**Preliminary Regulatory Impact Analysis**

**FMVSS No. 208**

**Occupant Crash Protection, Seat Belt Warning Systems (SBWS)**

*Office of Regulatory Analysis and Evaluation*

*NCSA*

*August 2023*

**Table of Contents**

[List of Abbreviations 4](#_Toc142902959)

[**Executive Summary** 5](#_Toc142902960)

[1 Introduction 12](#_Toc142902961)

[2 Background 19](#_Toc142902962)

[2.1 Regulatory History of Interlock and Seat Belt Warnings 19](#_Toc142902963)

[2.2 NHTSA Research and other Agency Efforts 20](#_Toc142902964)

[2.3 External Research 23](#_Toc142902965)

[2.4 Summary of Research Findings 27](#_Toc142902966)

[3 Target Population 27](#_Toc142902967)

[3.1 Rear Seat Occupants 28](#_Toc142902968)

[3.1.1 Adjustments to Target Population 28](#_Toc142902969)

[3.1.2 Adjusted Target Population 36](#_Toc142902970)

[3.2 Front Seat Occupants 38](#_Toc142902971)

[3.2.1 Adjusted Target Population 39](#_Toc142902972)

[4 Effectiveness 43](#_Toc142902973)

[4.1 Seat Belt Effectiveness 44](#_Toc142902974)

[4.2 Effect of SBWS on Rear Occupant 46](#_Toc142902975)

[4.2.1 Impact of SBWS 46](#_Toc142902976)

[4.2.2 Resulting Increase on Seat Belt Use Rates 50](#_Toc142902977)

[4.3 Effect of Indefinite Warning on Drivers and Right Front Passengers 54](#_Toc142902978)

[4.3.1 Seat Belt Use 55](#_Toc142902979)

[4.3.2 Impact on Seat Belt Use 57](#_Toc142902980)

[4.3.3 Resulting Increase on Seat Belt Use Rates 64](#_Toc142902981)

[5 Benefits 65](#_Toc142902982)

[5.1 SBWS for Rear Seat Occupants 66](#_Toc142902983)

[5.2 Indefinite Warning for Front Seat Occupants 74](#_Toc142902984)

[5.3 Change of Status Warning 90](#_Toc142902985)

[5.4 Unquantified Benefits/Alternate Uses 91](#_Toc142902986)

[5.5 Summary of Benefits 92](#_Toc142902987)

[6 Costs 93](#_Toc142902988)

[6.1 SBWS for Rear Seat Occupants 93](#_Toc142902989)

[6.2 Indefinite Warning for Front Seat Occupants 95](#_Toc142902990)

[6.3 Summary 97](#_Toc142902991)

[7 Lead Time 97](#_Toc142902992)

[8 Cost-Effectiveness and Net Benefits 99](#_Toc142902993)

[8.1 Cost-Effectiveness 101](#_Toc142902994)

[8.2 Net Benefits 108](#_Toc142902995)

[8.3 Summary 114](#_Toc142902996)

[9 Sensitivity Analysis 114](#_Toc142902997)

[9.1 Increase in Rear Occupant Seat Belt Usage 115](#_Toc142902998)

[9.1.1 Rear Seat Occupants Age 11+ 115](#_Toc142902999)

[9.1.2 Rear Seat Occupants Age 6 to 10 117](#_Toc142903000)

[9.1.3 Comparison to Main Analysis 119](#_Toc142903001)

[9.2 Balance Point Analysis 120](#_Toc142903002)

[10 Regulatory Alternatives 121](#_Toc142903003)

[10.1 Requiring Occupant Detection for Rear Seat Belt Warning System 121](#_Toc142903004)

[10.2 Front Center Seat SBWS 124](#_Toc142903005)

[10.3 90-Second Warning for Front Seat Occupants 132](#_Toc142903006)

[10.4 Summary of Regulatory Alternatives 136](#_Toc142903007)

[10.5 Non-regulatory Alternatives 137](#_Toc142903008)

[11 Initial Regulatory Flexibility Act and Unfunded Mandates Reform Act Analyses 137](#_Toc142903009)

[11.1 Regulatory Flexibility Act 137](#_Toc142903010)

[11.2 Unfunded Mandates Reform Act 146](#_Toc142903011)

[12 Appendix 148](#_Toc142903012)

[12.1 Appendix A 148](#_Toc142903013)

[12.2 Appendix B 152](#_Toc142903014)

[12.3 Appendix C 153](#_Toc142903015)

[12.4 Appendix D 170](#_Toc142903016)

[12.5 Appendix E 173](#_Toc142903017)

[12.6 Appendix F 177](#_Toc142903018)

[12.7 Appendix G 184](#_Toc142903019)

[12.8 Appendix H 186](#_Toc142903020)

[12.9 Appendix I 198](#_Toc142903021)

[12.10 Appendix J 200](#_Toc142903022)

List of Abbreviations

ATS American Travel Survey

CDS Crashworthiness Data System

CRS Child Restraint System

DOE Department of Energy

DOT Department of Transportation

EIA Energy Information Administration  
ELS Equivalent Lives Saved

ESC Electronic Stability Control

FARS Fatality Analysis Reporting System

FHWA Federal Highway Administration

FMVSS Federal Motor Vehicle Safety Standard

FRIA Final Regulatory Impact Analysis

GM General Motors

GVWR Gross Vehicle Weight Rating

IIHS Insurance Institute for Highway Safety

IVD Incomplete Vehicle Document

LTV Light Trucks and Vans

MAIS Maximum Abbreviated Injury Scale

MAP-21 Moving Ahead for Progress in the 21st Century Act, P.L. 112-141

MEPS-HC Medical Expenditure Panel Survey Household and Medical Provider Components

MY Model Year

NASS National Automotive Sampling System

NCAP New Car Assessment Program

NHTS National Household Travel Survey

NHTSA National Highway Traffic Safety Administration

NOPUS National Occupant Protection Use Surveys

NPRM Notice of Proposed Rulemaking

NPTS Nationwide Personal Transportation Survey

NVPP National Vehicle Population Profile

OMB Office of Management and Budget

PC Passenger Car

PRIA Preliminary Regulatory Impact Analysis

PVH Pediatric Vehicular Hyperthermia

QALY Quality-Adjusted Life-Year

RFA Regulatory Flexibility Analysis

RTECS Residential Transportation Energy Consumption Survey

SBWS Seat Belt Warning System

VMT Vehicle Miles Traveled

VSL Value of a Statistical Life

# **Executive Summary**

This Preliminary Regulatory Impact Analysis (PRIA) presents the benefits and costs associated with the proposed amendments to the existing seat belt warning provisions in the Federal Motor Vehicle Safety Standard (FMVSS) No. 208, “Occupant crash protection.”

The impacts of the proposed rule have been examined under Executive Order 12866, Executive Order 13563, Executive Order 14904, the Regulatory Flexibility Act (5 U.S.C. 601-612), the Congressional Review Act/Small Businesses Regulatory Enforcement Fairness Act (5 U.S.C. 801, Pub. L. 104-121), and the Unfunded Mandates Reform Act of 1995 (Pub. L. 104-4). Executive Orders 12866, 13563, and 14094 direct us to assess all benefits, costs, and transfers of available regulatory alternatives and, when regulation is necessary, to select regulatory approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity). A regulatory action is significant under Section 3(f)(1) of Executive Order 12866 (as amended by E.O. 14094) if the action has “an annual effect on the economy of $200 million or more (adjusted every 3 years by the Administrator of the Office of Information and Regulatory Affairs (OIRA) for changes in gross domestic product); or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, territorial, or tribal governments or communities.” OIRA has determined that this proposed rule is a significant regulatory action under Executive Order 12866 Section 3(f)(1).

The proposed requirements would apply to newly manufactured passenger cars (PC), multipurpose passenger vehicles, trucks, and buses with a Gross Vehicle Weight Rating (GVWR) of 4,536 kg (10,000 lbs.) or less, with limited exemptions for certain specified types of vehicles.

The National Highway Traffic Safety Administration’s (NHTSA) proposal includes three elements. First, NHTSA is proposing to require a visual seat belt warning system (SBWS) to alert the driver in regard to the status of the seat belts for rear seat occupants upon vehicle start up. Second, NHTSA is proposing to require a SBWS with an indefinite warning period for front outboard seat occupants. Third, NHTSA is also proposing to require an audiovisual warning whenever a fastened front outboard or rear seat occupant’s seat belt becomes unfastened while the vehicle's ignition switch is in the “on” or “start” position and the vehicle’s transmission selector is in a forward or reverse gear.

As seat belts are critical to vehicle occupant safety, the requirements specified in the proposed rule aim to increase seat belt use for both front and rear seat occupants. It is important to note that the incremental benefits resulting from the proposed rule stem not from the SBWS’s function itself, but instead result from the increase in seat belt use brought about by the SBWS. Therefore, the incremental benefits associated with the proposed rule are comprised of the fatalities and non-fatal injuries prevented as a result of the increase in seat belt use from the SBWS relative to seat belt use under the baseline.

To estimate the incremental benefits and costs associated with the proposed rule, this analysis first establishes a baseline for seat belt use based on the observed seat belt use rates for each seating position. Furthermore, as seat belt use in potentially fatal crashes is lower than overall use, this analysis also establishes a baseline for seat belt use in potentially fatal crashes based on the observed seat belt use rates. In establishing the baseline, this analysis also accounts for the percentage of new light vehicles in the fleet that include SBWS by seating position. When establishing the baseline for the SBWS for front seat occupants, this analysis accounts for the distribution of SBWS already installed in light vehicles including those that provide a seven-second, 90-second, and indefinite audible warning.

Table 1 presents a summary of the annual incremental benefits associated with the proposed rule by seating position. Due to uncertainty, this analysis estimated a lower (Lo) and higher (Hi) increase in seat belt use for rear seat occupants as a result of the SBWS. Therefore, when presenting benefits measures for rear-seat occupants or the proposed rule as a whole, this analysis presents benefits resulting from both the Lo and Hi increase in seat belt use.

Overall, the proposed rule would prevent approximately 100 fatalities in the Lo case and 111 fatalities in the Hi case, annually. Additionally, the proposed rule would prevent a total of 286 non-fatal injuries in the Lo case and 323 non-fatal injuries in the Hi case, annually. When taking into account the Lo and Hi cases, the requirements specified in the proposed rule for SBWS for rear seat occupants would prevent 22 and 34 fatalities and 75 and 112 non-fatal injuries, respectively. The requirements for the indefinite warning for front seat occupants would prevent 77 fatalities and 211 non-fatal injuries, annually.

Table 1: Summary of Annual Benefits

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | | **Annual Benefits (Number Prevented)** | |
| **Non-Fatal Injuries** | **Fatalities** |
| Rear Seat Occupants | Lo | 75 | 22 |
| Hi | 112 | 34 |
| Front Seat Occupants | | 211 | 77 |
| **Total** | **Lo** | **286** | **100** |
| **Hi** | **323** | **111** |

Note: Values may not sum due to rounding. Totals are rounded to the nearest whole number for presentation purposes.

The agency is proposing a lead time of one year from the first September after the final rule is published for those requirements for front seat occupants and two years from the first September for those requirements for rear seat occupants. Additionally, multi-stage manufacturers and alterers are automatically granted an additional year of lead time.

Table 2 presents a summary of annual incremental costs. The annual incremental costs associated with the proposed rule are the costs associated with installing the alarm and seat belt buckle sensor hardware. These incremental costs are in addition to those incurred based on the installation rates established in the baseline.

For driver seats, no additional hardware would be required to meet the specified requirements. As the changes would be limited to a settings adjustment or reprogramming of the alarm, the potential one-time cost for meeting the requirements for drivers seat would be de minimis. For front outboard passenger seats, the cost per vehicle is $2.13 which is applicable to the four percent or 640,000 light vehicles sold annually that are not already equipped with SBWS for front outboard passenger seats. For the rear seating positions, the cost per vehicle is $19.59 which is applicable to 53.1 percent or approximately 8.5 million light vehicles sold annually that are not already equipped with SBWS for rear seating positions. Summing those costs across seating positions, the total annual cost associated with the proposed rule is approximately $168 million in 2020 dollars.

Table 2: Summary of Annual Costs

|  |  |  |  |
| --- | --- | --- | --- |
| **Seating Position** | **Per Vehicle Cost** | **Affected number of vehicles** | **Total Cost** |
| Driver | $0 | 0 | $0 |
| Right Front Seat | $2.13 | 640,000 | $1,363,200 |
| Rear Seat | $19.59 | 8,496,00 | $166,436,640 |
| **Total Annual Cost** | |  | **$167,799,840** |

Table 3 and Table 4 summarize the findings of the cost-effectiveness and benefit-cost analyses for the proposed rule. Cost-effectiveness and benefit-cost analyses enable decision-makers to compare regulatory alternatives in order to identify those that achieve the most effective use of available resources. Certain calculations require that benefits and costs are represented in commeasurable units. Therefore, benefits which are measured in fatalities and non-fatal injuries prevented are reflected in equivalent lives saved (ELS) for the cost-effectiveness analysis and translated into monetary value for the benefit-cost analysis.

Furthermore, in order to compare benefits and costs, these analyses consider the benefits and costs associated with a specific model year (MY). The costs associated with a specific MY are incurred in the year that the vehicle is manufactured, while the benefits associated with the proposed rule occur over the course of the vehicle MY’s lifetime. Benefits occurring over the course of the vehicle MY’s lifetime are discounted in order to compare their present value to the costs incurred in the first year that the vehicle is manufactured. Although the cost-effectiveness and benefit-cost analyses consider the impacts of the proposed rule specific to a particular MY, the benefits and costs presented in the table also represent the annual benefits and costs when all applicable light vehicles are in compliance with the proposed rule, which may take several decades. Lastly, as this analysis considered a lower and higher estimated increase in seat belt use for rear seat occupants, both the resulting lower (Lo) and higher (Hi) benefits estimates are included in the presentation of cost-effectiveness and net benefits for both rear seat occupants and the proposed rule as a whole.

When discounted at three percent, the cost per equivalent live saved is approximately $1.71 million and $1.53 million for the Lo and Hi cases, respectively. When discounted at seven percent, the cost per equivalent live saved is $2.10 million and $1.89 million for the Lo and Hi cases, respectively. As the cost per equivalent life saved is less than the comprehensive economic cost of a fatality, the proposed rule is considered to be cost-effective.

Table 3: Summary of Cost-Effectiveness Analysis

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Category** | **Discounted at 3%** | | | **Discounted at 7%** | | |
| **Equivalent Lives Saved** | **Cost**  **(Millions)** | **Cost per Equivalent Live Saved**  **(Millions)** | **Equivalent Lives Saved** | **Cost**  **(Millions)** | **Cost per Equivalent Live Saved**  **(Millions)** |
| Lo | 98.3 | $167.8 | $1.71 | 79.7 | $167.8 | $2.10 |
| Hi | 109.4 | $1.53 | 88.7 | $1.89 |

When discounted at three precent, net benefits are estimated at approximately $1.0 billion and $1.14 billion for the Lo and Hi cases, respectively. When discounted at seven precent, net benefits are estimated at approximately $787 million and $895 million for the Lo and Hi cases, respectively. Positive net benefits indicate that the proposed rule is net beneficial.

Table 4: Summary of Benefit-Cost Analysis (Millions)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Category** | **Discounted at 3%** | | | **Discounted at 7%** | | |
| **Monetized Benefits** | **Cost** | **Net Benefits** | **Monetized Benefits** | **Cost** | **Net Benefits** |
| Lo | $1,177.9 | $167.8 | $1,010.0 | $955.2 | $167.8 | $787.4 |
| Hi | $1,310.5 | $1,142.7 | $1,062.8 | $895.0 |

As the conclusions drawn from this analysis may be impacted by the underlying assumptions, this PRIA includes a sensitivity analysis that considers how the cost-effectiveness and net benefits analyses may be impacted based on those assumptions. The sensitivity analysis included in this PRIA examines alternative values for the increase in seat belt use for rear seat occupants. Furthermore, given the uncertainty of the increase in seat belt usage resulting from the proposed rule, the sensitivity analysis also includes a balance point analysis for both the requirements for rear seat and front seat occupants. Each balance point analysis determines the increase in seat belt use at which the costs and benefits associated with the specific requirements would be equal. Overall, the sensitivity analysis lends support to the findings in the main analysis indicating that the proposed rule is cost-effective and net beneficial.

In specifying the requirements included in the proposed rule, the agency considered other regulatory alternatives. For rear seating positions, the agency considered a SBWS capable of detecting an occupant in a seat and non-regulatory alternatives. For front seat occupants, the agency considered requiring a seat belt warning system for the front center seating position and also considered requiring a 90-second warning instead of an indefinite warning.

Overall, in cases that this analysis was able to quantify the benefits and costs with these regulatory options, it found that the proposed rule was the most cost-effective and net beneficial option. However, in some cases, the benefits and costs associated with those regulatory options could not be calculated. As a result, the agency requests comments on some of the listed regulatory options for which there were data limitations and uncertainty.

# Introduction

This Preliminary Regulatory Impact Analysis (PRIA) accompanies the National Highway Traffic Safety Administration’s (NHTSA) proposed rule to amend the existing seat belt warning provisions in the Federal Motor Vehicle Safety Standard (FMVSS) No. 208, “Occupant crash protection.” The proposed requirements would apply to passenger cars (PC), multipurpose passenger vehicles, trucks, and buses with a Gross Vehicle Weight Rating (GVWR) of 4,536 kg (10,000 lbs.) or less, with limited exemptions for certain specified types of vehicles including school buses and law enforcement vehicles.

Increasing seat belt use is one of NHTSA’s highest priorities. When used properly, seat belts can significantly reduce the risk of fatal and serious injuries for front and rear seat occupants. To increase seat belt use in the United States, the agency relies on an array of programs and initiatives, such as the Click It or Ticket program and State primary seat belt enforcement laws. The agency has also regulated and researched different types of vehicle-based technologies such as interlocks and seat belt warning systems (SBWS) for increasing seat belt use.[[1]](#footnote-2) The requirements specified in the proposed rule aim to fully realize the benefits of seat belts by increasing seat belt use for both rear and front seat occupants.

The requirements in the proposed rule include three elements. First, the agency proposes to require, for the first time, a SBWS for the rear designated seating positions. Upon start up of the vehicle, this warning would last at least 60 seconds. NHTSA is proposing three different compliance options for the rear seat occupant SBWS. A manufacturer would have the choice of a warning that indicates (a) the number of rear seat belts that are in use, (b) for the occupied rear seats, how many or which rear seat belts are not in use, or (c) for the occupied rear seats, how many or which rear seat belts are in use and not in use.

All three compliance options would require the use of technology to determine whether or not a seat belt was in use. NHTSA’s proposal does not mandate a particular technology to determine belt use, but the belt use criteria is based solely on if the belt is fastened so manufacturers would likely meet the proposed requirements with a seat belt buckle sensor. Compliance options (b) and (c) would necessitate that the seats be equipped with occupant detection technology. On the other hand, compliance option (a) would not require the use of occupant detection technology. Additional features, such as a continuous or flashing visual signal visible to the driver, would be required for all three compliance options.

The second element included in the requirements pertains to front outboard seat occupants (driver and right front passenger). For front outboard seat occupants, the agency proposes to require a SBWS with an indefinite warning period. That is, the warning period would continue until occupants in the driver and right front seat use their seat belts.

The third element included in the requirements addresses the case in which a fastened front or rear seat occupant’s seat belt becomes unfastened. The agency is proposing to require an audiovisual warning whenever a fastened front or rear seat occupant’s seat belt becomes unfastened while the vehicle's ignition switch is in the “on” or “start” position and the vehicle’s transmission selector is in a forward or reverse gear. In response to a change in the status of a rear seat occupant, this warning would last for at least 30 seconds and, in the case of a change in status for front seat occupants, the warning would be indefinite.

The warnings provided by seat belt warning systems typically consist of visual and/or audible signals. An optimized warning system balances effectiveness and annoyance, so that the warning is noticeable enough that the occupants will be motivated to fasten their belts, but not so intrusive that an occupant may attempt to circumvent or disable it or the public will not accept it.[[2]](#footnote-3) Research by NHTSA and others shows that seat belt warning systems are effective at getting unbuckled occupants to fasten their seat belt. For a more extensive discussion of the warning types, please see the Notice of Proposed Rule Making (NPRM).

This PRIA estimates the incremental benefits and costs associated with the proposed rule relative to the baseline. Incremental benefits and costs represent the difference in benefits and costs in the baseline which represents the world in absence of the proposed rule versus those under the proposed rule. In specifying the baseline, this analysis considers the current requirements under FMVSS No. 208 and current seat belt usage rates.

Table 5 presents the baseline seat belt use rates for drivers, right front seat occupants, and rear seat occupants. The table includes the observed seat belt use rates and estimated seat belt use rates in potentially fatal crashes based on the observed seat belt use rates. As those individuals who are most resistant to seat belt use are typically more risk loving than the rest of the population, those individuals are more likely to be involved in serious crashes. Therefore, this analysis considers seat belt use rates in potentially fatal crashes rather than just simply taking into account the observed seat belt use rate and live-saved rate. 3

As seat belt use in potentially fatal crashes is lower than the observed seat belt use rate, this analysis makes use of a model that estimates seat belt use in potentially fatal crashes based on observed seat belt use rates.[[3]](#footnote-4), [[4]](#footnote-5) As this analysis was published in 2002, we request comment on the applicability of this model based on potential recent trends in occupant and driver safety risks.

Based on an observed use rate of 0.9060, the baseline seat belt use rate in potentially fatal crashes for drivers is 0.7842. Based on an observed use rate of 0.8541, the baseline seat belt use rate in potentially fatal crashes for front outboard passengers is 0.7183. Based on an observed rate of 0.9800 and 0.7512, the baseline seat belt use rate for rear-seat passengers age six to ten and 11 years and older in potentially fatal crashes is 0.8825 and 0.5953, respectively.

Table 5: Summary of Baseline Seat Belt Use Rates

|  |  |  |
| --- | --- | --- |
| **Occupant** | **Observed Seat Belt Use Rate** | **Seat Belt Use Rate in Potentially Fatal Crashes** |
| Driver | 0.9060 | 0.7842 |
| Right Front Seat Occupant | 0.8541 | 0.7183 |
| Rear Seat Occupant, Ages 6 – 10 | 0.9800 | 0.8825 |
| Rear Seat Occupant, Age 11+ | 0.7512 | 0.5953 |

Under the baseline, this analysis makes use of the available information to establish the installation rates and types of SBWS already included in the applicable vehicles. Table 6 presents a summary of the SBWS installation rate in the new vehicle fleet for both the right front passenger and rear seat occupants. Using MY2022 NCAP manufacturer data, under the baseline the rear SBWS installation rate is 46.9 percent. Additionally, this analysis also considers that all light vehicles would have SBWS for driver seats and 96 percent of light vehicles would include SBWS for right front seat passengers. Therefore, in estimating incremental benefits and costs, this analysis takes into account these installation rates for the specified seating positions.

Table 6: Summary of SBWS Installations in New Fleet by Seating Position

|  |  |
| --- | --- |
| **Seating Position** | **Percent of New Vehicles with SBWS** |
| Drivers | 100% |
| Right Front Seat | 96% |
| Rear Seats | 46.9% |

For incremental safety benefits resulting from requiring a 90-second audible warning or an indefinite warning, we considered the current market penetration of seat belt warning systems to prevent an over-estimation of the incremental benefits since certain applicable vehicles are already equipped with either a 90-second or indefinite warning system. For the market penetration rate, the agency has data based on manufacturer submitted information.[[5]](#footnote-6) Figure 1 shows a breakdown of the warning durations for drivers.[[6]](#footnote-7) The plot shows the frequency distribution of the fleet by the duration of the seat belt warning systems.

Figure 1: Distribution of Vehicle Models by Audible Warning Duration

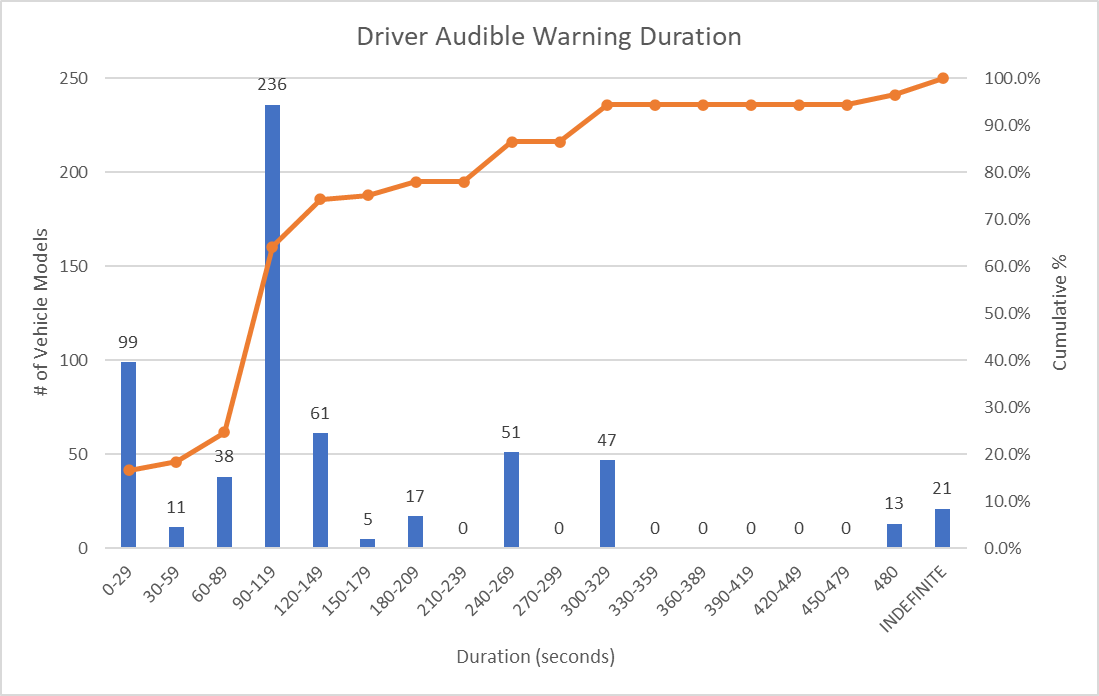


Table 7 presents vehicles sales and corresponding percentage of sales by warning length. Based on the available data, a large percentage of light vehicles are currently equipped with either a 90-second warning system (5.20 percent) or a 90+ seconds but not indefinite warning system (79.60 percent).

Table 7: Vehicle Sales by Warning Length for Front Seat Occupants for MY 2022

|  |  |  |
| --- | --- | --- |
| **Warning Length, front occupants** | **Sales** | **Percentage of Sales** |
| <90 second warning | 1,264,899 | 7.60% |
| 90 second warning, exactly | 867,735 | 5.20% |
| 90+ (but not indefinite) | 13,192,857 | 79.60% |
| *90 second and 90+ combined but not including <90 and indefinite* | *14,060,592* | *84.80%* |
| Indefinite | 1,193,758 | 7.20% |
| Unknown | 60,000 | 0.40% |
| Total | 16,579, 249 | 100% |

For the analysis, due to limited data, we categorized these four different warning systems based on providing a less than 90 second warning, 90 second and 90+ seconds but not indefinite warning, and indefinite warning. We make use of the available data to characterize the distribution of these systems in the baseline, as well as characterize the seat belt use for each system by warning duration.

Table 8 presents the proportion of light vehicle sales by warning type based on the three groups considered in this analysis. Those systems in the “less than 90 second warning” group (Bin No. 1) are later used as a proxy for the system that provides a seven-second warning in a study used for the analysis. Additionally, those systems in the “90-second or 90+ but not indefinite warning” group (Bin No. 2) are later used as a proxy for the system that provides a 100-second duration warning in a study used for the analysis.

Therefore, under the baseline, this analysis establishes that a seven-second duration warning system would fall in Bin No. 1 representing 7.63 percent of vehicles, a 90-second duration warning system would fall in Bin No. 2 representing 85.14 percent of light vehicles, and an indefinite duration warning system would fall in Bin No. 3 representing 7.23 percent of light vehicles in the new vehicle fleet.

Table 8: Proportion of New Fleet Sales by Warning Type for MY 2022

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bin No.** | **Warning Length, front occupants** | **Sales** | **Percentage of Sales** | **Weighted Sales Percent** |
| 1 | <90 second warning | 1,264,899 | 7.60% | 7.63% |
| 2 | 90 second and 90+ seconds but not indefinite | 14,060,592 | 84.80% | 85.14% |
| 3 | Indefinite | 1,193,758 | 7.20% | 7.23% |
|  | **Total percentage** |  | 99.6% | 100% |

It is important to note that the benefits associated with the proposed rule are not from the SBWS’s function itself, but instead result from the increase in seat belt use brought about by the SBWS. Therefore, the incremental benefits associated with the proposed rule are comprised of the fatalities and non-fatal injuries that would be prevented as a direct result of the increase in seat belt use from the SBWS relative to seat belt use under the baseline. Similarly, the incremental costs associated with the proposed rule would be those equipment costs incurred in addition to the types of systems and corresponding installation rates established in the baseline. Unless specified, all monetary values are presented in 2020 dollars.  
The rest of this document is organized as follows: Chapter 2 provides a summary of the regulatory history and research, Chapter 3 presents the target population, Chapter 4 presents the seat belt effectiveness and the increases in seat belt use for rear and front seat occupants, Chapter 5 presents the incremental benefits associated with the proposed rule, Chapter 6 presents the incremental costs associated with the proposed rule, Chapter 7 presents the lead time, Chapter 8 presents the cost-effectiveness and net benefits analyses, Chapter 9 presents the sensitivity analysis, Chapter 10 presents the regulatory alternatives considered for this rulemaking, and Chapter 11 presents the analyses conducted in accordance with the Regulatory Flexibility Act and Unfunded Mandates Reform Act.

# Background

This chapter provides a summary of the background information leading up to the proposed rule. The following sections discuss the regulatory history, NHTSA’s research and efforts, and external research pertaining to the proposed rule.

## Regulatory History of Interlock and Seat Belt Warnings

Early driver seat belt warning systems and seat belt interlocks date back to the 1970s, when seat belt use was only 12 to 15 percent.[[7]](#footnote-8) In 1971, NHTSA tried to increase seat belt use by requiring a warning for front outboard seating positions in vehicles manufactured after 1972.[[8]](#footnote-9) Starting in August 1973, new cars were also required to have interlocks that would not allow a car to be started if the front outboard seat belts were not fastened.[[9]](#footnote-10) However, as a result of consumer backlash toward these requirements, Congress adopted a provision, as part of the Motor Vehicle and School Bus Safety Amendments of 1974, prohibiting NHTSA from requiring, or permitting as a compliance option, either ignition interlocks designed to prevent starting or operating a motor vehicle, or audible signals that sounded for a period of more than eight seconds after the ignition was turned to the “start” or “on” position, if the seat belt was not fastened.[[10]](#footnote-11)

FMVSS No. 208 was ultimately amended to only require that the driver’s seating position be equipped with a SBWS that activates, under circumstances when the driver’s seat belt is not buckled, a continuous or intermittent audible signal for a period of not less than four seconds and not more than eight seconds. It must also have, depending on which option of FMVSS No. 208, S7.3 the manufacturer chooses to comply with, a warning light for not less than 60 seconds after the ignition switch is turned on or not less than four seconds and not more than eight seconds after the ignition switch is turned on (39 FR 42692).

