the 1973 model year vehicles.[157] Twenty-four passenger cars from 1974, along with comparable 1973 make-models, were reviewed. The changes were analyzed upward from the belt line and included a review of the A, B, and C pillars and the roof structure. From this study, we singled out twenty-one make-models that did not receive any overall redesign in 1974. For these make-models, it is plausible that any change from 1973 to 1974 is specifically due to FMVSS 216. Table 216-1 shows the estimated increase in weight and consumer cost of roof crush attributable to FMVSS 216 in passenger cars.

***TABLE 216-1***
***AVERAGE WEIGHT AND CONSUMER COST***
***OF ROOF CRUSH ATTRIBUTABLE TO FMVSS 216***
***IN PASSENGER CARS***

| MODEL YEAR | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| 1974-2001 | 2.93 | $3.47 |

NHTSA believes that light trucks met FMVSS 216 well before the September 1, 1993 requirement, with no substantial changes in roof design around that time. Consequently, no cost studies of roof crush in light trucks have been performed, and none are planned by the agency.

[155] Legal citation: *49 CFR 571.216* (2004).
[156] Kahane, DOT HS 807 489:50-51 (1989).
[157] Gladstone, DOT HS 806 769:8-1 thru 8-22 (1982).

### *FMVSS 217 – BUS EMERGENCY EXITS AND WINDOW RETENTION AND RELEASE*

FMVSS 217 became effective on September 1, 1973 and establishes minimum requirements for bus window retention and release to reduce the likelihood of passenger ejection in crashes and for emergency exits to facilitate passenger exit in emergencies.[158] Since this standard does not regulate components of new passenger cars or light trucks, it is outside the scope of this report. No cost studies of this standard have been done, and none are planned by the agency.

### *FMVSS 218- MOTORCYLE HELMETS*

FMVSS 218 became effective on March 1, 1974 and establishes minimum performance requirements for helmets designed for use by motorcyclists and other motor vehicle users to reduce deaths and injuries resulting from head impacts.[159] Since this standard does not regulate components of new passenger cars or light trucks, it is outside the scope of this report. No cost studies of this standard have been done, and none are planned by the agency.

### *FMVSS 219 – WINDSHIELD ZONE INTRUSION*

FMVSS 219 became effective on September 1, 1976 (passenger cars) and September 1, 1977 (multipurpose passenger vehicles, trucks, and buses) and specifies limits for the displacement into the windshield area of motor vehicle components during a crash. The purpose of this standard is to reduce crash injuries and fatalities that result from occupants contacting vehicle components displaced near or through the windshield. This standard applies to passenger cars and to multipurpose passenger vehicles, trucks, and buses with a GVWR of 10,000 pounds or less. However, it does not apply to forward control vehicles, walk-in van-type vehicles or to body-type vehicles with fold-down or removable windshields.[160]

A study was conducted in 1982 on twelve make-model pre-standard (1976) passenger cars, and their corresponding implementation (1977) and post-standard (1978) systems.[161] From that study, we singled out ten make-models that did not receive an overall redesign in 1977. Those ten make-models had no changes in weight and cost from 1976 to 1978. Because our teardowns did not show any added weight or cost in the standards implementation year, we will not attribute any weight or cost to FMVSS 219. However, it is conceivable that a more thorough teardown study including vehicles a year or two before 1976 could have revealed costs of changes made in anticipation of FMVSS 219, if there were any.

[158] Legal citation: *49 CFR 571.217* (2004).
[159] Legal citation: *49 CFR 571.218* (2004).
[160] Legal citation: *49 CFR 571.219* (2004).
[161] McVetty, DOT HS 806 187:19-36 (1982).

### *FMVSS 220 – SCHOOL BUS ROLLOVER PROTECTION*

FMVSS 220 became effective on April 1, 1977 and establishes performance requirements for school bus rollover protection to reduce the number of deaths and the severity of injuries that result from failure of the school bus body structure to withstand forces encountered in rollover crashes.[162] A cost study was completed in 1979.[163] Since this standard does not regulate components of new passenger cars or light trucks, it is outside the scope of this report.

### *FMVSS 221 – SCHOOL BUS BODY JOINT STRENGTH*

FMVSS 221 became effective on April 1, 1977 and establishes requirements for the strength of the body panel joints in school bus bodies to reduce deaths and injuries resulting from the structural collapse of school bus bodies during crashes.[164] A cost study was completed in 1979.[165] Since this standard does not regulate components of new passenger cars or light trucks, it is outside the scope of this report.

### *FMVSS 222 – SCHOOL BUS PASSENGER SEATING AND CRASH PROTECTION*

FMVSS 222 became effective on April 1, 1977 and establishes occupant protection requirements for school bus passenger seating and restraining barriers to reduce the number of deaths and the severity of injuries that result from the impact of school bus occupants against structures within the vehicle during crashes and sudden driving maneuvers.[166] A cost study was completed in 1979.[167] Since this standard does not regulate components of new passenger cars or light trucks, it is outside the scope of this report.

### *FMVSS 223 – REAR IMPACT GUARDS*

FMVSS 223 became effective on January 26, 1998 and specifies requirements for rear impact guards for trailers and semi-trailers to reduce the number of deaths and serious injuries that occur when light duty vehicles collide with the rear end of trailers and semi-trailers.[168] Since this standard does not regulate components of new passenger cars or light trucks, it is outside the scope of this report.

[162] Legal citation: *49 CFR 571.220* (2004).
[163] Harvey, DOT HS 805 320:12-13 (1979).
[164] Legal citation: *49 CFR 571.221* (2004).
[165] Harvey, DOT HS 805 320:13-19 (1979).
[166] Legal citation: *49 CFR 571.222* (2004).
[167] Harvey, DOT HS 805 320:19-23 (1979).
[168] Legal citation: *49 CFR 571.223* (2004).

### *FMVSS 224 – REAR IMPACT PROTECTION*

FMVSS 224 became effective on January 26, 1998 and establishes requirements for the installation of rear impact guards on trailers and semi-trailers with a GVWR of 10,000 pounds or more to reduce the number of deaths and serious injuries occurring when light duty vehicles impact the rear of trailers and semi-trailers of 10,000 pounds or more.[169] Since this standard does not regulate components of new passenger cars or light trucks, it is outside the scope of this report.

### *FMVSS 225 – CHILD RESTRAINT ANCHORAGE SYSTEMS*

FMVSS 225 became effective on September 1, 1999 and establishes requirements for child restraint anchorage systems to ensure their proper location and strength for the effective securing of child restraints, to reduce the likelihood of the anchorage systems' failure, and to increase the likelihood that child restraints are properly secured and thus more fully achieve their potential effectiveness in motor vehicles. This standard applies to passenger cars; to trucks and multipurpose passenger vehicles with a GVWR of 8,500 pounds or less, except walk-in van-type vehicles and vehicles manufactured to be sold exclusively to the U.S. Postal Service; and to buses (including school buses) with a GVWR of 10,000 pounds or less, except shuttle buses.[170] A cost study of this standard is included in NHTSA's 2004-2007 Evaluation Plan.[171]

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[169] Legal citation: *49 CFR 571.224* (2004).
[170] Legal citation: *49 CFR 571.225* (2004).
[171] National Highway Traffic Safety Administration, DOT HS 809 699:9-10 (2004).

## *SECTION 4 – FMVSS 300, 400, AND 500 SERIES*

The FMVSS 300, 400, and 500 series specify requirements for vehicles and components to prevent or reduce the severity of fires, protect occupants from hazards during vehicle operation, and provide safety for low-speed vehicles.

### *FMVSS 301 – FUEL SYSTEM INTEGRITY*

FMVSS 301 became effective on January 1, 1968 (passenger cars), in January 1976 (multipurpose passenger vehicles, trucks, and buses with a GVWR of 10,000 pounds or less), and on April 1, 1977 (school buses with a GVWR greater than 10,000 pounds). The standard specifies requirements for the integrity of motor vehicle fuel systems. The purpose of this standard is to reduce deaths and injuries occurring from fires that result from fuel spillage during and after motor vehicle crashes and from ingestion of fuels during siphoning. This standard applies to:

- passenger cars
- multipurpose passenger vehicles, trucks, and buses that have a GVWR of 10,000 pounds or less and use fuel with a boiling point above 0 $^{o}$C
- school buses that have a GVWR greater than 10,000 pounds and use fuel with a boiling point above 0 $^{o}$C[172]

Originally, cars only had to pass a front impact test into a rigid barrier at 30 mph. Fuel spillage after the impact was not allowed to exceed one ounce while the car was still in motion and five ounces during the first five minutes after the car came to a stop. During the next 25 minutes, fuel spillage could not exceed one ounce during any one-minute interval.[173]

During the 1970's, FMVSS 301 was significantly upgraded over a three-year phase-in period.

- Effective September 1, 1975. Passenger cars had to meet a static rollover test. Immediately after the frontal test, the damaged vehicle was slowly rotated 90 degrees, 180 degrees (up-side down), and 270 degrees, holding at each of these positions for five minutes. Fuel spillage could not exceed one ounce during any one-minute interval in this process.

- Effective September 1, 1976. Passenger cars had to meet 30 mph frontal, oblique frontal and rear-impact tests, plus a 20 mph lateral test, with each test followed by a static rollover test. The cars had the same limits on fuel spillage as in the original frontal test. LTVs with GVWR less than or equal to 6,000 pounds had to meet 30 mph frontal and rear-impact tests followed by the static rollover. LTVs with GVWR of 6,000-10,000

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[172] Legal citation: *49 CFR 571.301* (2004).

[173] Parsons, G.G., *Motor Vehicle Fires in Traffic Crashes and the Effects of the Fuel System Integrity Standard,* Washington: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1990 (DOT HS 807 675:xvii; 3-25 thru 3-28).

(including small LTV-based school buses) had to meet the frontal test without static rollover.

- Effective September 1, 1977. All LTVs up to 10,000 pounds (including small school buses) had to meet the same requirements as passenger cars: frontal, oblique frontal, rear-impact and lateral tests with subsequent rollover.

The type and extent of modifications near the time of the 1975-77 upgrade varied greatly by make-model. Strategies used by the manufacturers included.[174]

- strengthening the fuel tank or other components of the fuel delivery system
- strengthening the structures that hold the fuel tank in place
- shielding the fuel tank and delivery system from other parts of the vehicle
- relocating parts of the fuel system further away from other parts of the vehicle or areas likely to be damaged during impacts
- relocating other parts of the vehicle further away from the fuel system, or reshaping them to make them less likely to damage the fuel system

In November 2003, NHTSA issued a final rule upgrading the rear impact test that simulates being struck in the rear by another vehicle. The final rule replaces the full rear impact test procedure with an offset rear impact test procedure specifying that only a portion of the width of the rear of the test vehicle be impacted at 50 mph. Under the new rear impact procedure, a lighter deformable barrier is used. The barrier is very similar to the one used for dynamic testing of the side impact protection standard, except that the rear impact barrier's face is mounted slightly lower to simulate the diving of the front end of a vehicle during pre-crash braking. The new requirements will phase in between September 1, 2006 and September 1, 2008.

### *Passenger Car Studies*

Fuel system elements of twelve post-standard (1976) passenger cars and their corresponding pre-standard (1967) make-models were examined to determine the weight and consumer cost of equipment changes in response to FMVSS 301.[175] Table 301-1 shows the sales-weighted average weight and consumer cost of implementing the 1976 requirement, with the difference attributable to FMVSS 301 in passenger cars.

***TABLE 301-1***
***AVERAGE WEIGHT AND CONSUMER COST OF THE FUEL TANK AND FUEL TANK FILLER TUBE ATTRIBUTABLE TO FMVSS 301 IN PASSENGER CARS***

| CATEGORY | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| Pre-Standard | 24.14 | $45.91 |
| Post-Standard | 26.62 | $62.42 |
| DIFFERENCE | 2.48 | $16.51 |

[174] Ibid, 4-11 thru 4-22.
[175] McLean, DOT HS 803 871:63-87 (1978).

***Light Truck Studies***

FMVSS 301 was extended to light trucks in January 1976. To determine the weight and consumer cost of the equipment changes in response to FMVSS 301 requirements of September 1, 1976 and September 1, 1977, fuel system elements of two pre-standard (1976) light trucks and their corresponding post-standard (1977) make-models were examined.[176]

Examination of the 1976 and 1977 model year light trucks did not make a clearly defined conclusion on the implementation of the standard. One selected vehicle indicated an increase in weight of 11.73 pounds and cost of $9.43 in 2002 dollars, while the other vehicle exhibited no cost or weight increase from 1976 to 1977. Because of the small sample size and the possibility that the vehicle with no change could have made the equipment changes a year earlier, we prefer to attribute the full weight and cost imposed for passenger cars to light trucks.

Table 301-2 shows the sales-weighted average weight and consumer cost of implementing the 1976 requirement, with the difference attributable to FMVSS 301 in light trucks.

***TABLE 301-2***
***AVERAGE WEIGHT AND CONSUMER COST OF THE FUEL TANK AND FUEL TANK FILLER TUBE ATTRIBUTABLE TO FMVSS 301 IN LIGHT TRUCKS***

| CATEGORY | WEIGHT IN POUNDS | CONSUMER COST ($2002) |
|---|---|---|
| Pre-Standard | 24.14 | $45.91 |
| Post-Standard | 26.62 | $62.42 |
| Difference | 2.48 | $16.51 |

## *FMVSS 302 – FLAMMABILITY OF INTERIOR MATERIALS*

FMVSS 302 became effective on September 1, 1972 and specifies burn resistance requirements for materials used in the occupant compartments of motor vehicles. The purpose of the standard is to reduce the deaths and injuries to motor vehicle occupants caused by vehicle fires, especially those originating in the interior of the vehicle from sources such as matches or cigarettes. This standard applies to passenger cars, multipurpose passenger vehicles, trucks, and buses.[177] No cost studies of this standard have been done, and none are planned by the agency.

## *FMVSS 303 – FUEL SYSTEM INTEGRITY OF COMPRESSED NATURAL GAS VEHICLES*

FMVSS 303 became effective on April 25, 1994 and specifies requirements for the integrity of motor vehicle fuel systems using compressed natural gas (CNG), including the CNG fuel systems of bi-fuel, dedicated, and dual fuel CNG vehicles. The purpose of the standard is to reduce deaths and injuries occurring from fires that result from fuel leakage during and after motor vehicle crashes. This standard applies to passenger cars, multipurpose passenger vehicles, trucks, and buses that have a GVWR of 10,000 pounds or less and school buses regardless of

[176] McLean, DOT HS 803 871:63-87 (1978).
[177] Legal citation: *49 CFR 571.302* (2004).

weight that use CNG as a motor fuel.[178] No cost studies of this standard have been done, and none are currently planned by the agency.