The Moving Ahead for Progress in the 21st Century Act, P.L. 112-141 (MAP-21), was signed into law on July 6, 2012. MAP-21 §31202 modified 49 U.S.C. § 30124, Nonuse of safety belts, by removing the limit on the duration of the audible signal as well as lifting the restriction from permitting the use of ignition interlocks as a compliance option. In addition, §31503 of the law also requires the agency to initiate a rulemaking proceeding for rear SBWSs within two years from the Act’s date of enactment and to issue a final rule or to submit a report if the rule would not meet the statutory requirements that a federal motor vehicle safety standard must satisfy,[[11]](#footnote-12) within three years from the Act’s date of enactment.

## NHTSA Research and other Agency Efforts

NHTSA has sponsored research to quantify how effective SBWS are at getting occupants to use seat belts. In 1976, the agency studied the effectiveness of seat belt warnings. The authors concluded that the eight-second warning system required by FMVSS No. 208 was not effective in increasing seat belt use.[[12]](#footnote-13)

Since then, NHTSA has sponsored a series of studies on the effectiveness of seat belt warnings.[[13]](#footnote-14) The first phase of study consisted of an observational study published in 2007. This observational study of actual vehicles in the field in which the front seat belt use rates in vehicles with an enhanced SBWS were compared to rates in comparable vehicles with only basic SBWS.[[14]](#footnote-15) The study looked at 20 different enhanced SBWSs as well as baseline systems that had only a driver’s seat belt warning that did not exceed the FMVSS No. 208 requirements. Nine of the 20 enhanced SBWSs were driver-only systems. The enhanced systems studied had a variety of enhanced features. Some of those enhanced features were related to visual feedback, such as icons and/or text, and others were related to auditory feedback. Similar systems were combined into groups when determining effectiveness due to sample size limitations. Combining all the effectiveness estimates for all the enhanced SBWSs studied, it was estimated that these systems were associated with increased front seat belt usage of about three to four percentage points above front seat belt usage rates for vehicles without enhanced SBWSs.[[15]](#footnote-16) In other words, when we compared enhanced SBWSs to basic SBWSs, we found enhanced SBWSs increased front seat belt usage by three to four percentage points. The systems that achieved the highest percent seat belt usage increases were systems with an enhanced sound and text or icon displays.

The second phase examined which enhanced SBWS characteristics (e.g., visual, auditory, etc.) most influenced effectiveness and acceptance for drivers. Not surprisingly, this phase found all enhanced SBWSs were perceived to be more effective in encouraging seat belt use than the driver seat belt warning system required by FMVSS No. 208. Furthermore, this phase also found that there is a strong positive correlation among subjective effectiveness and annoyance. Therefore, systems with longer complete durations, more aggressive warning displays, and more frequent repetition patterns were perceived to be more effective relative to those that only remain in effect for a limited number of cycles, less aggressive warning displays, and less frequency repletion patterns. However, in the second phase of the study, which was published in late 2007, no clear consensus existed regarding which systems or displays were most acceptable and the degree to which annoyance was an important attribute of an effective system.[[16]](#footnote-17)

The third phase of our research study further analyzed the results of the first and second phases, as well as focused on optimizing the effectiveness and acceptance of enhanced SBWSs. The study found that there is good agreement between the two studies on the association of a greater likelihood of seat belt use with enhanced SBWSs and the importance of including an auditory component to the system. Based on the findings of this phase, a set of recommended system characteristics were presented as part of the report, as well as a proposed NCAP rating system for enhanced SBWSs.[[17]](#footnote-18)

The final phase, which was published in 2009, focused on evaluating the reactions of teenagers and their parents to enhanced SBWSs and developed a set of preliminary recommendations specifically oriented to teenage drivers and their passengers. Overall, the acceptability of the concept of an enhanced SBWS was good for both teens and their parents.[[18]](#footnote-19) As expected, this study also found that effectiveness and annoyance were highly correlated and that visual warnings are less effective and less annoying than other modalities. However, no system or feature emerged as dramatically more effective than would be expected based on its annoyance. The study also found that systems or features that perform well for one occupant generally performed well for others because they performed similarly across different demographics (males, females, drivers, passengers, etc.).[[19]](#footnote-20)

In addition to the research discussed above, NHTSA conducted an internal analysis of seat belt use data from the National Automotive Sampling System (NASS) Crashworthiness Data System (CDS), 2000 – 2011 crash years, for front outboard passenger seat occupants in MY 2006-2010 General Motors (GM), Ford and Chrysler vehicles.[[20]](#footnote-21), [[21]](#footnote-22) The GM and Ford vehicles were equipped with enhanced front outboard passenger SBWSs whereas the Chrysler vehicles were not equipped with a front outboard passenger SBWS. In the CDS analysis, we found that the seat belt use of front outboard passengers in vehicles without a front passenger SBWS was six percentage points lower than the restraint use of front outboard passengers in vehicles with an enhanced SBWS.

## External Research

In the early 1970s, the Insurance Institute for Highway Safety (IIHS) conducted an observational study on driver belt usage to compare the effectiveness of the newly required driver seat belt warning system and the interlock system.[[22]](#footnote-23) The report noted that the required SBWS resulted in an estimated two to five percent increase in driver’s seat belt usage.[[23]](#footnote-24)

In 2012, IIHS conducted a national telephone survey of drivers and passengers about seat belt use. Using this survey data, IIHS proceeded to conduct several studies. One of the studies focused on the drivers’ attitudes towards passenger seat belt use and seat belt warnings for front passengers and children in back seats.[[24]](#footnote-25) This study used the 477 respondents (of the 1,218 surveyed) that were drivers who transport a front-seat passenger at least once a week and 254 were drivers who transport an eight to15 years old child in the back seat. The respondents were asked about their attitudes toward seat belt use by their front passengers or rear child passengers and preferences for different passenger seat belt warning features. The study found that nearly every driver who transports children in the back seat would encourage their seat belt use, regardless of their own seat belt use habits. Additionally, most drivers who transport passengers in the front seat wanted passenger seat belt warnings to encourage their front seat passengers to buckle up. As far as signal characteristics, the study found that front and rear passenger warning signals that last indefinitely would be acceptable to most drivers who transport these passengers. The study also found that an auditory alert may be especially useful to alert drivers to children unbuckling in the rear seat during a trip.

In 2012, the Japanese Automobile Manufacturers Association conducted an experimental study on the effectiveness of rear SBWSs.[[25]](#footnote-26) The experiment utilized a vehicle equipped with variations of a rear SBWS. In total, the experiment evaluated 11 different types of signals provided to the driver and 14 different types of signals provided to the passenger. The vehicle was driven on a test track and the participants were asked questions to assess the rear SBWS as both drivers and rear seat passengers. As a driver, the participant was asked about the likelihood of requesting the rear seat passengers to fasten their seat belts with and without a rear SBWS. As a rear seat passenger, the participant was asked about the likelihood of fastening their seat belt and the likelihood of fastening their seat belt upon a request from the driver, both with and without a rear SBWS. Participants were asked to respond to the questions based on five ranks of likelihood of taking action including hardly ever, sometimes, half of the time, generally, and most of the time.

The study estimated that there was nearly a 15 to 20 percent increase in the rear passenger seat belt use rate when a visual signal was given only to the driver and that about a 30 percent increase when two visual signals were given, one to the driver and one to the passenger, or if the visual signal was visible to both. The study also estimated a 40 to 45 percent increase when a visual-only signal was provided directly in front of the rear seat passenger (back of front seat), or when a visual signal was given only to the driver and an audible signal was provided that could be heard by both the driver and rear seat passenger. In addition, the study reported that there was an estimated 50 to 59 percent rear seat belt use increase when an audiovisual warning was given to both the driver and rear seat passenger.[[26]](#footnote-27)

The driver’s request for rear seat passengers to use their belts was evaluated in two different ways. First, the effect of the type of rear SBWS on the driver’s motivation to request that rear seat passengers use their seat belt was evaluated. Second, the effect of the driver’s request on the rear seat passengers was evaluated. Without a rear SBWS the estimated percentage of driver requests to the rear seat passenger to use their seat belt was 21 percent. Depending on the type of rear SBWS, the estimated percentage of driver requests to rear seat passengers to use their seat belt increased by 24 to 67 precent. Without a rear SBWS the estimated percentage of rear seat passengers obeying the driver’s request to fasten their seat belt was 70 percent. Depending on the type of rear SBWS, the estimated percentage of obedience of the rear seat passengers to the driver’s request to fasten their seat belt increased by five to 21 precent. As expected, the systems that provide an audiovisual warning to both the driver and rear seat passenger provided the highest motivation for the driver to make a passenger seat belt use request and had the highest obedience by rear seat passengers to the driver’s request.

In addition, more recently, IIHS conducted an observational study on driver belt usage of a 90-second audible reminder and an indefinite audible reminder when compared to intermittent 7-second audible reminder.[[27]](#footnote-28) The study analyzed “forty-nine part-time belt users who had a recent seat belt citation and reported not always using a seat belt drove two vehicles for 1 week each. Thirty-three drove a Chevrolet with three intermittent 7-second audible reminders followed by either a BMW with a 100-second audible reminder[[28]](#footnote-29) (n=17) or a Subaru with an indefinite audible reminder (n=16).” Further, it found “Relative to the intermittent reminder, seat belt use was significantly increased 30 percent by the BMW reminder and 34 percent by the Subaru reminder.”

## Summary of Research Findings

The previous sections discussed the findings of research conducted by both NHTSA and other external sources. Table 9 provides a summary of those findings by study indicating the percentage of increase in seat belt use based on the system and seating position of the occupant. These findings are later used in in Chapter 4 of this PRIA when estimating the increase in seat belt use as a result of the proposed rule.

Table 9: Summary of NHTSA and External Studies

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Source** | **Study Type** | **Occupant Seat Position** | **SBRS System Compared** | **Percentage Point Increase in Belt Usage** |
| NASS-CDS analysis of GM, Ford and Chrysler conducted in 2013 | Observational | Front Outboard Passenger | No SBWS vs.  Enhanced SBWS, front | 6.0% |
| NHTSA Phase I study, 2007 | Observational | Front Seat occupants: Drivers and Front Right Passengers | Basic SBWS vs.  Enhanced SBWS | 3.0% to 4.0% |
| IIHS study, in 1970s | Observational | Driver | No SBWS vs.  Basic SBWS (estimated) | 2.0% to 5.0% |
| Japanese Automobile Manufacturers Association, in 2012 | Experimental | Rear Seat Passengers | Rear SBWS targeted to driver vs. passenger and types of warnings | 3.65% to 15.33% |
| IIHS study, 2019 | Observational | Driver | 7-second, 90-second, and Indefinite Warning SBWS | 30% to 34% |

# Target Population

This chapter presents the target population potentially addressed by the requirements specified in the proposed rule. The following sections in this chapter discuss the target population for rear and front seat occupants, respectively.

## Rear Seat Occupants

This section presents the target population potentially addressed by the proposed rule specific to rear seat occupants. Rear seat occupant data for occupants in the 2nd through 4th rows were grouped into two age groups: occupants ages six to ten years old and 11 years and older (11+). Children under six years old are not part of the target population because NHTSA identifies an age range of four to seven years old for when a child should transition from a forward-facing Child Restraint System (CRS) to a booster seat; as we explain in the NPRM, children in rear-facing and forward-facing CRSs are not part of the target population because these children are restrained by the CRS harness, not the seat belt.

The fatality estimates reflect the annual average fatalities based on 2011-2015 Fatality Analysis Reporting System (FARS) data and the non-fatal injury estimates reflect the annual average number of people who incurred non-fatal injuries by severity on the MAIS scale based on 2011-2015 NASS/CDS data. Note this analysis uses the term non-fatal injuries to refer to the number people who incurred non-fatal injuries which are presented on the MAIS scale.

As the 2011-2015 NASS/CDS data does not reflect injury data for vehicles older than ten years, we recognize that this data limitation may impact this analysis. This analysis recognizes that the target population for injuries may be underestimated and, as a result, the benefits calculations that are based on that target population may also be underestimated. We request comment on this data limitation in regard to the target population.

### Adjustments to Target Population

The target population was adjusted to avoid over-estimating benefits associated with the proposed rule. As the target population is based on 2011-2015 data, this analysis must account for safety impacts of new required safety technologies that have yet to be applied to the fleet. As those safety technologies would result in fewer crashes and resulting non-fatal injuries and fatalities, the target population considered in this analysis is adjusted to be representative of the crash problem potentially addressed by the proposed rule. More specifically, the target population was adjusted by anticipating the potential benefits of Electronic Stability Control (ESC) system (FMVSS No. 126), Side Impact Protection (FMVSS No. 214), Ejection Mitigation (FMVSS No. 226), and Roof Crush Resistance (FMVSS No. 216). The following sections present the adjustment factors that were applied to the target population to account for those safety technologies.

#### Electronic Stability Control

This subsection discusses the adjustment to the target population to account for the safety benefits from electronic stability control (ESC). Table 10 presents ESC effectiveness in rollovers and sales by vehicle type for MY 2011. The agency’s real-world crash data show that ESC is highly effective in preventing single vehicle side crashes and rollovers. For rollovers, a statistical analysis of 1997-2004 FARS data and state data from calendar years 1997-2003 shows that ESC is between 69 and 88 percent effective in preventing rollovers.[[29]](#footnote-30)

Table 10: ESC Effectiveness in Rollovers and MY2011 Sales by Vehicle Type

|  |  |  |
| --- | --- | --- |
| **Vehicle Type** | **Passenger Cars (PCs)** | **Light Trucks and Vans[[30]](#footnote-31) (LTVs)** |
| Fatal Single-vehicle Rollovers (FARS) | 69% | 88% |
| MY 2011 Projected Percent Sales | 44% | 56% |

Table 106 in Appendix C, presents the actual and estimated installation of ESC from FMVSS No. 126 ESC Final Regulatory Analysis for both PC and light trucks and vans (LTV). Based on the ESC final rule,[[31]](#footnote-32) this analysis assumes that all applicable new vehicles will be equipped with ESC before the proposed rule is effective.[[32]](#footnote-33)

Figure 2 presents the ESC installation rates by MY vehicle (see Appendix C for a detailed presentation of installations rates). To adjust the target population to account for the potential benefits from ESC, this analysis calculates the percentage of a particular MY of vehicles with ESC on the road by multiplying the exposure proportion columns by the with ESC (), populated with installation rates from Wards.[[33]](#footnote-34)

Figure 2: ESC installation rates by MY vehicle

Table 11 presents ESC effectiveness by vehicle type and crash type from the FMVSS No. 126 FRIA.[[34]](#footnote-35) Those effectiveness rates are used to exclude potential ESC benefits from the SBWS target population. For both PC and LTV, ESC has an effectiveness rate of 12 percent for side impact crashes. In the case of rollover crashes, ESC has an effectiveness rate of 69 percent for PCs and 88 percent for LTVs. **[[35]](#footnote-36)** ESC does not have effectiveness in preventing front or rear impact crashes and, therefore, does not require an adjustment for those types of crashes.

Table 11: Effectiveness of ESC by Vehicle Type and Crash Type

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Crash Type** | | | |
| **Front** | **Rear** | **Side** | **Rollover** |
| PC | 0 | 0 | 0.12 | 0.69 |
| LTV | 0 | 0 | 0.12 | 0.88 |

Effectiveness rates are typically used to calculate benefits by multiplying the number of crashes, fatalities, or non-fatal injuries in the target population by the effectiveness rate. The resulting estimate then presents the number of crashes, fatalities, or injuries prevented as a result of the specific countermeasure. For the purpose of this analysis, we make use of the effectiveness rate for ESC to exclude crashes, fatalities and non-fatal injuries in the target population that would be prevented as a result of ESC. That is, we use that effectiveness rate to account for safety benefits attributed to requirements outside of those specified in this proposed rule in order to avoid double-counting.

Table 12 presents adjustment factors for ESC specific to vehicle type and crash type (see Appendix C for detailed calculations). For passenger cars, the adjustment factor for ESC for side impact crashes is 0.9930 for side impact crashes and 0.6145 for rollover crashes. For LTVs, the adjustment factor for ESC for side impact crashes is 0.9384 and 0.5482 for rollover crashes. As ESC is not effective in front or rear impact crashes, there is no adjustment made for those types of crashes, which is represented by an adjustment factor of one.

Table 12: Summary of ESC Adjustment Factors

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Crash Type** | | | |
| **Front** | **Rear** | **Side** | **Rollover** |
| Passenger Cars | 1.0000 | 1.0000 | 0.9330 | 0.6145 |
| LTVs | 1.0000 | 1.0000 | 0.9384 | 0.5482 |

#### FMVSSS No. 214 Side Impacts Protection (Upgrade, Vehicle-to-Pole Test)

This subsection discusses the adjustment to the target population to account for the safety benefits from FMVSS No 214 Side Impacts Protection (Upgrade, Vehicle-to-Pole Test). Table 13 presents the injuries and fatalities for rear seat occupants in side impact crashes reflected in the target population in the FMVSS No. 214 FRIA[[36]](#footnote-37), as well as the safety benefits. The FRIA used 2000-2004 NASS/CDS, 2004 FARS, and 2004 GES side impact data. This analysis makes use of that information to estimate the adjustment factor for FMVSS No. 214.

Table 13: Rear Seat Injuries and Benefits[[37]](#footnote-38)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Category** | **AIS3** | **AIS4** | **AIS5** | **Fatal** | **Total** |
| Nonfatal and fatal injuries | 171 | 87 | 61 | 33 | 352 |
| Saved | 61 | 11 | 0 | 21 | 93 |

Based on the information provided in Table 13, the effectiveness rate for FVMSS No. 214 for fatalities of rear seat occupants in side impact crashes is 93 divided by 352 or 26.4 percent. This analysis makes use of that effectiveness rate as a proxy for fatal and non-fatal crashes for rear seat occupants in side crashes. FMVSS No. 214 does not have effectiveness in preventing front, rear, and rollover crashes and, therefore, does not require an adjustment for those types of crashes.

Table 14: Effectiveness of FMVSS 214 by Vehicle Type and Crash Type

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Crash Type** | | | |
| **Front** | **Rear** | **Side** | **Rollover** |
| PC | 0 | 0 | 0.264 | 0 |
| LTV | 0 | 0 | 0.264 | 0 |

The calculation of the adjustment factors for FMVSS No. 214 follow the same procedure as the calculation of the ESC adjustment factor and can be found in Appendix C. The exposure and timeline are the same and the installation rate is given as zero percent in 2008 and all years prior, 20 percent in 2009, 50 percent in 2010, 75 percent in 2011, and 100 percent in 2012 and all years after. This matches the phase-in schedules provided in the FRIA.

Table 15 presents the adjustment factors for FMVSS No. 214 by vehicle type and crash type. For side impact crashes, the adjustment factors for passenger cars and LTVs are 0.8259 and 0.8199, respectively. As FMVSS No. 214 only addresses side impact crashes, there is no adjustment made for front impact, rear impact, and rollover crashes, which is represented by an adjustment factor of one.

Table 15: Summary of FMVSS No. 214 Adjustment Factors

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Crash Type** | | | |
| **Front** | **Rear** | **Side** | **Rollover** |
| PC | 1.0000 | 1.0000 | 0.8259 | 1.0000 |
| LTV | 1.0000 | 1.0000 | 0.8199 | 1.0000 |

#### FMVSS No. 226 Ejection Mitigation

This subsection discusses the adjustment to the target population to account for the safety benefits from FMVSS No. 226 Ejection Mitigation. The calculation of the adjustment factors for FMVSS No. 226 follow the same procedure as the calculation of the ESC adjustment factor and can be found in Appendix C.

Table 16 presents the adjustment factors for FMVSS No. 226 by vehicle type and crash type. FMVSS No. 226 addresses the partial or complete ejection of vehicle occupants through side windows in crashes, particularly rollover crashes.[[38]](#footnote-39) For rollover crashes, the adjustment factor for passenger cars and LTVs is 0.9254 and 0.9309, respectively. As the adjustment for FMVSS No. 226 is only applicable to rollover crashes, there is no adjustment made for front, rear, and side impact crashes, which is represented by an adjustment factor of one. This analysis notes that there would be some benefits from FMVSS No. 226 for side impact crashes. However, due to the relatively small impact for side impact crashes, no adjustment factor was applied for FMVSS No. 226. As a result of that lack of adjustment to the target population, this analysis may slightly overestimate benefits.

Table 16: FMVSS 226 Adjustment Factors by Vehicle Type and Crash Type

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Crash Type** | | | |
| **Front** | **Rear** | **Side** | **Rollover** |
| PC | 1.0000 | 1.0000 | 1.0000 | 0.9254 |
| LTV | 1.0000 | 1.0000 | 1.0000 | 0.9309 |

#### FMVSS No. 216 Roof Crush Resistance

Table 17 presents the adjustment factors for FMVSS No. 216 “Roof crush resistance,” by vehicle type and crash type. The calculation of the adjustment factors for FMVSS No. 216 follow the same procedure as the calculation of the ESC adjustment factor and can be found in Appendix C. As safety impact of FMVSS No. 216 rule should only apply to the front seat, there is no resulting impact on the target population specific to rear seat occupants.[[39]](#footnote-40) Therefore, there is no adjustment made to the target population based on FMVSS. No 216 which is represented by an adjustment factor of one for all vehicle types and crash types.

Table 17: FMVSS 216 Adjustment factors by Vehicle Type and Crash Type

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Crash Type** | | | |
| **Front** | **Rear** | **Side** | **Rollover** |
| PC | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| LTV | 1.0000 | 1.0000 | 1.0000 | 1.0000 |

#### Summary of Adjustment Factors

This subsection summarizes the adjustment factors used to estimate the target population for rear seat occupants. As the FVMSS accounted for the adjustment factors only pertain to side impact and rollover crashes, this section discusses the resulting adjustment factors for those crash types. As none of the FMVSS accounted for front impact and rear impact crashes, no adjustment factor was applied to the non-fatal injuries and fatalities in the target population resulting from those crash types.

Table 18 presents the adjustment factor for side impact crashes for the target population for rear seat occupants. When accounting for safety impacts of new required safety technologies yet to be applied to the fleet, the adjustments for FMVSS No. 126 ESC and FVMSS No. 214 are applicable to side impact crashes. For both passenger cars and LTVS respectively, the resulting adjustment factor for side impact crashes is calculated by multiplying the adjustment factors for each of the FVMSS presented in the table. For passenger cars, the resulting adjustment factor for side impact crashes is 0.7705, which is 0.9330 multiplied by 0.8259. Similarly, for LTVs, the adjustment factor for side impact crashes is 0.7694, which is 0.9384 multiplied by 0.8199.

Table 18: Adjustment Factor for Side Impact Crashes for Rear Seat Occupants

|  |  |  |  |
| --- | --- | --- | --- |
| **Vehicle Type** | **Individual Adjustment Factors** | | **Resulting Adjustment Factor** |
| **FMVSS No. 126** | **FVMSS No. 214** |
| PC | 0.9330 | 0.8259 | 0.7705 |
| LTV | 0.9384 | 0.8199 | 0.7694 |

Table 19 presents the adjustment factor for rollover crashes for the target population for rear seat occupants. When accounting for safety impacts of new required safety technologies yet to be applied to the fleet, the adjustments for FMVSS No. 126 ESC and FVMSS No. 226 are applicable to rollover crashes. For both passenger cars and LTVS respectively, the resulting adjustment factor for rollover crashes is calculated by multiplying the adjustment factors for each of the FVMSS presented in the table. For passenger cars, the resulting adjustment factor for rollover crashes is 0.5686, which is 0.6145 multiplied by 0.9254. Similarly, for LTVs, the adjustment factor for rollover crashes is 0.5104, which is 0.5482 multiplied by 0.9309.

Table 19: Adjustment Factor for Rollover Crashes for Rear Seat Occupants

|  |  |  |  |
| --- | --- | --- | --- |
| **Vehicle Type** | **Individual Adjustment Factors** | | **Resulting Adjustment Factor** |
| **FMVSS No. 126** | **FVMSS No. 226** |
| PC | 0.6145 | 0.9254 | 0.5686 |
| LTV | 0.5482 | 0.9309 | 0.5104 |

### Adjusted Target Population

This subsection presents the adjusted target population for rear seat occupants. The adjusted target population reflects the adjustment factors discussed in the previous subsection on the annual average non-fatal injuries and fatalities between 2011 and 2015 from FARS and NASS/CDS. See Appendix D for the unadjusted target population for rear seat occupants.

Table 20 presents the adjusted annual average of injuries and fatalities for rear seat occupants 11 years and older. The adjusted annual average number of fatalities rear seat occupants 11 years and older is 691. Of those fatalities, 258 of the rear seat occupants were restrained and 433 were unrestrained. The adjusted annual average number of non-fatal injuries rear seat occupants 11 years and older is 23,492. Of those non-fatal injuries, 17,482 of the rear seat occupants were restrained and 6,010 were unrestrained.[[40]](#footnote-41)

Table 20: Adjusted Annual Injuries and Fatalities for Rear Seat Occupants 11 Years and Older

|  |  |  |  |
| --- | --- | --- | --- |
| **Injury Severity** | **Restrained** | **Unrestrained** | **Total** |
| MAIS 1 | 16,765 | 4,063 | 20,828 |
| MAIS 2 | 601 | 1,515 | 2,116 |
| MAIS 3 | 55 | 206 | 260 |
| MAIS 4 | 60 | 219 | 279 |
| MAIS 5 | 1 | 7 | 9 |
| **Total Injuries**  **MAIS 1-5** | **17,482** | **6,010** | **23,492** |
| **Fatal** | **258** | **433** | **691** |

Note: Values may not sum due to rounding. Occupant injuries with unknown belt use were distributed and included in the table. MAIS 1 & 2 injuries are considered as minor injuries and MAIS 3 – 5 are serious injuries.

Table 21 presents the adjusted annual average of injuries and fatalities for rear seat occupants ages six to ten years old. The adjusted annual average number of fatalities for rear seat occupants ages six to ten is 128. Of those fatalities, 87 of the rear seat occupants were restrained and 42 were unrestrained. The adjusted annual average number of non-fatal injuries for rear seat occupants ages six to ten is 7,182. Of those non-fatal injuries, 6,194 of the rear seat occupants were restrained and 1,025 were unrestrained.[[41]](#footnote-42) In comparison to rear seat occupants 11 years and older, rear seat occupants between the ages of six and ten years old has higher rates of belt use. Given the difference in seat belt usage between these two age groups, this analysis considered rear seat occupants ages six to 10 years old separately from rear seat occupants who are 11 years and older.

Table 21: Adjusted Annual Injuries and Fatalities for Rear Seat Occupants Ages 6 to 10

|  |  |  |  |
| --- | --- | --- | --- |
| **Injury Severity** | **Restrained** | **Unrestrained** | **Total** |
| MAIS 1 | 5,931 | 906 | 6,837 |
| MAIS 2 | 186 | 90 | 277 |
| MAIS 3 | 35 | 19 | 54 |
| MAIS 4 | 4 | 11 | 15 |
| MAIS 5 | 0 | 0 | 0 |
| **Total Injuries**  **MAIS 1-5** | **6,157** | **1,025** | **7,182** |
| **Fatal** | **87** | **42** | **128** |

Note: Values may not sum due to rounding. Occupant injuries with unknown belt use were distributed and included in the table. MAIS 1 & 2 injuries are considered as minor injuries and MAIS 3 – 5 are serious injuries.

## Front Seat Occupants

This section presents the adjusted target population potentially addressed by the proposed rule specific to front seat occupants. The adjusted target population reflects the adjustment factors established in the previous section on the annual average fatalities for front seat occupants ages six year and older between 2011 and 2015. Furthermore, due to a lack of data, this analysis makes use of the fatality data to estimate the annual average of non-fatal injuries to front seat occupants. By using the ratio of injuries to fatalities for rear-seat occupants to estimate the number of injuries for front seat occupants, this analysis may underestimate the target population specific to non-fatal injuries. As a result, the benefits calculations based on that target population may also be underestimated. We request comment on in regard to the approach used to establish the target population.

Table 22 presents the adjustment factors used to adjust the target population for front seat occupants by vehicle type and crash type. Since the FMVSSs analyzed for the rear seat “adjusted” target population would have similar effects on the target population of front occupants, this analysis makes use of the adjustment factors established in subsection 3.1.1 to adjust the target population for front seat occupants in order to account for safety impacts of new required safety technologies yet to be applied to the fleet. See Appendix D for the unadjusted target population based on the FARS data for front seat occupants.

Table 22: Target Population Adjustment Factors by Crash Modes, and Vehicle Type

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle type** | **Crash type** | | | |
| **Front** | **Rear** | **Side** | **Rollover** |
| PC | 1.0000 | 1.0000 | 0.7705 | 0.5686 |
| LTV | 1.0000 | 1.0000 | 0.7694 | 0.5104 |

Furthermore, the front occupant target population includes three types of occupants: drivers, right front seat occupants, and center front seat occupants. The following subsections discuss the adjusted target population for drivers and right front seat occupants who are both included in the requirements specified in the proposed rule. See section 10.2 for a discussion of the regulatory alternative that considers the inclusion of center front seat occupants.

### Adjusted Target Population

Table 23 presents the adjusted annual average of fatalities for drivers by vehicle type and crash type. For passenger cars, there were a total of 7,192 fatalities, annually. Of those fatalities, 4,205 were restrained and 2,987 were unrestrained driver fatalities. For light trucks, there were a total of 4,956 fatalities, annually. Of those fatalities, 2,287 were restrained and 2,669 were unrestrained driver fatalities.

Table 23: Annual Fatalities for Drivers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Crash type** | **Restrained** | **Unrestrained** | **Total** |
| **PC** | Rollover | 444 | 733 | 1,177 |
| Front | 2,304 | 1,634 | 3,938 |
| Side | 1,203 | 514 | 1,717 |
| Rear | 255 | 105 | 360 |
| **Total** | **4,205** | **2,987** | **7,192** |
| **LTV** | Rollover | 476 | 1,104 | 1,579 |
| Front | 1,359 | 1,253 | 2,612 |
| Side | 368 | 265 | 633 |
| Rear | 84 | 48 | 132 |
| **Total** | **2,287** | **2,669** | **4,956** |

There is a lack of data to establish the target population for drivers who incurred non-fatal injuries. Therefore, we estimated the number of non-fatal injuries based on the fatality data above and ratio of injuries to fatalities for rear seat occupants.

Table 24 presents the injury to fatality ratio for drivers by vehicle type. In order to estimate the number of non-fatal injures for drivers, we apply the appropriate ratio by injury severity and vehicle type to the number of fatalities presented in Table 23.

Table 24: Injury to Fatality Ratio by Vehicle Type

|  |  |  |
| --- | --- | --- |
| **Injury Severity** | **Injury-Fatal Ratio** | |
| **Passenger Cars** | **Light Trucks** |
| MAIS 1 | 4.626948383 | 4.81910849 |
| MAIS 2 | 2.024681819 | 1.63651249 |
| MAIS 3 | 0.558835586 | 0.01071116 |
| MAIS 4 | 0.404146475 | 0.07687071 |
| MAIS 5 | 0.009818823 | 0.00555692 |

Table 25 presents the adjusted annual fatalities and non-fatal injuries to drivers by vehicle type and crash type. For passenger cars, there were a total of 54,834 non-fatal injuries to drivers, annually. Of those non-fatal injuries, 32,063 were to restrained drivers and 22,771 were to unrestrained drivers. For light trucks, there were a total of 32,456 non-fatal injuries, annually. Of those non-fatal injuries, 14,975 were to restrained drivers and 17,480 were to unrestrained drivers.

Table 25: Adjusted Annual Fatalities and Non-Fatal Injuries to Drivers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Injury Severity** | **Restrained** | **Unrestrained** | **Total** |
| PC | MAIS 1 | 19,458 | 13,819 | 33,276 |
| MAIS 2 | 8,514 | 6,047 | 14,561 |
| MAIS 3 | 2,350 | 1,669 | 4,019 |
| MAIS 4 | 1,700 | 1,207 | 2,907 |
| MAIS 5 | 41 | 29 | 71 |
| **Total Injuries**  **(MAIS 1-5)** | **32,063** | **22,771** | **54,834** |
| **Fatal** | **4,205** | **2,987** | **7,192** |
| LTV | MAIS 1 | 11,020 | 12,863 | 23,883 |
| MAIS 2 | 3,742 | 4,368 | 8,111 |
| MAIS 3 | 24 | 29 | 53 |
| MAIS 4 | 176 | 205 | 381 |
| MAIS 5 | 13 | 15 | 28 |
| **Total Injuries**  **(MAIS 1-5)** | **14,975** | **17,480** | **32,456** |
| **Fatal** | **2,287** | **2,669** | **4,956** |

Table 26 presents the adjusted annual average of fatalities for right front seat occupants by vehicle type and crash type. For passenger cars, there were a total of 1,676 fatalities for right front seat occupants, annually. Of those fatalities, 1,074 were restrained and 602 were unrestrained right front seat occupants. For light trucks, there were a total of 983 fatalities. Of those fatalities, 508 were restrained and 475 were unrestrained right front seat occupant fatalities.

Table 26: Annual Adjusted Fatalities for Right Front Seat Occupants

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Crash type** | **Restrained** | **Unrestrained** | **Total** |
| **PC** | Rollover | 121 | 146 | 266 |
| Front | 509 | 296 | 805 |
| Side | 373 | 132 | 505 |
| Rear | 72 | 28 | 100 |
| **Total** | **1,074** | **602** | **1,676** |
| **LTV** | Rollover | 120 | 219 | 339 |
| Front | 257 | 191 | 448 |
| Side | 99 | 53 | 152 |
| Rear | 32 | 12 | 44 |
| **Total** | **508** | **475** | **983** |

As was the case for drivers, there is a lack of data to establish the target population for right front seat occupants who incurred non-fatal injuries. Therefore, we estimated the number of non-fatal injuries based on the fatality data above and the ratio of injuries to fatalities for rear seat occupants. In order to estimate the number of non-fatal injures for right front seat occupants, we apply the appropriate ratio by injury severity and vehicle type as presented in Table 24.

Table 27 presents the adjusted annual fatalities and non-fatal injuries to right front seat occupants by vehicle type and crash type. For passenger cars, there were a total of 12,779 non-fatal injuries. Of those non-fatal injuries, 8,190 were to restrained and 4,589 were to unrestrained right front seat occupants. For light trucks, there were a total of 6,438 non-fatal injuries to right front seat occupants, annually. Of those non-fatal injuries, 3,326 were to restrained and 3,112 were to unrestrained right front seat occupants.

Table 27: Annual Adjusted Fatalities and Non-Fatal Injuries to Right Front Seat Occupants

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Injury Severity** | **Restrained** | **Unrestrained** | **Total** |
| PC | MAIS 1 | 4,970 | 2,785 | 7,755 |
| MAIS 2 | 2,175 | 1,219 | 3,394 |
| MAIS 3 | 600 | 336 | 937 |
| MAIS 4 | 434 | 243 | 677 |
| MAIS 5 | 11 | 6 | 16 |
| **Total Injuries**  **(MAIS 1-5)** | **8,190** | **4,589** | **12,779** |
| **Fatal** | **1,074** | **602** | **1,676** |
| LTV | MAIS 1 | 2,447 | 2,290 | 4,737 |
| MAIS 2 | 831 | 778 | 1,609 |
| MAIS 3 | 5 | 5 | 11 |
| MAIS 4 | 39 | 37 | 76 |
| MAIS 5 | 3 | 3 | 5 |
| **Total Injuries**  **(MAIS 1-5)** | **3,326** | **3,112** | **6,438** |
| **Fatal** | **508** | **475** | **983** |

# Effectiveness

This chapter presents the effectiveness rates used to calculate benefits in this PRIA. It is important to note that the safety benefits associated with the proposed rule are not from the SBWS’s function itself, but instead result from the increase in seat belt use brought about by the SBWS. Therefore, the incremental safety benefits associated with the proposed rule are comprised of the lives saved and injuries prevented as a direct result of the increase in seat belt use relative to seat belt use under the baseline.  
As the safety benefits associated with the proposed rule are the result of the increase in seat belt use, section 4.1 presents the effectiveness rates for seat belts. The following two sections discuss the impact that the requirements specified in the proposed rule for SBWS for rear occupants and the indefinite warning will have on seat belt usage for front seat occupants, respectively.

## Seat Belt Effectiveness

As the benefits resulting from the proposed rule result from an increase in seat belt usage, this section presents the established effectiveness rates for seat belts. It is important to note that this analysis makes use of those established effectiveness rates in calculating benefits based on seat belt use rates. That is, under the proposed rule seat belt use rates would increase, but the effectiveness of seat belts remains the same. The following discussion details the effectiveness rates for seat belts specific to seating position, age group, vehicle type, and injury severity.

Table 28 present the effectiveness rate for seat belts specific to rear seat occupants by age group and vehicle type. For rear seat occupants ages six to ten in passenger cars, the effectiveness rates for seat belts are 0.550 for fatalities, 0.625 for MAIS 2-5 injuries, and 0.055 for MAIS 1 injuries. For rear seat occupants ages six to ten in light trucks, the effectiveness rates for seat belts are 0.704 for fatalities, 0.507 for MAIS 2-5 injuries, and 0.055 for MAIS 1 injuries.[[42]](#footnote-43), [[43]](#footnote-44) For rear seat occupants 11 years and older in passenger cars, the effectiveness rates for seat belts are 0.550 for fatalities, 0.625 for MAIS 2-5 injuries, and 0.055 for MAIS 1 injuries. For rear seat occupants 11 years and older in light trucks, the effectiveness rates for seat belts are 0.740 for fatalities, 0.507 for MAIS 2-5 injuries, and 0.055 for MAIS 1 injuries.

Table 28: Seat Belt Effectiveness for Rear Seat Occupants by Age Group and Vehicle Type[[44]](#footnote-45),[[45]](#footnote-46)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Age Group** | **Vehicle type** | **Injury Severity** | | |
| **Fatal** | **MAIS 2-5** | **MAIS 1** |
| 6-10 | PC | 0.550 | 0.625 | 0.055 |
| LTV | 0.740 | 0.507 | 0.055 |
| 11+ | PC | 0.550 | 0.625 | 0.055 |
| LTV | 0.740 | 0.507 | 0.055 |

Table 29 presents effectiveness rates for seat belts for drivers by vehicle type. For drivers in passenger cars, the effectiveness rates for seat belts are 0.440 for fatalities, 0.500 for MAIS 2-5 injuries, and 0.055 for MAIS 1 injuries. For drivers in light trucks, the effectiveness rates for seat belts are 0.730 for fatalities, 0.500 for MAIS 2-5 injuries, and 0.055 for MAIS 1 injuries.

Table 29: Seat Belt Effectiveness for Drivers by Vehicle Type

|  |  |  |  |
| --- | --- | --- | --- |
| **Vehicle Type** | **Injury Severity** | | |
| **Fatal** | **MAIS 2-5** | **MAIS 1** |
| PC | 0.440 | 0.500 | 0.055 | |
| LTV | 0.730 | 0.500 | 0.055 | |

Table 30 presents effectiveness rates for seat belts for right front passengers by vehicle type. For right front passengers in passenger cars, the effectiveness rates for seat belts are 0.44 for fatalities, 0.500 for MAIS 2-5 injuries, and 0.055 for MAIS 1 injuries. For right front seat passengers in light trucks, the effectiveness rates for seat belts are 0.630 for fatalities, 0.500 for MAIS 2-5 injuries, and 0.055 for MAIS 1 injuries.

Table 30: Seat Belt Effectiveness for Right Front Passenger by Vehicle Type

|  |  |  |  |
| --- | --- | --- | --- |
| **Vehicle Type** | **Injury Severity** | | |
| **Fatal** | **MAIS 2-5** | **MAIS 1** |
| PC | 0.440 | 0.500 | 0.055 |
| LTV | 0.630 | 0.500 | 0.055 |

## Effect of SBWS on Rear Occupant

This section discusses the effect of SBWS on rear seat occupant seat belt use rates. The next subsection discusses the impact of SBWS on seat belt use and the following presents the increase in seat belt use rates for rear seat occupants resulting from the requirements specified for SBWS in the proposed rule.

### Impact of SBWS

This subsection discusses the impact of SBWS on seat belt use. In order to estimate the increase in seat belt use rates for rear seat occupants as a result of the proposed rule, this analysis uses the estimate of front seat belt use increase due to various SBWSs (by comparing no-SBWS to enhanced SBWSs and basic SBWSs to enhanced SBWSs) to determine the increase in rear seat belt use due to the proposed SBWS. Note that this analysis did not consider the impact of an indefinite warning period for SBWS for rear seat occupants as that is not included in the proposed rule. See Appendix E for a detailed discussion of the previous studies on SBWS effectiveness. The following sections discuss the impact of SBWS on the seat belt use rates of rear seat occupant by age group.

#### Rear Seat Occupants 11 and older

This analysis uses the average seat belt use rate over four years from the National Occupant Protection Use Surveys (NOPUS) data from 2011 to 2014. Based on that data, this analysis estimates a seat belt use rate of 0.7512 for rear seat occupants 11 years and older. This analysis takes into account the estimated overall seat belt use rate of 0.8540 for front seat occupants, the estimated increase in belt use rate of two percent and three percent based on NHTSA’s research (see Section 2.2 and Appendix E), and the estimated seat belt use rate of 0.7512 for rear seat occupants. Based on that information, this analysis developed a linear regression model. According to a report by Westat, although it seems trivial, the effects of a seat belt warning system were always positive.[[46]](#footnote-47) In addition, in the hypothetical case that all occupants use seat belts in vehicles without a seat belt warning system, adding a seat belt warning system would not increase the seat belt use rate. That is, given a 100 percent seat belt use rate, the percentage point increase in seat belt use for the SBWS would be zero.

Figure 3 presents the linear regression model developed to estimate the increase in seat belt use rates for rear seat occupants. Based on the linear regression model, the proposed SBWS is estimated to result in a three to five percentage point increase in seat belt usage for rear seat occupants.

Figure 3: Linear Regression Model for Increase in Seat Belt Use for Rear Seat Occupants

Table 31 presents the estimated increase in seat belt use for rear seat occupants based on the current seat belt use rate. For rear seat occupants, this analysis considers a three to five percentage point range of potential belt use rate increases as a result of the requirement for SBWS. This analysis refers to the scenario with three percent rear belt use increase as “lower” or “Lo” and the scenario with five percent rear belt use increase as “upper” or “Hi.” We request comments on the assumptions used to estimate the increase in seat belt use for rear seat occupants.

Table 31: Estimated Belt Use Rate in Rear Seat Occupants

|  |  |  |
| --- | --- | --- |
| **Seat position** | **Seat belt use rate** | **Estimated Point increase with SBWS** |
| Rear seats | 75.12% | 3.4%[[47]](#footnote-48) to 5.1%[[48]](#footnote-49) |
| Hypothetical maximum range | 100% | 0.0% |

We note that the observed belt use rates are inclusive of all rear seat occupants whether they are in crashes or not. Therefore, this analysis must first estimate the seat belt use rate in potentially fatal crashes for rear seat occupants. To do so, this analysis uses the established relationship between observed use and use in potentially fatal crashes derived for front seat occupants as a proxy for rear seat occupants. Therefore, this analysis makes use of the NHTSA’ Belt Use model (Wang and Blincoe, 2001, 2003).[[49]](#footnote-50) The model makes use of the national observed belt use rate to predict the use rate in potentially fatal crashes.Using this model,[[50]](#footnote-51) we calculated the belt use rate in potentially fatal crashes of approximately 0.5939 when the observed belt use rate is 0.7512.

#### Rear Seat Occupants Six to Ten Years Old

This subsection uses a similar method as the previous subsection to estimate the increase in seat belt use for rear seat occupants ages six to ten. According to the National Child Restraint Use Special Study (NCRUSS) published in 2015, restraint use for six to ten years old occupants is 0.9800.[[51]](#footnote-52) We first note that not only is the seat belt use rate for this age group higher than their 11 years and older peers, but it also leaves very little room for improvement. That is, it is much closer to the hypothetical case mentioned above in which seat belt use rates reach 100 percent without SBWS and the warning system would result in a zero percent change.

Once again, the linear regression is used to find the increase in belt use. Using a starting belt use of 0.9800 from NCRUSS, the increase in belt use we see should be 0.3 percent (0.2742%) (Lo) and 0.4 percent (0.4112%) (Hi). Note that these are tenths of a percent increase for the six to ten age rear seat occupants, compared to the three to five percent increase for 11 years and older rear seat occupants. The main reason for the relatively small increase in percentage point is that the baseline belt use rate of the six to ten age group is already very high.

Lastly, this analysis once again makes use of the NHTSA’s Belt Use model[[52]](#footnote-53) to establish the seat belt use rate for this age group in potentially fatal crashes. Making use of this model, we calculated the belt use rate in potentially fatal crashes of approximately 0.8825 when the observed belt use rate is 0.9800.[[53]](#footnote-54)

#### Summary

Table 32 presents the increase in seat belt usage for rear seat occupants resulting from SBWS based on the findings of previous studies. For rear seat occupants ages six to ten, the increase in seat belt usage ranges from approximately 0.3 percent to 0.4 percent. For rear seat occupants 11 years and older, the increase in seat belt usage ranges from approximately three percent to five percent.

Table 32: Summary of Increase in Belt Use Rate with SBWS in Rear Seat Occupants

|  |  |  |
| --- | --- | --- |
| **Age Group** | **Range of increase in belt use rate** | |
| **Lo** | **Hi** |
| 6-10 | 0.2742% | 0.4112% |
| 11+ | 3.4105% | 5.1157% |

### Resulting Increase on Seat Belt Use Rates

This subsection makes use of the findings in the previous subsection to estimate the seat belt usage rates for rear seat occupants under the proposed rule. Under the baseline, the seat belt use rate for rear seat occupants is 0.7512. Additionally, under the baseline, 46.9 percent of the current fleet is already equipped rear passenger seat belt warning systems. Therefore, this subsection reflects the increase in seat belt usage resulting from SBWS on the baseline to determine seat belt usage under the proposed rule.

This analysis makes use of the available data to calculate seat belt usage rates as a function of SBWS presence. That is, this analysis can make use of the overall seat belt use rate, SBWS take rate under the baseline, and the increase in seat belt usage from SBWS to establish the seat belt use rates in both the SBWS and no SBWS cases. The following discussion presents an example of this calculation for rear seat occupants 11 years and older using the lower estimated increase in seat belt usage of approximately 3.41 percent.

Under the baseline, we observe a seat belt usage rate of 0.7512 for all rear seat occupants. That overall usage rate for rear seat occupants represents a fleet of which 46.9 percent are equipped with SBWS and 53.1 percent are not equipped with SBWS. Furthermore, in this example, we consider that SBWS increases seat belt use for rear seat occupants by approximately 0.0341. Therefore, equation (1) represents this characterization of the observed seat belt usage for all rear seat occupants:

(1)

Where is the seat belt usage rate in the case of no SBWS.

The first part of the equation represents the proportion of the fleet without SBWS and the corresponding seat belt use rate and the second part of the equation present the proportion of the fleet with SBWS along with accounting for the relative increase in seat belt use rate from SBWS.

This analysis makes use of equation (1) to solve for seat belt usage for rear seat occupants when the vehicle is not equipped with SBWS. Therefore, the resulting calculation to solve for is:

Therefore, we establish that in the case that the vehicle was not equipped with SBWS, the seat belt use rate for rear seat occupants in this example is 0.735205. Furthermore, we can also reflect the expected increase in seat belt use associated with SBWS to calculate the seat belt usage rate for rear seat occupants when the vehicle is equipped with SBWS. Equation (2) presents this calculation:

(2).

Plugging in the values for the seat belt rate without SBWS, we find that the corresponding seat belt use rate with SBWS is:

In this example, the seat belt usage rate for rear seat occupants when the vehicle is equipped with SBWS is 0.769310.

Similarly, this analysis can estimate seat belt use when all vehicles have SBWS or seat belt use under the proposed rule. To demonstrate the corresponding calculations, we continue with the example using the Lo estimated increase in seat belt use rates for rear seat occupants 11 years and older. Given the seat belt use values for both the SBWS and no SBWS cases, equation (1) can be adjusted to calculate the overall seat belt use rate for rear seat occupants that reflects the installation rates of SBWS under the proposed rule. That is, it can be used to reflect the case in which all vehicles are equipped with SBWS. Equation (3) presents this calculation:

(3).

Therefore, under the proposed rule, the seat belt use rate for rear seat occupants is 0.769310. The increase in seat belt use in this example is approximately 0.018. The increase reflects the difference in rear occupant seat belt use under the baseline of 0.7512, which was reflected in equation (1), to that under the proposed rule of 0.769310 calculated in equation (3). The following discussion presents the seat belt use rates in the baseline and proposed using the same calculations for all of age groups and vehicle types included in the rear seat occupant target population.

Table 33 presents the observed or baseline and proposed rule seat belt use rates for rear seat occupants in passenger cars. For rear seat occupants six to ten years old, under the proposed rule seat belt use rates in crashes that resulted in non-fatal injuries would increase from 0.9800 to 0.9815 in the Lo case and 0.9822 in the Hi case. In the case of potentially fatal crashes, seat belt use rates would increase from 0.8825 to 0.8845 in the Lo case and 0.8855 in the Hi case. For rear seat occupants 11 years and older, under the proposed rule seat belt use rates in crashes that resulted in non-fatal injuries would increase from 0.7512 to 0.7693 in the Lo case and 0.7784 in the Hi case. In the case of potentially fatal crashes, seat belt use rates would increase from 0.5953 to 0.6162 in the Lo case and 0.6268 in the Hi case. In the case of potentially fatal crashes, seat belt use rates would increase from 0.8825 to 0.8845 in the Lo case and 0.8855 in the Hi case. For rear seat occupants six to ten years old in passenger cars, seat belt use rates in crashes that resulted in non-fatal injuries would increase from 0.9800 to 0.9815 in the Lo case and 0.9822 in the Hi case.

Table 33: Rear Seat Belt Use and Belt Effectiveness, by Age, Vehicle Type, and Injury Severity

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Age** | **Vehicle Type** | **Injury Severity** | **Belt Eff.** | **Assume no SBWS (Lo)** | **Assume no SBWS (Hi)** | **Observed** | **RULE (Lo)** | **RULE (Hi)** |
| **6 - 10** | **PC** | (1) Minor Injury | 0.055 | 0.9787 | 0.9781 | 0.9800 | 0.9815 | 0.9822 |
| (2) Moderate Injury | 0.500 | 0.9787 | 0.9781 | 0.9800 | 0.9815 | 0.9822 |
| (3) Serious Injury | 0.500 | 0.9787 | 0.9781 | 0.9800 | 0.9815 | 0.9822 |
| (4) Severe Injury | 0.500 | 0.9787 | 0.9781 | 0.9800 | 0.9815 | 0.9822 |
| (5) Critical Injury | 0.500 | 0.9787 | 0.9781 | 0.9800 | 0.9815 | 0.9822 |
| Fatal | 0.440 | 0.8813 | 0.8806 | 0.8825 | 0.8845 | 0.8855 |
| **LTV** | (1) Minor Injury | 0.055 | 0.9787 | 0.9781 | 0.9800 | 0.9815 | 0.9822 |
| (2) Moderate Injury | 0.500 | 0.9787 | 0.9781 | 0.9800 | 0.9815 | 0.9822 |
| (3) Serious Injury | 0.500 | 0.9787 | 0.9781 | 0.9800 | 0.9815 | 0.9822 |
| (4) Severe Injury | 0.500 | 0.9787 | 0.9781 | 0.9800 | 0.9815 | 0.9822 |
| (5) Critical Injury | 0.500 | 0.9787 | 0.9781 | 0.9800 | 0.9815 | 0.9822 |
| Fatal | 0.730 | 0.8813 | 0.8806 | 0.8825 | 0.8845 | 0.8855 |
| **11+** | **PC** | (1) Minor Injury | 0.055 | 0.7352 | 0.7272 | 0.7512 | 0.7693 | 0.7784 |
| (2) Moderate Injury | 0.500 | 0.7352 | 0.7272 | 0.7512 | 0.7693 | 0.7784 |
| (3) Serious Injury | 0.500 | 0.7352 | 0.7272 | 0.7512 | 0.7693 | 0.7784 |
| (4) Severe Injury | 0.500 | 0.7352 | 0.7272 | 0.7512 | 0.7693 | 0.7784 |
| (5) Critical Injury | 0.500 | 0.7352 | 0.7272 | 0.7512 | 0.7693 | 0.7784 |
| Fatal | 0.440 | 0.5793 | 0.5713 | 0.5953 | 0.6162 | 0.6268 |
| **LTV** | (1) Minor Injury | 0.055 | 0.7352 | 0.7272 | 0.7512 | 0.7693 | 0.7784 |
| (2) Moderate Injury | 0.500 | 0.7352 | 0.7272 | 0.7512 | 0.7693 | 0.7784 |
| (3) Serious Injury | 0.500 | 0.7352 | 0.7272 | 0.7512 | 0.7693 | 0.7784 |
| (4) Severe Injury | 0.500 | 0.7352 | 0.7272 | 0.7512 | 0.7693 | 0.7784 |
| (5) Critical Injury | 0.500 | 0.7352 | 0.7272 | 0.7512 | 0.7693 | 0.7784 |
| Fatal | 0.730 | 0.5793 | 0.5713 | 0.5953 | 0.6162 | 0.6268 |

## Effect of Indefinite Warning on Drivers and Right Front Passengers

This section discusses the effect of SBWS on seat belt use rates for front outboard seat occupants. The next subsection discusses the impact of the indefinite warning on seat belt use and the following subsection then presents the increase in seat belt use rates resulting from the indefinite warning for front outboard seat occupants. The last subsection then calculates the increase in seat belt use for front outboard seat occupants from the baseline as result of the requirements specified for the indefinite warning in the proposed rule.

### Seat Belt Use

As the benefits associated with the proposed rule stem from the increase in seat belt use, this analysis must take into account current seat belt use by front seat occupants. That is, this analysis must consider the proportion of front seat occupants that always, sometimes, and never use seat belts. In estimating the benefits, the requirements for the indefinite warning can only potentially increase the seat belt use rates of those front seat occupants who sometimes or never use seat belts.

In order to estimate the percentage of drivers who sometimes and never use the seat belts, this analysis makes use of a study by Chu (2002) titled “STATISTICAL BRIEF #62: Characteristics of Persons Who Seldom or Never Wear Seat Belts, 2002.”[[54]](#footnote-55) Table 34 presents the findings of the study. Based on the 2002 MEPS-HC, the study found that among persons 16 to 64 years of age 87.7 percent reported always or nearly always using seat belts when driving or riding in a car. The study also found that 6.9 percent reported sometimes using seat belts and 5.4 percent reported seldom or never using seat belts when driving or riding in a car.

Table 34: Characterization of Seat Belt Use Habits

|  |  |
| --- | --- |
| **Belt user and related items** | **Rate** |
| A reported "sometimes using seat belts" | 6.9% |
| A reported "seldom or never using seat belts when driving or riding in a car” | 5.4% |
| Percentage of drivers who always use seat belts, calculated | 87.7% |
| Total | 100.0% |

Table 35 presents front seat occupant seat belt usage for 2020 and 2021 based on NOPUS data. In 2021, 90.6 percent of the drivers and 89.4 percent of right front seat occupants in the survey used the seat belts.

Table 35: Front Seat Occupant Seat Belt Usage 2020-2021

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Occupant Group** | **2020** | | **2021** | | **2020-2021 Change** | | |
| **Seat Belt Use** | **95% Confidence Interval** | **Seat Belt Use** | **95% Confidence Interval** | **Changes in Percentage Points** | **95% Confidence Interval** | **P-Value** |
| All Occupants | 90.3% | (88.7, 91.7) | 90.4% | (88.9, 91.7) | 0.1 | (-1.5, 1.7) | 0.90 |
| Drivers | 90.5% | (88.8, 91.9) | 90.6% | (89.0, 92.0) | 0.1 | (-1.4, 1.7) | 0.85 |
| Right-Front Occupants | 89.6% | (87.9, 91.1) | 89.4% | (87.7, 90.9) | -0.1 | (-2.2, 2.0) | 0.90 |

This analysis makes use of the available data to estimate the probability of using a seat belt for those who reported sometimes using seat belts. To establish the use rate among the 6.9 percent of drivers that reported sometimes using seat belts, we first take into account that 87.7 percent of driver reported always using seat belts which is reflected as a 100 percent use rate. Equation (4) represents the calculation of the overall usage rate for those who report always using seat belts:

(4).

Second, we take into account that the overall seat belt use without the indefinite SBWS alert is 90.6 percent. Therefore, we reflect what we know about those who always and those who never use seat belts in relation to the overall seat belt use rate in equation (5):

(5)

Where x is the use rate for drivers who report sometimes use seat belts.

The first part of the equation represents the proportion of drivers who always use seat belts, the second part is those who sometimes use seat belts, and the third part is those who never use seat belts. Solving equation (5) for , results in a seat belt usage rate of 0.42 for those who report sometimes using seat belts.

Table 36: Seat Belt Usage by those who Always, Sometimes, and Never Use Seat Belts

|  |  |  |  |
| --- | --- | --- | --- |
| **Seat belt user** | **Parameters used for the calculation** | | |
| **Percent of total** | **Belt use rate** | **Overall Use Rate** |
| Always | 87.7% | 100% | 87.7% |
| Sometimes | 6.9% | 42% | 2.9% |
| Never | 5.4% | 0% | 0% |
| Observed belt use, drivers |  |  | 90.6% |

We note that the analysis of part-time belt users by Chu (2002) was based on the 2002 MEPS-HC. Although it is based on a relatively old survey, the belt use percentages which consist of both “always or nearly always using seat belts” and “sometimes using seat belts” would be similar to the observed belt use in 2021, an observed belt use of 90.6 percent. Thus, we believe it would be reasonable to assume the ratio or more importantly relative amount of the usage remains the same under the baseline. We request comment on these estimates.

### Impact on Seat Belt Use

This subsection discusses the impact of an indefinite warning SBWS on seat belt use for front seat occupants. The proposed rule requires all applicable vehicles be equipped with a seat belt warning system with an indefinite warning period for the right front outboard passengers and drivers. This subsection discusses the impact of an indefinite warning on the seat belt use rate on drivers and right front outboard seat passengers.

For the effects of requiring a SBWS with an indefinite warning system, we analyzed a study conducted by the IIHS titled “The effects of persistent audible seat belt reminders and a speed-limiting interlock on the seat belt use of drivers who do not always use a seat belt,” referred to as the Kidd (2019) study in this document.[[55]](#footnote-56) The report included part-time seat belt users who had a recent seat belt citation and reported not always using a seat belt. In the report, those part-time belt users drove two vehicles for a certain period of time. Each of the participants first drove a Chevrolet with intermittent seven-second audible reminders. Then 17 of the participants drove a BMW with a 100-second audible reminder and the other 16 participants drove a Subaru with an indefinite audible reminder. The study then noted the difference in seat belt use between the first and second vehicle for each driver.

Table 37 presents the findings of the Kidd study based on whether the second vehicle included at least a 90-second[[56]](#footnote-57) warning or indefinite warning. The Kidd study found that relative to the seven-second audible reminder, seat belt use rate increased by 30 percent by the BMW reminder with a 100-second audible warning and 34 percent by the Subaru reminder with an indefinite audible warning.

Table 37: Percent Increase in Seat Belt Usage by Warning

|  |  |
| --- | --- |
| **IIHS study** | **Percent increase in belt use** |
| Baseline vs Indefinite | 34% |
| Baseline vs at least 90-second | 30% |

Overall, the findings from the study show that the transition from the baseline warning of seven seconds to either the 90-second minimum or indefinite warning result in an increase in seat belt use. However, another finding is that even if a seat belt warning is designed to last until the belt is used, seat belt use rates would not reach 100 percent. This is especially the case if front occupants can circumvent the warning such as put the belt behind the back of the driver.

We, again, note that the observed belt use rates are inclusive of all drivers whether they are in crashes or not. Therefore, this analysis first establishes an overall belt use rate in potentially fatal crashes for drivers. For the estimate, we again use the NHTSA’s Belt Use model.[[57]](#footnote-58) The model makes use of the national observed belt use rate to predict the use rate in potentially fatal crashes.[[58]](#footnote-59) Making use of the model,[[59]](#footnote-60) we calculated the belt use rate in potentially fatal crashes would be 0.7842 when we have an observed belt use rate of 0.9060 in the baseline.

This analysis makes use of the findings related to drivers who sometimes or never use seat belts, as well as the observed and estimated belt use rates in potentially fatal crashes to estimate the degree of the expected increase in seat belt use rates in potentially fatal crashes for drivers when the baseline (i.e., seven second) warning is replaced with an indefinite warning system.

This analysis makes use of the weighted sales proportions presented earlier in Table 8 to establish the seat belt use rate associated with each type of warning system. For this analysis, warning systems with less than 90 second warning duration (Bin No. 1 of Table 8) are used as a proxy for the system that provides a seven-second duration warning and warning systems with 90-second or 90+ second but not indefinite duration (Bin No. 2 of Table 8) are used as a proxy for the warning system that provides a 90-second duration warning. That is, the observed seat belt use rate established under the baseline reflects the case in which a seven-second duration warning system would fall in Bin No. 1 representing 7.63 percent of vehicles, a 90-second duration warning system would fall in Bin No. 2 representing 85.14 percent of light vehicles, and an indefinite duration warning system would fall in Bin No. 3 representing 7.23 percent of light vehicles in the new vehicle fleet.[[60]](#footnote-61) For simplicity, the remainder of this analysis refers to those systems in Bin No. 1 as systems with a seven-second warning, those Bin No. 2 as systems with a 90-second warning, and those in No. 3 as systems with an indefinite warning.

This analysis first establishes the baseline seat belt use rate for all three warning systems. The previous subsections established an overall observed seat belt use rate of 0.9060 for drivers. Furthermore, we calculated the belt use rate in potentially fatal crashes would be 0.7842 and an observed seat belt use rate of 0.9060. Furthermore, we assume based on the IIHS study that relative to a seven-second warning, a 90-second warning[[61]](#footnote-62) results in a 30 percent increase in seat belt use and an indefinite warning results in a 34 percent increase. We can make use of that information to establish the equation (6) that represents the calculation of the overall seat belt use rate in potentially fatal crashes of 0.7842 percent:

(6)

Where x is the seat belt use rate observed for the seven-second warning.

The first part of the equation represents the 7.63 precent of vehicles with a in Bin No.1, the second part represents the 85.14 percent of vehicles in Bin No.2 that results in a 30 percent increase in seat belt use, and the third part represents the 7.23 percent of vehicles in Bin No. 3 that results in a 34 percent increase in seat belt use. Solving for x, we find that the seat belt use rate for the seven-second warning in potentially fatal crashes is 0.6127. Furthermore, we can increase that seat belt rate by 30 percent to calculate the seat belt use rate for 90-second or more warning systems in potentially fatal crashes of approximately 0.7965. Similar, we can increase the seat belt rate by 34 percent to calculate the seat belt use rate for indefinite warning systems in potentially fatal crashes of approximately 0.8210.