### *FMVSS 304 – COMPRESSED NATURAL GAS FUEL CONTAINER INTEGRITY*

FMVSS 304 became effective March 27, 1995 and specifies requirements for the integrity of CNG, motor vehicle fuel containers. The purpose of this standard is to reduce deaths and injuries occurring from fires that result from fuel leakage during and after motor vehicle crashes. This standard applies to each passenger car, multipurpose passenger vehicle, truck, and bus that uses CNG as a motor fuel and to each container designed to store CNG as motor fuel on-board any motor vehicle.[179] No cost studies of this standard have been done, and none are currently planned by the agency.

### *FMVSS 305 – ELECTRIC-POWERED VEHICLES: ELECTROLYTE SPILLAGE AND ELECTRICAL SHOCK PROTECTION*

FMVSS 305 became effective on September 27, 2000 and specifies requirements for limitation of electrolyte spillage, retention of propulsion batteries during a crash, and electrical isolation of the chassis from the high-voltage system to be met by vehicles that use electricity as propulsion. The purpose of this standard is to reduce deaths and injuries during a crash that occur because of electrolyte spillage from propulsion batteries, intrusion of propulsion battery system components into the occupant compartment, and electrical shock. This standard applies to passenger cars and to multipurpose passenger vehicles, trucks, and buses with a GVWR of 10,000 pounds or less, that use more than 48 nominal volts of electricity as propulsion power and whose speed attainable in 1.6 km on a paved level surface is more than 40 km/h.[180] No cost studies of this standard have been done, and none are currently planned by the agency.

### *FMVSS 401 – INTERIOR TRUNK RELEASE*

FMVSS 401 became effective on August 17, 2001 and establishes the requirements for providing a trunk release mechanism that makes it possible for a person trapped inside the trunk compartment of a passenger car to escape from the compartment. This standard applies to passenger cars that have a trunk compartment. This does not apply to passenger cars with a back door.[181] No cost studies of this standard have been done, and none are currently planned by the agency.

***FMVSS 402*** - (Does not currently exist)

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[178] Legal citation: *49 CFR 571.303* (2004).
[179] Legal citation: *49 CFR 571.304* (2004).
[180] Legal citation: *49 CFR 571.305* (2004).
[181] Legal citation: *49 CFR 571.401* (2004).

*FMVSS 403 – PLATFORM LIFT SYSTEMS FOR MOTOR VEHICLES*

FMVSS 403 becomes effective on December 27, 2004 and specifies requirements for platform lifts used to assist persons with limited mobility in entering or leaving a motor vehicle. The purpose of this standard is to prevent injuries and fatalities to passengers and bystanders during the operation of platform lifts installed in motor vehicles. This standard applies to platform lifts designed to carry passengers into and out of motor vehicles.[182] No cost studies of this standard have been done, and none are currently planned by the agency.

*FMVSS 404 – PLATFORM LIFT INSTALLATIONS IN MOTOR VEHICLES*

FMVSS 404 becomes effective on December 27, 2004 and specifies requirements for vehicles equipped with platform lifts used to assist persons with limited ability in entering or leaving a motor vehicle. The purpose of this standard is to prevent injuries and fatalities to passengers and bystanders during the operation of platform lifts installed in motor vehicles. This standard applies to motor vehicles equipped with a platform lift to carry passengers into and out of the motor vehicle.[183] No cost studies of this standard have been done, and none are currently planned by the agency.

*FMVSS 500 – LOW-SPEED VEHICLES*

FMVSS 500 became effective on June 17, 1998 and specifies requirements for low-speed vehicles to ensure that low-speed vehicles operated on the public streets, roads, and highways are equipped with minimum motor vehicle equipment appropriate for motor vehicle safety.[184] A low-speed vehicle is a four-wheeled motor vehicle, other than a truck, whose top speed is greater than 20 mph, but not greater than 25 mph. A possible cost study of this standard is included in NHTSA's 2004-2007 Evaluation Plan.[185]

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[182] Legal citation: *49 CFR 571.403* (2004).
[183] Legal citation: *49 CFR 571.404* (2004).
[184] Legal citation: *49 CFR 571.500* (2004).
[185] National Highway Traffic Safety Administration, DOT HS 809 699:31-32 (2004).

## *SECTION 5 – FINAL SUMMARY AND TABLES*

The cost and weight added by all the FMVSS, and by each individual FMVSS to passenger cars and light trucks from 1968 to 2001 have grown over the years with the addition of new standards and amendments to existing standards, the introduction of new technologies, and the percentage of passenger cars and light trucks meeting the standard in a particular model year – offset by subsequent reductions in the costs of some technologies.

NHTSA estimates that the FMVSS added an average of $839 (in 2002 dollars) and 125 pounds to the average passenger car in model year 2001. Since passenger cars cost an average of $21,217 (in 2002 dollars) and weighed 3,148 pounds in model year 2001, approximately four percent of the cost and four percent of the weight of a new passenger car could be attributed to the FMVSS. An average of $711 (in 2002 dollars) and 86 pounds was added to the average light truck in model year 2001. With light trucks costing an average of $23,995 (in 2002 dollars) and weighing 4,238 pounds in model year 2001, approximately three percent of the cost and two percent of the weight of a new truck could be attributed to the FMVSS. The average cost of the 2001 passenger cars and light trucks are based on the Manufacturer's Suggested Retail Price (MSRP).[186]

The final summary tables provide a breakout of the cost and weight attributable to each FMVSS for passenger cars and light trucks in each model year. All cost data have been inflated to 2002 dollars using the gross domestic product implicit price deflator adjustments from the Bureau of Economic Analysis.

Tables 5A through 5D summarize the consumer cost and weight of each FMVSS for passenger cars and light trucks for model years 1968-2001 and subdivide costs and weights into "voluntary" and "mandatory" categories. The voluntary (shaded) category accounts for the cost and weight of all equipment added or modified before the effective date in clear anticipation of the standard; whereas, the mandatory category accounts for additions or modifications that took place on or after the effective date. An explanation of the tables follows:

- The unit cost and weight of each FMVSS was obtained from their respective tables within the report.

- The percent of passenger cars and light trucks that met the standard in a particular model year was obtained from Polk registration files.

- The total cost and weight of each FMVSS was calculated by multiplying the unit cost by the percent of passenger cars and light trucks that met the standard.

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[186] The MSRP cost for the 2001 passenger car and light truck does not include price reductions such as rebates or incentives offered by the dealer and/or the manufacturer, nor does it include price additions such as added charges and optional features.

Abeles, E.C., *Analysis of Light-Duty Vehicle Price Trends in the U.S., How Vehicle Prices Change Relative to Consumers, Compliance Costs and a Baseline Measure for 1975-2001*, University of California at Davis, June 2004 (UCD-ITS-RR-04-15:10,12).

- The total voluntary cost and weight of all FMVSS was calculated by adding the voluntary cost and weight of each FMVSS.

- The total mandatory cost and weight of all FMVSS was calculated by adding the mandatory cost and weight of each FMVSS.

- The total FMVSS cost and weight was calculated by adding the total voluntary cost and weight and the total mandatory cost and weight.

- The tables include only the FMVSS that are believed to have added cost or weight to passenger cars or light trucks and that have been studied as of September 2004.

More detailed descriptions of the technologies and cost estimation procedures associated with each FMVSS may be found in the preceding chapters. However, here are some brief notes on the salient features of Tables 5A through 5D:

***Passenger Cars***:

- ***FMVSS 105***: the upgrade from single to dual master cylinders was the principal cost- and weight-increasing safety technology. Follow-up studies showed that the cost and weight of dual master cylinders decreased somewhat between 1976 and 1982.

- ***FMVSS 108***: side marker lamps were installed in all passenger cars, and center high mounted stop lamps (CHMSL) in some passenger cars a few years before the effective date, but after a rulemaking process was underway. These are shown as “voluntary” costs (shaded). Side marker lamps cost and weighed less in 1968-1969 because some cars had fixtures of simpler design that, subsequently, would not have met the standard.

- ***FMVSS 118*** involved electrical changes to prevent the operation of power windows when the ignition or electrical accessory systems are off. Unit costs per passenger car have not changed, but total cost rose as the proportion of new passenger cars equipped with power windows has increased.

- ***FMVSS 124*** resulted in an extra spring to assure the throttle returns to idle when the driver’s foot is not on the accelerator.

- ***FMVSS 201*** includes secure glove compartment doors and seat back padding to protect occupants in interior impact, as specified in the original standard. No costs are shown for the head impact protection upgrade, phased in during model years 1999-2003, because NHTSA has not completed the cost evaluation.

- ***FMVSS 202*** resulted in head restraints being added to passenger cars. The cost and weight of head restraints decreased between 1969 and 1982.

- ***FMVSS 203 and 204*** resulted in energy absorbing, telescoping steering assemblies to protect drivers in frontal crashes.

- ***FMVSS 207***: seat back locks for the front seat added cost and weight in two-door passenger cars. The industry shifted from manual to inertial locks circa 1980. The total cost has declined as the market share of two-door passenger cars decreased from 64 percent in 1974 to 20 percent in 2001.

- ***FMVSS 208***: safety belts are required at all designated seating positions, including rear seats, and the tables show the sum of the costs and weights of all the safety belts in the passenger car. The cost of manual belts increased from 1968 to 1974 due to improvements such as integral 3-point belts and locking retractors. Automatic protection was phased into passenger cars in model years 1987-1990. Cost and weight of safety belts increased substantially in 1987-1990 as automatic belts were phased in, and returned to earlier levels in 1991-1996 as manual 3-point belts returned. Driver air bags, and subsequently dual air bags, were increasingly used to meet the automatic protection requirement. In model years 1997-2001, all passenger cars had dual air bags and manual 3-point belts. The table does not include the cost of pretensioners, load limiters or adjustable anchors since they are not required, or proposed, as a requirement of FMVSS 208.

- ***FMVSS 214***: the initial static crush requirement for side doors went into effect for passenger cars on January 1, 1973, although NHTSA had announced it was planning such a requirement as early as October 1968. Side door beams provided the crush strength needed to meet the standard. The cost of side door beams in some 1969-1972 cars is included because the rulemaking process was underway by then. Cost and weight decreased substantially from 1973 to 1979, partly because passenger cars were downsized. In the FMVSS 214 section of Chapter 3, all costs and weights are computed separately for two-door and four-door passenger cars; however, Tables 5A and 5B show sales-weighted averages for all passenger cars. As a result, these averages change slightly from year to year, usually upward, as the market has shifted to more four-door passenger cars. The phase-in of the dynamic crash test requirement in model years 1994-1997 substantially increased the cost and weight added by FMVSS 214.

- ***FMVSS 216***: roofs and supporting pillars were strengthened in some passenger cars circa 1974.

- ***FMVSS 301***: the original fuel integrity standard, effective January 1, 1968, apparently did not add cost or weight to passenger cars. However, a significant upgrade in 1975-1976 resulted in strengthening, shielding or relocating the fuel tank, fuel delivery system, and supporting structures.

***Light Trucks***:

- ***FMVSS 104***: light trucks were equipped with multi-speed windshield wipers and windshield washing systems.

- ***FMVSS 105*** was extended to light trucks effective September 1, 1983. However, it had been in effect for passenger cars since 1968 and its extension to light trucks proposed by 1972. Therefore, installations of dual master cylinders in model years 1968-1983 have been included as "voluntary" costs.

- ***FMVSS 108***: side marker lamps were installed in all light trucks, and center high mounted stop lamps (CHMSL) in some of them a few years before the effective date, but after a rulemaking process was underway. These are shown as "voluntary" costs.

- ***FMVSS 118*** was extended to light trucks effective July 25, 1988, but was already in effect for passenger cars by the time power windows began to appear on trucks. Thus, a voluntary cost is tabulated for model years 1978-1988.

- ***FMVSS 124*** is assumed to have the same cost in light trucks as in passenger cars.

- ***FMVSS 201*** went into effect on September 1, 1981. Seat backs were padded if there was another row of seats behind them. Unit costs stayed the same, but the total cost has increased as the light truck fleet shifted from conventional-cab pickup trucks to SUVs, minivans and crew-cab pickup trucks.

- ***FMVSS 202***: head restraints were not required in light trucks until September 1, 1991. However, many trucks were equipped with head restraints or high-back seats during the years that FMVSS 202 was in effect, or in process, for passenger cars. These are shown as voluntary costs.

- ***FMVSS 203 and 204*** went into effect on September 1, 1981. Energy absorbing, telescoping steering assemblies began to appear in light trucks on a voluntary basis in 1970, a few years after they became a requirement in passenger cars.

- ***FMVSS 208***: safety belts were required at all designated seating positions, including rear seats, effective July 1, 1971 but were already there on a voluntary basis in model years 1968-1971, when FMVSS 208 was in effect for passenger cars. The cost of safety belts increased from 1971 to 1982 as all light trucks received integral 3-point belts and locking retractors. Cost and weight continued to increase after 1987, as the truck market shifted to vehicles with more seats, and as 3-point belts superseded lap belts at rear outboard seats. The automatic protection requirement was phased into light trucks up to 8,500 GVWR in model years 1995-1998, but the shift to driver air bags, and subsequently dual air bags began several years earlier, shortly after air bags were introduced in cars. Effective June 22, 1995, light trucks that could not accommodate rear-facing child seats anywhere except the front seat were allowed to have an on-off switch for the passenger air bag. That facilitated the implementation of dual air bags in pickup trucks.

- ***FMVSS 214***: the static crush requirement for side doors was extended to light trucks on September 1, 1993, with some voluntary installations in preceding years. Side door beams provided the crush strength needed to meet the standard. The dynamic crash test requirement went into effect on September 1, 1998, but apparently has not added any significant cost or weight.

- ***FMVSS 216*** was extended to light trucks effective September 1, 1994, but apparently has not added any significant cost or weight.

- ***FMVSS 301***: the original fuel integrity standard, effective January 1, 1968, apparently did not add cost or weight to light trucks. However, a significant upgrade in model year 1978 resulted in strengthening, shielding or relocating the fuel tank, fuel delivery system, and supporting structures.