Similarly, we can make use of that information to establish the equation (6) that represents the calculation of the overall seat belt use rate in crashes resulting in non-fatal injuries:

Where x is the seat belt use rate observed for the seven-second warning.

Solving for x, we find that the baseline seat belt use rate for the seven-second warning in crashes resulting in non-fatal injuries is 0.7078. Furthermore, we can increase that seat belt rate by 30 percent to calculate the seat belt use rate for 90-second warning systems in crashes resulting in non-fatal injuries crashes of approximately 0.9202. Similarly, we can increase the seat belt rate by 34 percent to calculate the seat belt use rate for indefinite warning systems in crashes resulting in non-fatal injuries crashes of approximately 0.9485.

Following the same methods, we can calculate the seat belt use rates under the proposed rule for right front seat occupants. This analysis established an overall observed seat belt use rate of 0.8940 for right front seat occupants. Furthermore, we calculated the belt use rate in potentially fatal crashes would be 0.7688 and a seat belt use rate in crashes resulting in non-fatal injuries of 0.8541 when we have an observed belt use rate of 0.8940 in the baseline. We again make use of equation (6) to estimate seat belt use under the baseline for the seven-second warning, 90-second warning, and indefinite warning in both potentially fatal crashes and crashes that resulted in non-fatal injuries. For right front seat occupants, seat belt use in potentially fatal crashes is 0.6006 when there is a seven-second warning, 0.7808 when there is a 90-second warning, and 0.8048 when there is an indefinite warning. In the case of crashes resulting in non-fatal injuries, seat belt use is 0.6673 when there is a seven-second warning, 0.8674 when there is a 90-second warning, and 0.8942 when there is an indefinite warning.

Taking into account the baseline seat belt use rate for each warning system for drivers and right front seat occupants and the estimated increase in seat belt use resulting from the indefinite warning, this analysis can estimate the seat belt use rates under the proposed rule. Additionally, this analysis assumes that although their seat belt usage would increase, the percentage of front seat occupants who sometimes use seat belts established in the baseline would remain the same. That is, we would expect those who sometimes use seat belts to use them more often, but not transition to the group who always uses seat belts. Furthermore, we note that this analysis established the increase in seat belt use for those who sometimes use seat belts. However, this analysis makes the assumption that the impact of the indefinite warning system will be the same for those who sometimes use and those who never use seat belts. We request comment on that assumption.

Table 38 summarizes the increase in seat belt use for drivers when moving from a seven-second warning to an indefinite warning system. This calculation involves accounting for the proportion of drivers who sometimes, never, and always use seat belts specific to those who start with a seven-second warning system based on the distribution of warning systems. Reflecting the increase in seat belt use of 34 percent for an indefinite warning on those who start with a seven-second warning system, seat belt use in potentially fatal crashes for drivers would increase from approximately 0.6127 to approximately 0.6533. Therefore, this analysis uses the corresponding ratio of increase of 1.066247 to reflect the increase in seat belt use for drivers when moving from a seven-second to an indefinite warning (see Appendix F for detailed calculations).

Table 38: Summary of Increase in Seat Belt Use for Drivers 7-Second Warning to Indefinite Warning

|  |  |
| --- | --- |
| **Belt user and related items** | **Rate** |
| The reported "sometimes using seat belts", calculated | 14.49% |
| The reported "seldom or never using seat belts when driving or riding in a car", calculated | 11.34% |
| Percentage of drivers who always use seat belts, calculated | 74.2% |
| Driver overall belt use rate without an indefinite SBWS alert, observed | 76.6% |
| Probability of using belt use for part time seat belt user while in a vehicle, calculated | 17% |
| Increase in belt use due to an indefinite warning only for part time belt users, from the IIHS report | 34% |
| Increase in belt use due to an indefinite warning for never use belt users, assumed | 34% |
| Percentage of the "seldom or never using belts" group, with an indefinite warning | 7.5% |
| Percentage of drivers who always use seat belts with an indefinite warning | 78.0% |
| Belt use rate (i.e., increased) due to an indefinite warning for part time belt users | 22.7% |
| Driver overall belt use rate with the indefinite SBWS alert, observed | 81.3% |
| Overall increase in belt use rate, observed | 4.6890% |
| Overall increase in belt use rate, in potentially fatal crashes, using a ratio, actual | 4.0588% |
| Existing belt use rate in potentially fatal crashes | 61.2670% |
| Overall belt use rate, in potentially fatal crashes, estimated | 65.3258% |
| **Increase in belt use, in potentially fatal crashes, ratio** | **1.066247** |

Table 39 summarizes the increase in seat belt use for right front seat occupants including the data inputs specific to right front seat occupants. This calculation involves accounting for the proportion of right front seat occupants who sometimes, never, and always use seat belts specific to those who start with a seven-second warning system based on the distribution of systems. Reflecting the increase in seat belt use of 34 percent for an indefinite warning on those who start with a seven-second warning system, seat belt use in potentially fatal crashes for right front seat occupants would increase from approximately 0.6006 to approximately 0.6380. Therefore, we use the corresponding ratio of increase of 1.062254 to reflect the increase in seat belt use for right front seat occupants when moving from a seven-second to an indefinite warning.

Table 39: Summary of Increase in Seat Belt Use for Right Front Seat 7-Second Warning to Indefinite Warning

|  |  |
| --- | --- |
| **Belt user and related items** | **Rate** |
| The reported "sometimes using seat belts", calculated | 14.50% |
| The reported "seldom or never using seat belts when driving or riding in a car", calculated | 11.35% |
| Percentage of Front-Passengers who always use seat belts, calculated | 74.1% |
| Driver overall belt use rate without an indefinite SBWS alert, observed | 75.6% |
| Probability of using belt use for part time seat belt user while in a vehicle, calculated | 10% |
| Increase in belt use due to an indefinite warning only for part time belt users, from the IIHS report | 34% |
| Increase in belt use due to an indefinite warning for never use belt users, assumed | 34% |
| Percentage of the "seldom or never using belts" group, with an indefinite warning | 7.5% |
| Percentage of drivers who always use seat belts with an indefinite warning | 78.0% |
| Belt use rate (i.e., increased) due to an indefinite warning for part time belt users | 13.3% |
| Driver overall belt use rate with the indefinite SBWS alert, observed | 79.9% |
| Overall increase in belt use rate, observed | 4.3480% |
| Overall increase in belt use rate, in potentially fatal crashes, using a ratio, actual | 3.7389% |
| Existing belt use rate in potentially fatal crashes | 60.0594% |
| Overall belt use rate, in potentially fatal crashes, | 63.7983% |
| **Increase in belt use, in potentially fatal crashes, ratio** | **1.062254** |

### Resulting Increase on Seat Belt Use Rates

Table 40 presents the estimated increase in seat belt use for drivers under the proposed rule. The calculation of the seat belt use rate under the proposed rule makes use of the baseline seat belt use rates and ratio of increase established in the previous subsections. When moving from a seven-second to an indefinite warning, seat belt use would increase to approximately 0.6533 in potentially fatal crashes and approximately 0.7547 in crashes resulting in non-fatal injuries. When moving from a 90-second to an indefinite warning, seat belt use would increase to approximately 0.7993 in potentially fatal crashes and approximately 0.9234 in crashes resulting in non-fatal injuries.

Table 40: Increase in Seat Belt Use for Drivers

|  |  |  |
| --- | --- | --- |
| **Warning Type Change** | **Seat Belt Use Rate** | |
| **Baseline x Ratio of Increase** | **Proposed Rule** |
| ***Potentially Fatal Crashes*** | | |
| **7-second to Indefinite** | 0.6127 x 1.066247 | 0.65329 |
| **90-second to Indefinite** | 0.7965 x 1.003447 | 0.79925 |
| ***Crashes Resulting in Non-fatal Injuries*** | | |
| **7-second to Indefinite** | 0.7078 x 1.066247 | 0.7547 |
| **90-second to Indefinite** | 0.9202 x 1.003447 | 0.9234 |

Table 41 presents the increase in seat belt use for right front seat occupants under the proposed rule. When moving from a 7-second to an indefinite warning, seat belt use would increase to approximately 0.6380 in potentially fatal crashes and approximately 0.7088 in crashes resulting in non-fatal injuries. When moving from a 90-second to an indefinite warning, seat belt use would increase to approximately 0.7829 in potentially fatal crashes and approximately 0.8697 in crashes resulting in non-fatal injuries.

Table 41: Increase in Seat Belt Use for Right Front Seat Occupants

|  |  |  |
| --- | --- | --- |
| **Warning Type Change** | **Seat Belt Use Rate** | |
| **Baseline** | **Proposed Rule** |
| ***Potentially Fatal Crashes*** | | |
| **7-second to Indefinite** | 0.6006 x 1.062254 | 0.637989752 |
| **90-second to Indefinite** | 0.7808 x 1.00263 | 0.782854 |
| ***Crashes Resulting in Non-fatal Injuries*** | | |
| **7-second to Indefinite** | 0.6673 x 1.062254 | 0.708842094 |
| **90-second to Indefinite** | 0.8674 x 1.00263 | 0.869681262 |

# Benefits

This chapter presents the incremental benefits associated with the proposed rule. The first three sections of this chapter present the incremental benefits associated with the three requirements specified in the proposed rule. The following section then discusses unquantified benefits and alternative uses and the final section provides a summary of the chapter.

## SBWS for Rear Seat Occupants

This section presents the incremental benefits resulting from the requirements specified in the proposed rule for SBWS for rear seat occupants. Incremental benefits are those additional fatalities and non-fatal injuries prevented due to the increase in seat belt use under the proposed rule relative seat belt use under the baseline. In order to calculate incremental benefits, this analysis first accounts the baseline effects given the current seat belt use rates and then accounts for the impact of the increase in seat belt use under the proposed rule.

We first note that the non-fatal injuries and fatalities prevented are a function of the seat belt use rate. In order to calculate incremental benefits resulting from proposed rule, this analysis must first establish the potential injuries and fatalities addressed by seat belts. Potential injuries and fatalities are those that would occur in the case of a seat belt use rate of zero percent. By establishing the potential injuries and fatalities, this analysis then estimates incremental benefits based on the difference in fatalities and non-fatal injuries prevented given the change in seat belt use under the baseline and the proposed rule.

Based on the available information, this analysis is able to establish the relationship between the “Observed Injuries/Fatalities” and the “Potential Injuries/Fatalities.” Potential injuries and fatalities represent the number of injuries and fatalities that would be observed in the hypothetical scenario in which the seat belt use rate is zero. Observed injuries and fatalities are those reflected in the adjusted target population and represent the number of injuries and fatalities associated with the current seat belt use rates. Therefore, equation (7) presents the relationship between observed injuries and potential injuries:

,

then solving for potential injuries, yields:

(7).

To better illustrate this relationship, we present an example that considers rear seat occupants 11 years and older in a passenger car who suffer minor MAIS 1 injuries. The effectiveness rate for seat belts in this scenario is 0.0550 and the current seat belt usage rate is 0.7512. Lastly, in this example, there are a total of 15,111 injuries in the adjusted target population. We then reflect that in equation (8):

=15,762

Therefore, in the hypothetical case that there was no seat belt use, there would be a total 15,762 MAIS 1 injuries for rear seat occupants 11 years and older in passenger cars. Furthermore, in the context of this example the number of MAIS 1 injuries was reduced from 15,762 to 15,111 under the baseline. That is, the seat belt use rate under the baseline prevented a total of 651 MAIS 1 injuries. This same procedure is used to calculate the potential injuries for the rear seat occupants in the adjusted target population for both age groups and vehicle types.

Table 42 presents the potential injuries and fatalities for rear seat occupants ages six to ten by vehicle type. For rear seat occupants ages six to ten in passenger cars, there are a total of 3,710 potential MAIS 1-5 injuries and 131 potential fatalities. For rear seat occupants ages six to ten in LTVs, there are a total of 4,325 potential MAIS 1-5 injuries and 177 potential fatalities. Although those potential injuries and fatalities reflect a hypothetical case in which there is no seat belt usage, this analysis uses potential injuries and fatalities to calculate the fatalities and non-fatal injuries prevented under both the proposed rule and baseline.

Table 42: Potential Injuries and Fatalities for Rear Seat Occupants Ages 6 to 10 by Vehicle Type

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Injury Severity** | **Target Population** | | | **Seat Belt Effectiveness** | **Current Seat Belt Use Rate** | **Potential Injuries and Fatalities** |
| **Restrained** | **Unrestrained** | **Total** |
| ***Passenger Car*** | | | | | | |
| MAIS 1 | 2,198 | 807 | 3,005 | 0.055 | 0.9800 | 3,176 |
| MAIS 2 | 134 | 4 | 139 | 0.625 | 0.9800 | 357 |
| MAIS 3 | 35 | 19 | 54 | 0.625 | 0.9800 | 138 |
| MAIS 4 | 4 | 11 | 15 | 0.625 | 0.9800 | 39 |
| **Non-Fatal Injuries**  **(MAIS 1-5)** | **2,372** | **840** | **3,212** | **-** | **-** | **3,710** |
| **Fatality** | **51** | **17** | **67** | **0.550** | **0.8825** | **131** |
| ***Light Truck*** | | | | | | |
| MAIS 1 | 3,733 | 99 | 3,832 | 0.0550 | 0.9822 | 4,050 |
| MAIS 2 | 52 | 86 | 138 | 0.507 | 0.9822 | 274 |
| **Non-Fatal Injuries**  **(MAIS 1-5)** | **3,785** | **185** | **3,970** | **-** | **-** | **4,325** |
| **Fatality** | **36** | **25** | **61** | **0.7400** | **0.8825** | **177** |

Table 43 presents the potential injuries and fatalities for rear seat occupants 11 years and older by vehicle type. For rear seat occupants 11 years and older in passenger cars, there are a total of 19,014 potential MAIS 1-5 injuries and 936 potential fatalities. For rear seat occupants ages 11 years and older in LTVs, there are a total of 7,481 potential MAIS 1-5 injuries and 721 potential fatalities. Although those potential injuries and fatalities reflect a hypothetical case in which the seat belt use rate is zero, this analysis uses potential injuries and fatalities to calculate the fatalities and non-fatal injuries prevented based on the seat belt use rates under both the baseline and proposed rule.

Table 43: Potential Injuries and Fatalities for Rear Seat Occupants 11 Years and Older by Vehicle Type

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Injury Severity** | **Target Population** | | | **Seat Belt Effectiveness** | **Current Seat Belt Use Rate** | **Potential Injuries and Fatalities** |
| **Restrained** | **Unrestrained** | **Total** |
| ***Passenger Car*** | | | | | | |
| MAIS 1 | 12,853 | 2,257 | 15,111 | 0.055 | 0.7512 | 15,762 |
| MAIS 2 | 308 | 964 | 1,272 | 0.625 | 0.7512 | 2,398 |
| MAIS 3 | 42 | 203 | 245 | 0.625 | 0.7512 | 462 |
| MAIS 4 | 16 | 186 | 201 | 0.625 | 0.7512 | 379 |
| MAIS 5 | 1 | 5 | 6 | 0.625 | 0.7512 | 11 |
| **Non-Fatal Injuries**  **(MAIS 1-5)** | **13,221** | **3,615** | **16,836** | - | **-** | **19,014** |
| **Fatality** | **222** | **408** | **630** | **0.550** | **0.5953** | **936** |
| ***Light Truck*** | | | | | | |
| MAIS 1 | 3,911 | 1,806 | 5,717 | 0.055 | 0.7512 | 5,964 |
| MAIS 2 | 293 | 551 | 844 | 0.507 | 0.7512 | 1,363 |
| MAIS 3 | 13 | 3 | 15 | 0.507 | 0.7512 | 25 |
| MAIS 4 | 44 | 33 | 77 | 0.507 | 0.7512 | 125 |
| MAIS 5 | 0 | 2 | 2 | 0.507 | 0.7512 | 4 |
| **Non-Fatal Injuries**  **(MAIS 1-5)** | **4,261** | **2,395** | **6,657** | - | - | **7,481** |
| **Fatality** | **123** | **280** | **403** | **0.740** | **0.5953** | **721** |

By calculating the potential injuries and fatalities, this analysis is able to estimate the benefits associated with a particular level of seat belt usage. Equation (8) presents the calculation of unadjusted benefits and similarly baseline effects for a given seat belt use rate:

(8).

Continuing with the example above, we can apply the appropriate seat belt usage rate and effectiveness to the potential injuries to estimate the number of MAIS 1 injuries prevented for rear seat occupants 11 years and older in passenger cars. Making use of equation (8), we can make use of the effectiveness rate for seat belts for MAIS 1 injuries and the current seat belt use rate for rear seat occupants 11 years and older in passenger cars to calculate the resulting injuries prevented in that scenario. In other words, we can replicate the adjusted target population for MAIS 1 injuries for rear seat occupants 11 years and older in passenger cars by reflecting the current or baseline seat belt use rate, seat belt effectiveness, and potential injuries calculated above. Plugging those values into equation (8):

.

Therefore, we find that seat belt usage prevented 651 of the 15,762 MAIS 1 injuries which then leaves the remaining 15,111 MAIS 1 injuries reflected in the adjusted target population for rear seat occupants 11 years and older in passenger cars. While this example is used to illustrate the number of MAIS 1 injuries for this group in the adjusted target population, it can also be used to estimate the incremental benefits resulting from the proposed rule. That is, we can reflect the increase in seat belt use presented in section 4.2 to calculate the number of injuries and fatalities prevented as a result of the SBWS. Using the lower estimated increase in seat belt use, we estimate the number of MAIS 1 injuries prevented under the proposed rule again using equation (8):

.

Therefore, taking into account the lower increase in seat belt use, the proposed rule would prevent 16 MAIS injuries for rear seat occupants 11 years and older in passenger cars. To calculate these incremental benefits associated with the proposed rule in this case, we subtract baseline effects from benefits under the proposed rule before they have been adjusted to account for baseline effects. Relative to the baseline, the increase in seat belt use from the proposed rule results in an additional 16 MAIS 1 injuries (667 minus 651) prevented for rear seat occupants age 11 years and older in passenger cars.

Table 44 and Table 45 present the calculation of incremental benefits associated with the proposed rule for rear seat occupants ages six to ten and rear seat occupants 11 years and older, respectively. Incremental benefits reflect the number of non-fatal injuries and fatalities prevented as a result of the proposed rule relative to the baseline. More specifically, incremental benefits from the proposed rule are those resulting from the increase in seat belt use resulting from the SBWS. Note that there is no change in the effectiveness of seat belts when calculating baseline effects and benefits of the proposed rule.

As shown in Table 44 and Table 45, to estimate incremental benefits, we first establish the number of non-fatal injuries and fatalities prevented by seat belts under the baseline seat belt usage rates. Effects under the baseline are calculated by reflecting the current or observed seat belt use rate (c) and seat belt effectiveness (b) on the potential injuries and fatalities (a). Benefits under the proposed rule before adjusting for baseline effects reflect both the Lo and Hi case and are calculated by reflecting the seat belt use rate ((d) in Lo case and (e) in the Hi case) and seat belt effectiveness (b) on the potential injuries and fatalities (a). Incremental benefits are then calculated as difference in non-fatal injuries and fatalities prevented between the proposed rule and baseline.

Table 44: Incremental Benefits for Rear Seat Occupants Ages 6 to 10 by Vehicle Type

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Injury Severity** | **Potential Injuries**  **(a)** | **Seat Belt Effectiveness**  **(b)** | **Baseline Seat Belt Use Rate**  **(c)** | **Baseline Effects**  **(a) x (b) x (c)** | **Proposed Rule Seat Belt Use Rate** | | **Calculation of Benefits Under the Proposed Rule Unadjusted for Baseline Effects** | | **Incremental Benefits (Unadjusted Proposed Rule minus Baseline)** | |
| **Lo**  **(d)** | **Hi**  **(e)** | **Lo**  **(a) x (b) x (d)** | **Hi**  **(a) x (b) x (e)** | **Lo** | **Hi** |
| ***Passenger Cars*** | | | | | | | | | | |
| MAIS 1 | 3,176 | 0.0550 | 0.9800 | 171 | 0.9815 | 0.9822 | 171 | 172 | 0 | 1 |
| MAIS 2 | 357 | 0.6250 | 0.9800 | 220 | 0.9815 | 0.9822 | 221 | 221 | 0 | 0 |
| MAIS 3 | 138 | 0.6250 | 0.9800 | 86 | 0.9815 | 0.9822 | 86 | 86 | 0 | 0 |
| MAIS 4 | 39 | 0.6250 | 0.9800 | 24 | 0.9815 | 0.9822 | 24 | 24 | 0 | 0 |
| **Non-Fatal Injuries**  **(MAIS 1-5)** | **3,710** | **-** | **-** | **501** | **-** | **-** | **502** | **502** | **1** | **1** |
| **Fatality** | **131** | **0.5500** | **0.8825** | **63** | **0.8845** | **0.8855** | **64** | **64** | **0** | **0** |
| ***Light Trucks*** | | | | | | | | | | |
| MAIS 1 | 4,050 | 0.0550 | 0.9800 | 218 | 0.9815 | 0.9822 | 219 | 219 | 0 | 0 |
| MAIS 2 | 274 | 0.5068 | 0.9800 | 136 | 0.9815 | 0.9822 | 136 | 136 | 0 | 0 |
| **Non-Fatal Injuries**  **(MAIS 1-5)** | **4,325** | - | - | **354** | **-** | **-** | **355** | **355** | **1** | **1** |
| **Fatality** | **177** | **0.7400** | **0.8825** | **116** | **0.8845** | **0.8855** | **116** | **116** | **0** | **0** |

Note: Values may not sum due to rounding. Benefits are rounded to the nearest whole number for presentation purposes.

Table 45: Incremental Benefits for Rear Seat Occupants Age 11 or Older by Vehicle Type

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Injury Severity** | **Potential Injuries**  **(a)** | **Seat Belt Effectiveness**  **(b)** | **Baseline Seat Belt Use Rate**  **(c)** | **Baseline Effects**  **(a) x (b) x (c)** | **Proposed Rule Seat Belt Use Rate** | | **Calculation of Benefits Under the Proposed Rule Unadjusted for Baseline Effects** | | **Incremental Benefits (Unadjusted Proposed Rule minus Baseline)** | |
| **Lo**  **(d)** | **Hi**  **(e)** | **Lo**  **(a) x (b) x (d)** | **Hi**  **(a) x (b) x (e)** | **Lo** | **Hi** |
| ***Passenger Cars*** | | | | | | | | | | |
| MAIS 1 | 15,762 | 0.0550 | 0.7512 | 651 | 0.7693 | 0.7784 | 667 | 675 | 16 | 24 |
| MAIS 2 | 2,398 | 0.6250 | 0.7512 | 1,126 | 0.7693 | 0.7784 | 1153 | 1166 | 27 | 41 |
| MAIS 3 | 462 | 0.6250 | 0.7512 | 217 | 0.7693 | 0.7784 | 222 | 225 | 5 | 8 |
| MAIS 4 | 379 | 0.6250 | 0.7512 | 178 | 0.7693 | 0.7784 | 184 | 184 | 4 | 6 |
| MAIS 5 | 12 | 0.6250 | 0.7512 | 5 | 0.7693 | 0.7784 | 5 | 6 | 0 | 0 |
| **Non-Fatal Injuries**  **(MAIS 1-5)** | **19,014** | - | **-** | **2,177** | **-** | **-** | **2,229** | **2,256** | **52** | **79** |
| **Fatality** | **936** | **0.5500** | **0.5953** | **307** | **0.6162** | **0.6268** | **317** | **323** | **11** | **16** |
| ***Light Trucks*** | | | | | | | | | | |
| MAIS 1 | 5,964 | 0.0550 | 0.7512 | 246 | 0.7693 | 0.7784 | 252 | 255 | 6 | 9 |
| MAIS 2 | 1,363 | 0.5068 | 0.7512 | 519 | 0.7693 | 0.7784 | 531 | 538 | 13 | 19 |
| MAIS 3 | 25 | 0.5068 | 0.7512 | 9 | 0.7693 | 0.7784 | 9 | 10 | 0 | 0 |
| MAIS 4 | 125 | 0.5068 | 0.7512 | 47 | 0.7693 | 0.7784 | 48 | 49 | 1 | 2 |
| MAIS 5 | 4 | 0.5068 | 0.7512 | 1 | 0.7693 | 0.7784 | 1 | 1 | 0 | 0 |
| **Non-Fatal Injuries**  **(MAIS 1-5)** | **7,481** | - | **-** | **822** | - | - | **843** | **853** | **21** | **31** |
| **Fatality** | **721** | **0.7400** | **0.5953** | **317** | **0.6162** | **0.6268** | **329** | **334** | **11** | **17** |

Note: Values may not sum due to rounding. Benefits are rounded to the nearest whole number for presentation purposes.

Table 46 presents a summary of the incremental benefits for rear seat occupants associated with the proposed rule. As a result of the requirements for the SBWS for rear seat occupants, 75 to 112 non-fatal injuries and 22 to 34 fatalities would be prevented.

Table 46: Summary of Incremental Benefits for Rear Seat Occupants

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Category** | **Baseline Effects** | **Proposed Rule Benefits Unadjusted for Baseline Effects** | | **Incremental Benefits**  **Unadjusted Proposed Rule Benefits – Baseline Effects)** | |
| **Lo** | **Hi** | **Hi** | **Lo** |
| ***Rear Seat Occupants Ages 6-10*** | | | | | |
| Non-fatal Injuries (MAIS 1-5) | 853 | 854 | 855 | 1 | 2 |
| Fatalities\* | 180 | 180 | 180 | 0 | 1 |
| ***Rear Seat Occupants Ages 11+*** | | | | | |
| Non-fatal Injuries (MAIS 1-5) | 3,001 | 3,074 | 3,111 | 74 | 110 |
| Fatalities | 624 | 646 | 657 | 22 | 33 |
| ***All Rear Seat Occupants*** | | | | | |
| Non-fatal Injuries (MAIS 1-5) | 3,854 | 3,928 | 3,966 | 75 | 112 |
| Fatalities | 804 | 826 | 837 | 22 | 34 |

Note: Values may not sum due to rounding. Benefits are rounded to the nearest whole number for presentation purposes.

\*Although benefits in each case presents a total of 180 fatalities prevented due to rounding, in the case on the Hi estimate one additional fatality would be prevented under the proposed rule relative to the baseline.

## Indefinite Warning for Front Seat Occupants

This section presents the incremental benefits resulting from the requirements specified in the proposed rule for the indefinite warning for front seat occupants. Incremental benefits are those additional fatalities and non-fatal injuries prevented due to the increase in seat belt use under the proposed rule relative seat belt use under the baseline. In order to calculate incremental benefits, this analysis calculates the number of fatalities and non-fatal injuries prevented given the current seat belt use rates, as well as the number of fatalities and non-fatal injuries prevented due to the increase in seat belt use under the proposed rule. We first note non-fatal injuries and fatalities prevented are a function of the seat belt use rate. In order to calculate incremental benefits, this analysis must first establish the potential injuries and fatalities for both drivers and passengers for both vehicle types. Potential injuries and fatalities are those that would occur in a world without seat belt usage or a zero percent use rate. By establishing the potential injuries and fatalities, this analysis then estimates the number of fatalities and non-fatal injuries based on seat belt use rates under both the baseline and the proposed rule. It then calculates incremental benefits associated with the proposed rule based on the difference between the baseline effects and benefits under the proposed rule.

This analysis makes use of the weighted sales proportions by warning type in Table 8 to distribute the non-fatal injuries and fatalities in the adjusted target population by warning system under the baseline. That is, these sales proportions are used to establish the number of non-fatal injuries and fatalities in the adjusted target population that occurred in vehicles with seven-second, 90-second, and indefinite warnings under the baseline. Furthermore, by allocating the non-fatal injuries and fatalities in the adjusted target population by these sales proportions, we ensure that this analysis does not claim any incremental benefits for the 7.23 percent light vehicles already equipped with an indefinite warning.

We note that Table 9 combines “90 second and “90+ seconds” into a single bin. Therefore, this analysis may slightly overestimate safety benefits since a “90 seconds” warning system could be more effective than those that provide exactly 90 seconds of warning. Nevertheless, the effect of putting these systems together in the same bin would not be significant since the difference between a 90-second system and an indefinite warning system is relatively small based on the Kidd study, in terms of an increase in belt use rates. In other words, including 90+ seconds systems in the 90 second bin may underestimate the effectiveness of the 90+ seconds system.

Table 47 presents the adjusted target population for drivers by warning type. The adjusted target population for each warning type is calculated by reflected the sale proportion for that warning type on the number of non-fatal injuries and fatalities in the target population. The following presentation of the calculation of incremental benefits for drivers will address the target population by warning type. Note that there are no incremental benefits for the proportion of the target population which would already be equipped with an indefinite warning system.

Table 47: Adjusted Target Population for Drivers by Warning Type

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Injury Severity** | **Adjusted Target Population**  ***(100%)*** | **Adjusted Target Population by Warning System** | | |
| **7-Second Warning**  ***(7.63%)*** | **90-Second Warning**  ***(85.14%)*** | **Indefinite Warning**  ***(7.23%)*** |
| ***Passenger Car*** | | | | |
| MAIS 1 | 33,276 | 2,539 | 28,332 | 2,405 |
| MAIS 2 | 14,561 | 1,111 | 12,398 | 1,052 |
| MAIS 3 | 4,019 | 307 | 3,422 | 290 |
| MAIS 4 | 2,907 | 222 | 2,475 | 210 |
| MAIS 5 | 71 | 5 | 60 | 6 |
| **Fatality** | 7,192 | 549 | 6,123 | 520 |
| ***Light Trucks*** | | | | |
| MAIS 1 | 23,883 | 1,822 | 20,334 | 1,727 |
| MAIS 2 | 8,111 | 619 | 6,905 | 587 |
| MAIS 3 | 53 | 4 | 45 | 4 |
| MAIS 4 | 381 | 29 | 324 | 28 |
| MAIS 5 | 28 | 2 | 23 | 3 |
| **Fatality** | 4,956 | 378 | 4,220 | 358 |

Table 48 and Table 49 present the potential injuries and fatalities for the proportions of the target population that start with a seven-second and 90-second warning, respectively. This analysis makes use of equation (8) which was presented in section 5.1 when estimating incremental benefits for rear seat occupants. Making use of the available information, this analysis calculates the potential injuries and fatalities in the hypothetical scenario in which the seat belt use rate is zero. Although those potential injuries and fatalities reflect a hypothetical case in which the seat belt use rate is zero, this analysis uses potential injuries and fatalities to calculate the fatalities and non-fatal injuries associated with the seat belt use rates under both the baseline and proposed rule.