TABLE 5A
AVERAGE CONSUMER COST PER PASSENGER CAR FOR
IMPLEMENTATION OF THE FMVSS FOR MODEL YEARS 1968-2001

| Model Year | FMVSS 105 - BRAKES DUAL MASTER CYL. Unit Cost | % of Cars | 105 Cost | FMVSS 108 - LAMPS SIDE MARKER Unit Cost | % of Cars | Cost | CHMSL Unit Cost | % of Cars | Cost | 108 Cost | FMVSS 118 POWER WINDOWS Unit Cost | % of Cars | 118 Cost | FMVSS 124 ACCELERATOR CONTROLS Unit Cost | % of Cars | 124 Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1968 | 12.14 | 100% | 12.14 | **20.90** | **100%** | **20.90** | | | | **20.90** | | | | | | |
| 1969 | 12.14 | 100% | 12.14 | **20.90** | **100%** | **20.90** | | | | **20.90** | | | | | | |
| 1970 | 12.14 | 100% | 12.14 | 29.37 | 100% | 29.37 | | | | 29.37 | | | | | | |
| 1971 | 12.14 | 100% | 12.14 | 29.37 | 100% | 29.37 | | | | 29.37 | 0.92 | 20.6% | 0.19 | | | |
| 1972 | 12.14 | 100% | 12.14 | 29.37 | 100% | 29.37 | | | | 29.37 | 0.92 | 26.6% | 0.24 | | | |
| 1973 | 12.14 | 100% | 12.14 | 29.37 | 100% | 29.37 | | | | 29.37 | 0.92 | 25.7% | 0.24 | | | |
| 1974 | 12.14 | 100% | 12.14 | 29.37 | 100% | 29.37 | | | | 29.37 | 0.92 | 18.9% | 0.17 | 0.47 | 100% | 0.47 |
| 1975 | 12.14 | 100% | 12.14 | 29.37 | 100% | 29.37 | | | | 29.37 | 0.92 | 24.5% | 0.23 | 0.47 | 100% | 0.47 |
| 1976 | 12.14 | 100% | 12.14 | 29.37 | 100% | 29.37 | | | | 29.37 | 0.92 | 23.1% | 0.21 | 0.47 | 100% | 0.47 |
| 1977 | 11.93 | 100% | 11.93 | 29.37 | 100% | 29.37 | | | | 29.37 | 0.92 | 27.0% | 0.25 | 0.47 | 100% | 0.47 |
| 1978 | 11.72 | 100% | 11.72 | 29.37 | 100% | 29.37 | | | | 29.37 | 0.92 | 23.8% | 0.22 | 0.47 | 100% | 0.47 |
| 1979 | 11.51 | 100% | 11.51 | 29.37 | 100% | 29.37 | | | | 29.37 | 0.92 | 25.0% | 0.23 | 0.47 | 100% | 0.47 |
| 1980 | 11.30 | 100% | 11.30 | 29.37 | 100% | 29.37 | | | | 29.37 | 0.92 | 20.3% | 0.19 | 0.47 | 100% | 0.47 |
| 1981 | 11.09 | 100% | 11.09 | 29.37 | 100% | 29.37 | | | | 29.37 | 0.92 | 23.4% | 0.22 | 0.47 | 100% | 0.47 |
| 1982 | 10.88 | 100% | 10.88 | 29.37 | 100% | 29.37 | | | | 29.37 | 0.92 | 28.4% | 0.26 | 0.47 | 100% | 0.47 |
| 1983 | 10.88 | 100% | 10.88 | 29.37 | 100% | 29.37 | | | | 29.37 | 0.92 | 39.0% | 0.36 | 0.47 | 100% | 0.47 |
| 1984 | 10.88 | 100% | 10.88 | 29.37 | 100% | 29.37 | | | | 29.37 | 0.92 | 40.3% | 0.37 | 0.47 | 100% | 0.47 |
| 1985 | 10.88 | 100% | 10.88 | 29.37 | 100% | 29.37 | **9.74** | **4.8%** | **0.47** | 29.84 | 0.92 | 44.4% | 0.41 | 0.47 | 100% | 0.47 |
| 1986 | 10.88 | 100% | 10.88 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 43.0% | 0.40 | 0.47 | 100% | 0.47 |
| 1987 | 10.88 | 100% | 10.88 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 42.5% | 0.39 | 0.47 | 100% | 0.47 |
| 1988 | 10.88 | 100% | 10.88 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 46.9% | 0.43 | 0.47 | 100% | 0.47 |
| 1989 | 10.88 | 100% | 10.88 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 49.4% | 0.45 | 0.47 | 100% | 0.47 |
| 1990 | 10.88 | 100% | 10.88 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 57.6% | 0.53 | 0.47 | 100% | 0.47 |
| 1991 | 10.88 | 100% | 10.88 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 54.9% | 0.51 | 0.47 | 100% | 0.47 |
| 1992 | 10.88 | 100% | 10.88 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 61.8% | 0.57 | 0.47 | 100% | 0.47 |
| 1993 | 10.88 | 100% | 10.88 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 67.7% | 0.62 | 0.47 | 100% | 0.47 |
| 1994 | 10.88 | 100% | 10.88 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 73.2% | 0.67 | 0.47 | 100% | 0.47 |
| 1995 | 10.88 | 100% | 10.88 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 73.7% | 0.68 | 0.47 | 100% | 0.47 |
| 1996 | 10.88 | 100% | 10.88 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 79.6% | 0.73 | 0.47 | 100% | 0.47 |
| 1997 | 10.88 | 100% | 10.88 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 79.6% | 0.73 | 0.47 | 100% | 0.47 |
| 1998 | 10.88 | 100% | 10.88 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 83.0% | 0.76 | 0.47 | 100% | 0.47 |
| 1999 | 10.88 | 100% | 10.88 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 83.0% | 0.76 | 0.47 | 100% | 0.47 |
| 2000 | 10.88 | 100% | 10.88 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 85.0% | 0.78 | 0.47 | 100% | 0.47 |
| 2001 | 10.88 | 100% | 10.88 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 85.0% | 0.78 | 0.47 | 100% | 0.47 |

**NO COST**
**VOLUNTARY COST**
**MANDATORY COST**

TABLE 5A
AVERAGE CONSUMER COST PER PASSENGER CAR FOR
IMPLEMENTATION OF THE FMVSS FOR MODEL YEARS 1968-2001

| Model Year | FMVSS 201- INTERIOR PROTECTION: GLOVE COMP. DOORS Unit Cost | % of Cars | Cost | SEAT BACK PADDING Unit Cost | % of Cars | Cost | 201 Cost | FMVSS 202 HEAD RESTRAINTS Unit Cost | % of Cars | 202 Cost | FMVSS 203/204 STEERING ASSEMBLY Unit Cost | % of Cars | 203-4 Cost | FMVSS 207 SEAT BACK LOCKS Unit Cost | % of Cars | 207 Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1968 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | **38.27** | **12%** | **4.59** | 27.45 | 100% | 27.45 | 16.53 | 54.2% | 8.96 |
| 1969 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 38.27 | 100% | 38.27 | 27.45 | 100% | 27.45 | 16.53 | 54.8% | 9.06 |
| 1970 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 37.59 | 100% | 37.59 | 27.45 | 100% | 27.45 | 16.53 | 57.9% | 9.58 |
| 1971 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 36.92 | 100% | 36.92 | 27.45 | 100% | 27.45 | 16.53 | 58.4% | 9.66 |
| 1972 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 36.25 | 100% | 36.25 | 27.45 | 100% | 27.45 | 16.53 | 56.2% | 9.28 |
| 1973 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 35.58 | 100% | 35.58 | 27.45 | 100% | 27.45 | 16.53 | 57.8% | 9.55 |
| 1974 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 34.91 | 100% | 34.91 | 27.45 | 100% | 27.45 | 16.53 | 64.3% | 10.63 |
| 1975 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 34.24 | 100% | 34.24 | 27.45 | 100% | 27.45 | 16.53 | 61.3% | 10.14 |
| 1976 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 33.56 | 100% | 33.56 | 27.45 | 100% | 27.45 | 16.53 | 60.9% | 10.07 |
| 1977 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 32.89 | 100% | 32.89 | 27.45 | 100% | 27.45 | 16.53 | 59.2% | 9.78 |
| 1978 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 32.22 | 100% | 32.22 | 27.45 | 100% | 27.45 | 16.53 | 58.5% | 9.67 |
| 1979 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 31.55 | 100% | 31.55 | 27.45 | 100% | 27.45 | 16.53 | 60.0% | 9.91 |
| 1980 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 30.88 | 100% | 30.88 | 27.45 | 100% | 27.45 | 16.13 | 58.1% | 9.37 |
| 1981 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 30.21 | 100% | 30.21 | 27.45 | 100% | 27.45 | 16.13 | 49.7% | 8.02 |
| 1982 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 30.89 | 100% | 30.89 | 27.45 | 100% | 27.45 | 16.13 | 45.8% | 7.39 |
| 1983 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 30.89 | 100% | 30.89 | 27.45 | 100% | 27.45 | 16.13 | 41.1% | 6.62 |
| 1984 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 30.89 | 100% | 30.89 | 27.45 | 100% | 27.45 | 16.13 | 41.6% | 6.70 |
| 1985 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 30.89 | 100% | 30.89 | 27.45 | 100% | 27.45 | 16.13 | 38.6% | 6.22 |
| 1986 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 30.89 | 100% | 30.89 | 27.45 | 100% | 27.45 | 16.13 | 37.4% | 6.04 |
| 1987 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 30.89 | 100% | 30.89 | 27.45 | 100% | 27.45 | 16.13 | 34.9% | 5.63 |
| 1988 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 30.89 | 100% | 30.89 | 27.45 | 100% | 27.45 | 16.13 | 37.8% | 6.09 |
| 1989 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 30.89 | 100% | 30.89 | 27.45 | 100% | 27.45 | 16.13 | 38.3% | 6.18 |
| 1990 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 30.89 | 100% | 30.89 | 27.45 | 100% | 27.45 | 16.13 | 33.0% | 5.32 |
| 1991 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 30.89 | 100% | 30.89 | 27.45 | 100% | 27.45 | 16.13 | 31.8% | 5.12 |
| 1992 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 30.89 | 100% | 30.89 | 27.45 | 100% | 27.45 | 16.13 | 27.8% | 4.48 |
| 1993 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 30.89 | 100% | 30.89 | 27.45 | 100% | 27.45 | 16.13 | 28.4% | 4.57 |
| 1994 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 30.89 | 100% | 30.89 | 27.45 | 100% | 27.45 | 16.13 | 28.0% | 4.51 |
| 1995 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 30.89 | 100% | 30.89 | 27.45 | 100% | 27.45 | 16.13 | 26.0% | 4.20 |
| 1996 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 30.89 | 100% | 30.89 | 27.45 | 100% | 27.45 | 16.13 | 23.5% | 3.79 |
| 1997 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 30.89 | 100% | 30.89 | 27.45 | 100% | 27.45 | 16.13 | 21.6% | 3.48 |
| 1998 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 30.89 | 100% | 30.89 | 27.45 | 100% | 27.45 | 16.13 | 19.6% | 3.16 |
| 1999 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 30.89 | 100% | 30.89 | 27.45 | 100% | 27.45 | 16.13 | 19.7% | 3.18 |
| 2000 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 30.89 | 100% | 30.89 | 27.45 | 100% | 27.45 | 16.13 | 19.1% | 3.08 |
| 2001 | 0.12 | 100% | 0.12 | 4.32 | 100% | 4.32 | 4.44 | 30.89 | 100% | 30.89 | 27.45 | 100% | 27.45 | 16.13 | 20.0% | 3.22 |

| |
|---|
| **NO COST** |
| **VOLUNTARY COST** |
| **MANDATORY COST** |

TABLE 5A
AVERAGE CONSUMER COST PER PASSENGER CAR FOR
IMPLEMENTATION OF THE FMVSS FOR MODEL YEARS 1968-2001

| Model Year | FMVSS 208/209/210 | | | | | | | | | | FMVSS 214 - SIDE IMPACT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SAFETY BELTS | | | DRIVER AIR BAGS | | | DUAL AIR BAGS | | | | STATIC TEST | | | DYNAMIC TEST | | | |
| | Unit Cost | % of Cars | Cost | Unit Cost | % of Cars | Cost | Unit Cost | % of Cars | Cost | 208 Cost | Unit Cost | % of Cars | Cost | Unit Cost | % of Cars | Cost | 214 Cost |
| 1968 | 90.76 | 100% | 90.76 | | | | | | | 90.76 | | | | | | | |
| 1969 | 92.38 | 100% | 92.38 | | | | | | | 92.38 | **67.12** | **17%** | **11.41** | | | | **11.41** |
| 1970 | 92.38 | 100% | 92.38 | | | | | | | 92.38 | **65.91** | **35%** | **23.07** | | | | **23.07** |
| 1971 | 92.38 | 100% | 92.38 | | | | | | | 92.38 | **65.73** | **44%** | **28.92** | | | | **28.92** |
| 1972 | 116.41 | 100% | 116.41 | | | | | | | 116.41 | **66.63** | **49%** | **32.65** | | | | **32.65** |
| 1973 | 116.37 | 100% | 116.37 | | | | | | | 116.37 | 65.99 | 85% | 56.09 | | | | 56.09 |
| 1974 | 118.09 | 100% | 118.09 | | | | | | | 118.09 | 60.82 | 100% | 60.82 | | | | 60.82 |
| 1975 | 118.52 | 100% | 118.52 | | | | | | | 118.52 | 59.08 | 100% | 59.08 | | | | 59.08 |
| 1976 | 118.48 | 100% | 118.48 | | | | | | | 118.48 | 56.41 | 100% | 56.41 | | | | 56.41 |
| 1977 | 116.16 | 100% | 116.16 | | | | | | | 116.16 | 53.94 | 100% | 53.94 | | | | 53.94 |
| 1978 | 116.16 | 100% | 116.16 | | | | | | | 116.16 | 51.15 | 100% | 51.15 | | | | 51.15 |
| 1979 | 116.55 | 100% | 116.55 | | | | | | | 116.55 | 48.12 | 100% | 48.12 | | | | 48.12 |
| 1980 | 116.55 | 100% | 116.55 | | | | | | | 116.55 | 48.27 | 100% | 48.27 | | | | 48.27 |
| 1981 | 117.71 | 100% | 117.71 | | | | | | | 117.71 | 48.91 | 100% | 48.91 | | | | 48.91 |
| 1982 | 116.91 | 100% | 116.91 | | | | | | | 116.91 | 49.21 | 100% | 49.21 | | | | 49.21 |
| 1983 | 117.57 | 100% | 117.57 | | | | | | | 117.57 | 49.58 | 100% | 49.58 | | | | 49.58 |
| 1984 | 117.57 | 100% | 117.57 | | | | | | | 117.57 | 49.54 | 100% | 49.54 | | | | 49.54 |
| 1985 | 117.57 | 100% | 117.57 | **284.09** | **0.1%** | **0.37** | | | | 117.94 | 49.77 | 100% | 49.77 | | | | 49.77 |
| 1986 | 117.60 | 100% | 117.60 | **284.09** | **0.8%** | **2.13** | | | | 119.73 | 49.86 | 100% | 49.86 | | | | 49.86 |
| 1987 | 145.49 | 100% | 145.49 | 284.09 | 1.2% | 3.32 | 396.72 | 0.1% | 0.20 | 149.01 | 50.06 | 100% | 50.06 | | | | 50.06 |
| 1988 | 186.04 | 100% | 186.04 | 284.09 | 1.7% | 4.72 | 396.72 | 0.0% | 0.08 | 190.84 | 49.84 | 100% | 49.84 | | | | 49.84 |
| 1989 | 218.52 | 100% | 218.52 | 284.09 | 3.6% | 10.28 | 396.72 | 0.7% | 2.86 | 231.66 | 49.79 | 100% | 49.79 | | | | 49.79 |
| 1990 | 324.19 | 100% | 324.19 | 284.09 | 26.5% | 75.31 | 396.72 | 2.0% | 7.93 | 407.43 | 50.21 | 100% | 50.21 | | | | 50.21 |
| 1991 | 301.83 | 100% | 301.83 | 284.09 | 35.2% | 99.94 | 396.72 | 0.6% | 2.18 | 403.95 | 50.30 | 100% | 50.30 | | | | 50.30 |
| 1992 | 261.75 | 100% | 261.75 | 284.09 | 48.4% | 137.56 | 396.72 | 4.9% | 19.40 | 418.71 | 50.61 | 100% | 50.61 | | | | 50.61 |
| 1993 | 264.77 | 100% | 264.77 | 284.09 | 49.4% | 140.40 | 396.72 | 14.1% | 55.86 | 461.03 | 50.57 | 100% | 50.57 | | | | 50.57 |
| 1994 | 246.75 | 100% | 246.75 | 284.09 | 25.4% | 72.10 | 396.72 | 58.4% | 231.53 | 550.38 | 50.60 | 100% | 50.60 | 127.10 | 10% | 12.71 | 63.31 |
| 1995 | 176.07 | 100% | 176.07 | 284.09 | 9.1% | 25.97 | 396.72 | 89.5% | 355.10 | 557.14 | 50.75 | 100% | 50.75 | 127.76 | 25% | 31.94 | 82.69 |
| 1996 | 153.47 | 100% | 153.47 | 284.09 | 4.9% | 14.01 | 396.72 | 94.6% | 375.30 | 542.78 | 50.94 | 100% | 50.94 | 128.45 | 40% | 51.38 | 102.32 |
| 1997 | 124.63 | 100% | 124.63 | | | | 396.72 | 100% | 396.72 | 521.35 | 51.09 | 100% | 51.09 | 128.94 | 100% | 128.94 | 180.03 |
| 1998 | 124.63 | 100% | 124.63 | | | | 396.72 | 100% | 396.72 | 521.35 | 51.24 | 100% | 51.24 | 129.44 | 100% | 129.44 | 180.68 |
| 1999 | 124.63 | 100% | 124.63 | | | | 396.72 | 100% | 396.72 | 521.35 | 51.23 | 100% | 51.23 | 129.41 | 100% | 129.41 | 180.64 |
| 2000 | 124.63 | 100% | 124.63 | | | | 396.72 | 100% | 396.72 | 521.35 | 51.28 | 100% | 51.28 | 129.58 | 100% | 129.58 | 180.86 |
| 2001 | 124.63 | 100% | 124.63 | | | | 396.72 | 100% | 396.72 | 521.35 | 51.21 | 100% | 51.21 | 129.35 | 100% | 129.35 | 180.56 |

**NO COST**
**VOLUNTARY COST**
**MANDATORY COST**

TABLE 5A
AVERAGE CONSUMER COST PER PASSENGER CAR FOR
IMPLEMENTATION OF THE FMVSS FOR MODEL YEARS 1968-2001

| Model Year | FMVSS 216 ROOF CRUSH Unit Cost | % of Cars | 216 Cost | FMVSS 301 FUEL SYSTEM INTEGRITY Unit Cost | % of Cars | 301 Cost | TOTAL VOL COST | TOTAL MAND COST | TOTAL FMVSS COST |
|---|---|---|---|---|---|---|---|---|---|
| 1968 | | | | | | | **25.49** | 143.75 | 169.24 |
| 1969 | | | | | | | **32.31** | 183.74 | 216.05 |
| 1970 | | | | | | | **23.07** | 212.95 | 236.02 |
| 1971 | | | | | | | **28.92** | 212.55 | 241.47 |
| 1972 | | | | | | | **32.65** | 235.59 | 268.24 |
| 1973 | | | | | | | | 291.23 | 291.23 |
| 1974 | 3.47 | 100% | 3.47 | | | | | 301.97 | 301.97 |
| 1975 | 3.47 | 100% | 3.47 | | | | | 299.54 | 299.54 |
| 1976 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 312.58 | 312.58 |
| 1977 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 306.66 | 306.66 |
| 1978 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 302.85 | 302.85 |
| 1979 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 299.58 | 299.58 |
| 1980 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 298.26 | 298.26 |
| 1981 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 297.87 | 297.87 |
| 1982 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 297.25 | 297.25 |
| 1983 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 297.61 | 297.61 |
| 1984 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 297.66 | 297.66 |
| 1985 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | **0.84** | 297.45 | 298.29 |
| 1986 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | **2.13** | 297.37 | 299.50 |
| 1987 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 338.32 | 338.32 |
| 1988 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 380.42 | 380.42 |
| 1989 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 421.31 | 421.31 |
| 1990 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 596.71 | 596.71 |
| 1991 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 593.10 | 593.10 |
| 1992 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 607.59 | 607.59 |
| 1993 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 650.01 | 650.01 |
| 1994 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 752.09 | 752.09 |
| 1995 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 777.93 | 777.93 |
| 1996 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 782.84 | 782.84 |
| 1997 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 838.81 | 838.81 |
| 1998 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 839.18 | 839.18 |
| 1999 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 839.16 | 839.16 |
| 2000 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 839.29 | 839.29 |
| 2001 | 3.47 | 100% | 3.47 | 16.51 | 100% | 16.51 | | 839.13 | 839.13 |

**NO COST**
**VOLUNTARY COST**
**MANDATORY COST**

TABLE 5B
AVERAGE WEIGHT PER PASSENGER CAR FOR
IMPLEMENTATION OF THE FMVSS FOR MODEL YEARS 1968-2001

| Model | FMVSS 105 - BRAKES | | | FMVSS 108 - LAMPS | | | | | | | FMVSS 118 | | | FMVSS 124 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DUAL MASTER CYL. | | | SIDE MARKER | | | CHMSL | | | | POWER WINDOWS | | | ACCELERATOR CONTROLS | | |
| Year | Unit Weight | % of Cars | 105 Weight | Unit Weight | % of Cars | Weight | Unit Weight | % of Cars | Weight | 108 Weight | Unit Weight | % of Cars | 118 Weight | Unit Weight | % of Cars | 124 Weight |
| 1968 | 1.74 | 100% | 1.74 | **1.46** | **100%** | **1.46** | | | | **1.46** | | | | | | |
| 1969 | 1.74 | 100% | 1.74 | **1.46** | **100%** | **1.46** | | | | **1.46** | | | | | | |
| 1970 | 1.74 | 100% | 1.74 | 1.95 | 100% | 1.95 | | | | 1.95 | | | | | | |
| 1971 | 1.74 | 100% | 1.74 | 1.95 | 100% | 1.95 | | | | 1.95 | 0.04 | 20.6% | 0.01 | | | |
| 1972 | 1.74 | 100% | 1.74 | 1.95 | 100% | 1.95 | | | | 1.95 | 0.04 | 26.6% | 0.01 | | | |
| 1973 | 1.74 | 100% | 1.74 | 1.95 | 100% | 1.95 | | | | 1.95 | 0.04 | 25.7% | 0.01 | | | |
| 1974 | 1.74 | 100% | 1.74 | 1.95 | 100% | 1.95 | | | | 1.95 | 0.04 | 18.9% | 0.01 | 0.02 | 100% | 0.02 |
| 1975 | 1.74 | 100% | 1.74 | 1.95 | 100% | 1.95 | | | | 1.95 | 0.04 | 24.5% | 0.01 | 0.02 | 100% | 0.02 |
| 1976 | 1.74 | 100% | 1.74 | 1.95 | 100% | 1.95 | | | | 1.95 | 0.04 | 23.1% | 0.01 | 0.02 | 100% | 0.02 |
| 1977 | 1.61 | 100% | 1.61 | 1.95 | 100% | 1.95 | | | | 1.95 | 0.04 | 27.0% | 0.01 | 0.02 | 100% | 0.02 |
| 1978 | 1.48 | 100% | 1.48 | 1.95 | 100% | 1.95 | | | | 1.95 | 0.04 | 23.8% | 0.01 | 0.02 | 100% | 0.02 |
| 1979 | 1.34 | 100% | 1.34 | 1.95 | 100% | 1.95 | | | | 1.95 | 0.04 | 25.0% | 0.01 | 0.02 | 100% | 0.02 |
| 1980 | 1.21 | 100% | 1.21 | 1.95 | 100% | 1.95 | | | | 1.95 | 0.04 | 20.3% | 0.01 | 0.02 | 100% | 0.02 |
| 1981 | 1.08 | 100% | 1.08 | 1.95 | 100% | 1.95 | | | | 1.95 | 0.04 | 23.4% | 0.01 | 0.02 | 100% | 0.02 |
| 1982 | 0.95 | 100% | 0.95 | 1.95 | 100% | 1.95 | | | | 1.95 | 0.04 | 28.4% | 0.01 | 0.02 | 100% | 0.02 |
| 1983 | 0.95 | 100% | 0.95 | 1.95 | 100% | 1.95 | | | | 1.95 | 0.04 | 39.0% | 0.02 | 0.02 | 100% | 0.02 |
| 1984 | 0.95 | 100% | 0.95 | 1.95 | 100% | 1.95 | | | | 1.95 | 0.04 | 40.3% | 0.02 | 0.02 | 100% | 0.02 |
| 1985 | 0.95 | 100% | 0.95 | 1.95 | 100% | 1.95 | **0.85** | **4.8%** | **0.04** | 1.99 | 0.04 | 44.4% | 0.02 | 0.02 | 100% | 0.02 |
| 1986 | 0.95 | 100% | 0.95 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 43.0% | 0.02 | 0.02 | 100% | 0.02 |
| 1987 | 0.95 | 100% | 0.95 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 42.5% | 0.02 | 0.02 | 100% | 0.02 |
| 1988 | 0.95 | 100% | 0.95 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 46.9% | 0.02 | 0.02 | 100% | 0.02 |
| 1989 | 0.95 | 100% | 0.95 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 49.4% | 0.02 | 0.02 | 100% | 0.02 |
| 1990 | 0.95 | 100% | 0.95 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 57.6% | 0.02 | 0.02 | 100% | 0.02 |
| 1991 | 0.95 | 100% | 0.95 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 54.9% | 0.02 | 0.02 | 100% | 0.02 |
| 1992 | 0.95 | 100% | 0.95 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 61.8% | 0.02 | 0.02 | 100% | 0.02 |
| 1993 | 0.95 | 100% | 0.95 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 67.7% | 0.03 | 0.02 | 100% | 0.02 |
| 1994 | 0.95 | 100% | 0.95 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 73.2% | 0.03 | 0.02 | 100% | 0.02 |
| 1995 | 0.95 | 100% | 0.95 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 73.7% | 0.03 | 0.02 | 100% | 0.02 |
| 1996 | 0.95 | 100% | 0.95 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 79.6% | 0.03 | 0.02 | 100% | 0.02 |
| 1997 | 0.95 | 100% | 0.95 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 79.6% | 0.03 | 0.02 | 100% | 0.02 |
| 1998 | 0.95 | 100% | 0.95 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 83.0% | 0.03 | 0.02 | 100% | 0.02 |
| 1999 | 0.95 | 100% | 0.95 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 83.0% | 0.03 | 0.02 | 100% | 0.02 |
| 2000 | 0.95 | 100% | 0.95 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 85.0% | 0.03 | 0.02 | 100% | 0.02 |
| 2001 | 0.95 | 100% | 0.95 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 85.0% | 0.03 | 0.02 | 100% | 0.02 |