Table 48: Potential Injuries and Fatalities for Drivers 7-Second Warning

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Injury Severity** | **Total Observed (Restrained and Unrestrained)** | **Seat Belt Effectiveness** | **Current Seat Belt Use Rate** | **Potential Injuries and Fatalities** |
| ***Passenger Car*** | | | | |
| MAIS 1 | 2,539 | 0.055 | 0.7078 | 2,642 |
| MAIS 2 | 1,111 | 0.500 | 0.7078 | 1,720 |
| MAIS 3 | 307 | 0.500 | 0.7078 | 475 |
| MAIS 4 | 222 | 0.500 | 0.7078 | 344 |
| MAIS 5 | 5 | 0.500 | 0.7078 | 8 |
| Fatality | 549 | 0.440 | 0.6127 | 751 |
| ***Light Trucks*** | | | | |
| MAIS 1 | 1,822 | 0.055 | 0.7078 | 1,896 |
| MAIS 2 | 619 | 0.500 | 0.7078 | 958 |
| MAIS 3 | 4 | 0.500 | 0.7078 | 6 |
| MAIS 4 | 29 | 0.500 | 0.7078 | 45 |
| MAIS 5 | 2 | 0.500 | 0.7078 | 3 |
| Fatality | 378 | 0.730 | 0.6127 | 684 |

Note: Values may not sum due to rounding. Totals are rounded to the nearest whole number for presentation purposes.

Table 49: Potential Injuries and Fatalities for Drivers 90-Second Warning

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Injury Severity** | **Total Observed (Restrained and Unrestrained)** | **Seat Belt Effectiveness** | **Current Seat Belt Use Rate** | **Potential Injuries and Fatalities** |
| ***Passenger Car*** | | | | |
| MAIS 1 | 28,332 | 0.055 | 0.9202 | 29,842 |
| MAIS 2 | 12,398 | 0.500 | 0.9202 | 22,964 |
| MAIS 3 | 3,422 | 0.500 | 0.9202 | 6,338 |
| MAIS 4 | 2,475 | 0.500 | 0.9202 | 4,584 |
| MAIS 5 | 60 | 0.500 | 0.9202 | 111 |
| Fatality | 6,123 | 0.440 | 0.7965 | 9,427 |
| ***Light Trucks*** | | | | |
| MAIS 1 | 20,334 | 0.055 | 0.9202 | 21,418 |
| MAIS 2 | 6,905 | 0.500 | 0.9202 | 12,789 |
| MAIS 3 | 45 | 0.500 | 0.9202 | 83 |
| MAIS 4 | 324 | 0.500 | 0.9202 | 600 |
| MAIS 5 | 23 | 0.500 | 0.9202 | 43 |
| Fatality | 4,220 | 0.730 | 0.7965 | 10,081 |

Note: Values may not sum due to rounding. Totals are rounded to the nearest whole number for presentation purposes.

Table 50 and Table 51 present the calculation of benefits for drivers for the proportion of the adjusted target population starting with seven-second warning and 90-second warning, respectively.

Table 50: Incremental Benefits for Drivers 7-Second Warning to Indefinite Warning

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Injury Severity** | **Potential Injuries**  **(a)** | **Seat Belt Effectiveness**  **(b)** | **Baseline Seat Belt Use Rate**  **(c)** | **Baseline Effects**  **(a) x (b) x (c)** | **Proposed Rule Seat Belt Use Rate** | **Calculation of Benefits Under the Proposed Rule Unadjusted for Baseline Effects** | **Incremental Benefits (Unadjusted Proposed Rule minus Baseline)** |
| ***Passenger Cars*** | | | | | | | |
| MAIS 1 | 2,642 | 0.055 | 0.7078 | 103 | 0.7547 | 110 | 7 |
| MAIS 2 | 1,720 | 0.500 | 0.7078 | 609 | 0.7547 | 649 | 40 |
| MAIS 3 | 475 | 0.500 | 0.7078 | 168 | 0.7547 | 179 | 11 |
| MAIS 4 | 344 | 0.500 | 0.7078 | 122 | 0.7547 | 130 | 8 |
| MAIS 5 | 8 | 0.500 | 0.7078 | 3 | 0.7547 | 3 | 0 |
| **Non-Fatal Injuries**  **(MAIS 1-5)** | **5,189** | **-** | **-** | **1,004** | **-** | **1,071** | **67** |
| **Fatality** | **751** | **0.440** | **0.6127** | **202** | **0.6533** | **216** | **13** |
| ***Light Trucks*** | | | | | | | |
| MAIS 1 | 1,896 | 0.055 | 0.7078 | 74 | 0.7547 | 79 | 5 |
| MAIS 2 | 958 | 0.500 | 0.7078 | 339 | 0.7547 | 362 | 22 |
| MAIS 3 | 6 | 0.500 | 0.7078 | 2 | 0.7547 | 2 | 0 |
| MAIS 4 | 45 | 0.500 | 0.7078 | 16 | 0.7547 | 17 | 1 |
| MAIS 5 | 3 | 0.500 | 0.7078 | 1 | 0.7547 | 1 | 0 |
| **Non-Fatal Injuries**  **(MAIS 1-5)** | **2,908** | - | - | **432** |  | **461** | **29** |
| **Fatality** | **684** | **0.730** | **0.6127** | **306** | **0.6533** | **326** | **20** |

Note: Values may not sum due to rounding. Totals are rounded to the nearest whole number for presentation purposes.

Table 51: Incremental Benefits for Drivers 90-Second Warning to Indefinite Warning

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Injury Severity** | **Potential Injuries**  **(a)** | **Seat Belt Effectiveness**  **(b)** | **Baseline Seat Belt Use Rate**  **(c)** | **Baseline Effects**  **(a) x (b) x (c)** | **Proposed Rule Seat Belt Use Rate** | **Calculation of Benefits Under the Proposed Rule Unadjusted for Baseline Effects** | **Incremental Benefits (Unadjusted Proposed Rule minus Baseline)** |
| ***Passenger Cars*** | | | | | | | |
| MAIS 1 | 29,842 | 0.055 | 0.9202 | 1,510 | 0.9234 | 1,516 | 5 |
| MAIS 2 | 22,964 | 0.500 | 0.9202 | 10,566 | 0.9234 | 10,602 | 37 |
| MAIS 3 | 6,338 | 0.500 | 0.9202 | 2,916 | 0.9234 | 2,926 | 10 |
| MAIS 4 | 4,584 | 0.500 | 0.9202 | 2,109 | 0.9234 | 2,116 | 7 |
| MAIS 5 | 111 | 0.500 | 0.9202 | 51 | 0.9234 | 51 | 0 |
| **Non-Fatal Injuries**  **(MAIS 1-5)** | **63,839** | - | **-** | **17,152** | **-** | **17,212** | **60** |
| **Fatality** | **9,427** | **0.440** | **0.7965** | **3,304** | **0.7993** | **3,315** | **12** |
| ***Light Trucks*** | | | | | | | |
| MAIS 1 | 21,418 | 0.055 | 0.9202 | 1,084 | 0.9234 | 1,088 | 4 |
| MAIS 2 | 12,789 | 0.500 | 0.9202 | 5,884 | 0.9234 | 5,905 | 20 |
| MAIS 3 | 83 | 0.500 | 0.9202 | 38 | 0.9234 | 38 | 0 |
| MAIS 4 | 600 | 0.500 | 0.9202 | 276 | 0.9234 | 277 | 1 |
| MAIS 5 | 43 | 0.500 | 0.9202 | 20 | 0.9234 | 20 | 0 |
| **Non-Fatal Injuries**  **(MAIS 1-5)** | **34,933** | **-** | **-** | **7,302** | **-** | **7,328** | **25** |
| **Fatality** | **10,081** | **0.730** | **0.7965** | **5,862** | **0.7993** | **5,882** | **20** |

Note: Values may not sum due to rounding. Totals are rounded to the nearest whole number for presentation purposes.

Table 59 presents a summary of the annual incremental benefits for drivers associated with the proposed rule. For drivers in passenger cars, the requirements for an indefinite warning would prevent 25 fatalities and 126 non-fatal injuries, annually. For drivers in LTVs, the requirements for an indefinite warning would prevent 41 fatalities and 54 non-fatal injuries, annually.

Table 52: Summary of Annual Incremental Benefits for Drivers

|  |  |  |  |
| --- | --- | --- | --- |
| **Injury Severity** | **Incremental Benefits** | | |
| **7-Second** | **90-Second** | **Total** |
| ***Passenger Cars*** | | | |
| MAIS 1 | 7 | 5 | 12 |
| MAIS 2 | 40 | 37 | 77 |
| MAIS 3 | 11 | 10 | 21 |
| MAIS 4 | 8 | 7 | 15 |
| MAIS 5 | 0 | 0 | 0 |
| Non-Fatal Injuries (MAIS 1-5) | 67 | 60 | 126 |
| Fatality | 13 | 12 | 25 |
| ***Light Trucks*** | | | |
| MAIS 1 | 5 | 4 | 9 |
| MAIS 2 | 22 | 20 | 43 |
| MAIS 3 | 0 | 0 | 0 |
| MAIS 4 | 1 | 1 | 2 |
| MAIS 5 | 0 | 0 | 0 |
| Non-Fatal Injuries (MAIS 1-5) | 29 | 25 | 54 |
| Fatality | 20 | 21 | 41 |

Note: Values may not sum due to rounding. Totals are rounded to the nearest whole number for presentation purposes.

Similarly, this analysis follows the same process to estimate the incremental benefits for right front seat occupants. Table 53 presents the adjusted target population for right front seat occupants by warning type. The adjusted target population for each warning type is calculated by reflecting the sales proportions for that warning type in Table 8 on the number of non-fatal injuries and fatalities in the adjusted target population. The following presentation of the calculation of incremental benefits for drivers will address the adjusted target population by warning type. Note that there are no incremental benefits for the proportion of the adjusted target population which is already equipped with an indefinite warning system.

Table 53: Adjusted Target Population for Right Front Seat Occupant by Warning Type

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Injury Severity** | **Adjusted Target Population**  ***(100%)*** | **Adjusted Target Population by Warning System** | | |
| **7-Second Warning**  ***(7.63%)*** | **90-Second Warning**  ***(85.14%)*** | **Indefinite Warning**  ***(7.23%)*** |
| ***Passenger Car*** | | | | |
| MAIS 1 | 7,755 | 592 | 6,603 | 560 |
| MAIS 2 | 3,394 | 259 | 2,890 | 245 |
| MAIS 3 | 937 | 71 | 798 | 68 |
| MAIS 4 | 677 | 52 | 576 | 49 |
| MAIS 5 | 16 | 1 | 14 | 1 |
| Fatality | 1,676 | 128 | 1,427 | 121 |
| ***Light Trucks*** | | | | |
| MAIS 1 | 4,737 | 361 | 4,033 | 343 |
| MAIS 2 | 1,609 | 123 | 1,370 | 116 |
| MAIS 3 | 11 | 1 | 9 | 1 |
| MAIS 4 | 76 | 6 | 65 | 5 |
| MAIS 5 | 5 | 0 | 4 | 1 |
| Fatality | 983 | 75 | 837 | 71 |

Table 54 and Table 55 present the potential injuries and fatalities for the proportions of the adjusted target population that start with a seven-second and 90-second warning, respectively. This analysis makes use of equation (7) which was presented in section 5.1 when estimating incremental benefits for rear seat occupants. Making use of the available information, this analysis calculates the potential injuries and fatalities in the hypothetical scenario that there is no seat belt use. Although those potential injuries and fatalities reflect a hypothetical case in which the seat belt use rate is zero, this analysis uses potential injuries and fatalities to calculate the fatalities and non-fatal injuries prevented given the seat belt use rates under both the baseline and proposed rule.

Table 54: Potential Injuries and Fatalities for Right Front Seat Occupants 7-second Warning

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Injury Severity** | **Total Observed (Restrained and Unrestrained)** | **Seat Belt Effectiveness** | **Current Seat Belt Use Rate** | **Potential Injuries and Fatalities** |
| ***Passenger Car*** | | | | |
| MAIS 1 | 592 | 0.055 | 0.6673 | 614 |
| MAIS 2 | 259 | 0.500 | 0.6673 | 389 |
| MAIS 3 | 71 | 0.500 | 0.6673 | 107 |
| MAIS 4 | 52 | 0.500 | 0.6673 | 78 |
| MAIS 5 | 1 | 0.500 | 0.6673 | 2 |
| Fatality | 128 | 0.440 | 0.6006 | 174 |
| ***Light Trucks*** | | | | |
| MAIS 1 | 361 | 0.055 | 0.6673 | 375 |
| MAIS 2 | 123 | 0.500 | 0.6673 | 184 |
| MAIS 3 | 1 | 0.500 | 0.6673 | 1 |
| MAIS 4 | 6 | 0.500 | 0.6673 | 9 |
| MAIS 5 | 0 | 0.500 | 0.6673 | 1 |
| Fatality | 75 | 0.730 | 0.6006 | 134 |

Note: Values may not sum due to rounding. Totals are rounded to the nearest whole number for presentation purposes.

Table 55: Potential Injuries and Fatalities for Right Front Seat Occupants 90-second Warning

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Injury Severity** | **Total Observed (Restrained and Unrestrained)** | **Seat Belt Effectiveness** | **Current Seat Belt Use Rate** | **Potential Injuries and Fatalities** |
| ***Passenger Car*** | | | | |
| MAIS 1 | 6,603 | 0.055 | 0.8674 | 6,933 |
| MAIS 2 | 2,890 | 0.500 | 0.8674 | 5,103 |
| MAIS 3 | 798 | 0.500 | 0.8674 | 1,409 |
| MAIS 4 | 576 | 0.500 | 0.8674 | 1,018 |
| MAIS 5 | 14 | 0.500 | 0.8674 | 24 |
| Fatality | 1,427 | 0.440 | 0.7808 | 2,174 |
| ***Light Trucks*** | | | | |
| MAIS 1 | 4,033 | 0.055 | 0.8674 | 4,235 |
| MAIS 2 | 1,370 | 0.500 | 0.8674 | 2,419 |
| MAIS 3 | 9 | 0.500 | 0.8674 | 17 |
| MAIS 4 | 65 | 0.500 | 0.8674 | 114 |
| MAIS 5 | 4 | 0.500 | 0.8674 | 8 |
| Fatality | 837 | 0.730 | 0.7808 | 1,946 |

Note: Values may not sum due to rounding. Totals are rounded to the nearest whole number for presentation purposes.

Table 56 and Table 57 present the calculation of benefits for right front seat occupants for the proportion of the adjusted target population starting with seven-second warning and 90-second warning, respectively.

Table 56: Incremental Benefits for Right Front Seat Occupant 7-Second Warning to Indefinite Warning

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Injury Severity** | **Potential Injuries**  **(a)** | **Seat Belt Effectiveness**  **(b)** | **Baseline Seat Belt Use Rate**  **(c)** | **Baseline Effects**  **(a) x (b) x (c)** | **Proposed Rule Seat Belt Use Rate** | **Calculation of Benefits Under the Proposed Rule Unadjusted for Baseline Effects** | **Incremental Benefits (Unadjusted Proposed Rule minus Baseline)** |
| ***Passenger Cars*** | | | | | | | |
| MAIS 1 | 614 | 0.055 | 0.6673 | 23 | 0.7088 | 24 | 1 |
| MAIS 2 | 389 | 0.5 | 0.6673 | 130 | 0.7088 | 138 | 8 |
| MAIS 3 | 107 | 0.5 | 0.6673 | 36 | 0.7088 | 38 | 2 |
| MAIS 4 | 78 | 0.5 | 0.6673 | 26 | 0.7088 | 28 | 2 |
| MAIS 5 | 2 | 0.5 | 0.6673 | 1 | 0.7088 | 1 | 0 |
| **Non-Fatal Injuries**  **(MAIS 1-5)** | **1,190** | - | - | **215** | - | **228** | **13** |
| **Fatality** | **174** | **0.44** | **0.6006** | **46** | **0.6380** | **49** | **3** |
| ***Light Trucks*** | | | | | | | |
| MAIS 1 | 375 | 0.055 | 0.6673 | 14 | 0.7088 | 15 | 1 |
| MAIS 2 | 184 | 0.5 | 0.6673 | 61 | 0.7088 | 65 | 4 |
| MAIS 3 | 1 | 0.5 | 0.6673 | 0 | 0.7088 | 0 | 0 |
| MAIS 4 | 9 | 0.5 | 0.6673 | 3 | 0.7088 | 3 | 0 |
| MAIS 5 | 1 | 0.5 | 0.6673 | 0 | 0.7088 | 0 | 0 |
| **Non-Fatal Injuries**  **(MAIS 1-5)** | **570** | - | - | **79** | - | **84** | **5** |
| **Fatality** | **134** | **0.73** | **0.6006** | **59** | **0.6380** | **62** | **4** |

Note: Values may not sum due to rounding. Totals are rounded to the nearest whole number for presentation purposes.

Table 57: Incremental Benefits for Right Front Seat Occupant 90-Second Warning to Indefinite Warning

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Injury Severity** | **Potential Injuries**  **(a)** | **Seat Belt Effectiveness**  **(b)** | **Baseline Seat Belt Use Rate**  **(c)** | **Baseline Effects**  **(a) x (b) x (c)** | **Proposed Rule Seat Belt Use Rate** | **Calculation of Benefits Under the Proposed Rule Unadjusted for Baseline Effects** | **Incremental Benefits (Unadjusted Proposed Rule minus Baseline)** |
| ***Passenger Cars*** | | | | | | | |
| MAIS 1 | 6,933 | 0.055 | 0.8674 | 331 | 0.8697 | 332 | 1 |
| MAIS 2 | 5,103 | 0.5 | 0.8674 | 2,213 | 0.8697 | 2,219 | 6 |
| MAIS 3 | 1,409 | 0.5 | 0.8674 | 611 | 0.8697 | 613 | 2 |
| MAIS 4 | 1,018 | 0.5 | 0.8674 | 442 | 0.8697 | 443 | 1 |
| MAIS 5 | 24 | 0.5 | 0.8674 | 10 | 0.8697 | 10 | 0 |
| **Non-Fatal Injuries**  **(MAIS 1-5)** | **14,487** | **-** | **-** | **3,607** | - | **3,616** | **9** |
| **Fatality** | **2,174** | **0.44** | **0.7808** | **747** | 0.7829 | **749** | **2** |
| ***Light Trucks*** | | | | | | | |
| MAIS 1 | 4,235 | 0.055 | 0.8674 | 202 | 0.8697 | 203 | 1 |
| MAIS 2 | 2,419 | 0.5 | 0.8674 | 1,049 | 0.8697 | 1052 | 3 |
| MAIS 3 | 17 | 0.5 | 0.8674 | 7 | 0.8697 | 7 | 0 |
| MAIS 4 | 114 | 0.5 | 0.8674 | 49 | 0.8697 | 50 | 0 |
| MAIS 5 | 8 | 0.5 | 0.8674 | 3 | 0.8697 | 3 | 0 |
| **Non-Fatal Injuries**  **(MAIS 1-5)** | **6,793** | **-** | **-** | **1,311** | **-** | **1,315** | **3** |
| **Fatality** | **1,946** | **0.73** | **0.7808** | **1,109** | **0.7829** | **1,112** | **3** |

Note: Values may not sum due to rounding. Totals are rounded to the nearest whole number for presentation purposes.

Table 58 presents a summary of the annual incremental benefits for right front seat occupants associated with the proposed rule. For right front seat occupants in passenger cars, the requirements for an indefinite warning would prevent 5 fatalities and 23 non-fatal injuries, annually. For right front seat occupants in LTVs, the requirements for an indefinite warning would prevent 7 fatalities and 8 non-fatal injuries, annually.

Table 58: Summary of Annual Incremental Benefits for Right Front Seat Occupants

|  |  |  |  |
| --- | --- | --- | --- |
| **Injury Severity** | **Incremental Benefits** | | |
| **7-Second to Indefinite** | **90-Second to Indefinite** | **Total** |
| ***Passenger Cars*** | | | |
| MAIS 1 | 1 | 1 | 2 |
| MAIS 2 | 8 | 6 | 14 |
| MAIS 3 | 2 | 2 | 4 |
| MAIS 4 | 2 | 1 | 3 |
| MAIS 5 | 0 | 0 | 0 |
| Non-Fatal Injuries (MAIS 1-5) | 13 | 9 | 23 |
| Fatality | 3 | 2 | 5 |
| ***Light Trucks*** | | | |
| MAIS 1 | 1 | 1 | 1 |
| MAIS 2 | 4 | 3 | 7 |
| MAIS 3 | 0 | 0 | 0 |
| MAIS 4 | 0 | 0 | 0 |
| MAIS 5 | 0 | 0 | 0 |
| Non-Fatal Injuries (MAIS 1-5) | 5 | 3 | 8 |
| Fatality | 4 | 3 | 7 |

Note: Values may not sum due to rounding. Totals are rounded to the nearest whole number for presentation purposes.

Table 59 presents a summary of the incremental benefits for front seat occupants associated with the proposed rule. As a result of the proposed rule, a total of 77 fatalities and 211 non-fatal injuries would be prevented annually. These totals are inclusive of both drivers and right front seat passengers as well as both passenger cars and LTVs.

Table 59: Summary of Incremental Benefits for Front Seat Occupants

|  |  |  |  |
| --- | --- | --- | --- |
| **Injury Severity** | **Incremental Benefits** | | |
| **Drivers** | **Right Front Seat** | **Total** |
| MAIS 1 | 21 | 4 | 24 |
| MAIS 2 | 120 | 20 | 140 |
| MAIS 3 | 22 | 4 | 25 |
| MAIS 4 | 17 | 3 | 20 |
| MAIS 5 | 1 | 0 | 1 |
| Non-Fatal Injuries (MAIS 1-5) | 180 | 31 | 211 |
| Fatality | 66 | 11 | 77 |

Note: Values may not sum due to rounding. Totals are rounded to the nearest whole number for presentation purposes.

Lastly, this analysis reflects the incremental benefits on the observed injuries to establish the overall effectiveness for the indefinite warning. Table 60 presents the calculation of effectiveness for the indefinite warning. Overall, the effectiveness rate for the indefinite warning for front seat occupants ranges from 0.03 to 0.51 percent for non-fatal MAIS 1-5 injuries and is 0.52 percent for fatalities. For drivers, the effectiveness rate for the indefinite warning ranges from 0.04 to 0.53 percent for non-fatal MAIS 1-5 injuries and is 0.54 percent for fatalities. For right front seat occupants, the effectiveness rate for the indefinite warning ranges from 0.03 to 0.41 percent for non-fatal MAIS 1-5 injuries and is 0.43 percent for fatalities.

Table 60: Effectiveness for the Indefinite Warning

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Injury Severity** | **Drivers** | | | **Right Front Seat Occupants** | | | **All Front Seat Occupants** | | | |
| **Observed Injuries** | **Incremental Benefits** | **Effectiveness** | **Observed Injuries** | **Incremental Benefits** | **Effectiveness** | **Observed Injuries** | **Incremental Benefits** | **Effectiveness** |
| MAIS 1 | 57,159 | 21 | 0.04% | 12,492 | 4 | 0.03% | 69,651 | 24 | 0.03% |
| MAIS 2 | 22,672 | 120 | 0.53% | 5,003 | 20 | 0.41% | 27,675 | 140 | 0.51% |
| MAIS 3 | 4,072 | 22 | 0.53% | 948 | 4 | 0.41% | 5,020 | 25 | 0.51% |
| MAIS 4 | 3,288 | 17 | 0.53% | 753 | 3 | 0.41% | 4,041 | 20 | 0.51% |
| MAIS 5 | 99 | 1 | 0.51% | 21 | 0 | 0.41% | 120 | 1 | 0.50% |
| Fatal | 12,148 | 66 | 0.54% | 2,659 | 11 | 0.43% | 14,807 | 77 | 0.52% |

Note: Values may not sum due to rounding. Incremental benefits are rounded to the nearest whole number for presentation purposes.

## 

## Change of Status Warning

This section discusses the benefits associated with the requirements for a change in status warning in the proposed rule. The agency is proposing to require an audiovisual warning whenever a fastened front outboard or rear passenger seat belt becomes unfastened while the vehicle's ignition switch is in the “on” or “start” position and the vehicle’s transmission selector is in a forward or reverse gear. The system would be required to provide an audiovisual warning indicating a seat belt was unfastened for at least 30 seconds for rear seats or until the seat belt is refastened for the front outboard seats.

The Euro NCAP assessment protocol requires a change of status warning when a seat belt experiences a change of status (from buckled to unbuckled) at vehicle speeds above 25 km/h or a distance traveled threshold for systems with occupant detection. For rear seats, the system must also activate a 30 second audible signal and a 60 second visual signal. In contrast to the Euro NCAP assessment protocol for the change of status warning, this rulemaking proposes that the change of status warning to activate when the transmission is in any forward or reverse position instead of using a specific speed threshold. This would allow the change of status warning to activate at low speeds or when the vehicle is stopped (e.g., at a traffic light, in traffic, etc.). We believe that the SBWSs for rear seating positions that are available in vehicles in the United States are capable of providing this type of change of status warning to the driver.

For drivers that transport children restrained by seat belts, this feature may reduce the risk of injury to children by alerting the driver that the child has unbuckled his or her seat belt and may potentially prevent such a behavior in the future. In fact, the 2012 IIHS survey found that more than three-quarters of drivers supported belt warnings that would alert them when children in rear seats are not buckled.[[62]](#footnote-63) The study also reported that 55 percent of the drivers, who transport children in the rear seat and who said their children do not always use seat belts, have had the experience of their child unbuckling during a trip. ASC, Volvo, IEE, the Consumers Union, and one individual expressed their support for requiring a change of status warning signal in response to the request for comment (RFC) (75 FR 37343).

While this analysis was unable to quantify the benefits associated with this requirement due to data limitations, there are potential safety benefits for the requirement for a change of status signal. We are requesting comment on this requirement and the associated qualitative discussion of potential safety benefits.

## Unquantified Benefits/Alternate Uses

Seat belt sensors and occupant detection technology have been discussed in the context of SBWS, but there exists the possibility that these technologies would perhaps aid in potential benefits through alternative uses. Vehicles equipped with automatic emergency notification during a crash may be able to provide more data to first responders about the number of occupants in the vehicle. Given current data limitations, NHTSA is unable to quantify the potential safety benefit associated with alternative uses at this time. However, the agency notes that increased information about the number of individuals involved in a motor vehicle accident, as well as their restraint status, might lead to a potential for better safety outcomes.

Additionally, increased seat belt use for rear seat occupants resulting from the proposed rule may generate safety benefits for front seat occupants. That is, front seat occupants may avoid injurious interactions from unrestrained rear seat occupants. However, due to data limitations, this analysis was not able to quantify those potential safety benefits. NHTSA requests comments on injury rates for cases in which front seat occupants incur injuries resulting from impacts with unrestrained rear seat occupants.

Lastly, this analysis acknowledges that it is possible that increases in seat belt usage may correspond with an increase in risky behavior.[[63]](#footnote-64) Potential increases in risky behavior could increase the chance of being in a crash but would have lower chances of injuries and fatalities due to the effectiveness of seat belt. However, due to limitations, this analysis is unable to estimate the potential disbenefits resulting from increased risky behavior.

## Summary of Benefits

This chapter presented the incremental benefits for rear seat occupants from the requirements for SBWS and the incremental benefits for front seat occupants from the requirements for indefinite warnings. Incremental benefits in both cases represent those that would be realized as a result of the respective requirements specified in the proposed rule relative to the baseline.

Table 61 presents a summary of the annual incremental benefits associated with the proposed rule. Overall, the proposed rule would prevent approximately 100 to 111 fatalities and 286 to 323 non-fatal MAIS 1-5 injuries annually. When taking into account the Lo and Hi cases, the requirements specified in the proposed rule for SBWS for rear seat occupants would prevent 22 to 34 fatalities and 75 to 112 non-fatal MAIS 1-5 injuries annually. The requirements for the indefinite warning for front seat occupants would prevent 77 fatalities and 211 non-fatal MAIS 1-5 injuries annually.

Table 61: Summary of Annual Incremental Benefits

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Category** | **Total Injuries Prevented (MAIS 1-5)** | | **Total Fatalities Prevented** | |
| ***Rear Seat Occupants*** | | | | |
|  | ***Lo*** | ***Hi*** | ***Lo*** | ***Hi*** |
| Ages 6-10 | 1 | 2 | 0 | 1 |
| Ages 11+ | 74 | 110 | 22 | 33 |
| **Total** | 75 | 112 | 22 | 34 |
| ***Front Seat Occupants*** | | | | |
| Drivers | 180 | | 66 | |
| Right Front Seat Passenger | 31 | | 11 | |
| Total | 211 | | 77 | |
| ***Proposed Rule*** | | | | |
| **Total** | **286** | **323** | **100** | **111** |

Note: Values may not sum due to rounding. Totals are rounded to the nearest whole number for presentation purposes.

# Costs

This chapter presents the costs associated with meeting the requirements specified in the proposed rule. The following sections discuss the costs associated with meeting the requirements specified for SBWS for rear seat occupants and indefinite warnings for front outboard seat occupants, respectively. The last section provides a summary of the chapter.

## SBWS for Rear Seat Occupants

This section discusses the costs associated with meeting the requirements specified in the proposed rule for SBSW for rear seat occupants. The proposal contains three compliance options for the rear SBWS.[[64]](#footnote-65) The least costly option requires that the SBWS visually, through icons or text, report which or how many rear seat belts are in use, rather than notify the driver of rear seat belt non-use. This type of system does not require occupant detection. Instead, it relies on the driver or the human factor to determine the number of rear seat occupants and then decide if that number equals the number of seat belts that are reported by the SBWS as being buckled. It would also provide an audible warning signal in the event that the status of a rear seat belt buckle changes during the course of the trip. The majority of U.S. vehicle models with rear SBWSs employ this type of system. While the main limitation of such a system is its reliance on the driver to know the number of rear seat passengers and compare it to the visual reporting of the rear SBWS, it eliminates the false alarm concerns[[65]](#footnote-66) associated with a system that integrates occupant detection.

For the analysis, we estimated the cost of a rear SBWS without occupant detection.[[66]](#footnote-67) As the 2022 NCAP data shows that 46.9 percent of vehicles are equipped with rear SBWS, this analysis assumes that 53.1 percent of the vehicles do not have rear SBWS. Based on that assumption, we estimate that approximately 8.5 million of the 16 million vehicles sold annually would be impacted by the proposed rule. Furthermore, based on Wards,[[67]](#footnote-68) approximately 70.9 percent of new vehicle sales in the United States were vehicles from foreign manufacturers and approximately 29.1 percent were vehicles from domestic manufacturers.

Cost estimates are from Cost and Weight Analysis of Enhanced Seat Belt Reminder Systems completed in 2019 for NHTSA by Ricard Strategic Consulting.[[68]](#footnote-69) The teardown analysis provides three values for system cost for rear SBWSs (without occupant detection) in vehicles. One vehicle had three seats in the rear with an overall system cost of $12.32, which translates to a cost of $4.11 per seat. The other two vehicles had five rear seats with overall rear SBWS costs of $19.54 and $18.99, which translates to a per seat cost of $3.91 and $3.80, respectively. Based on that information, the average per-seat cost of $3.94 in 2017 dollars. Converted to 2020 dollars, this amounts to $4.16 per seat before markup factor. Multiplying costs by 1.51 for markup yields a final cost of $6.28 per seat. Given an average of 3.12 rear seats per vehicle, this yields a per vehicles cost of $19.59 in 2020 dollars. We request comment on our estimate of the annual cost for SBWS for rear seat occupants and the supporting assumptions.

Table 62 presents the total cost to meet the requirements specified in the proposed rule for SBWS for rear seat occupants. Total cost is calculated by reflecting the cost per vehicle across the number of vehicles impacted by the proposed rule annually. Based the cost per vehicle of $19.59 for the approximately 8.5 million vehicles impacted, the total annual cost associated with meeting the requirements specified in the proposed rule for SBWS for rear seat occupants is approximately $166.4 million.