**NO WEIGHT**
**VOLUNTARY WEIGHT**
**MANDATORY WEIGHT**

TABLE 5B
AVERAGE WEIGHT PER PASSENGER CAR FOR
IMPLEMENTATION OF THE FMVSS FOR MODEL YEARS 1968-2001

| Model Year | FMVSS 201 - INTERIOR PROTECTION: GLOVE COMP. DOORS: Unit Weight | % of Cars | Weight | SEAT BACK PADDING: Unit Weight | % of Cars | Weight | 201 Weight | FMVSS 202 HEAD RESTRAINTS: Unit Weight | % of Cars | 202 Weight | FMVSS 203/204 STEERING ASSEMBLY: Unit Weight | % of Cars | 203-4 Weight | FMVSS 207 SEAT BACK LOCKS: Unit Weight | % of Cars | Weight |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1968 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | **8.77** | **12%** | **1.05** | 1.89 | 100% | 1.89 | 3.07 | 54.2% | 1.66 |
| 1969 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 8.77 | 100% | 8.77 | 1.89 | 100% | 1.89 | 3.07 | 54.8% | 1.68 |
| 1970 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 8.52 | 100% | 8.52 | 1.89 | 100% | 1.89 | 3.07 | 57.9% | 1.78 |
| 1971 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 8.27 | 100% | 8.27 | 1.89 | 100% | 1.89 | 3.07 | 58.4% | 1.79 |
| 1972 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 8.02 | 100% | 8.02 | 1.89 | 100% | 1.89 | 3.07 | 56.2% | 1.72 |
| 1973 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 7.76 | 100% | 7.76 | 1.89 | 100% | 1.89 | 3.07 | 57.8% | 1.77 |
| 1974 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 7.51 | 100% | 7.51 | 1.89 | 100% | 1.89 | 3.07 | 64.3% | 1.97 |
| 1975 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 7.26 | 100% | 7.26 | 1.89 | 100% | 1.89 | 3.07 | 61.3% | 1.88 |
| 1976 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 7.01 | 100% | 7.01 | 1.89 | 100% | 1.89 | 3.07 | 60.9% | 1.87 |
| 1977 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 6.76 | 100% | 6.76 | 1.89 | 100% | 1.89 | 3.07 | 59.2% | 1.82 |
| 1978 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 6.50 | 100% | 6.50 | 1.89 | 100% | 1.89 | 3.07 | 58.5% | 1.80 |
| 1979 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 6.25 | 100% | 6.25 | 1.89 | 100% | 1.89 | 3.07 | 60.0% | 1.84 |
| 1980 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 6.00 | 100% | 6.00 | 1.89 | 100% | 1.89 | 3.96 | 58.1% | 2.30 |
| 1981 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 5.75 | 100% | 5.75 | 1.89 | 100% | 1.89 | 3.96 | 49.7% | 1.97 |
| 1982 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 5.63 | 100% | 5.63 | 1.89 | 100% | 1.89 | 3.96 | 45.8% | 1.81 |
| 1983 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 5.63 | 100% | 5.63 | 1.89 | 100% | 1.89 | 3.96 | 41.1% | 1.63 |
| 1984 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 5.63 | 100% | 5.63 | 1.89 | 100% | 1.89 | 3.96 | 41.6% | 1.65 |
| 1985 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 5.63 | 100% | 5.63 | 1.89 | 100% | 1.89 | 3.96 | 38.6% | 1.53 |
| 1986 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 5.63 | 100% | 5.63 | 1.89 | 100% | 1.89 | 3.96 | 37.4% | 1.48 |
| 1987 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 5.63 | 100% | 5.63 | 1.89 | 100% | 1.89 | 3.96 | 34.9% | 1.38 |
| 1988 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 5.63 | 100% | 5.63 | 1.89 | 100% | 1.89 | 3.96 | 37.8% | 1.50 |
| 1989 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 5.63 | 100% | 5.63 | 1.89 | 100% | 1.89 | 3.96 | 38.3% | 1.52 |
| 1990 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 5.63 | 100% | 5.63 | 1.89 | 100% | 1.89 | 3.96 | 33.0% | 1.31 |
| 1991 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 5.63 | 100% | 5.63 | 1.89 | 100% | 1.89 | 3.96 | 31.8% | 1.26 |
| 1992 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 5.63 | 100% | 5.63 | 1.89 | 100% | 1.89 | 3.96 | 27.8% | 1.10 |
| 1993 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 5.63 | 100% | 5.63 | 1.89 | 100% | 1.89 | 3.96 | 28.4% | 1.12 |
| 1994 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 5.63 | 100% | 5.63 | 1.89 | 100% | 1.89 | 3.96 | 28.0% | 1.11 |
| 1995 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 5.63 | 100% | 5.63 | 1.89 | 100% | 1.89 | 3.96 | 26.0% | 1.03 |
| 1996 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 5.63 | 100% | 5.63 | 1.89 | 100% | 1.89 | 3.96 | 23.5% | 0.93 |
| 1997 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 5.63 | 100% | 5.63 | 1.89 | 100% | 1.89 | 3.96 | 21.6% | 0.85 |
| 1998 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 5.63 | 100% | 5.63 | 1.89 | 100% | 1.89 | 3.96 | 19.6% | 0.78 |
| 1999 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 5.63 | 100% | 5.63 | 1.89 | 100% | 1.89 | 3.96 | 19.7% | 0.78 |
| 2000 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 5.63 | 100% | 5.63 | 1.89 | 100% | 1.89 | 3.96 | 19.1% | 0.76 |
| 2001 | 0.01 | 100% | 0.01 | 0.65 | 100% | 0.65 | 0.66 | 5.63 | 100% | 5.63 | 1.89 | 100% | 1.89 | 3.96 | 20.0% | 0.79 |

**NO WEIGHT**
**VOLUNTARY WEIGHT**
**MANDATORY WEIGHT**

TABLE 5B
AVERAGE WEIGHT PER PASSENGER CAR FOR
IMPLEMENTATION OF THE FMVSS FOR MODEL YEARS 1968-2001

| Model Year | FMVSS 208/209/210 | | | | | | | | | | FMVSS 214 - SIDE IMPACT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SAFETY BELTS | | | DRIVER AIR BAGS | | | DUAL AIR BAGS | | | | STATIC TEST | | | DYNAMIC TEST | | | |
| | Unit Weight | % of Cars | Weight | Unit Weight | % of Cars | Weight | Unit Weight | % of Cars | Weight | 208 Weight | Unit Weight | % of Cars | Weight | Unit Weight | % of Cars | Weight | 214 Weight |
| 1968 | 9.92 | 100% | 9.92 | | | | | | | 9.92 | | | | | | | |
| 1969 | 10.49 | 100% | 10.49 | | | | | | | 10.49 | **38.00** | **17%** | **6.46** | | | | **6.46** |
| 1970 | 10.49 | 100% | 10.49 | | | | | | | 10.49 | **37.66** | **35%** | **13.18** | | | | **13.18** |
| 1971 | 10.49 | 100% | 10.49 | | | | | | | 10.49 | **37.61** | **44%** | **16.55** | | | | **16.55** |
| 1972 | 15.28 | 100% | 15.28 | | | | | | | 15.28 | **37.84** | **49%** | **18.54** | | | | **18.54** |
| 1973 | 15.29 | 100% | 15.29 | | | | | | | 15.29 | 37.67 | 85% | 32.02 | | | | 32.02 |
| 1974 | 16.51 | 100% | 16.51 | | | | | | | 16.51 | 35.29 | 100% | 35.29 | | | | 35.29 |
| 1975 | 16.58 | 100% | 16.58 | | | | | | | 16.58 | 33.72 | 100% | 33.72 | | | | 33.72 |
| 1976 | 16.57 | 100% | 16.57 | | | | | | | 16.57 | 31.94 | 100% | 31.94 | | | | 31.94 |
| 1977 | 16.40 | 100% | 16.40 | | | | | | | 16.40 | 30.15 | 100% | 30.15 | | | | 30.15 |
| 1978 | 16.40 | 100% | 16.40 | | | | | | | 16.40 | 28.29 | 100% | 28.29 | | | | 28.29 |
| 1979 | 16.47 | 100% | 16.47 | | | | | | | 16.47 | 26.49 | 100% | 26.49 | | | | 26.49 |
| 1980 | 16.47 | 100% | 16.47 | | | | | | | 16.47 | 26.41 | 100% | 26.41 | | | | 26.41 |
| 1981 | 16.53 | 100% | 16.53 | | | | | | | 16.53 | 26.06 | 100% | 26.06 | | | | 26.06 |
| 1982 | 16.48 | 100% | 16.48 | | | | | | | 16.48 | 25.90 | 100% | 25.90 | | | | 25.90 |
| 1983 | 16.53 | 100% | 16.53 | | | | | | | 16.53 | 25.70 | 100% | 25.70 | | | | 25.70 |
| 1984 | 16.53 | 100% | 16.53 | | | | | | | 16.53 | 25.72 | 100% | 25.72 | | | | 25.72 |
| 1985 | 16.53 | 100% | 16.53 | **13.46** | **0.1%** | **0.02** | | | | 16.55 | 25.60 | 100% | 25.60 | | | | 25.60 |
| 1986 | 16.54 | 100% | 16.54 | **13.46** | **0.8%** | **0.10** | | | | 16.64 | 25.55 | 100% | 25.55 | | | | 25.55 |
| 1987 | 18.77 | 100% | 18.77 | 13.46 | 1.2% | 0.16 | 26.76 | 0.1% | 0.01 | 18.94 | 25.44 | 100% | 25.44 | | | | 25.44 |
| 1988 | 22.18 | 100% | 22.18 | 13.46 | 1.7% | 0.22 | 26.76 | 0.0% | 0.01 | 22.41 | 25.56 | 100% | 25.56 | | | | 25.56 |
| 1989 | 25.01 | 100% | 25.01 | 13.46 | 3.6% | 0.49 | 26.76 | 0.7% | 0.19 | 25.69 | 25.59 | 100% | 25.59 | | | | 25.59 |
| 1990 | 33.86 | 100% | 33.86 | 13.46 | 26.5% | 3.57 | 26.76 | 2.0% | 0.54 | 37.97 | 25.36 | 100% | 25.36 | | | | 25.36 |
| 1991 | 31.29 | 100% | 31.29 | 13.46 | 35.2% | 4.74 | 26.76 | 0.6% | 0.15 | 36.18 | 25.31 | 100% | 25.31 | | | | 25.31 |
| 1992 | 28.31 | 100% | 28.31 | 13.46 | 48.4% | 6.52 | 26.76 | 4.9% | 1.31 | 36.14 | 25.14 | 100% | 25.14 | | | | 25.14 |
| 1993 | 28.66 | 100% | 28.66 | 13.46 | 49.4% | 6.65 | 26.76 | 14.1% | 3.77 | 39.08 | 25.17 | 100% | 25.17 | | | | 25.17 |
| 1994 | 27.35 | 100% | 27.35 | 13.46 | 25.4% | 3.42 | 26.76 | 58.4% | 15.62 | 46.39 | 25.15 | 100% | 25.15 | 36.20 | 10% | 3.62 | 28.77 |
| 1995 | 22.19 | 100% | 22.19 | 13.46 | 9.1% | 1.23 | 26.76 | 89.5% | 23.95 | 47.37 | 25.06 | 100% | 25.06 | 36.44 | 25% | 9.11 | 34.17 |
| 1996 | 20.53 | 100% | 20.53 | 13.46 | 4.9% | 0.66 | 26.76 | 94.6% | 25.31 | 46.50 | 24.96 | 100% | 24.96 | 36.80 | 40% | 14.72 | 39.68 |
| 1997 | 18.38 | 100% | 18.38 | | | | 26.76 | 100% | 26.76 | 45.14 | 24.88 | 100% | 24.88 | 37.07 | 100% | 37.07 | 61.95 |
| 1998 | 18.38 | 100% | 18.38 | | | | 26.76 | 100% | 26.76 | 45.14 | 24.79 | 100% | 24.79 | 37.37 | 100% | 37.37 | 62.16 |
| 1999 | 18.38 | 100% | 18.38 | | | | 26.76 | 100% | 26.76 | 45.14 | 24.80 | 100% | 24.80 | 37.35 | 100% | 37.35 | 62.15 |
| 2000 | 18.38 | 100% | 18.38 | | | | 26.76 | 100% | 26.76 | 45.14 | 24.77 | 100% | 24.77 | 37.45 | 100% | 37.45 | 62.22 |
| 2001 | 18.38 | 100% | 18.38 | | | | 26.76 | 100% | 26.76 | 45.14 | 24.81 | 100% | 24.81 | 37.31 | 100% | 37.31 | 62.12 |

**NO WEIGHT**
**VOLUNTARY WEIGHT**
**MANDATORY WEIGHT**

TABLE 5B
AVERAGE WEIGHT PER PASSENGER CAR FOR
IMPLEMENTATION OF THE FMVSS FOR MODEL YEARS 1968-2001

| Model Year | FMVSS 216 ROOF CRUSH Unit Weight | % of Cars | 216 Weight | FMVSS 301 FUEL SYSTEM INTEGRITY Unit Weight | % of Cars | 301 Weight | TOTAL VOL WEIGHT | TOTAL MAND WEIGHT | TOTAL FMVSS WEIGHT |
|---|---|---|---|---|---|---|---|---|---|
| 1968 | | | | | | | **2.51** | 15.87 | 18.39 |
| 1969 | | | | | | | **7.92** | 25.23 | 33.15 |
| 1970 | | | | | | | **13.18** | 27.03 | 40.21 |
| 1971 | | | | | | | **16.55** | 26.80 | 43.35 |
| 1972 | | | | | | | **18.54** | 31.27 | 49.82 |
| 1973 | | | | | | | | 63.09 | 63.09 |
| 1974 | 2.93 | 100% | 2.93 | | | | | 70.48 | 70.48 |
| 1975 | 2.93 | 100% | 2.93 | | | | | 68.64 | 68.64 |
| 1976 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 69.07 | 69.07 |
| 1977 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 66.68 | 66.68 |
| 1978 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 64.41 | 64.41 |
| 1979 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 62.33 | 62.33 |
| 1980 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 62.33 | 62.33 |
| 1981 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 61.33 | 61.33 |
| 1982 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 60.72 | 60.72 |
| 1983 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 60.38 | 60.38 |
| 1984 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 60.42 | 60.42 |
| 1985 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | **0.06** | 60.19 | 60.24 |
| 1986 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | **0.10** | 60.10 | 60.20 |
| 1987 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 63.14 | 63.14 |
| 1988 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 66.84 | 66.84 |
| 1989 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 70.18 | 70.18 |
| 1990 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 82.02 | 82.02 |
| 1991 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 80.13 | 80.13 |
| 1992 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 79.76 | 79.76 |
| 1993 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 82.76 | 82.76 |
| 1994 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 93.66 | 93.66 |
| 1995 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 99.96 | 99.96 |
| 1996 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 104.50 | 104.50 |
| 1997 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 125.34 | 125.34 |
| 1998 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 125.47 | 125.47 |
| 1999 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 125.46 | 125.46 |
| 2000 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 125.51 | 125.51 |
| 2001 | 2.93 | 100% | 2.93 | 2.48 | 100% | 2.48 | | 125.44 | 125.44 |

**NO WEIGHT**
**VOLUNTARY WEIGHT**
**MANDATORY WEIGHT**

TABLE 5C
AVERAGE CONSUMER COST PER LIGHT TRUCK FOR
IMPLEMENTATION OF THE FMVSS FOR MODEL YEARS 1968-2001

| | FMVSS 104 - WINDSHIELD WIPING/WASHING SYSTEMS | | | | | | | FMVSS 105 - HYDRAULIC BRAKES | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | WIPERS | | | WASHERS | | | | DUAL MASTER CYLINDER | | | WARNING LIGHT | | | |
| Model Year | Unit Cost | % of LTs | Cost | Unit Cost | % of LTs | Cost | 104 Cost | Unit Cost | % of LTs | Cost | Unit Cost | % of LTs | Cost | 105 Cost |
| 1968 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | **10.88** | **100%** | **10.88** | | | | **10.88** |
| 1969 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | **10.88** | **100%** | **10.88** | | | | **10.88** |
| 1970 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | **10.88** | **100%** | **10.88** | | | | **10.88** |
| 1971 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | **10.88** | **100%** | **10.88** | | | | **10.88** |
| 1972 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | **10.88** | **100%** | **10.88** | | | | **10.88** |
| 1973 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | **10.88** | **100%** | **10.88** | | | | **10.88** |
| 1974 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | **10.88** | **100%** | **10.88** | | | | **10.88** |
| 1975 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | **10.88** | **100%** | **10.88** | | | | **10.88** |
| 1976 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | **10.88** | **100%** | **10.88** | | | | **10.88** |
| 1977 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | **10.88** | **100%** | **10.88** | | | | **10.88** |
| 1978 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | **10.88** | **100%** | **10.88** | | | | **10.88** |
| 1979 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | **10.88** | **100%** | **10.88** | | | | **10.88** |
| 1980 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | **10.88** | **100%** | **10.88** | | | | **10.88** |
| 1981 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | **10.88** | **100%** | **10.88** | | | | **10.88** |
| 1982 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | **10.88** | **100%** | **10.88** | | | | **10.88** |
| 1983 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | **10.88** | **100%** | **10.88** | | | | **10.88** |
| 1984 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | 10.88 | 100% | 10.88 | 0.12 | 100% | 0.12 | 11.00 |
| 1985 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | 10.88 | 100% | 10.88 | 0.12 | 100% | 0.12 | 11.00 |
| 1986 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | 10.88 | 100% | 10.88 | 0.12 | 100% | 0.12 | 11.00 |
| 1987 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | 10.88 | 100% | 10.88 | 0.12 | 100% | 0.12 | 11.00 |
| 1988 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | 10.88 | 100% | 10.88 | 0.12 | 100% | 0.12 | 11.00 |
| 1989 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | 10.88 | 100% | 10.88 | 0.12 | 100% | 0.12 | 11.00 |
| 1990 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | 10.88 | 100% | 10.88 | 0.12 | 100% | 0.12 | 11.00 |
| 1991 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | 10.88 | 100% | 10.88 | 0.12 | 100% | 0.12 | 11.00 |
| 1992 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | 10.88 | 100% | 10.88 | 0.12 | 100% | 0.12 | 11.00 |
| 1993 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | 10.88 | 100% | 10.88 | 0.12 | 100% | 0.12 | 11.00 |
| 1994 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | 10.88 | 100% | 10.88 | 0.12 | 100% | 0.12 | 11.00 |
| 1995 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | 10.88 | 100% | 10.88 | 0.12 | 100% | 0.12 | 11.00 |
| 1996 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | 10.88 | 100% | 10.88 | 0.12 | 100% | 0.12 | 11.00 |
| 1997 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | 10.88 | 100% | 10.88 | 0.12 | 100% | 0.12 | 11.00 |
| 1998 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | 10.88 | 100% | 10.88 | 0.12 | 100% | 0.12 | 11.00 |
| 1999 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | 10.88 | 100% | 10.88 | 0.12 | 100% | 0.12 | 11.00 |
| 2000 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | 10.88 | 100% | 10.88 | 0.12 | 100% | 0.12 | 11.00 |
| 2001 | 4.02 | 100% | 4.02 | 11.03 | 100% | 11.03 | 15.05 | 10.88 | 100% | 10.88 | 0.12 | 100% | 0.12 | 11.00 |

**NO COST**
**VOLUNTARY COST**
**MANDATORY COST**

TABLE 5C
AVERAGE CONSUMER COST PER LIGHT TRUCK FOR
IMPLEMENTATION OF THE FMVSS FOR MODEL YEARS 1968-2001

| | FMVSS 108 - LAMPS | | | | | | | FMVSS 118 | | | FMVSS 124 | | | FMVSS 201 - INT.PROTECTION | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SIDE MARKER | | | CHMSL | | | | POWER WINDOWS | | | ACCELERATOR CONTROLS | | | SEAT BACK PADDING | | |
| Model Year | Unit Cost | % of LTs | Cost | Unit Cost | % of LTs | Cost | 108 Cost | Unit Cost | % of LTs | 118 Cost | Unit Cost | % of LTs | 124 Cost | Unit Cost | % of LTs | 201 Cost |
| 1968 | **20.90** | **100%** | **20.90** | | | | **20.90** | | | | | | | | | |
| 1969 | **20.90** | **100%** | **20.90** | | | | **20.90** | | | | | | | | | |
| 1970 | 29.37 | 100% | 29.37 | | | | 29.37 | | | | | | | | | |
| 1971 | 29.37 | 100% | 29.37 | | | | 29.37 | | | | | | | | | |
| 1972 | 29.37 | 100% | 29.37 | | | | 29.37 | | | | | | | | | |
| 1973 | 29.37 | 100% | 29.37 | | | | 29.37 | | | | | | | | | |
| 1974 | 29.37 | 100% | 29.37 | | | | 29.37 | | | | 0.47 | 100% | 0.47 | | | |
| 1975 | 29.37 | 100% | 29.37 | | | | 29.37 | | | | 0.47 | 100% | 0.47 | | | |
| 1976 | 29.37 | 100% | 29.37 | | | | 29.37 | | | | 0.47 | 100% | 0.47 | | | |
| 1977 | 29.37 | 100% | 29.37 | | | | 29.37 | | | | 0.47 | 100% | 0.47 | | | |
| 1978 | 29.37 | 100% | 29.37 | | | | 29.37 | **0.92** | **2.3%** | **0.02** | 0.47 | 100% | 0.47 | | | |
| 1979 | 29.37 | 100% | 29.37 | | | | 29.37 | **0.92** | **3.6%** | **0.03** | 0.47 | 100% | 0.47 | | | |
| 1980 | 29.37 | 100% | 29.37 | | | | 29.37 | **0.92** | **5.5%** | **0.05** | 0.47 | 100% | 0.47 | | | |
| 1981 | 29.37 | 100% | 29.37 | | | | 29.37 | **0.92** | **7.9%** | **0.07** | 0.47 | 100% | 0.47 | | | |
| 1982 | 29.37 | 100% | 29.37 | | | | 29.37 | **0.92** | **12.2%** | **0.11** | 0.47 | 100% | 0.47 | 13.48 | 33.3% | 4.48 |
| 1983 | 29.37 | 100% | 29.37 | | | | 29.37 | **0.92** | **15.4%** | **0.14** | 0.47 | 100% | 0.47 | 13.48 | 33.3% | 4.48 |
| 1984 | 29.37 | 100% | 29.37 | | | | 29.37 | **0.92** | **19.0%** | **0.17** | 0.47 | 100% | 0.47 | 13.48 | 33.3% | 4.48 |
| 1985 | 29.37 | 100% | 29.37 | | | | 29.37 | **0.92** | **22.4%** | **0.21** | 0.47 | 100% | 0.47 | 13.48 | 33.3% | 4.48 |
| 1986 | 29.37 | 100% | 29.37 | | | | 29.37 | **0.92** | **24.6%** | **0.23** | 0.47 | 100% | 0.47 | 13.48 | 33.3% | 4.48 |
| 1987 | 29.37 | 100% | 29.37 | | | | 29.37 | **0.92** | **27.5%** | **0.25** | 0.47 | 100% | 0.47 | 13.48 | 51.1% | 6.88 |
| 1988 | 29.37 | 100% | 29.37 | | | | 29.37 | **0.92** | **29.6%** | **0.27** | 0.47 | 100% | 0.47 | 13.48 | 51.1% | 6.88 |
| 1989 | 29.37 | 100% | 29.37 | | | | 29.37 | 0.92 | 37.4% | 0.34 | 0.47 | 100% | 0.47 | 13.48 | 51.1% | 6.88 |
| 1990 | 29.37 | 100% | 29.37 | | | | 29.37 | 0.92 | 46.2% | 0.43 | 0.47 | 100% | 0.47 | 13.48 | 51.1% | 6.88 |
| 1991 | 29.37 | 100% | 29.37 | **9.74** | **28.9%** | **2.82** | 32.19 | 0.92 | 48.3% | 0.44 | 0.47 | 100% | 0.47 | 13.48 | 51.1% | 6.88 |
| 1992 | 29.37 | 100% | 29.37 | **9.74** | **24.7%** | **2.40** | 31.77 | 0.92 | 47.2% | 0.43 | 0.47 | 100% | 0.47 | 13.48 | 51.1% | 6.88 |
| 1993 | 29.37 | 100% | 29.37 | **9.74** | **28.0%** | **2.73** | 32.10 | 0.92 | 54.9% | 0.50 | 0.47 | 100% | 0.47 | 13.48 | 51.1% | 6.88 |
| 1994 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 56.4% | 0.52 | 0.47 | 100% | 0.47 | 13.48 | 51.1% | 6.88 |
| 1995 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 61.6% | 0.57 | 0.47 | 100% | 0.47 | 13.48 | 83.5% | 11.25 |
| 1996 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 65.5% | 0.60 | 0.47 | 100% | 0.47 | 13.48 | 83.5% | 11.25 |
| 1997 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 67.5% | 0.62 | 0.47 | 100% | 0.47 | 13.48 | 83.5% | 11.25 |
| 1998 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 74.1% | 0.68 | 0.47 | 100% | 0.47 | 13.48 | 83.5% | 11.25 |
| 1999 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 77.1% | 0.71 | 0.47 | 100% | 0.47 | 13.48 | 83.5% | 11.25 |
| 2000 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 77.7% | 0.71 | 0.47 | 100% | 0.47 | 13.48 | 83.5% | 11.25 |
| 2001 | 29.37 | 100% | 29.37 | 9.74 | 100% | 9.74 | 39.11 | 0.92 | 83.5% | 0.77 | 0.47 | 100% | 0.47 | 13.48 | 83.5% | 11.25 |

**NO COST**
**VOLUNTARY COST**
**MANDATORY COST**

TABLE 5C
AVERAGE CONSUMER COST PER LIGHT TRUCK FOR
IMPLEMENTATION OF THE FMVSS FOR MODEL YEARS 1968-2001

| | FMVSS 202 | | | FMVSS 203/204 | | | FMVSS 208/209/210 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HEAD RESTRAINTS | | | STEERING ASSEMBLY | | | SAFETY BELTS | | | DRIVER AIR BAGS | | | DUAL AIR BAGS | | | ON/OFF SWITCHES | | | |
| Model Year | Unit Cost | % of LTs | 202 Cost | Unit Cost | % of LTs | 203-4 Cost | Unit Cost | % of LTs | Cost | Unit Cost | % of LTs | Cost | Unit Cost | % of LTs | Cost | Unit Cost | % of LTs | Cost | 208 Cost |
| 1968 | 30.97 | 10.3% | 3.20 | | | | 56.55 | 100% | 56.55 | | | | | | | | | | 56.55 |
| 1969 | 30.97 | 10.3% | 3.20 | | | | 56.61 | 100% | 56.61 | | | | | | | | | | 56.61 |
| 1970 | 30.97 | 10.3% | 3.20 | 27.45 | 3% | 0.82 | 56.63 | 100% | 56.63 | | | | | | | | | | 56.63 |
| 1971 | 30.97 | 10.3% | 3.20 | 27.45 | 4% | 1.10 | 56.64 | 100% | 56.64 | | | | | | | | | | 56.64 |
| 1972 | 30.97 | 10.3% | 3.20 | 27.45 | 2% | 0.55 | 83.21 | 100% | 83.21 | | | | | | | | | | 83.21 |
| 1973 | 30.97 | 10.3% | 3.20 | 27.45 | 47% | 12.90 | 83.21 | 100% | 83.21 | | | | | | | | | | 83.21 |
| 1974 | 30.97 | 24.1% | 7.46 | 27.45 | 48% | 13.18 | 84.39 | 100% | 84.39 | | | | | | | | | | 84.39 |
| 1975 | 30.97 | 24.1% | 7.46 | 27.45 | 48% | 13.18 | 84.47 | 100% | 84.47 | | | | | | | | | | 84.47 |
| 1976 | 30.97 | 24.1% | 7.46 | 27.45 | 53% | 14.55 | 84.50 | 100% | 84.50 | | | | | | | | | | 84.50 |
| 1977 | 30.97 | 24.1% | 7.46 | 27.45 | 55% | 15.10 | 94.82 | 100% | 94.82 | | | | | | | | | | 94.82 |
| 1978 | 30.97 | 24.1% | 7.46 | 27.45 | 53% | 14.55 | 94.83 | 100% | 94.83 | | | | | | | | | | 94.83 |
| 1979 | 30.97 | 24.1% | 7.46 | 27.45 | 60% | 16.47 | 94.82 | 100% | 94.82 | | | | | | | | | | 94.82 |
| 1980 | 30.97 | 24.1% | 7.46 | 27.45 | 77% | 21.14 | 95.04 | 100% | 95.04 | | | | | | | | | | 95.04 |
| 1981 | 30.97 | 24.1% | 7.46 | 27.45 | 79% | 21.69 | 95.14 | 100% | 95.14 | | | | | | | | | | 95.14 |
| 1982 | 30.97 | 24.1% | 7.46 | 27.45 | 100% | 27.45 | 95.14 | 100% | 95.14 | | | | | | | | | | 95.14 |
| 1983 | 30.97 | 40.8% | 12.63 | 27.45 | 100% | 27.45 | 95.14 | 100% | 95.14 | | | | | | | | | | 95.14 |
| 1984 | 30.97 | 47.2% | 14.63 | 27.45 | 100% | 27.45 | 95.14 | 100% | 95.14 | | | | | | | | | | 95.14 |
| 1985 | 30.97 | 53.8% | 16.65 | 27.45 | 100% | 27.45 | 95.14 | 100% | 95.14 | | | | | | | | | | 95.14 |
| 1986 | 30.97 | 55.3% | 17.11 | 27.45 | 100% | 27.45 | 95.14 | 100% | 95.14 | | | | | | | | | | 95.14 |
| 1987 | 30.97 | 64.3% | 19.91 | 27.45 | 100% | 27.45 | 106.63 | 100% | 106.63 | | | | | | | | | | 106.63 |
| 1988 | 30.97 | 60.9% | 18.85 | 27.45 | 100% | 27.45 | 106.72 | 100% | 106.72 | | | | | | | | | | 106.72 |
| 1989 | 30.97 | 58.2% | 18.02 | 27.45 | 100% | 27.45 | 107.32 | 100% | 107.32 | | | | | | | | | | 107.32 |
| 1990 | 30.97 | 69.4% | 21.51 | 27.45 | 100% | 27.45 | 107.49 | 100% | 107.49 | | | | | | | | | | 107.49 |
| 1991 | 30.97 | 70.5% | 21.84 | 27.45 | 100% | 27.45 | 107.89 | 100% | 107.89 | 265.78 | 3.1% | 8.19 | | | | | | | 116.08 |
| 1992 | 30.97 | 100% | 30.97 | 27.45 | 100% | 27.45 | 111.90 | 100% | 111.90 | 265.78 | 14.8% | 39.20 | | | | | | | 151.10 |
| 1993 | 30.97 | 100% | 30.97 | 27.45 | 100% | 27.45 | 111.90 | 100% | 111.90 | 265.78 | 19.3% | 51.30 | | | | | | | 163.20 |
| 1994 | 30.97 | 100% | 30.97 | 27.45 | 100% | 27.45 | 111.90 | 100% | 111.90 | 265.78 | 26.8% | 71.18 | 383.75 | 7.6% | 29.01 | | | | 212.09 |
| 1995 | 30.97 | 100% | 30.97 | 27.45 | 100% | 27.45 | 137.57 | 100% | 137.57 | 265.78 | 66.3% | 176.21 | 383.75 | 13.6% | 52.11 | | | | 365.89 |
| 1996 | 30.97 | 100% | 30.97 | 27.45 | 100% | 27.45 | 137.57 | 100% | 137.57 | 265.78 | 55.6% | 147.67 | 383.75 | 37.7% | 144.64 | 28.12 | 3% | 0.79 | 430.67 |
| 1997 | 30.97 | 100% | 30.97 | 27.45 | 100% | 27.45 | 137.57 | 100% | 137.57 | 265.78 | 22.3% | 59.14 | 383.75 | 71.3% | 273.77 | 28.12 | 22% | 6.23 | 476.71 |
| 1998 | 30.97 | 100% | 30.97 | 27.45 | 100% | 27.45 | 137.57 | 100% | 137.57 | | | | 383.75 | 97.8% | 375.46 | 28.12 | 37% | 10.30 | 523.33 |
| 1999 | 30.97 | 100% | 30.97 | 27.45 | 100% | 27.45 | 137.57 | 100% | 137.57 | | | | 383.75 | 98.6% | 378.42 | 28.12 | 37% | 10.27 | 526.26 |
| 2000 | 30.97 | 100% | 30.97 | 27.45 | 100% | 27.45 | 137.57 | 100% | 137.57 | | | | 383.75 | 99.1% | 380.22 | 28.12 | 34% | 9.63 | 527.42 |
| 2001 | 30.97 | 100% | 30.97 | 27.45 | 100% | 27.45 | 137.57 | 100% | 137.57 | | | | 383.75 | 99.7% | 382.52 | 28.12 | 31% | 8.75 | 528.84 |