Table 62: Total Annual Cost for SBWS for Rear Seat Occupants

|  |  |  |
| --- | --- | --- |
| **Number of Vehicles Impacted** | **Per Vehicle Cost** | **Total Cost** |
| 8,496,000 | $19.59 | $166,436,640 |

## Indefinite Warning for Front Seat Occupants

This section discusses the costs associated with meeting the requirements specified in the proposed rule for indefinite warnings for front seat occupants. For drivers, no additional hardware would be required to meet the specified requirements. That is, drivers’ seats are already equipped with the alarm function and the changes would be limited to settings adjustment or reprogramming of the alarm. Therefore, there incremental cost for drivers’ seats to meet the requirements of the proposed rule would be de minimis . We request comment on this assumption.

The 2022 NCAP data shows that SBWS are already available for right front seat occupants in 96 percent of new vehicles. Therefore, this analysis assumes that four percent of the vehicles do not have front SBWS for that seating position. Based on that assumption, we estimate that approximately 640,000 of the 16 million vehicles sold annually would be impacted by the proposed rule.

This analysis makes use of the estimates presented in the previous section to estimate the costs for right front seat passengers. Making use of the cost estimate in the tear down study,[[69]](#footnote-70) for one seat the average cost to equip the front outboard passenger seat with SBWS is $2.13, for a buckle sensor, in 2020 dollars.

Table 63 presents the total cost to meet the requirements specified in the proposed rule for the indefinite warning for front seat occupants. Total cost is calculated by reflecting the cost per vehicle across the number of vehicles impacted by the proposed rule annually. Based on the cost per vehicle of $2.13 for the approximately 640,000 vehicles impacted, the total annual cost associated with meeting the requirements specified in the proposed rule for SBWS for right front seat occupants is approximately $1.4 million. We request comment on our estimate of the annual cost for indefinite warning for front seat occupants and the supporting assumptions.

Table 63: Total Annual Cost for Indefinite Alert for Front Seat Occupants

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Seating Position** | **Number of Vehicles Impacted** | | **Per Vehicle Cost** | **Total Cost** |
| Driver | 0 | | $0 | $0 |
| Right Front Seat Passenger | 640,000 | | $2.13 | $1,363,200 |
| **Total Cost** |  |  | | **$1,363,200** |

## Summary

This chapter presented the incremental costs associated with meeting the requirements specified for SBWS for rear seat occupants and indefinite warnings for front seat occupants. The incremental costs associated with the proposed rule are the equipment costs associated with the alarm and seat belt buckle sensor hardware. For driver seats, no additional hardware would be required to meet the specified requirements. As the changes would be limited to settings adjustment or reprogramming of the alarm, there is no incremental cost for drivers to meet the requirements of the proposed rule. For the unit cost per vehicle for the right front occupant seat, the cost per vehicle is $2.13 and for the rear seat occupants is $19.59. Taking into account the number of affected vehicles annually, the total annual cost associated with the proposed rule is estimated at approximately $168 million in 2020 dollars. Lastly, as the incremental weight of the required sensors are negligible, the proposed rule is not expected to impact fuel consumption.

Table 64: Summary of Annual Costs

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Seating Position** | **Number of Vehicles Impacted** | | **Per Vehicle Cost** | | **Total Cost** |
| Driver | 0 | | $0 | | $0 |
| Right Front Seat | 640,000 | | $2.13 | | $1,363,200 |
| Rear | 8,496,00 | | $19.59 | | $166,436,640 |
| **Total Annual Cost** | |  | |  | **$167,799,840** |

# Lead Time

The agency is proposing a lead time of one year from the first September after the final rule is published for those requirements for front seat occupants and two years from the first September for those requirements for rear seat occupants. Consistent with 49 CFR 571.8(b), multi-stage manufacturers and alterers have an additional year to comply.

In order to equip vehicles with one of the proposed SBWS for rear seat occupants, a manufacturer would likely be able to utilize existing vehicle components such as audible signals and the center console display. However, integrating a rear seat belt warning system in vehicles would require equipping the rear seats with certain components most vehicles do not already have, such as the appropriate seat belt use sensing technology (seat belt buckle sensors, which are readily available), redesigning the hardware and software as necessary to incorporate the required signals, incorporating new visual signals in the instrument panel (if the visual signal is located there) and validating the performance of these components and systems.

Occupant detection technology for the front seats is readily available, and the majority of the front outboard passenger seats already have either a seat belt warning system or occupant sensing technology needed to meet the proposed requirements. Installation rates within the rear seat are much lower.

The proposed driver seat belt warning for buses with a GVWR greater than 3,855 kg (8,500 lbs.) and less than or equal to 4,536 kg (10,000 lbs.) would also require little or no effort from vehicle manufacturers to comply since, as previously discussed, the majority of these buses already meet or surpass the driver seat belt warning requirements voluntarily.

Overall, the proposed seat belt warning requirements should not require much interior redesign, nor should they require the use of much new technology. When the FMVSS No. 208 driver’s seat belt warning was first required in 1971, less than a year of lead-time was given for vehicles that chose a compliance option that required the warning. We believe that two years of lead-time will provide manufacturers with ample time to integrate the proposed rear passenger seat belt warnings (if one is not already in place).

At the same time, we appreciate the challenges multi-stage manufacturers and alterers may face as a result of these new requirements in terms of obtaining and implementing the necessary hardware. However, most of the components necessary to meet the proposed minimum performance requirements for the proposed seat belt warnings are readily available from original equipment manufacturers and we do not foresee any major delays in obtaining them. In accordance with 49 CFR 571.8(b), multi-stage manufacturers and alterers could defer compliance by one year.

# Cost-Effectiveness and Net Benefits

This chapter presents the cost-effectiveness and benefit-cost analyses for the proposed rule. Cost-effectiveness and benefit-cost analyses provide useful information about the relative performance of regulatory alternatives. Impacts associated with regulatory alternatives are broadly categorized into benefits and costs and are then converted from impact quantities, such as fatal crashes, into dollar values. As a result, decision-makers are able to make direct comparisons across regulatory alternatives and identify those that achieve the most effective use of available resources. In addition, commenters to the rulemaking are able to weigh the relative value of both costs and benefits using a consistent metric.

This section first presents the values used to convert benefits measures and to account for the timing in which benefits will be realized. The following sections then make use of those values as well as the benefits and cost presented in previous chapters to calculate the measures employed in the cost-effectiveness and benefit-cost analyses.

Table 65 presents the relative injury factors used to determine the proportional comprehensive benefits attributed to non-fatal injuries of each MAIS severity. In August 2016, the United States DOT issued revised guidance regarding the treatment of the value of a statistical life in regulatory analyses.[[70]](#footnote-71) Adjusted to current economics, we estimated a fatal comprehensive cost of $11.9 million in 2020 dollars (see Appendix B for details). Comprehensive costs include not only a monetary value for the loss of life or the injury suffered, but also after-tax lost productivity due to the injury or fatality, plus the additional societal economic costs including medical care, emergency services, insurance administrative costs, workplace costs, and legal costs.

Table 65: Relative Injury Factors and Comprehensive Unit Costs by Injury Severity Level

|  |  |  |  |
| --- | --- | --- | --- |
| **MAIS Level** | **Non-fatal Injury Severity** | **Relative Injury Factor** | **Comprehensive Unit Cost** |
| MAIS 1 | Minor | 0.0038 | $56,035 |
| MAIS 2 | Moderate | 0.0454 | $553,146 |
| MAIS 3 | Serious | 0.1078 | $1,307,335 |
| MAIS 4 | Severe | 0.2677 | $3,215,701 |
| MAIS 5 | Critical | 0.6125 | $7,327,043 |
| MAIS 6 | Unsurvivable | 1.000 | $11,950,834 |

Furthermore, both cost-effectiveness and benefit-cost analyses must account for the timing in which impacts are realized. That is, these analyses must consider impacts in the present as well as those in all relevant future years. To account for the greater value of impacts occurring in the present relative to those occurring further in the future, future impacts are discounted so that all values are represented as present values. Consistent with the Office of Management and Budget’s (OMB) guidance, these analyses use discount rates of three and seven percent.[[71]](#footnote-72)

Table 66 presents the discount factor for both passenger cars and LTVs by discount rate (see Appendix A for details). For passenger cars, the discount factor is 0.8354 and 0.6816 for a three and seven percent discount rate, respectively. For LTVs, the discount factor is 0.8216 and 0.6626 for a three and seven percent discount rate, respectively.

Table 66: Discount Factor by Discount Rate and Vehicle Type

|  |  |  |
| --- | --- | --- |
| **Vehicle Type** | **Discount Rate** | |
| **3%** | **7%** |
| Passenger Car | 0.8354 | 0.6816 |
| Light Truck | 0.8216 | 0.6626 |

The following sections detail the measures employed in the cost-effectiveness and benefit-cost analyses. These analyses make use of the benefits and costs presented in previous chapters to calculate the measures used to compare and categorize regulatory alternatives.

## Cost-Effectiveness

The purpose of a cost-effectiveness analysis is to compare a set of regulatory alternatives with the same primary outcome in order to identify the most effective use of the resources available. A regulatory alternative is considered to be cost-effective if the estimated cost per unit of change is less than an appropriate benchmark. While cost-effectiveness measures serve as a means of comparing regulatory alternatives, it must be noted that the results of a cost-benefit analysis are based on averages and, therefore, must be treated with great care. Furthermore, the most cost-effective regulatory alternative may not always maximize net benefits.

In order to make a comparison across alternatives, the primary outcome of the regulatory action must be quantified on a single numerical index. As the proposed rule addresses an issue of safety, the objective is to prevent fatalities and non-fatal injuries which are not measured on the same scale. Therefore, in order to compare outcomes across regulatory alternatives, fatalities and non-fatal injuries must be reflected on a single numerical index. Equivalent lives saved (ELS) is a single numerical index that reflects both fatalities and non-fatal injuries and, therefore, is used to measure and compare the benefits associated with regulatory alternatives that address an issue of safety.

To calculate ELS, non-fatal injuries must be expressed in terms of fatalities. Non-fatal injuries are expressed in terms of equivalent fatalities by comparing the value of preventing non-fatal injuries to the value of preventing a fatality. Comprehensive values, which include both economic impacts and lost quality or value of life considerations, are used to determine the relative value of fatalities and non-fatal injuries. By applying the relative injury factor to the number of non-fatal injuries by MAIS level, the number of non-fatal injuries can be converted to equivalent fatalities.

Table 67 presents the calculation of ELS for rear seat occupants based on the benefits estimated in Chapter 5 and the relativeinjury factors from Table 65. As a result of the requirement for SBWS for rear seat occupants, a total of approximately 26.36 to 39.70 equivalent fatalities would be prevented. This range takes into account the Lo and Hi increases in seat belt use resulting from the SBWS. Appendix H presents the calculation of fatal equivalents specific to passenger cars and LTVs separately in order to calculate discounted fatal equivalents for rear seat occupants which are presented later in this section.

Table 67: Calculation of Equivalent Lives Saved for Rear Seat Occupants

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Category** | **Lo** | | | **Hi** | | |
| **Safety Benefits** | **Relative Injury Factor** | **Equivalent Lives Saved** | **Safety Benefits** | **Relative Injury Factor** | **Equivalent Lives Saved** |
| ***Rear Seat Occupants 6-10*** | | | | | | |
| MAIS 1 | 0.6 | 0.0038 | 0.0023 | 0.9 | 0.0038 | 0.0033 |
| MAIS 2 | 0.5 | 0.0454 | 0.0248 | 0.8 | 0.0454 | 0.0363 |
| MAIS 3 | 0.0 | 0.1078 | 0.0000 | 0.0 | 0.1078 | 0.0000 |
| MAIS 4 | 0.0 | 0.2677 | 0.0000 | 0.0 | 0.2677 | 0.0000 |
| MAIS 5 | 0.0 | 0.6125 | 0.0000 | 0.0 | 0.6125 | 0.0000 |
| Fatalities | 0.4 | 1.000 | 0.4056 | 0.6 | 1.000 | 0.6084 |
| **Total Ages 6-10** | |  | **0.4327** |  |  | **0.6481** |
| ***Rear Seat Occupants 11+*** | | | | | | |
| MAIS 1 | 21.6 | 0.0038 | 0.0822 | 32.5 | 0.0038 | 0.1235 |
| MAIS 2 | 39.6 | 0.0454 | 1.7990 | 59.5 | 0.0454 | 2.7035 |
| MAIS 3 | 5.4 | 0.1078 | 0.5871 | 8.2 | 0.1078 | 0.8823 |
| MAIS 4 | 5.4 | 0.2677 | 1.4527 | 8.2 | 0.2677 | 2.1831 |
| MAIS 5 | 0.2 | 0.6125 | 0.0965 | 0.2 | 0.6125 | 0.1450 |
| Fatalities | 21.9 | 1.000 | 21.9076 | 33.0 | 1.000 | 33.0186 |
| **Total Ages 11+** | |  | **25.9252** |  |  | **39.0561** |
| ***All Rear Seat Occupants*** | | | | | | |
| MAIS 1 | 22.2 | 0.0038 | 0.0845 | 33.4 | 0.0038 | 0.1268 |
| MAIS 2 | 40.2 | 0.0454 | 1.8238 | 60.3 | 0.0454 | 2.7398 |
| MAIS 3 | 5.4 | 0.1078 | 0.5871 | 8.2 | 0.1078 | 0.8823 |
| MAIS 4 | 5.4 | 0.2677 | 1.4527 | 8.2 | 0.2677 | 2.1831 |
| MAIS 5 | 0.2 | 0.6125 | 0.0965 | 0.2 | 0.6125 | 0.1450 |
| Fatalities | 22.3 | 1.000 | 22.3132 | 33.6 | 1.000 | 33.6270 |
| **Total** | |  | **26.3578** |  |  | **39.7042** |

Note: Values may not sum due to rounding.

Table 68 presents the calculation of ELS for drivers. As a result of the requirement for the indefinite warning for drivers, a total of approximately 78.72 equivalent fatalities for drivers would be prevented.

Table 68: Calculation of Equivalent Lives Saved for Drivers

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **Safety Benefits** | **Relative Injury Factor** | **Equivalent Lives Saved** |
| ***Passenger Cars*** | | | |
| MAIS 1 | 12.07 | 0.0038 | 0.0459 |
| MAIS 2 | 77.08 | 0.0454 | 3.4993 |
| MAIS 3 | 21.28 | 0.1078 | 2.2939 |
| MAIS 4 | 15.40 | 0.2677 | 4.1229 |
| MAIS 5 | 0.37 | 0.6125 | 0.2237 |
| Fatalities | 25.03 | 1.0000 | 25.0336 |
| Total PC |  |  | **35.2192** |
| ***LTVs*** | | | |
| MAIS 1 | 8.66 | 0.0038 | 0.0329 |
| MAIS 2 | 42.93 | 0.0454 | 1.9489 |
| MAIS 3 | 0.27 | 0.1078 | 0.0295 |
| MAIS 4 | 2.02 | 0.2677 | 0.5395 |
| MAIS 5 | 0.14 | 0.6125 | 0.0852 |
| Fatalities | 40.86 | 1.0000 | 40.8612 |
| Total LTV |  |  | **43.4972** |
| ***Total*** | | | |
| MAIS 1 | 20.73 | 0.0038 | 0.0788 |
| MAIS 2 | 120.00 | 0.0454 | 5.4482 |
| MAIS 3 | 21.55 | 0.1078 | 2.3234 |
| MAIS 4 | 17.42 | 0.2677 | 4.6624 |
| MAIS 5 | 0.50 | 0.6125 | 0.3089 |
| Fatalities | 65.89 | 1.0000 | 65.8948 |
| **Total** |  |  | **78.7164** |

Note: Values may not sum due to rounding.

Table 69 presents the calculation of ELS for right front seat occupants. As a result of the requirement for the indefinite warning for front seat occupants, a total of approximately 13.63 equivalent fatalities for right front seat occupants would be prevented.

Table 69: Calculation of Equivalent Lives Saved for Right Front Seat Occupants

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **Safety Benefits** | **Relative Injury Factor** | **Equivalent Lives Saved** |
| ***Passenger Cars*** | | | |
| MAIS 1 | 2.27 | 0.0038 | 0.0085 |
| MAIS 2 | 13.89 | 0.0454 | 0.6303 |
| MAIS 3 | 3.84 | 0.1078 | 0.4136 |
| MAIS 4 | 2.77 | 0.2677 | 0.7421 |
| MAIS 5 | 0.07 | 0.6125 | 0.0401 |
| Fatalities | 4.82 | 1 | 4.8242 |
| Total PC |  |  | **6.6589** |
| ***LTVs*** | | | |
| MAIS 1 | 1.39 | 0.0038 | 0.0052 |
| MAIS 2 | 6.59 | 0.0454 | 0.2988 |
| MAIS 3 | 0.05 | 0.1078 | 0.0049 |
| MAIS 4 | 0.31 | 0.2677 | 0.0833 |
| MAIS 5 | 0.02 | 0.6125 | 0.0125 |
| Fatalities | 6.56 | 1 | 6.5640 |
| Total LTV |  |  | **6.9687** |
| ***Total*** | | | |
| MAIS 1 | 3.66 | 0.0038 | 0.0137 |
| MAIS 2 | 20.48 | 0.0454 | 0.9291 |
| MAIS 3 | 3.88 | 0.1078 | 0.4185 |
| MAIS 4 | 3.08 | 0.2677 | 0.8254 |
| MAIS 5 | 0.086 | 0.6125 | 0.0527 |
| Fatalities | 11.39 | 1 | 11.3882 |
| **Total** |  |  | **13.6276** |

Note: Values may not sum due to rounding.

Table 70 presents the total fatal equivalents for front seat occupants. As a result of the indefinite warning, a total of approximately 92.34 equivalents fatalities would be prevented for front seat occupants. Of those ELS, 78.72 are safety benefits are from an increase in seat belt use for drivers and 13.63 are from an increase in seat belt use for right front seat occupants.

Table 70: Total Fatal Equivalents for Front Seat Occupants

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **Drivers** | **Right Front Seat Occupants** | **Total Equivalent Lives Saved** |
| Passenger Cars | 35.22 | 6.66 | 41.88 |
| LTVs | 43.50 | 6.97 | 50.47 |
| **Total** | **78.72** | **13.63** | **92.34** |

Note: Values may not sum due to rounding.

A cost-effectiveness analysis must take into account the timing in which benefits and costs are realized. Therefore, this analysis considers the benefits and costs associated with the requirements specified in the proposed rule over the lifetime of one MY’s production. The costs associated with the proposed rule are incurred in the year in which the vehicle is manufactured and, therefore, do not require discounting. On the other hand, the benefits associated with the proposed rule occur over the course of a vehicle’s lifetime. Therefore, the ESL by the proposed rule are discounted to reflect their present value.

Table 71 presents the ELS discounted at three and seven percent. ELS for each category were discounted using the discount factors presented in Table 66. When discounted at three percent, the proposed rule would result in 98.3 and 109.4 ELS, annually. When discounted at seven percent, the proposed rule would result in 79.7 and 88.7 ELS, annually. Taking into account the Lo and Hi increase in seat belt use, the requirements specified for SBWS for rear seat occupants would result in 21.9 and 32.9 ELS when discounted at three percent and 17.7 and 26.7 ELS when discounted at seven percent. When discounted at three and seven percent, the requirements specified for the indefinite warning for front seat occupants would result in 76.4 and 62.0 ELS, respectively. See Appendix H for detailed calculations of discounted ELS for both rear and front seat occupants.

Table 71: Discounted Equivalent Lives Saved

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **Undiscounted** | **Discounted at 3%** | **Discounted at 7%** |
| ***Rear Seat Occupants*** | | | |
| Rear Seat Occupants Ages 6-10 | 0.43 – 0.65 | 0.38 – 0.57 | 0.31 – 0.46 |
| Rear Seat Occupants Ages 11+ | 25.9 – 39.1 | 21.5 – 32.4 | 17.4 – 26.3 |
| Total Rear Seat Occupants | 26.4 - 39.7 | 21.9 – 32.9 | 17.7 – 26.7 |
| ***Front Seat Occupants*** | | | |
| Drivers | 78.7 | 65.2 | 52.8 |
| Right Front Seat Occupants | 13.7 | 11.3 | 9.2 |
| Total Front Seat Occupants | 92.3 | 76.5 | 62.0 |
| ***Total*** | | | |
| Rear Seat Occupants | 26.4 - 39.7 | 21.9 – 32.9 | 17.7 – 26.7 |
| Front Seat Occupants | 92.3 | 76.4 | 62.0 |
| **Total, Proposed Rule** | **118.7 – 132.0** | **98.3 – 109.4** | **79.7 – 88.7** |

Note: Values may not sum due to rounding.

As the unit of change used in this cost-effectiveness analysis is the number of ELS, a regulatory alternative is considered to be cost-effective if the average cost per ELS is less than the comprehensive economic cost of a fatality. That is, the regulatory alternative yields safety benefits at a lower cost than the benchmark value for those benefits.

Table 72 presents the summary of the cost-effectiveness analysis. As this analysis considered a lower and higher estimated increase in seat belt use for rear seat occupants, both the lower (Lo) and higher (Hi) case estimates are included in this cost-effectiveness analysis. Therefore, cost-effectiveness measures for both rear seat occupants and the proposed rule as a whole are presented for both the Lo and Hi cases. When discounted at three percent, the cost per equivalent live saved for the Lo and Hi cases are $1.71 million and $1.53 million, respectively. When discounted at seven percent, the cost per equivalent live saved for the Lo and Hi cases are $2.10 million and $1.89 million, respectively. Comparing these estimates to the comprehensive cost of a fatality of approximately $11.95 million, this analysis finds that the proposed rule is cost-effective.

Additionally, when only considering the costs and benefits for rear seat occupants, the cost per equivalent live saved for the Lo and Hi cases is $7.61 million and $5.05 million when discounted at three percent and $9.38 million and $6.23 million when discounted at seven percent. Lastly, when only considering the costs and benefits for front seat occupants, the cost per equivalent live saved is $0.02 million when discounted at three and seven percent. Therefore, when considering the requirements specific to rear and front seat occupants separately, both remain cost-effective.

Table 72: Summary of Cost-Effectiveness Analysis

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Category** | | **Discounted at 3%** | | | **Discounted at 7%** | | |
| **Equivalent Lives Saved** | **Cost**  **(Millions)** | **Cost per Equivalent Live Saved**  **(Millions)** | **Equivalent Lives Saved** | **Cost**  **(Millions)** | **Cost per Equivalent Live Saved**  **(Millions)** |
| Rear Seat Occupants | Lo | 21.9 | $166.4 | $7.61 | 17.7 | $166.4 | $9.38 |
| Hi | 32.9 | $5.05 | 26.7 | $6.23 |
| Front Seat Occupants | | 76.4 | $1.4 | $0.02 | 62.0 | $1.4 | $0.02 |
| **Total** | **Lo** | **98.3** | **$167.8** | **$1.71** | **79.7** | **$167.8** | **$2.10** |
| **Hi** | **109.4** | **$1.53** | **88.7** | **$1.89** |

Note: Values may not sum due to rounding.

## Net Benefits

Net benefits are used as an absolute measure of the returns offered by a particular regulatory alternative. Net benefits may be positive (negative) indicating that benefits are greater (less) than the costs. Additionally, net benefits may be zero if benefits and costs are equal or if there are no benefits and costs associated with a regulatory action. A positive value for net benefits indicates that society would be better off under the regulatory alternative. On the other hand, a negative net benefit indicates that society would be worse off. However, as was noted earlier, the results of a benefit-cost analysis are based on averages and must be treated with great care.

Net benefits are calculated by subtracting total costs from total benefits. Therefore, the calculation of net benefits requires that benefits and costs are represented in commeasurable units. Therefore, benefits which are measured in fatalities and non-fatal injuries must be translated into monetary value.

Table 73 presents the calculation of monetized benefits associated with the proposed rule for rear seat occupants. Monetized benefits are calculated by multiplying the comprehensive unit costs from Table 65 by the corresponding safety benefits. Monetized benefits associated with the SBWS for rear seat occupants are estimated at approximately $316 million for Lo case and approximately $476 million for the Hi case. Appendix H presents the monetized benefits specific to passenger cars and LTVs separately in order to calculate discounted monetized benefits for rear seat occupants which are presented later in this section.

Table 73: Calculation of Monetized Benefits for Rear Seat Occupants

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Category** | **Lo** | | | **Hi** | | |
| **Safety Benefits** | **Comprehensive Cost** | **Monetized Benefits** | **Safety Benefits** | **Comprehensive Cost** | **Monetized Benefits** |
| ***Rear Seat Occupants 6-10*** | | | | | | |
| MAIS 1 | 0.6 | $56,035 | $33,408 | 0.9 | $56,035 | $48,998 |
| MAIS 2 | 0.5 | $553,146 | $301,897 | 0.8 | $553,146 | $442,783 |
| MAIS 3 | 0.0 | $1,307,335 | $0 | 0.0 | $1,307,335 | $0 |
| MAIS 4 | 0.0 | $3,215,701 | $0 | 0.0 | $3,215,701 | $0 |
| MAIS 5 | 0.0 | $7,327,043 | $0 | 0.0 | $7,327,043 | $0 |
| Fatalities | 0.4 | $11,950,834 | $4,847,637 | 0.6 | $11,950,834 | $7,271,456 |
| Total Ages 6-10 | |  | **$5,182,943** |  |  | **$7,763,237** |
| ***Rear Seat Occupants 11+*** | | | | | | |
| MAIS 1 | 21.6 | $56,035 | $1,211,917 | 32.5 | $56,035 | $1,821,223 |
| MAIS 2 | 39.6 | $553,146 | $21,918,916 | 59.5 | $553,146 | $32,938,924 |
| MAIS 3 | 5.4 | $1,307,335 | $7,120,554 | 8.2 | $1,307,335 | $10,700,501 |
| MAIS 4 | 5.4 | $3,215,701 | $17,450,673 | 8.2 | $3,215,701 | $26,224,216 |
| MAIS 5 | 0.2 | $7,327,043 | $1,154,520 | 0.2 | $7,327,043 | $1,734,970 |
| Fatalities | 21.9 | $11,950,834 | $261,813,734 | 33.0 | $11,950,834 | $394,599,647 |
| **Total Ages 11+** | |  | **$310,670,314** |  |  | **$468,019,480** |
| ***All Rear Seat Occupants*** | | | | | | |
| MAIS 1 | 22.2 | $56,035 | $1,245,324 | 33.4 | $56,035 | $1,870,221 |
| MAIS 2 | 40.2 | $553,146 | $22,220,814 | 60.3 | $553,146 | $33,381,707 |
| MAIS 3 | 5.4 | $1,307,335 | $7,120,554 | 8.2 | $1,307,335 | $10,700,501 |
| MAIS 4 | 5.4 | $3,215,701 | $17,450,673 | 8.2 | $3,215,701 | $26,224,216 |
| MAIS 5 | 0.2 | $7,327,043 | $1,154,520 | 0.2 | $7,327,043 | $1,734,970 |
| Fatalities | 22.3 | $11,950,834 | $266,661,371 | 33.6 | $11,950,834 | $401,871,103 |
| **Total Rear Seat Occupants** | | | **$315,853,257** |  |  | **$475,782,717** |

Note: Values may not sum due to rounding.

Table 74 presents the calculations of monetized benefits for drivers. Monetized benefits resulting from the increase in seat belt use for drivers from the indefinite warning are estimated at approximately $943 million. Of that total, monetized benefits specific to passenger cars are

estimated at approximately $423 and approximately $520 million for LTVs.

Table 74: Calculation of Monetized Benefits for Drivers

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **Safety Benefits** | **Relative Disutility Factors** | **Monetized Benefits** |
| ***Passenger Cars*** | | | |
| MAIS 1 | 12.07 | $56,035 | $676,187 |
| MAIS 2 | 77.08 | $553,146 | $42,634,502 |
| MAIS 3 | 21.28 | $1,307,335 | $27,819,500 |
| MAIS 4 | 15.40 | $3,215,701 | $49,525,654 |
| MAIS 5 | 0.37 | $7,327,043 | $2,675,836 |
| Fatalities | 25.03 | $11,950,834 | $299,172,355 |
| **Total Drivers** |  |  | **$422,504,035** |
| ***LTVs*** | | | |
| MAIS 1 | 8.66 | $56,035 | $485,280 |
| MAIS 2 | 42.93 | $553,146 | $23,745,175 |
| MAIS 3 | 0.27 | $1,307,335 | $357,556 |
| MAIS 4 | 2.02 | $3,215,701 | $6,480,441 |
| MAIS 5 | 0.14 | $7,327,043 | $1,019,558 |
| Fatalities | 40.86 | $11,950,834 | $488,325,015 |
| **Total Right Front Seat** |  |  | **$520,413,025** |
| ***Total*** | | | |
| MAIS 1 | 20.73 | $56,035 | $1,161,467 |
| MAIS 2 | 120.00 | $553,146 | $66,379,677 |
| MAIS 3 | 21.55 | $1,307,335 | $28,177,057 |
| MAIS 4 | 17.42 | $3,215,701 | $56,006,096 |
| MAIS 5 | 0.50 | $7,327,043 | $3,695,394 |
| Fatalities | 65.89 | $11,950,834 | $787,497,370 |
| **Total, Drivers** |  |  | **$942,917,061** |

Note: Values may not sum due to rounding.

Table 75 presents the calculations of monetized benefits for right front seat occupants. Monetized benefits resulting from the increase in seat belt use for right front seat occupants from the indefinite warning are estimated at approximately $163 million. Of that total, monetized benefits specific to passenger cars are estimated at approximately $80 and approximately $83 million for LTVs.

Table 75: Calculation of Monetized Benefits for Right Front Seat Occupants

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **Safety Benefits** | **Relative Disutility Factors** | **Monetized Benefits** |
| ***Passenger Cars*** | | | |
| MAIS 1 | 2.27 | $56,035 | $127,409 |
| MAIS 2 | 13.89 | $553,146 | $7,685,887 |
| MAIS 3 | 3.84 | $1,307,335 | $5,014,976 |
| MAIS 4 | 2.77 | $3,215,701 | $8,912,647 |
| MAIS 5 | 0.07 | $7,327,043 | $479,945 |
| Fatalities | 4.82 | $11,950,834 | $57,653,496 |
| **Total Drivers** |  |  | **$79,874,359** |
| ***LTVs*** | | | |
| MAIS 1 | 1.39 | $56,035 | $77,889 |
| MAIS 2 | 6.59 | $553,146 | $3,645,232 |
| MAIS 3 | 0.05 | $1,307,335 | $65,367 |
| MAIS 4 | 0.31 | $3,215,701 | $996,867 |
| MAIS 5 | 0.02 | $7,327,043 | $146,541 |
| Fatalities | 6.56 | $11,950,834 | $78,397,471 |
| **Total Right Front Seat** |  |  | **$83,329,367** |
| ***Total*** | | | |
| MAIS 1 | 3.66 | $56,035 | $205,234 |
| MAIS 2 | 20.48 | $553,146 | $11,329,550 |
| MAIS 3 | 3.88 | $1,307,335 | $5,073,850 |
| MAIS 4 | 3.08 | $3,215,701 | $9,913,180 |
| MAIS 5 | 0.09 | $7,327,043 | $629,927 |
| Fatalities | 11.39 | $11,950,834 | $136,098,602 |
| **Total, Right Front Seat Occupants** | |  | **$163,250,343** |

Note: Values may not sum due to rounding.