**NO COST**
**VOLUNTARY COST**
**MANDATORY COST**

TABLE 5C
AVERAGE CONSUMER COST PER LIGHT TRUCK FOR
IMPLEMENTATION OF THE FMVSS FOR MODEL YEARS 1968-2001

| Model Year | FMVSS 214 - SIDE IMPACT STATIC TEST Unit Cost | % of LTs | 214 Cost | FMVSS 301 FUEL SYSTEM INTEGRITY Unit Cost | % of LTs | 301 Cost | TOTAL VOL COST | TOTAL MAND COST | TOTAL FMVSS COST |
|---|---|---|---|---|---|---|---|---|---|
| 1968 | | | | | | | 91.53 | 15.05 | 106.58 |
| 1969 | | | | | | | 91.59 | 15.05 | 106.64 |
| 1970 | | | | | | | 71.53 | 44.42 | 115.95 |
| 1971 | | | | | | | 71.82 | 44.42 | 116.24 |
| 1972 | | | | | | | 14.63 | 127.63 | 142.26 |
| 1973 | | | | | | | 26.98 | 127.63 | 154.61 |
| 1974 | | | | | | | 31.51 | 129.28 | 160.79 |
| 1975 | | | | | | | 31.51 | 129.36 | 160.87 |
| 1976 | | | | | | | 32.88 | 129.39 | 162.27 |
| 1977 | | | | | | | 33.43 | 139.71 | 173.14 |
| 1978 | | | | 16.51 | 100% | 16.51 | 32.91 | 156.23 | 189.14 |
| 1979 | | | | 16.51 | 100% | 16.51 | 34.84 | 156.22 | 191.06 |
| 1980 | | | | 16.51 | 100% | 16.51 | 39.52 | 156.44 | 195.96 |
| 1981 | | | | 16.51 | 100% | 16.51 | 40.09 | 156.54 | 196.63 |
| 1982 | | | | 16.51 | 100% | 16.51 | 18.45 | 188.47 | 206.92 |
| 1983 | | | | 16.51 | 100% | 16.51 | 23.65 | 188.47 | 212.12 |
| 1984 | | | | 16.51 | 100% | 16.51 | 14.80 | 199.47 | 214.28 |
| 1985 | | | | 16.51 | 100% | 16.51 | 16.86 | 199.47 | 216.33 |
| 1986 | | | | 16.51 | 100% | 16.51 | 17.34 | 199.47 | 216.81 |
| 1987 | | | | 16.51 | 100% | 16.51 | 20.16 | 213.36 | 233.52 |
| 1988 | | | | 16.51 | 100% | 16.51 | 19.12 | 213.45 | 232.58 |
| 1989 | | | | 16.51 | 100% | 16.51 | 18.02 | 214.40 | 232.42 |
| 1990 | | | | 16.51 | 100% | 16.51 | 21.51 | 214.65 | 236.15 |
| 1991 | **29.44** | **8%** | **2.36** | 16.51 | 100% | 16.51 | 35.19 | 215.07 | 250.26 |
| 1992 | **29.44** | **9%** | **2.65** | 16.51 | 100% | 16.51 | 44.26 | 250.04 | 294.29 |
| 1993 | **29.44** | **15%** | **4.42** | 16.51 | 100% | 16.51 | 58.44 | 250.11 | 308.55 |
| 1994 | 29.44 | 100% | 29.44 | 16.51 | 100% | 16.51 | 100.19 | 289.30 | 389.49 |
| 1995 | 29.44 | 100% | 29.44 | 16.51 | 100% | 16.51 | | 547.71 | 547.71 |
| 1996 | 29.44 | 100% | 29.44 | 16.51 | 100% | 16.51 | | 612.52 | 612.52 |
| 1997 | 29.44 | 100% | 29.44 | 16.51 | 100% | 16.51 | | 658.58 | 658.58 |
| 1998 | 29.44 | 100% | 29.44 | 16.51 | 100% | 16.51 | | 705.27 | 705.27 |
| 1999 | 29.44 | 100% | 29.44 | 16.51 | 100% | 16.51 | | 708.22 | 708.22 |
| 2000 | 29.44 | 100% | 29.44 | 16.51 | 100% | 16.51 | | 709.39 | 709.39 |
| 2001 | 29.44 | 100% | 29.44 | 16.51 | 100% | 16.51 | | 710.86 | 710.86 |

**NO COST**
**VOLUNTARY COST**
**MANDATORY COST**

TABLE 5D
AVERAGE WEIGHT PER LIGHT TRUCK FOR
IMPLEMENTATION OF THE FMVSS FOR MODEL YEARS 1968-2001

| | FMVSS 104 - WINDSHIELD WIPING/WASHING SYSTEMS | | | | | | | FMVSS 105 - HYDRAULIC BRAKES | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | WIPERS | | | WASHERS | | | | DUAL MASTER CYLINDER | | | WARNING LIGHT | | | |
| Model Year | Unit Weight | % of LTs | Weight | Unit Weight | % of LTs | Weight | 104 Weight | Unit Weight | % of LTs | Weight | Unit Weight | % of LTs | Weight | 105 Weight |
| 1968 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | **0.95** | **100%** | **0.95** | | | | **0.95** |
| 1969 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | **0.95** | **100%** | **0.95** | | | | **0.95** |
| 1970 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | **0.95** | **100%** | **0.95** | | | | **0.95** |
| 1971 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | **0.95** | **100%** | **0.95** | | | | **0.95** |
| 1972 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | **0.95** | **100%** | **0.95** | | | | **0.95** |
| 1973 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | **0.95** | **100%** | **0.95** | | | | **0.95** |
| 1974 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | **0.95** | **100%** | **0.95** | | | | **0.95** |
| 1975 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | **0.95** | **100%** | **0.95** | | | | **0.95** |
| 1976 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | **0.95** | **100%** | **0.95** | | | | **0.95** |
| 1977 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | **0.95** | **100%** | **0.95** | | | | **0.95** |
| 1978 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | **0.95** | **100%** | **0.95** | | | | **0.95** |
| 1979 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | **0.95** | **100%** | **0.95** | | | | **0.95** |
| 1980 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | **0.95** | **100%** | **0.95** | | | | **0.95** |
| 1981 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | **0.95** | **100%** | **0.95** | | | | **0.95** |
| 1982 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | **0.95** | **100%** | **0.95** | | | | **0.95** |
| 1983 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | **0.95** | **100%** | **0.95** | | | | **0.95** |
| 1984 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | 0.95 | 100% | 0.95 | 0.01 | 100% | 0.01 | 0.96 |
| 1985 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | 0.95 | 100% | 0.95 | 0.01 | 100% | 0.01 | 0.96 |
| 1986 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | 0.95 | 100% | 0.95 | 0.01 | 100% | 0.01 | 0.96 |
| 1987 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | 0.95 | 100% | 0.95 | 0.01 | 100% | 0.01 | 0.96 |
| 1988 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | 0.95 | 100% | 0.95 | 0.01 | 100% | 0.01 | 0.96 |
| 1989 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | 0.95 | 100% | 0.95 | 0.01 | 100% | 0.01 | 0.96 |
| 1990 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | 0.95 | 100% | 0.95 | 0.01 | 100% | 0.01 | 0.96 |
| 1991 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | 0.95 | 100% | 0.95 | 0.01 | 100% | 0.01 | 0.96 |
| 1992 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | 0.95 | 100% | 0.95 | 0.01 | 100% | 0.01 | 0.96 |
| 1993 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | 0.95 | 100% | 0.95 | 0.01 | 100% | 0.01 | 0.96 |
| 1994 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | 0.95 | 100% | 0.95 | 0.01 | 100% | 0.01 | 0.96 |
| 1995 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | 0.95 | 100% | 0.95 | 0.01 | 100% | 0.01 | 0.96 |
| 1996 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | 0.95 | 100% | 0.95 | 0.01 | 100% | 0.01 | 0.96 |
| 1997 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | 0.95 | 100% | 0.95 | 0.01 | 100% | 0.01 | 0.96 |
| 1998 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | 0.95 | 100% | 0.95 | 0.01 | 100% | 0.01 | 0.96 |
| 1999 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | 0.95 | 100% | 0.95 | 0.01 | 100% | 0.01 | 0.96 |
| 2000 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | 0.95 | 100% | 0.95 | 0.01 | 100% | 0.01 | 0.96 |
| 2001 | 0.49 | 100% | 0.49 | 1.61 | 100% | 1.61 | 2.10 | 0.95 | 100% | 0.95 | 0.01 | 100% | 0.01 | 0.96 |

**NO WEIGHT**
**VOLUNTARY WEIGHT**
**MANDATORY WEIGHT**

TABLE 5D
AVERAGE WEIGHT PER LIGHT TRUCK FOR
IMPLEMENTATION OF THE FMVSS FOR MODEL YEARS 1968-2001

| | FMVSS 108 - LAMPS | | | | | | | FMVSS 118 | | | FMVSS 124 | | | FMVSS 201- INT. PROTECTION | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SIDE MARKER | | | CHMSL | | | | POWER WINDOWS | | | ACCELERATOR CONTROLS | | | SEAT BACK PADDING | | |
| Model Year | Unit Weight | % of LTs | Weight | Unit Weight | % of LTs | Weight | 108 Weight | Unit Weight | % of LTs | 118 Weight | Unit Weight | % of LTs | 124 Weight | Unit Weight | % of LTs | 201 Weight |
| 1968 | **1.46** | **100%** | **1.46** | | | | **1.46** | | | | | | | | | |
| 1969 | **1.46** | **100%** | **1.46** | | | | **1.46** | | | | | | | | | |
| 1970 | 1.95 | 100% | 1.95 | | | | 1.95 | | | | | | | | | |
| 1971 | 1.95 | 100% | 1.95 | | | | 1.95 | | | | | | | | | |
| 1972 | 1.95 | 100% | 1.95 | | | | 1.95 | | | | | | | | | |
| 1973 | 1.95 | 100% | 1.95 | | | | 1.95 | | | | | | | | | |
| 1974 | 1.95 | 100% | 1.95 | | | | 1.95 | | | | 0.02 | 100% | 0.02 | | | |
| 1975 | 1.95 | 100% | 1.95 | | | | 1.95 | | | | 0.02 | 100% | 0.02 | | | |
| 1976 | 1.95 | 100% | 1.95 | | | | 1.95 | | | | 0.02 | 100% | 0.02 | | | |
| 1977 | 1.95 | 100% | 1.95 | | | | 1.95 | | | | 0.02 | 100% | 0.02 | | | |
| 1978 | 1.95 | 100% | 1.95 | | | | 1.95 | **0.04** | **2.3%** | **0.00** | 0.02 | 100% | 0.02 | | | |
| 1979 | 1.95 | 100% | 1.95 | | | | 1.95 | **0.04** | **3.6%** | **0.00** | 0.02 | 100% | 0.02 | | | |
| 1980 | 1.95 | 100% | 1.95 | | | | 1.95 | **0.04** | **5.5%** | **0.00** | 0.02 | 100% | 0.02 | | | |
| 1981 | 1.95 | 100% | 1.95 | | | | 1.95 | **0.04** | **7.9%** | **0.00** | 0.02 | 100% | 0.02 | | | |
| 1982 | 1.95 | 100% | 1.95 | | | | 1.95 | **0.04** | **12.2%** | **0.00** | 0.02 | 100% | 0.02 | 3.78 | 33.3% | 1.26 |
| 1983 | 1.95 | 100% | 1.95 | | | | 1.95 | **0.04** | **15.4%** | **0.01** | 0.02 | 100% | 0.02 | 3.78 | 33.3% | 1.26 |
| 1984 | 1.95 | 100% | 1.95 | | | | 1.95 | **0.04** | **19.0%** | **0.01** | 0.02 | 100% | 0.02 | 3.78 | 33.3% | 1.26 |
| 1985 | 1.95 | 100% | 1.95 | | | | 1.95 | **0.04** | **22.4%** | **0.01** | 0.02 | 100% | 0.02 | 3.78 | 33.3% | 1.26 |
| 1986 | 1.95 | 100% | 1.95 | | | | 1.95 | **0.04** | **24.6%** | **0.01** | 0.02 | 100% | 0.02 | 3.78 | 33.3% | 1.26 |
| 1987 | 1.95 | 100% | 1.95 | | | | 1.95 | **0.04** | **27.5%** | **0.01** | 0.02 | 100% | 0.02 | 3.78 | 51.1% | 1.93 |
| 1988 | 1.95 | 100% | 1.95 | | | | 1.95 | **0.04** | **29.6%** | **0.01** | 0.02 | 100% | 0.02 | 3.78 | 51.1% | 1.93 |
| 1989 | 1.95 | 100% | 1.95 | | | | 1.95 | 0.04 | 37.4% | 0.01 | 0.02 | 100% | 0.02 | 3.78 | 51.1% | 1.93 |
| 1990 | 1.95 | 100% | 1.95 | | | | 1.95 | 0.04 | 46.2% | 0.02 | 0.02 | 100% | 0.02 | 3.78 | 51.1% | 1.93 |
| 1991 | 1.95 | 100% | 1.95 | **0.85** | **28.9%** | **0.25** | 2.20 | 0.04 | 48.3% | 0.02 | 0.02 | 100% | 0.02 | 3.78 | 51.1% | 1.93 |
| 1992 | 1.95 | 100% | 1.95 | **0.85** | **24.7%** | **0.21** | 2.16 | 0.04 | 47.2% | 0.02 | 0.02 | 100% | 0.02 | 3.78 | 51.1% | 1.93 |
| 1993 | 1.95 | 100% | 1.95 | **0.85** | **28.0%** | **0.24** | 2.19 | 0.04 | 54.9% | 0.02 | 0.02 | 100% | 0.02 | 3.78 | 51.1% | 1.93 |
| 1994 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 56.4% | 0.02 | 0.02 | 100% | 0.02 | 3.78 | 51.1% | 1.93 |
| 1995 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 61.6% | 0.02 | 0.02 | 100% | 0.02 | 3.78 | 83.5% | 3.15 |
| 1996 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 65.5% | 0.03 | 0.02 | 100% | 0.02 | 3.78 | 83.5% | 3.15 |
| 1997 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 67.5% | 0.03 | 0.02 | 100% | 0.02 | 3.78 | 83.5% | 3.15 |
| 1998 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 74.1% | 0.03 | 0.02 | 100% | 0.02 | 3.78 | 83.5% | 3.15 |
| 1999 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 77.1% | 0.03 | 0.02 | 100% | 0.02 | 3.78 | 83.5% | 3.15 |
| 2000 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 77.7% | 0.03 | 0.02 | 100% | 0.02 | 3.78 | 83.5% | 3.15 |
| 2001 | 1.95 | 100% | 1.95 | 0.85 | 100% | 0.85 | 2.80 | 0.04 | 83.5% | 0.03 | 0.02 | 100% | 0.02 | 3.78 | 83.5% | 3.15 |

**NO WEIGHT**
**VOLUNTARY WEIGHT**
**MANDATORY WEIGHT**

TABLE 5D
AVERAGE WEIGHT PER LIGHT TRUCK FOR
IMPLEMENTATION OF THE FMVSS FOR MODEL YEARS 1968-2001

| | FMVSS 202 | | | FMVSS 203/204 | | | FMVSS 208/209/210 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HEAD RESTRAINTS | | | STEERING ASSEMBLY | | | SAFETY BELTS | | | DRIVER AIR BAGS | | | DUAL AIR BAGS | | | ON/OFF SWITCHES | | | |
| Model Year | Unit Weight | % of LTs | 202 Weight | Unit Weight | % of LTs | 203-4 Weight | Unit Weight | % of LTs | Weight | Unit Weight | % of LTs | Weight | Unit Weight | % of LTs | Weight | Unit Weight | % of LTs | Weight | 208 Weight |
| 1968 | **3.98** | **10.3%** | **0.41** | | | | **5.59** | **100%** | **5.59** | | | | | | | | | | **5.59** |
| 1969 | **3.98** | **10.3%** | **0.41** | | | | **5.60** | **100%** | **5.60** | | | | | | | | | | **5.60** |
| 1970 | **3.98** | **10.3%** | **0.41** | **1.89** | **3%** | **0.06** | **5.60** | **100%** | **5.60** | | | | | | | | | | **5.60** |
| 1971 | **3.98** | **10.3%** | **0.41** | **1.89** | **4%** | **0.08** | **5.61** | **100%** | **5.61** | | | | | | | | | | **5.61** |
| 1972 | **3.98** | **10.3%** | **0.41** | **1.89** | **2%** | **0.04** | 10.45 | 100% | 10.45 | | | | | | | | | | 10.45 |
| 1973 | **3.98** | **10.3%** | **0.41** | **1.89** | **47%** | **0.89** | 10.45 | 100% | 10.45 | | | | | | | | | | 10.45 |
| 1974 | **3.98** | **24.1%** | **0.96** | **1.89** | **48%** | **0.91** | 10.70 | 100% | 10.70 | | | | | | | | | | 10.70 |
| 1975 | **3.98** | **24.1%** | **0.96** | **1.89** | **48%** | **0.91** | 10.72 | 100% | 10.72 | | | | | | | | | | 10.72 |
| 1976 | **3.98** | **24.1%** | **0.96** | **1.89** | **53%** | **1.00** | 10.73 | 100% | 10.73 | | | | | | | | | | 10.73 |
| 1977 | **3.98** | **24.1%** | **0.96** | **1.89** | **55%** | **1.04** | 12.00 | 100% | 12.00 | | | | | | | | | | 12.00 |
| 1978 | **3.98** | **24.1%** | **0.96** | **1.89** | **53%** | **1.00** | 12.00 | 100% | 12.00 | | | | | | | | | | 12.00 |
| 1979 | **3.98** | **24.1%** | **0.96** | **1.89** | **60%** | **1.13** | 12.00 | 100% | 12.00 | | | | | | | | | | 12.00 |
| 1980 | **3.98** | **24.1%** | **0.96** | **1.89** | **77%** | **1.46** | 12.04 | 100% | 12.04 | | | | | | | | | | 12.04 |
| 1981 | **3.98** | **24.1%** | **0.96** | **1.89** | **79%** | **1.49** | 12.07 | 100% | 12.07 | | | | | | | | | | 12.07 |
| 1982 | **3.98** | **24.1%** | **0.96** | 1.89 | 100% | 1.89 | 12.07 | 100% | 12.07 | | | | | | | | | | 12.07 |
| 1983 | **3.98** | **40.8%** | **1.62** | 1.89 | 100% | 1.89 | 12.07 | 100% | 12.07 | | | | | | | | | | 12.07 |
| 1984 | **3.98** | **47.2%** | **1.88** | 1.89 | 100% | 1.89 | 12.07 | 100% | 12.07 | | | | | | | | | | 12.07 |
| 1985 | **3.98** | **53.8%** | **2.14** | 1.89 | 100% | 1.89 | 12.07 | 100% | 12.07 | | | | | | | | | | 12.07 |
| 1986 | **3.98** | **55.3%** | **2.20** | 1.89 | 100% | 1.89 | 12.07 | 100% | 12.07 | | | | | | | | | | 12.07 |
| 1987 | **3.98** | **64.3%** | **2.56** | 1.89 | 100% | 1.89 | 13.33 | 100% | 13.33 | | | | | | | | | | 13.33 |
| 1988 | **3.98** | **60.9%** | **2.42** | 1.89 | 100% | 1.89 | 13.36 | 100% | 13.36 | | | | | | | | | | 13.36 |
| 1989 | **3.98** | **58.2%** | **2.32** | 1.89 | 100% | 1.89 | 13.54 | 100% | 13.54 | | | | | | | | | | 13.54 |
| 1990 | **3.98** | **69.4%** | **2.76** | 1.89 | 100% | 1.89 | 13.59 | 100% | 13.59 | | | | | | | | | | 13.59 |
| 1991 | **3.98** | **70.5%** | **2.81** | 1.89 | 100% | 1.89 | 13.71 | 100% | 13.71 | **14.31** | **3.1%** | **0.44** | | | | | | | 14.15 |
| 1992 | 3.98 | 100% | 3.98 | 1.89 | 100% | 1.89 | 14.91 | 100% | 14.91 | **14.31** | **14.8%** | **2.11** | | | | | | | 17.02 |
| 1993 | 3.98 | 100% | 3.98 | 1.89 | 100% | 1.89 | 14.91 | 100% | 14.91 | **14.31** | **19.3%** | **2.76** | | | | | | | 17.67 |
| 1994 | 3.98 | 100% | 3.98 | 1.89 | 100% | 1.89 | 14.91 | 100% | 14.91 | **14.31** | **26.8%** | **3.83** | **26.48** | **7.6%** | **2.00** | | | | 20.74 |
| 1995 | 3.98 | 100% | 3.98 | 1.89 | 100% | 1.89 | 18.41 | 100% | 18.41 | 14.31 | 66.3% | 9.49 | 26.48 | 13.6% | 3.60 | | | | 31.50 |
| 1996 | 3.98 | 100% | 3.98 | 1.89 | 100% | 1.89 | 18.41 | 100% | 18.41 | 14.31 | 55.6% | 7.95 | 26.48 | 37.7% | 9.98 | 0.65 | 3% | 0.02 | 36.36 |
| 1997 | 3.98 | 100% | 3.98 | 1.89 | 100% | 1.89 | 18.41 | 100% | 18.41 | 14.31 | 22.3% | 3.18 | 26.48 | 71.3% | 18.89 | 0.65 | 22% | 0.14 | 40.62 |
| 1998 | 3.98 | 100% | 3.98 | 1.89 | 100% | 1.89 | 18.41 | 100% | 18.41 | | | | 26.48 | 97.8% | 25.91 | 0.65 | 37% | 0.24 | 44.56 |
| 1999 | 3.98 | 100% | 3.98 | 1.89 | 100% | 1.89 | 18.41 | 100% | 18.41 | | | | 26.48 | 98.6% | 26.11 | 0.65 | 37% | 0.24 | 44.76 |
| 2000 | 3.98 | 100% | 3.98 | 1.89 | 100% | 1.89 | 18.41 | 100% | 18.41 | | | | 26.48 | 99.1% | 26.24 | 0.65 | 34% | 0.22 | 44.87 |
| 2001 | 3.98 | 100% | 3.98 | 1.89 | 100% | 1.89 | 18.41 | 100% | 18.41 | | | | 26.48 | 99.7% | 26.40 | 0.65 | 31% | 0.20 | 45.01 |

**NO WEIGHT**
**VOLUNTARY WEIGHT**
**MANDATORY WEIGHT**

TABLE 5D
AVERAGE WEIGHT PER LIGHT TRUCK FOR
IMPLEMENTATION OF THE FMVSS FOR MODEL YEARS 1968-2001

| Model Year | FMVSS 214 - SIDE IMPACT STATIC TEST | | | FMVSS 301 FUEL SYSTEM INTEGRITY | | | TOTAL VOL Weight | TOTAL MAND Weight | TOTAL FMVSS Weight |
|---|---|---|---|---|---|---|---|---|---|
| | Unit Weight | % of LTs | 214 Weight | Unit Weight | % of LTs | 301 Weight | | | |
| 1968 | | | | | | | **8.41** | 2.10 | 10.51 |
| 1969 | | | | | | | **8.42** | 2.10 | 10.52 |
| 1970 | | | | | | | **7.02** | 4.05 | 11.07 |
| 1971 | | | | | | | **7.05** | 4.05 | 11.10 |
| 1972 | | | | | | | **1.40** | 14.50 | 15.90 |
| 1973 | | | | | | | **2.25** | 14.50 | 16.75 |
| 1974 | | | | | | | **2.82** | 14.77 | 17.59 |
| 1975 | | | | | | | **2.82** | 14.79 | 17.61 |
| 1976 | | | | | | | **2.91** | 14.80 | 17.71 |
| 1977 | | | | | | | **2.95** | 16.07 | 19.02 |
| 1978 | | | | 2.48 | 100% | 2.48 | **2.91** | 18.55 | 21.46 |
| 1979 | | | | 2.48 | 100% | 2.48 | **3.04** | 18.55 | 21.59 |
| 1980 | | | | 2.48 | 100% | 2.48 | **3.37** | 18.59 | 21.96 |
| 1981 | | | | 2.48 | 100% | 2.48 | **3.40** | 18.62 | 22.02 |
| 1982 | | | | 2.48 | 100% | 2.48 | **1.91** | 21.77 | 23.68 |
| 1983 | | | | 2.48 | 100% | 2.48 | **2.58** | 21.77 | 24.35 |
| 1984 | | | | 2.48 | 100% | 2.48 | **1.89** | 22.73 | 24.61 |
| 1985 | | | | 2.48 | 100% | 2.48 | **2.15** | 22.73 | 24.88 |
| 1986 | | | | 2.48 | 100% | 2.48 | **2.21** | 22.73 | 24.94 |
| 1987 | | | | 2.48 | 100% | 2.48 | **2.57** | 24.66 | 27.23 |
| 1988 | | | | 2.48 | 100% | 2.48 | **2.43** | 24.69 | 27.12 |
| 1989 | | | | 2.48 | 100% | 2.48 | **2.32** | 24.89 | 27.20 |
| 1990 | | | | 2.48 | 100% | 2.48 | **2.76** | 24.94 | 27.70 |
| 1991 | **23.76** | **8%** | **1.90** | 2.48 | 100% | 2.48 | **5.39** | 25.06 | 30.45 |
| 1992 | **23.76** | **9%** | **2.14** | 2.48 | 100% | 2.48 | **4.46** | 30.24 | 34.70 |
| 1993 | **23.76** | **15%** | **3.56** | 2.48 | 100% | 2.48 | **6.56** | 30.24 | 36.81 |
| 1994 | 23.76 | 100% | 23.76 | 2.48 | 100% | 2.48 | **5.83** | 54.85 | 60.69 |
| 1995 | 23.76 | 100% | 23.76 | 2.48 | 100% | 2.48 | | 72.67 | 72.67 |
| 1996 | 23.76 | 100% | 23.76 | 2.48 | 100% | 2.48 | | 77.53 | 77.53 |
| 1997 | 23.76 | 100% | 23.76 | 2.48 | 100% | 2.48 | | 81.79 | 81.79 |
| 1998 | 23.76 | 100% | 23.76 | 2.48 | 100% | 2.48 | | 85.73 | 85.73 |
| 1999 | 23.76 | 100% | 23.76 | 2.48 | 100% | 2.48 | | 85.93 | 85.93 |
| 2000 | 23.76 | 100% | 23.76 | 2.48 | 100% | 2.48 | | 86.04 | 86.04 |
| 2001 | 23.76 | 100% | 23.76 | 2.48 | 100% | 2.48 | | 86.18 | 86.18 |

**NO WEIGHT**
**VOLUNTARY WEIGHT**
**MANDATORY WEIGHT**

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