Table 76 presents the monetized benefits for all front seat occupants. Monetized benefits associated with requirements for the indefinite warning for front seat occupants are estimated at approximately $1.11 billion, annually. Approximately $943 million of those monetized benefits are the result of increase seat belt use for drivers and approximately $163 million are from the increase in seat belt use for right front seat occupants.

Table 76: Monetized Benefits for Front Seat Occupants (Millions)

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **Drivers** | **Right Front Seat Occupants** | **Total** |
| Passenger Cars | $422.5 | $79.9 | $502.4 |
| LTVs | $520.4 | $83.3 | $603,8 |
| **Total** | **$942.9** | **$163.2** | **$1,106.2** |

Note: Values may not sum due to rounding.

Table 77 presents the discounted monetized benefits associated with the proposed rule. Monetized benefits for each category were discounted using the discount factors presented in Table 66. As this analysis considered a lower and higher estimated increase in seat belt use for rear seat occupants, both the lower (Lo) and higher (Hi) case estimates are included when calculating monetized benefits. Therefore, monetized benefits for both rear seat occupants and the proposed rule as a whole are presented for both the Lo and Hi cases. When discounted at three percent, annual monetized benefits associated with the proposed rule are estimated at approximately $1.2 billion and $1.3 billion, respectively. When discounted at seven percent, annual monetized benefits associated with the proposed rule are estimated at approximately $955 million and $1.1 billion, respectively.

Monetized benefits associated with the requirements specified for SBWS for rear seat occupants are estimated at approximately $262 million to $390 million when discounted at three percent and approximately $213 million to $320 million when discounted at seven percent. When discounted at three and seven percent, monetized benefits associated with the requirements specified for the indefinite warning for front seat occupants are estimated at approximately $916 million and $743 million, respectively. See Appendix H for detailed calculations of discounted monetized benefits for both rear and front seat occupants.

Table 77: Discounted Monetized Benefits (Millions)

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **Undiscounted** | **Discounted at 3%** | **Discounted at 7%** |
| ***Rear Seat Occupants*** | | | |
| Rear Seat Occupants Ages 6-10 | $5.2-$7.8 | $4.5 - $6.8 | $3.7 - $5.5 |
| Rear Seat Occupants Ages 11+ | $311 - $468 | $258 - $388 | $209 - $315 |
| Total Rear Seat Occupants | $316 - $476 | $262 -$395 | $213 - $320 |
| ***Front Seat Occupants*** | | | |
| Drivers | $942.9 | $780.5 | $632.8 |
| Right Front Seat Occupants | $163.3 | $135.2 | $109.7 |
| Total Front Seat Occupants | $1,106.2 | $915.8 | $742.5 |
| ***Total*** | | | |
| Rear Seat Occupants | $316 - $476 | $262 - $395 | $213 - $320 |
| Front Seat Occupants | $1,106.2 | $915.8 | $742.5 |
| **Total, Proposed Rule** | **$1,422 - $1,582** | **$1,178 - $1,311** | **$955 - $1,063** |

Note: Values may not sum due to rounding.

Table 78 the summary of the benefit-cost analysis. As this analysis considered a lower and higher estimated increase in seat belt use for rear seat occupants, both the lower (Lo) and higher (Hi) case estimates are included in this benefit-cost analysis. Therefore, net benefits measures for both rear seat occupants and the proposed rule as a whole are presented for both the Lo and Hi cases. When discounted at three percent, net benefits associated with the proposed rule are estimate at approximately $1.1 billion. When discounted at seven percent, net benefits associated with the proposed rule are estimate at approximately $787 million and $895 million, respectively. Therefore, the proposed rule is considered to be net beneficial.

When only considering the costs and benefits for rear seat occupants, net benefits are approximately $96 million and $228 million when discounted at three percent and $46 million and $154 million when discounted at seven percent. Lastly, when only considering the costs and benefits for front seat occupants, net benefits are estimated at approximately $914 million and $741 million when discounted at three and seven percent, respectively. Therefore, when considering the requirements specific to rear and front seat occupants separately both remain net beneficial.

Table 78: Summary of Net Benefits (Millions)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Category** | | **Discounted at 3%** | | | **Discounted at 7%** | | |
| **Monetized Benefits** | **Cost** | **Net Benefits** | **Monetized Benefits** | **Cost** | **Net Benefits** |
| Rear Seat Occupants | Lo | $262.1 | $166.4 | $95.6 | $212.7 | $166.4 | $46.2 |
| Hi | $394.8 | $228.3 | $320.4 | $153.9 |
| Front Seat Occupants | | $915.8 | $1.4 | $914.4 | $742.5 | $1.4 | $741.1 |
| **Total** | Lo | $1,177.9 | **$167.8** | $1,010.0 | $955.2 | **$167.8** | $787.4 |
| Hi | $1,310.5 | $1,142.7 | $1,062.8 | $895.0 |

Note: Values may not sum due to rounding.

## Summary

This chapter presented the cost-effectiveness and benefit-cost analyses for the proposed rule. Benefits associated with the proposed rule, which are measured in fatalities prevented and non-fatal injuries reduced, were converted into equivalent lives saved. When discounting at three and seven percent, the cost per equivalent live saved is approximately $1.53 to $1.71 million for the Lo case and $1.89 and $2.10 million for the Hi case, respectively. As these estimates are less than the comprehensive cost of a fatality, the proposed rule is considered to be cost-effective.

To calculate net benefits, benefits and costs must be represented in commeasurable units. Therefore, the safety benefits associated with the proposed rule are translated into monetary value. When discounted at three and seven percent, the net benefits associated with the proposed rule are approximately $1.1 billion for the Lo case and range from $787 million to $895 million for the Hi case, respectively. Therefore, the proposed rule is considered to be net beneficial.

# Sensitivity Analysis

This chapter presents the sensitivity analysis which considers how the conclusions drawn from the analyses in this PRIA may change based on the assumptions used in the analyses. When inputs that affect the analysis are uncertain, the agency makes its best judgment about the probable values or range of values that will occur. This analysis examines alternatives to these assumptions to illustrate how sensitive the results are to the values initially selected. The next section presents a sensitivity analysis that considers the level of increase in seat belt usage for rear seat occupants. The following section then presents a balance point analysis for both rear and front seat occupants.

## Increase in Rear Occupant Seat Belt Usage

This section presents a sensitivity analysis that considers the increase in seat belt use resulting from the requirements specified in the proposed rule for SBWS for rear seat occupants. The following subsections presents the sensitivity analysis considering the increase in seat belt use for SBWS for rear seat occupants by age group.

### Rear Seat Occupants Age 11+

In the main analysis, this analysis estimates that the requirements for SBWS would increase seat belt usage by three to five percent for rear seat occupants age 11 years and older. Alternatively, this sensitivity analysis considers the case in which seat belt usage for rear seat occupants age 11 years and older increases to match that of front seat occupants. An increase in seat belt usage of 11 percent represents the increase in seat belt use which would close the gap between use rates for front and rear seat occupants.[[72]](#footnote-73) More specifically, an increase of 11 percent would result in a seat belt use rate of 0.8612 in crashes resulting in non-fatal injuries and 0.7272 in potentially fatal crashes.[[73]](#footnote-74)

Table 79 presents the calculation of incremental benefits for rear seat occupants 11 years and older for this sensitivity analysis. Taking into account rate of 0.8612 in crashes resulting in non-fatal injuries and 0.7272 in potentially fatal crashes, 315 non-fatal injuries and 69 fatalities would be prevented for rear seat occupants 11 years and older in passenger cars. For rear seat occupants 11 years and older in LTVs, 120 non-fatal injuries and 72 fatalities would be prevented.

Table 79: Sensitivity Analysis: Incremental Benefits for Rear Seat Occupants 11 Years and Older

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Injury Severity** | **Potential Injuries**  **(a)** | **Seat Belt Effectiveness**  **(b)** | **Baseline Seat Belt Use Rate**  **(c)** | **Baseline Effects**  **(a) x (b) x (c)** | **Use Rate Increase by 11%**  **(d)** | **Benefits Under Increase of 11%**  **(a) x (b) x (d)** | **Incremental Benefits** |
| ***Passenger Cars*** | | | | | | | |
| MAIS 1 | 15,762 | 0.055 | 0.7512 | 651 | 0.8612 | 747 | 95 |
| MAIS 2 | 2,398 | 0.625 | 0.7512 | 1,126 | 0.8612 | 1291 | 165 |
| MAIS 3 | 462 | 0.625 | 0.7512 | 217 | 0.8612 | 249 | 32 |
| MAIS 4 | 379 | 0.625 | 0.7512 | 178 | 0.8612 | 204 | 26 |
| MAIS 5 | 11 | 0.625 | 0.7512 | 5 | 0.8612 | 6 | 1 |
| **Non-Fatal Injuries**  **(MAIS 1-5)** | 19,012 | - | 0.7512 | 2,177 | - | 2,496 | 319 |
| **Fatality** | 937 | **0.55** | **0.5953** | **307** | 0.7272 | **375** | **68** |
| ***Light Trucks*** | | | | | | | |
| MAIS 1 | 5,963 | 0.055 | 0.7512 | 246 | 0.8612 | 282 | 36 |
| MAIS 2 | 1,363 | 0.5068 | 0.7512 | 519 | 0.8612 | 594 | 75 |
| MAIS 3 | 24 | 0.5068 | 0.7512 | 9 | 0.8612 | 11 | 1 |
| MAIS 4 | 124 | 0.5068 | 0.7512 | 47 | 0.8612 | 54 | 7 |
| MAIS 5 | 3 | 0.5068 | 0.7512 | 1 | 0.8612 | 1 | 0 |
| **Non-Fatal Injuries**  **(MAIS 1-5)** | 7,478 | - | 0.7512 | 822 | - | 942 | 120 |
| **Fatality** | 720 | **0.74** | **0.5953** | 317 | 0.7272 | **388** | **70** |

Note: Values may not sum due to rounding. Totals are rounded to the nearest whole number for presentation purposes

Table 80 presents a summary of the incremental benefits under the proposed rule, as well as those in this sensitivity analysis for rear seat occupants age 11 years and older. In the case that seat belt use for rear seat occupants 11 years and older increased to match that of front seat occupants, a total of 138 fatalities and 438 non-fatal injuries would be prevented annually. Relative to those estimated in the main analysis, incremental benefits in this sensitivity analysis are approximately four to 5.9 times greater for fatalities prevented and approximately 4.2 to 6.3 times greater for non-fatal injuries prevented.

Table 80: Sensitivity Analysis: Summary of Incremental Benefits for Rear Seat Occupants 11+

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **Incremental Benefits** | | |
| **Proposed Rule** | | **Sensitivity Analysis** |
| **Lo** | **Hi** |
| Non-fatal Injuries (MAIS 1-5) | 74 | 110 | 438 |
| Fatalities | 22 | 33 | 138 |

Note: Values may not sum due to rounding. Totals are rounded to the nearest whole number for presentation purposes.

### Rear Seat Occupants Age 6 to 10

In the main analysis, this analysis estimates that the requirements for SBWS would increase seat belt usage by 0.3 percent to 0.5 percent for rear seat occupants ages six to ten. Alternatively, this sensitivity analysis also considers the case in which the increase in seat belt use rates for rear seat occupants ages six to ten is twice the Hi estimate in the main analysis. For rear seat occupants ages six to ten, doubling the increase in seat belt use for the Hi case would result in a seat belt use rate of 0.9840 in crashes resulting in non-fatal injuries and 0.8994 in potentially fatal crashes.

Table 81 presents the calculation of incremental benefits for rear seat occupants six to ten years older for the sensitivity analysis. Taking into account rate of 0.9840 in crashes resulting in non-fatal injuries and 0.8994 in potentially fatal crashes, two non-fatal injuries would be prevented for rear seat occupants six to ten years old in passenger cars. For rear seat occupants six to ten years older in LTVs, two non-fatal injuries and one fatality would be prevented.

Table 81: Sensitivity Analysis: Incremental Benefits for Rear Seat Occupants 6 to 10 Years Old

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Injury Severity** | **Potential Injuries**  **(a)** | **Seat Belt Effectiveness**  **(b)** | **Baseline Seat Belt Use Rate**  **(c)** | **Baseline Effects**  **(a) x (b) x (c)** | **Double the Hi Increase** | **Benefits when Doubling the Hi Increase** | **Incremental Benefits** |
| ***Passenger Cars*** | | | | | | | |
| MAIS 1 | 3,176 | 0.055 | 0.9800 | 171 | 0.9840 | 172 | 1 |
| MAIS 2 | 357 | 0.625 | 0.9800 | 219 | 0.9840 | 220 | 1 |
| MAIS 3 | 138 | 0.625 | 0.9800 | 85 | 0.9840 | 85 | 0 |
| MAIS 4 | 39 | 0.625 | 0.9800 | 24 | 0.9840 | 24 | 0 |
| **Non-Fatal Injuries**  **(MAIS 1-5)** | **3,710** | **-** | **-** | **498** | **-** | **501** | **2** |
| **Fatality** | **131** | **0.55** | **0.8825** | **64** | **0.8994** | **64** | **0** |
| ***Light Trucks*** | | | | | | | |
| MAIS 1 | 4,050 | 0.055 | 0.9800 | 218 | 0.9840 | 219 | 1 |
| MAIS 2 | 274 | 0.5068 | 0.9800 | 136 | 0.9840 | 137 | 1 |
| **Non-Fatal Injuries**  **(MAIS 1-5)** | **4,325** | **-** | **-** | **355** | **-** | **356** | **2** |
| **Fatality** | **177** | **0.74** | **0.8825** | **116** | **0.8994** | **116** | **1** |

Note: Values may not sum due to rounding. Totals are rounded to the nearest whole number for presentation purposes.

Table 82 presents a summary of the incremental benefits under the proposed rule, as well as those in this sensitivity analysis for rear seat occupants six to ten years old. In the case that seat belt use for rear seat occupants six to ten years old was double that of the Hi estimate, a total of one fatality and 4 non-fatal injuries would be prevented annually. Relative to those estimated in the main analysis, incremental benefits in this sensitivity analysis are approximately two to four times greater for non-fatal injuries prevented. In the case of fatalities, the estimated fatalities prevented in this sensitivity analysis matches that of the Hi estimate in the main analysis.

Table 82: Sensitivity Analysis: Summary of Incremental Benefits for Rear Seat Occupants Age 6 to 10

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **Incremental Benefits** | | |
| **Proposed Rule** | | **Sensitivity Analysis** |
| **Lo** | **Hi** |
| Non-fatal Injuries (MAIS 1-5) | **1** | **2** | **4** |
| Fatalities | **0** | **1** | **1** |

Note: Values may not sum due to rounding. Totals are rounded to the nearest whole number for presentation purposes.

### Comparison to Main Analysis

This subsection makes use of the incremental benefits calculated in the previous subsections for rear seat occupants by age group to compare the findings of this sensitivity analysis to the main analysis. Taking into account the increased seat belt use rates considered in this sensitivity analysis for both age groups, ELS for rear seat occupants are estimated at 136.1 and 110.4 when discounted at three and seven percent, respectively. The estimated ELS in this sensitivity analysis reflect an approximate 26 to 40 percent increase from the Lo and Hi estimates in the main analysis.

Taking into account the increased seat belt use rates considered in this sensitivity analysis for both age groups, monetized benefits for rear seat occupants are estimated at approximately $1.42 and $1.15 billion when discounted at three and seven percent, respectively. Monetized benefits in this sensitivity analysis reflect an approximate nine to 22 percent increase from those calculated for the Lo and Hi estimates in the main analysis.

Table 83: Sensitivity Analysis: Comparison of Fatal Equivalents and Monetized Benefits Rear Seat Occupants

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Category** | | **Fatal Equivalents** | | **Monetized Benefits (Millions)** | |
| **Discounted at 3%** | **Discounted at 7%** | **Discounted at 3%** | **Discounted at 7%** |
| Proposed Rule | Lo | 97.1 | 78.7 | $1,163 | $943.1 |
| Hi | 108.2 | 87.7 | $1,296 | $1,051 |
| Sensitivity Analysis | | 136.1 | 110.4 | $1,415 | $1,147.8 |

## Balance Point Analysis

To account for uncertainty about the actual effectiveness of SBWS for rear seat occupants and the indefinite warning for front seat occupants, the agency performed a balance point analysis to determine what increase in rear seat belt use would be needed to result in a cost-effective system. That is, a balance point is any specific circumstance for which all the monetized benefits of the rule are equal to all the monetized costs. The balance point analysis was performed using the Goal Seek function of Excel.

The balance point analysis indicated that in order for the benefits and costs associated with the requirements for SBWS for rear seat occupants seat belt use must increase by 2.13 percent when discounting at three percent and 2.64 when discounting at seven percent.

Similarly, the balance point analysis indicated that in order for the benefits and costs associated with the requirements for the indefinite warning for front seat occupants seat belt use must increase by 0.15 percent when discounting at three percent and 0.19 when discounting at seven percent. This analysis notes that seat belt use for front seat occupants is already high. As a result, there is less of an opportunity to increase seat belt rates for front seat occupants. Additionally, it may be comparatively more difficult to change the behavior of the most reticent front seat occupants.

# Regulatory Alternatives

This chapter presents the regulatory alternatives considered by the agency. The following sections discuss the regulatory options in detail and, when possible, present the benefits and costs associated with those alternatives. The final section provides a summary of the regulatory alternatives considered for this rulemaking.

## Requiring Occupant Detection for Rear Seat Belt Warning System

NHTSA considered including a requirement for occupant detection for the rear seats. This section discusses the potential costs and benefits associated with this regulatory alternative.

In estimating the cost associated with this regulatory alternative, this analysis first takes into account the estimated cost in the main analysis for SBWS for rear seat occupants. Furthermore, the teardown report used to estimate costs in the main analysis included one vehicle which was equipped with occupant detection, and two teardown summaries were provided for the same vehicle. One of those summaries details the cost of the SBWS without occupant detection, as would be required by the rule, and the other includes the SBWS with occupant detection which would be required under this regulatory alternative. Therefore, we can use the difference in those estimates to assess the cost associated occupant detection.

Based on the difference in cost between the SBWS with and without occupant detection, the manufacturer’s cost for occupant detection is $7.99 per seat in 2017 dollars. This analysis then updates this estimated cost to reflect 2020 dollars based on the 1.51 markup factor for the end-user costs (or consumer costs) and the 3.12 average rear seats per vehicle. Therefore, this analysis estimates a cost of $39.74 per vehicle for occupant detection. The overall cost per vehicle for SBWS with occupant detection for rear seats is $59.33. That estimated cost per vehicle reflects the cost of $19.59 in the main analysis for SBWS and the additional cost of $39.74 for occupant detection.

Table 84 presents the total annual cost for this regulatory alternative. In estimating total costs, this analysis considers the percentage of light vehicles equipped with SBWS and those equipped with occupant detection for rear seat occupants under the baseline. As was the case in the main analysis, this estimate reflects that 53.1 percent of vehicles do not have rear SBWS based on the 2022 NCAP data. Additionally, based on the 2022 NCAP data, the cost estimate for this regulatory alternative takes into account that seven percent of light vehicles have rear seat occupant detection. Therefore, the cost per vehicle for occupant detection is applicable to 93 percent or approximately 14.9 million vehicles. The total cost for this regulatory alternative is approximately $757.8 million. This cost estimate reflects an increase in cost from that of the main analysis of approximately $591.3 million for occupant detection for rear seats.

Table 84: Total Annual Cost of Rear Seat Occupant SBWS with Seat Belt Sensor and Occupant Detection Sensor

|  |  |  |  |
| --- | --- | --- | --- |
| **Addition to Meet Requirements** | **Number of Impacted Vehicles** | **Cost per Vehicle** | **Total Cost** |
| Adding SBWS | 8,496,000 | $19.59 | $166,436,640 |
| Adding Occupant Detection | 14,880,00 | $39.74 | $591,331,200 |
| **Total Cost** |  |  | **$757,767,840** |

While this analysis makes use of the teardown study to estimate the costs associated with this regulatory alternative, there is a lack of data to estimate the increase in seat belt use and resulting benefits. SBWS for rear seat occupants include positive-only systems, negative-only systems, and full-status systems. Positive-only systems are those which indicate how many or which seat belts are in use and, thus, do not require occupant detection. This PRIA expects that most manufacturers will meet the requirements under the proposed rule with a positive-only system.

Negative-only systems are those which a visual signal indicates, for occupied seats, which seat belts are not in use. Lastly, full-status systems are those which a visual signal indicates, for occupied seats, how many or which seat belts are and are not in use. The latter two systems would require occupant detection.

Given the expectation that most manufacturers would meet the requirements with a positive-only system, the benefits and costs estimates in the main analysis reflect that expectation. In considering the increase in seat belt use under this regulatory alternative, we consider how much more seat belt use may increase as a result of SBWS with occupant detection relative to SBWS without it. That is, there is uncertainty in how much more effective a SBWS with occupant detection will be in increasing seat belt use given the already estimated increase in seat belt use with a SBWS without occupant detection. Furthermore, those who are most resistant to seat belt use are most likely the most difficult to sway towards using seat belts.

While cost-effectiveness and net benefits analyses are used to compare regulatory alternatives, this analysis considers the increase in seat belt use at which this regulatory alternative would be cost effective and net beneficial. As the seat belt use rate for rear seat occupants six to ten years old is already very high (0.9800 under the baseline and 0.9822 under the Hi estimate for the proposed rule), there is little room for increases as it is unlikely that the seat belt use rate will reach 100 percent. Therefore, for rear occupants six to ten years old, this analysis makes use of the Hi estimated increase in seat belt use from the main analysis. Therefore, in order for benefits and costs to be equal for this regulatory option, seat belt use for rear seat occupants 11 years and older would need to increase by approximately 9.37 percent when discounted at three percent and 11.6 percent when discounted at seven percent.

In considering the findings of the breakeven analysis, we note that net benefits in a breakeven analysis are zero. Therefore, a 9 to 12 percent increase in seat belt use would result in this regulatory option to be net beneficial but would still make it less net beneficial than the proposed rule. Furthermore, a 9 to nearly 12 percent increase in seat belt use is about three times the estimated Lo increase of 3.4 percent and double the estimated Hi increase of 5.1 percent in the main analysis. As was noted earlier, the SBWS considered under this regulatory alternative are capable of letting the driver know for occupied rear seats, which seat belts are or are not in use. While we would expect some possible increase in seat belt use from that specific functionality, it is doubtful that it would be close to double or triple the increase in seat belt use estimated for SBWS without occupant detection. Lastly, there are also other factors that may impact the effectiveness of SBWS with occupant detection.

Overall, this analysis was able to estimate the costs associated with this regulatory option, but due to limitations was not able to estimate increase in seat belt use and resulting benefits. As a result, this analysis considered how much more effective these systems would need to be in increasing seat belt use to make up for the additional cost. Based on the available information, the agency did not choose this regulatory alternative. However, due to the uncertainty in the effectiveness for SBWS with occupant detection for rear seat occupants, we request comments on these assumptions.

## Front Center Seat SBWS

NHTSA also considered requiring a SBWS for the front center seating position. To estimate incremental benefits, this analysis makes use of the 2011-2015 FARS data to establish the target population addressed by this regulatory alterative. Furthermore, this analysis makes use of the adjustment factors established in Chapter 3 to account for safety impacts of new required safety technologies that have yet to be applied to the fleet (see Appendix D for the unadjusted fatalities).

Table 85 presents the annual adjusted fatalities for front center seat passengers by vehicle type and crash type. For passenger cars, there were a total of six fatalities for front center seat passengers, annually. Of those fatalities, two were restrained and three were unrestrained front center seat passengers. As noted in the table, fatalities presented in the table are rounded to the nearest whole number and, therefore, may not sum due to rounding. However, it is important to note that unrounded numbers are carried through the benefits calculations. For light trucks, there were a total of 28 fatalities for front center seat passengers, annually. Of those fatalities, five were restrained and 23 were unrestrained front center seat occupant fatalities.

Table 85: Annual Adjusted Fatalities for Front Center Seat Passengers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Crash type** | **Restrained** | **Unrestrained** | **Total** |
| **PC** | Rollover | 1 | 1 | 1 |
| Front | 1 | 2 | 3 |
| Side | 1 | 1 | 1 |
| Rear | 0 | 1 | 1 |
| **Total** | **2** | **3** | **6** |
| **LTV** | Rollover | 1 | 12 | 13 |
| Front | 2 | 9 | 11 |
| Side | 1 | 2 | 3 |
| Rear | 0 | 1 | 1 |
| **Total** | **5** | **23** | **28** |

Note: Values may not sum due to rounding. Fatalities were rounded to the nearest whole number for presentation purposes. Unrounded numbers were carried through the benefits calculations. Fatalities in which the occupant’s seat belt status was unknown were distributed and the resulting estimates were then rounded to the nearest whole number.

Due to a lack of data, this analysis makes use of the injury-to-fatality ratios by injury severity as presented in Table 24. In order to estimate the number of non-fatal injures for front center seat passengers, we apply the appropriate ratio by injury severity and vehicle type to the number of fatalities presented in Table 85.

Table 86 presents the annual adjusted target population for front center seat passengers. For passenger cars, there were a total of 43 non-fatal injuries for front center seat passengers, annually. Of those non-fatal injuries, 25 were restrained and 18 were unrestrained front center seat passengers. For light trucks, there were a total of 28 non-fatal injuries for front center seat passengers. Of those fatalities, five were restrained and 23 were unrestrained front center seat passengers.

Table 86: Annual Adjusted Fatalities and Non-Fatal Injuries to Front Center Seat Passengers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Injury Severity** | **Restrained** | **Unrestrained** | **Total** |
| PC | MAIS 1 | 11 | 15 | 26 |
| MAIS 2 | 5 | 7 | 11 |
| MAIS 3 | 1 | 2 | 3 |
| MAIS 4 | 1 | 1 | 2 |
| MAIS 5 | 0 | 0 | 0 |
| **Total Injuries**  **(MAIS 1-5)** | **18** | **25** | **43** |
| **Fatal** | **2** | **3** | **6** |
| LTV | MAIS 1 | 23 | 112 | 135 |
| MAIS 2 | 8 | 38 | 46 |
| MAIS 3 | 0 | 0 | 0 |
| MAIS 4 | 0 | 2 | 2 |
| MAIS 5 | 0 | 0 | 0 |
| **Total Injuries**  **(MAIS 1-5)** | **31** | **152** | **183** |
| **Fatal** | **5** | **23** | **28** |

Note: Values may not sum due to rounding. Injuries and fatalities are rounded to the nearest whole number for presentation purposes. Unrounded numbers were carried through the benefits calculation.

Due to a lack of data, this analysis is unable to establish the seat belt use rate for front center passengers under the baseline. Therefore, due to that limitation, this analysis also cannot estimate the increase in seat belt use rates under this regulatory alternative. Therefore, as front center seat passengers are most similar to right front seat passengers, this analysis makes use of the effectiveness rates calculated for right front seat passengers. Effectiveness rates for right front seat passengers are presented in Table 60 and are calculated by dividing incremental benefits by the number of observed fatalities and non-fatal injuries. In this analysis, we make use of that effectiveness rate to calculate incremental benefits by multiplying effectiveness by the number of observed fatalities and non-fatal injuries.

Table 87 presents the calculation of incremental benefits for front center seat passengers. Given the relatively small target population, when making use of the effectiveness rate from right front seat passengers the resulting incremental benefits are small. Across all injury severity levels, incremental benefits are less than one. Additionally, we make note that using the effectiveness calculated for right front seat passengers may overestimate benefits in this analysis as the right front seat includes seat belts and air bags while the front center seat only includes seat belts.

Table 87: Incremental Benefits for Front Center Seat Passengers

|  |  |  |  |
| --- | --- | --- | --- |
| **Injury Severity** | **Observed Injuries** | **Effectiveness** | **Incremental Benefits** |
| ***Passenger Cars*** | | | |
| MAIS 1 | 26 | 0.03% | 0.0078 |
| MAIS 2 | 11 | 0.41% | 0.0466 |
| MAIS 3 | 3 | 0.41% | 0.0129 |
| MAIS 4 | 2 | 0.41% | 0.0093 |
| MAIS 5 | 0 | 0.41% | 0.0002 |
| Fatal | 6 | 0.43% | 0.0241 |
| ***LTVs*** | | | |
| MAIS 1 | 135 | 0.03% | 0.0405 |
| MAIS 2 | 46 | 0.41% | 0.1878 |
| MAIS 3 | 0 | 0.41% | 0.0012 |
| MAIS 4 | 2 | 0.41% | 0.0088 |
| MAIS 5 | 0 | 0.41% | 0.0006 |
| Fatal | 28 | 0.43% | 0.1203 |

Note: Values may not sum due to rounding.

Table 88 presents the incremental benefits associated with this regulatory alternative by vehicle type and discount rate. Discounted incremental benefits are calculated by applying the discount factors presented in Table 66 by discount rate and vehicle type.

Table 88: Discounted Benefits by Vehicle Type

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Injury Severity** | **Undiscounted Incremental Benefits** | **Discounted at 3%** | **Discounted at 7%** |
| **PC** | MAIS 1 | 0.0078 | 0.0065 | 0.0053 |
| MAIS 2 | 0.0466 | 0.0389 | 0.0317 |
| MAIS 3 | 0.0129 | 0.0107 | 0.0088 |
| MAIS 4 | 0.0093 | 0.0078 | 0.0063 |
| MAIS 5 | 0.0002 | 0.0002 | 0.0002 |
| Fatality | 0.0241 | 0.0202 | 0.0164 |
| **LTV** | MAIS 1 | 0.0405 | 0.0333 | 0.0268 |
| MAIS 2 | 0.1878 | 0.1543 | 0.1245 |
| MAIS 3 | 0.0012 | 0.0010 | 0.0008 |
| MAIS 4 | 0.0088 | 0.0072 | 0.0058 |
| MAIS 5 | 0.0006 | 0.0005 | 0.0004 |
| Fatality | 0.1203 | 0.0989 | 0.0798 |

Table 89 presents the incremental benefits associated with this regulatory alternative by vehicle type and discount rate. Total discounted benefits are calculated by summing the benefits for passenger cars and LTVs in the previous table by injury severity. The resulting discounted total benefits are used to calculate fatal equivalents and monetized benefits for this regulatory alternative.

Table 89: Discounted Benefits for Front Center Seat Passengers

|  |  |  |
| --- | --- | --- |
| **Injury Severity** | **Discounted Benefits** | |
| **3%** | **7%** |
| MAIS 1 | 0.0398 | 0.0321 |
| MAIS 2 | 0.1932 | 0.1562 |
| MAIS 3 | 0.0117 | 0.0096 |
| MAIS 4 | 0.0150 | 0.0122 |
| MAIS 5 | 0.0007 | 0.0006 |
| **Fatality** | 0.1191 | 0.0962 |

Table 90 presents the annual ELS for front center seat passengers discounted at three and seven percent, respectively. When discounted at three and seven percent., this regulatory alternative would result in approximately 0.1337 ELS and 0.1081 ELS, respectively. Discounted ELS are used in the cost-effectiveness analysis for this regulatory alternative.

Table 91 presents the annual monetized benefits for front center seat passengers discounted at three and seven percent, respectively. When discounted at three and seven percent., monetized benefits for regulatory alternative are approximately 1.60 million and 1.29 million, respectively. Discounted monetized benefits are used in the benefit-cost analysis for this regulatory alternative.

Table 90: Annual Equivalent Lives Saved by Discounted Rate

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Injury Severity** | **Discounted Benefits at 3%** | **Relative Disutility Factors** | **Equivalent Lives Saved** | **Injury Severity** | **Discounted Benefits at 7%** | **Relative Disutility Factors** | **Equivalent Lives Saved** |
| MAIS 1 | 0.0398 | 0.0038 | 0.0002 | MAIS 1 | 0.0321 | 0.0038 | 0.0001 |
| MAIS 2 | 0.1932 | 0.0454 | 0.0088 | MAIS 2 | 0.1562 | 0.0454 | 0.0071 |
| MAIS 3 | 0.0117 | 0.1078 | 0.0013 | MAIS 3 | 0.0096 | 0.1078 | 0.0010 |
| MAIS 4 | 0.0150 | 0.2677 | 0.0040 | MAIS 4 | 0.0122 | 0.2677 | 0.0033 |
| MAIS 5 | 0.0007 | 0.6125 | 0.0004 | MAIS 5 | 0.0006 | 0.6125 | 0.0004 |
| Fatalities | 0.1191 | 1.0000 | 0.1191 | Fatalities | 0.0962 | 1.0000 | 0.0962 |
| **Total** |  |  | **0.1337** | **Total** |  |  | **0.1081** |

Note: Values may not sum due to rounding.

Table 91: Annual Monetized Benefits by Discounted Rate

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Injury Severity** | **Discounted Benefits at 3%** | **Comprehensive Unit Costs** | **Monetized Benefits** | **Injury Severity** | **Discounted Benefits at 7%** | **Comprehensive Unit Costs** | **Monetized Benefits** |
| MAIS 1 | 0.0398 | $56,035 | $2,228 | MAIS 1 | 0.0321 | $56,035 | $1,800 |
| MAIS 2 | 0.1932 | $553,146 | $106,889 | MAIS 2 | 0.1562 | $553,146 | $86,406 |
| MAIS 3 | 0.0117 | $1,307,335 | $15,360 | MAIS 3 | 0.0096 | $1,307,335 | $12,520 |
| MAIS 4 | 0.0150 | $3,215,701 | $48,285 | MAIS 4 | 0.0122 | $3,215,701 | $39,176 |
| MAIS 5 | 0.0007 | $7,327,043 | $5,222 | MAIS 5 | 0.0006 | $7,327,043 | $4,225 |
| Fatalities | 0.1191 | $11,950,834 | $1,422,854 | Fatalities | 0.0962 | $11,950,834 | $1,149,765 |
| **Total** |  |  | **$1,600,838** | **Total** |  |  | **$1,293,892** |

Note: Values may not sum due to rounding.

In estimating the costs for this regulatory alternative, this analysis makes use of the cost estimates established in Chapter 6, We assume that the cost for front center seat passengers would include the cost for a buckle sensor and occupant detection. Therefore, the cost per vehicle for this regulatory alternative is $14.86 in 2020 dollars. This cost estimate reflects a cost of $2.13 to add a buckle sensor and the cost to add occupant detection for $12.73.

In assessing the number of vehicles that would be impacted by this regulatory alternative, we consider that the front center seat is not a common feature in new light vehicles. Based on our engineering judgement, we expect that 800,000 vehicles or five percent of the new vehicle fleet include a center seating position. We request comment on this assumption.

Table 92 presents the total cost to meet the requirements under this regulatory alternative for SBWS for front center seat passengers. Total cost is calculated by reflecting the cost per vehicle across the number of vehicles impacted by the proposed rule annually. Based on the cost per vehicle of $14.86 for the approximately 800,000 vehicles impacted, the total annual cost associated with meeting the requirements specified in the proposed rule for SBWS for rear seat occupants is approximately $11.89 million.

Table 92: Total Cost for Front Center Seat Passengers

|  |  |  |
| --- | --- | --- |
| **Number of Vehicles Impacted** | **Per Vehicle Cost** | **Total Cost** |
| 800,000 | $14.86 | $11,888,000 |

Table 93 presents the of the cost-effectiveness analysis for this regulatory alternative. When discounted at three and seven percent, the cost per ELS for this regulatory alternative is approximately $88.91 million and $110.00 million, respectively. As this cost is higher than the comprehensive cost of a fatalities, this analysis finds that this regulatory alternative is not cost-effective.

Table 93: Cost-Effectiveness Analysis for Front Center Seat Passengers (Millions)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Category** | **Discounted at 3%** | | | **Discounted at 7%** | | |
| **Equivalent Lives Saved** | **Cost** | **Cost per Equivalent Live Saved** | **Equivalent Lives Saved** | **Cost** | **Cost per Equivalent Live Saved** |
| Front Center Seat | 0.1337 | $11.89 | $88.91 | 0.1081 | $11.89 | $110.00 |

Table 94 presents the of the benefit-cost analysis for this regulatory alternative. When discounted at three and seven percent, net benefits for this regulatory alternative are negative. Negative net benefits indicate that the regulatory alternative is not net beneficial.

Table 94: Benefit-Cost Analysis for Front Center Seat Passengers (Millions)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Category** | **Discounted at 3%** | | | **Discounted at 7%** | | |
| **Monetized Benefits** | **Cost** | **Net Benefits** | **Monetized Benefits** | **Cost** | **Net Benefits** |
| Front Center Seat | $1.60 | $11.89 | -$10.29 | $1.29 | $11.89 | -$10.59 |

As this analysis finds that requirement for SBWS for front center seat passengers is not cost-effective or net beneficial, the agency did not include this requirement in the proposed rule.

## 90-Second Warning for Front Seat Occupants

NHTSA considered specifying a 90-second warning for front seat occupants instead of an indefinite warning system. As was noted earlier, the Kidd study found that moving from a seven-second warning to a 90-second warning increased seat belt use by 30 percent. In comparison moving from a seven-second warning to the indefinite warning increased seat belt use by 34 percent. Taking into account the lesser impact of the 90-second warning relative to an indefinite warning, this analysis assumes that the 90-second warning system will only impact those who sometimes use seat belts. That is, the move from a seven-second warning to 90-second warning would have no impact on those who never use seat belts. We request comment on that assumption.

Table 95 presents the ratio of increase in seat belt use for front seat occupants when moving from a seven-second warning to a 90-second warning. The calculation of the ratio of increase follows the same procedure as that in the main analysis with the exception of the impact that the warning system has on those who reported never using seat belts.

Table 95: Ratio of Increase In Seat Belt Use for Front Seat Occupants for 90-Second Warning

|  |  |  |
| --- | --- | --- |
| **Seating position** | **Warning system Change** | **Ratio of Increase** |
| Driver | 7-second to 90-second | 1.010396 |
| Right Front Seat Occupant | 1.006173 |

Table 96 presents the increase in seat belt use for drivers when moving from a seven-second warning to a 90-second warning. When moving from a seven-second to a 90-second warning, seat belt use would increase from 0.6127 to approximately 0.6191 in potentially fatal crashes and from 0.7078 to approximately 0.7152 in crashes resulting in non-fatal injuries.

Table 96: Increase in Seat Belt Use for Drivers for 90-Second Warning

|  |  |  |
| --- | --- | --- |
| **Warning Type Change** | **Seat Belt Use Rate** | |
| **Baseline x Ratio of Increase** | **90-Second Warning** |
| ***Potentially Fatal Crashes*** | | |
| **7-second to 90-second** | 0.6127 x 1.010396 | 0.61907 |
| ***Crashes Resulting in Non-fatal Injuries*** | | |
| **7-second to 90-second** | 0.7078 x 1.010396 | 0.715158 |

Table 97 presents the increase in seat belt use for right front seat occupants when moving from a seven-second warning to a 90-second warning. When moving from a seven-second to a 90-second warning, seat belt use would increase from 0.6006 to approximately 0.6043 in potentially fatal crashes and from 0.6673 to approximately 0.6714 in crashes resulting in non-fatal injuries. The analysis for this regulatory alternative follows the same procedure as that of the main analysis to estimate incremental benefits for both drivers and right front seat occupants as a result of the 90-second warning.

Table 97: Increase in Seat Belt Use for Right Front Seat Occupants for 90-Second Warning

|  |  |  |
| --- | --- | --- |
| **Warning Type Change** | **Seat Belt Use Rate** | |
| **Baseline x Ratio of Increase** | **90-Second Warning** |
| ***Potentially Fatal Crashes*** | | |
| **7-second to 90-second** | 0.6006 x 1.00617 | 0.604308 |
| ***Crashes Resulting in Non-fatal Injuries*** | | |
| **7-second to 90-second** | 0.6673 x 1.00617 | 0.671417 |

Table 98 presents the incremental benefits and corresponding effectiveness rate for the 90-second warning. As a result of the 90-second warning, a total of six fatalities and 17 non-fatal injuries to front seat occupants would be prevented annually. Additionally, effectiveness for the 90-second warning ranges from zero to 0.04 percent for non-fatal MAIS 1-5 injuries and is 0.04 percent for fatalities.

Table 98: Incremental Benefits and Effectiveness for the 90-Second Warning

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Injury Severity** | **Drivers** | | | **Right Front Seat Occupants** | | | **All Front Seat Occupants** | | | |
| **Observed Injuries** | **Incremental Benefits** | **Effectiveness** | **Observed Injuries** | **Incremental Benefits** | **Effectiveness** | **Observed Injuries** | **Incremental Benefits** | **Effectiveness** |
| MAIS 1 | 57,159 | 2 | 0.00% | 12,492 | 0 | 0.00% | 69,651 | 2 | 0.00% |
| MAIS 2 | 22,672 | 10 | 0.04% | 5,003 | 1 | 0.02% | 27,675 | 11 | 0.04% |
| MAIS 3 | 4,072 | 2 | 0.04% | 948 | 0 | 0.02% | 5,020 | 2 | 0.04% |
| MAIS 4 | 3,288 | 1 | 0.04% | 753 | 0 | 0.02% | 4,041 | 2 | 0.04% |
| MAIS 5 | 99 | 0 | 0.04% | 21 | 0 | 0.02% | 120 | 0 | 0.04% |
| Fatal | 12,148 | 5 | 0.04% | 2,659 | 1 | 0.02% | 14,807 | 6 | 0.04% |

Note: Values may not sum due to rounding. Fatalities and non-fatal injuries prevented are rounded to the nearest whole number for presentation purposes.

Table 99 presents the discounted net benefits for the 90-second warning. When discounted at three and seven percent, net benefits for the 90-second warning are estimated at approximately $69 million and $56 million, respectively. Overall, discounted net benefits for this regulatory alternative are lower than that of the proposed rule.

Table 99: Discounted Net Benefits for 90-Second Warning (Millions)

|  |  |  |
| --- | --- | --- |
| **Category** | **Discount Rate** | |
| **3%** | **7%** |
| Driver | $62.87 | $50.98 |
| Right Front Seat Occupant | $6.32 | $4.87 |
| **Total** | **$69.19** | **$55.85** |

Note: Values may not sum due to rounding.

## Summary of Regulatory Alternatives

This chapter presented the regulatory options considered for this rulemaking and, when possible, presented the benefits and costs associated with those alternatives. Table 100 summarizes those regulatory options as well as the consideration of those alternatives relative to the proposed rule. In some cases, benefits and/or costs were not estimated due to data limitations. However, these analyses found that the proposed rule is the most cost-effective and net beneficial option.

Table 100: Summary of Regulatory Alternatives

|  |  |  |
| --- | --- | --- |
| **Regulatory Alternative** | **Seating Position Impacted** | **Considerations** |
| Requiring Occupant Detection for Rear Seats | Rear Seat Occupants | Increase in seat belt use would have to be double or triple that of the main analysis to breakeven. |
| Front Center Seat SBWS | Front Seat Occupants | Not cost-effective and not net beneficial. |
| 90-Second Warning for Front Seat Occupants | Lower effectiveness and less net beneficial than the proposed rule. |

## Non-regulatory Alternatives

NHTSA also considered non-regulatory approaches as an alternative. It identified two potential non-regulatory approaches: awarding NCAP bonus points and voluntary guidelines. These non-regulatory alternatives could be appropriate if NHTSA determined that the proposed amendments to the standard would not meet the requirements and considerations set forth in 49 USC 30111. If NHTSA does determine that the proposed amendments would meet those considerations, MAP-21 directs it to issue a final rule. In light of the MAP-21 mandate and our tentative conclusion that the proposed requirements would meet the section 30111 criteria, it was decided not to pursue non-regulatory alternatives.

# Initial Regulatory Flexibility Act and Unfunded Mandates Reform Act Analyses

This chapter presents the analyses conducted for the Regulatory Flexibility Act and Unfunded Mandates Reform Act.

## Regulatory Flexibility Act

The Regulatory Flexibility Act of 1980 (5 U.S.C §601 et seq.) requires agencies to evaluate the potential effects of their proposed and final rules on small business, small organizations and small Government jurisdictions. The Act requires agencies to prepare and make available for an initial and final regulatory flexibility analysis (RFA) describing the impact of proposed and final rules on small entities. An RFA is not required if the head of the agency certifies that the proposed or final rule will not have a significant impact on a substantial number of small entities. The head of the agency has made such a certification with regard to this proposed rule.

The factual basis for the certification (5 U.S.C. 605(b)) is set forth below. Although the agency is not required to issue an initial regulatory flexibility analysis, we discuss below many of the issues that an initial regulatory flexibility analysis would address.

Section 603(b) of the Act specifies the content of an RFA. Each RFA must contain:

1. A description of the reasons why action by the agency is being considered;
2. A succinct statement of the objectives of, and legal basis for a final rule;
3. A description of and, where feasible, an estimate of the number of small entities to which the final rule will apply;
4. A description of the projected reporting, recording keeping and other compliance requirements of a final rule including an estimate of the classes of small entities which will be subject to the requirement and the type of professional skills necessary for preparation of the report or record;
5. An identification, to the extent practicable, of all relevant Federal rules which may duplicate, overlap or conflict with the final rule;
6. Each final regulatory flexibility analysis shall also contain a description of any significant alternatives to the final rule which accomplish the stated objectives of applicable statutes and which minimize any significant economic impact of the final rule on small entities.

1. Description of the reason why action by the agency is being considered

NHTSA is requiring this action to improve the safety of occupants by increasing belt use rates in vehicle crashes. Using a seat belt is one of the most effective strategies a motor vehicle occupant can take to prevent death and injury in a crash. Seat belts protect occupants in various ways. They prevent occupants from being ejected from the vehicle, provide “ride-down” by gradually decelerating the occupant as the vehicle deforms and absorbs energy, and reduce occupants contacting other occupants or contacting harmful interior surfaces.

2. Objectives of, and legal basis for, the proposed rule

NHTSA is proposing today’s NPRM under the National Traffic and Motor Vehicle Safety Act (“Motor Vehicle Safety Act”) and the Moving Ahead for Progress in the 21st Century Act (“MAP-21”).[[74]](#footnote-75) MAP-21 §31503 requires the agency to initiate a rulemaking proceeding to amend FMVSS No. 208 to provide a seat belt use warning system for designated seating positions in the rear seat. It also directed the Secretary to either issue a final rule, or, if the Secretary determined that such an amendment did not meet the requirements and considerations of 49 U.S.C. §30111, to submit a report to Congress describing the reasons for not prescribing such a standard. Further, the Motor Vehicle Safety Act states that the Secretary of Transportation is responsible for prescribing motor vehicle safety standards that are practicable, meet the need for motor vehicle safety, and are stated in objective terms (authority has been delegated to NHTSA).[[75]](#footnote-76) This proposed rule is intended to improve the safety of occupants in passenger vehicles.

3. Description and estimate of the number of small entities to which the proposed rule would apply

This proposed rule would directly affect passenger vehicle manufacturers and multistage manufacturers and alterers.

Business entities are defined as small businesses using the North American Industry Classification system (NAICS) code, for the purpose of receiving Small Business Administration assistance. One of the criteria for determining size, as stated in 13 CFR 121.201, is the number of employees in the firm. For establishments primarily engaged in manufacturing or assembling automobiles, light and heavy duty trucks, buses, motor homes, new tires, or motor vehicle body manufacturing (NAICS code 336211), the firm must have 1,000 employees or fewer to be classified as a small business.

Table 101 provides information about the three current small domestic manufacturers in the United State for MY 2015. All are small manufacturers, having much less than 1,000 employees.

Table 101: Small Vehicle Manufacturers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Manufacturer** | **Employees** | **Estimated Sales** | **Sale Price Range** | **Est. Revenues** |
| Panoz(1) | 70 | 25 | $60,000 to $750,000 | $\* |
| Saleen | 22 | 100 | $40,000 to $150,000 | $ 3,800,390\*\* |
| Shelby(2) | 44 | 60 | $24,000 to $300,000 | $2,110,000\*\*\* |

1. A subsidiary of Delta Wing LLC
2. A subsidiary of Carroll Shelby International, Inc.

\* no information

\*\* for the year ended March 2015[[76]](#footnote-77)

\*\*\* projected from the nine month revenue ended September 30, 2003

As explained below in 4.2.(a), the agency believes that the proposed rule would not have a significant economic impact on small domestic vehicle manufacturers.

4. A description of the projected reporting, recording keeping and other compliance requirements of a final rule including an estimate of the classes of small entities which will be subject to the requirement and the type of professional skills necessary for preparation of the report or record.

4.1. Reporting & Recording Impacts:

The NPRM proposes that written instruction be provided for certain vehicles. The vehicles are those with removable seats that necessitate the owner manually reconnecting a rear seat belt warning system when he or she reinstalls the seat. We do not believe that small light vehicle manufacturers would be significantly affected by this requirement. NHTSA does not believe that the small domestic passenger car manufacturers produce vehicles with removable rear seats that necessitate the owner reattaching the warning system. Even if they did, and for multistage manufacturers and alterers that do produce such vehicles (with removable rear seats with SBWSs that necessitate the owner reattaching the system), the requirements would not be significant. All that would be required is an instruction telling consumers how to reattach the warning system when they reinstall the removable seats. In addition, we propose that information be provided in the vehicle owner’s manual or elsewhere (for simplicity, in this discussion we assume the instructions would be in the owner’s manual since that is where written instructions are typically provided) that accurately describes the SBWS features and warning signals, including the location and format of the visual warnings, in an easily understandable format. Information of this sort is already required by FMVSS No. 208 on the driver SBWS, so this proposal simply extends the information to passenger seats.

4.2. Compliance Impacts:

*(a) Small vehicle manufacturers:*

There are three small domestic motor vehicle manufacturers in the United States in MY 2015*,* as previously shown in Table 101:. All are small manufacturers, having less than 1,000 employees.

The proposed rule would directly affect motor vehicle manufacturers. However, we believe that the proposed rule would not have a significant economic impact on these entities. Small manufacturers are already certifying their vehicle’s compliance, for the driver’s position, with FMVSS No. 208’s seat belt warning system requirements. The means they use to certify to the current requirements would be similar to or the same as those they would use to certify to the proposed rear SBRS requirements. Further, the proposed certification test is a relatively simple test, involving a test technician placing a person or test dummy in a seat and checking if the requisite signals activate. Checking to see if visual and audible warnings activate for the driver SBRS has been a part of FMVSS No. 208 compliance testing for many years, and manufacturers are knowledgeable about conducting it.

Small manufacturers have options available to certify compliance, none of which will result in a significant economic impact on these entities. The manufacturers can and do obtain seating systems from seat suppliers and install the seats on the body following the instructions of the seat supplier. Seat and seat belt suppliers are large entities with resources available to assist small manufacturers in incorporating the SBRSs, if manufacturers need technical assistance (which we do not think they will need, given the simplicity of the systems, particularly those rear systems that do not involve occupant detection). We do not believe that current manufacturing practices would have to change significantly as a result of a final rule.

We believe vehicle manufacturers including small manufacturers are obtaining seat and seat belt systems (with SBRSs) from suppliers. Since the seat belt systems are similar whether they are used by large or small vehicle manufacturers, small manufacturers would not need any additional lead time to comply with the proposed rule.

In addition, we also believed that the proposed rulemaking would not have a significant impact on the small vehicle manufacturers because the market for the vehicles produced by these entities is highly inelastic. Purchasers of these vehicles are attracted by the desire to have an unusual vehicle. Further, all light vehicles would have to comply with the proposed SBRS requirements. Since the price of complying with the proposed rule would likely be passed on to the final consumer, the price of competitor’s models would increase by similar amounts. Further, we do not believe that raising the price of a vehicle to include the value of a rear SBRS would have much, if any, effect on vehicle sales.

*(b) Final stage manufacturers and alterers:* There are a significant number (several hundred) of second-stage or final-stage manufacturers and alterers that would be impacted by a final rule. These manufacturers buy incomplete vehicles to finish as complete vehicles or modify previously-certified vehicles. Many of these latter vehicles are van conversions; there are a variety of vehicles affected.

To produce a vehicle, a final-stage manufacturer can either stay within the incomplete vehicle document (IVD) furnished by the incomplete vehicle manufacturer (which are typically large vehicle manufacturers, such as GM or Ford), or the final-stage manufacturer can work with incomplete vehicle manufacturers to enable the final-stage manufacturer to certify to the new requirements.[[77]](#footnote-78) The final-stage manufacturer can also certify to the standard using due care based on an assessment of the information available to the manufacturer.

While there are a substantial number of multi-stage manufacturers that could be impacted by the proposed rule, we believe that the impact on them would not be significant. We note that these manufacturers are already certifying their vehicles to FMVSS No. 208’s SBRS requirements that apply to the driver’s seating position. They are already familiar with the equipment and manufacturing processes involved to certify their vehicles to seat belt warning system requirements.

Further, we believe that the majority of incomplete vehicles with rear seats will be equipped with a SBWS already installed. It would be a feasible matter to produce a completed vehicle using an incomplete vehicle that has a system already installed. We anticipate that final-stage manufacturers will base their vehicles on incomplete vehicles that already have the SBWS installed rather than install the system themselves.

For final-stage manufacturers working with incomplete vehicles that do not have rear seats or SBRSs already installed, completing vehicles to meet the proposed requirements is feasible. The manufacturers can obtain seat and seat belt systems (with SBWSs) from suppliers. NHTSA recognizes in the NPRM that the suppliers might be supplying larger vehicle manufacturers during the development and lead time period, and do not have the design capabilities to handle all of the smaller manufacturers, including final-stage manufacturers. The rulemaking proposal accounts for this limitation by proposing to allow final-stage manufacturers extra time to comply with the proposed requirements, to reduce the economic impact of the proposed rule on these small entities.

For alterers (an alterer is a person who alters by addition, substitution or removal of components (other than readily attachable components) a certified vehicle before the first purchase of the vehicle other than for resale), the impacts of the proposed rule would not be significant. The proposed rule would allow alterers additional time to comply with the proposed requirements. If an alterer is removing rear seats, the person making the alteration would simply have to be careful not to affect the compliance of the SBWS system for the seats not removed.

An alterer that is adding rear seats could obtain seating systems with SBWS from seat suppliers and install the seats on the body following the instructions of the seat supplier. Changes would have to be made to the instrument panel area to add the requisite visual signal, but the proposed rule provides flexibility to manufacturers in providing the visual signal.

We note also that the proposed certification test is a relatively simple test, involving a test technician placing a person or test dummy in a seat and checking if the requisite signals activate. Checking to see if visual and audible warnings activate for the driver SBRS has been a part of FMVSS No. 208 compliance testing for many years, and manufacturers are knowledgeable about conducting it.

Thus, while there are a substantial number of multi-stage manufacturers and alterers that would be impacted by the proposed rule, we have reduced the impacts on those entities. For the above reasons, this proposed rule would not have a significant impact on a substantial number of small entities.

*(c)SBWS manufacturers:* The proposed rule would only indirectly affect these entities, so a Regulatory Flexibility Analysis is not required for these entities. In any event, the agency does not believe that there are a significant number of small seat belt warning system and occupant sensor manufacturers. Even if there were, the proposed rule is expected to have a positive impact on their business.

5. An identification, to the extent practicable, of all relevant Federal rules which may duplicate, overlap, or conflict with the final rule

We know of no Federal rules which duplicate, overlap, or conflict with the final rule.

6. A description of any significant alternatives to the final rule which accomplish the stated objectives of applicable statutes and which minimize any significant economic impact of the final rule on small entities.

The proposed rule provides several compliance options (alternatives) to manufacturers, including small entities. This flexibility reduces the economic impact of the proposal on small entities. The proposed rule provides a compliance alternative that can be met without the use of occupant detection in the rear seats. Occupant detection technology in rear seats is advanced over the existing technology in wide use today and could be challenging for manufacturers to implement at this time, especially small entities.

NHTSA also designed the proposed rule to provide an alternative lead time to manufacturers of vehicles built in two or more stages (multi-stage manufacturers) and alterers. It provides an additional year of lead time for manufacturers to certify the compliance of their vehicles. (49 CFR 571.8(b).) This additional year provides small multi-stage manufacturers flexibility and ample time--a total of three years from publication of a final rule--to work with seat manufacturers and/or incomplete vehicle manufacturers (both of which are large entities), or to undertake the evaluation themselves, to make the necessary assessments to acquire a basis for certifying their vehicles’ compliance.

There are no other significant alternatives to the proposed rule which accomplish all the objectives of the rulemaking while minimizing the impact on small entities.

## Unfunded Mandates Reform Act

The Unfunded Mandates Reform Act of 1995 (Public Law 104-4) (UMRA) requires agencies to prepare a written assessment of the costs, benefits, and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditures by States, local or tribal governments, in the aggregate, or by the private sector, of $100 million or more (adjusted annually for inflation with base year of 1995) in any one year. Adjusting this amount by the implicit gross domestic product price deflator for the 2022 results in $177 million. The assessment may be included in conjunction with other assessments, as it is here.

The proposed rule on SBRS is not likely to result in expenditures by State, local or tribal governments of more than $100 million annually. However, it is estimated to result in the expenditure by automobile manufacturers and/or their suppliers by approximately$168 million annually. The estimated costs have been discussed in this PRIA.

The UMRA requires the agency to select the “least costly, most cost-effective or least burdensome alternative that achieves the objectives of the rule.” As discussed below, the agency considered alternatives to the proposed rule. None of the alternatives is preferable to the selected alternative proposed by the NPRM. See the Alternatives Chapter (VI) for details regarding every alternative considered.

# Appendix

## Appendix A

Table 102 and Table 103 present the survival rates and vehicle miles traveled (VMT) by vehicle age for PC and LTVs, respectively. For the ESC adjustment, we used the estimate of the survival fraction (proportion) of vehicles of a given age that are still on the road as a function of the vehicle’s age.

Note that there are two major components affecting the number of vehicles on the road: vehicle survivability and travel mileage schedule. For the ESC adjustment, the travel mileage schedule or VMT, as a proxy for crash exposure, is already reflected in the target crash data.

Since potential benefits would accrue during the operational life of a model year vehicle, the future benefits are discounted to show their present values. For discounting, we used the miles that a vehicle is driven and the survival fraction (proportion) of vehicles of a given age that are still on the road as a function of the vehicle’s age. The primary source of data for determining vehicles in operation is the National Vehicle Population Profile (NVPP) compiled by R.L. Polk and Company. The NVPP is an annual census, as of July 1 of each year, of passenger cars and light trucks registered for on-road operation in the United States.

For the vehicle mileage schedule or VMT, survey data are used. One such survey is National Household Travel Survey (NHTS) sponsored by the Federal Highway Administration, Bureau of Transportation Statistics, and the National Highway Traffic Safety Administration. The NHTS is the integration of two national travel surveys: the Federal Highway Administration-sponsored Nationwide Personal Transportation Survey (NPTS) and the Bureau of Transportation Statistics sponsored American Travel Survey (ATS).

The Residential Transportation Energy Consumption Survey (RTECS) was designed by the Energy Information Administration (EIA) of the Department of Energy (DOE) to collect information on the use of energy in residential vehicles in the United States. For additional information, see DOT HS 809 952 “Vehicle survivability and travel mileage schedules.”

Table 102 and Table 103 also present the construction of the three and seven percent discount factors for PC and LTVs, respectively. The aggregate exposure is equal to the survival rate multiplied by the exposure, and the exposure proportion is that year’s exposure divided by the sum of all exposure values in the table. That exposure proportion multiplied by the raw discount factor[[78]](#footnote-79) from the equation yields the weighted discount factor. Summing the discount factor for all years provides the overall discount factor, which will be multiplied by benefits to provide discounted benefits.

Table 102: Survival Rates and Vehicle Miles Traveled (VMT) by Vehicle Age for Passenger Cars (PC)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **RAW DISCOUNT FACTOR 3%** | **RAW DISCOUNT FACTOR 7%** | **PC Survival** | **PC Exposure** | **PC Aggregate Exposure** | **PC Exposure Proportion** | **PC Weighted Discount Factor 3%** | **PC Weighted Discount Factor 7%** |
| 1 | 99% | 97% | 1.0000 | 15,861 | 15,861 | 11% | **11%** | **11%** |
| 2 | 96% | 90% | 0.9878 | 13,684 | 13,518 | 10% | **9%** | **9%** |
| 3 | 93% | 84% | 0.9766 | 13,479 | 13,163 | 9% | **9%** | **8%** |
| 4 | 90% | 79% | 0.9614 | 13,218 | 12,708 | 9% | **8%** | **7%** |
| 5 | 88% | 74% | 0.9450 | 12,977 | 12,264 | 9% | **8%** | **6%** |
| 6 | 85% | 69% | 0.9298 | 12,521 | 11,643 | 8% | **7%** | **6%** |
| 7 | 83% | 64% | 0.9113 | 11,465 | 10,448 | 7% | **6%** | **5%** |
| 8 | 80% | 60% | 0.8912 | 10,203 | 9,092 | 6% | **5%** | **4%** |
| 9 | 78% | 56% | 0.8689 | 8,842 | 7,683 | 5% | **4%** | **3%** |
| 10 | 76% | 53% | 0.8397 | 7,493 | 6,292 | 4% | **3%** | **2%** |
| 11 | 73% | 49% | 0.7999 | 6,264 | 5,011 | 4% | **3%** | **2%** |
| 12 | 71% | 46% | 0.7556 | 5,266 | 3,979 | 3% | **2%** | **1%** |
| 13 | 69% | 43% | 0.7055 | 4,906 | 3,461 | 2% | **2%** | **1%** |
| 14 | 67% | 40% | 0.6527 | 4,644 | 3,031 | 2% | **1%** | **1%** |
| 15 | 65% | 37% | 0.5946 | 4,604 | 2,738 | 2% | **1%** | **1%** |
| 16 | 63% | 35% | 0.5311 | 4,497 | 2,388 | 2% | **1%** | **1%** |
| 17 | 61% | 33% | 0.4585 | 4,394 | 2,015 | 1% | **1%** | **0%** |
| 18 | 60% | 31% | 0.3832 | 4,296 | 1,646 | 1% | **1%** | **0%** |
| 19 | 58% | 29% | 0.3077 | 4,203 | 1,293 | 1% | **1%** | **0%** |
| 20 | 56% | 27% | 0.2414 | 4,114 | 993 | 1% | **0%** | **0%** |
| 21 | 55% | 25% | 0.1833 | 4,030 | 739 | 1% | **0%** | **0%** |
| 22 | 53% | 23% | 0.1388 | 3,951 | 548 | 0% | **0%** | **0%** |
| 23 | 51% | 22% | 0.1066 | 3,877 | 413 | 0% | **0%** | **0%** |
| 24 | 50% | 20% | 0.0820 | 3,807 | 312 | 0% | **0%** | **0%** |
| 25 | 48% | 19% | 0.0629 | 3,741 | 235 | 0% | **0%** | **0%** |
| 26 | 47% | 18% | 0.0514 | 3,681 | 189 | 0% | **0%** | **0%** |
| 27 | 46% | 17% | 0.0420 | 3,625 | 152 | 0% | **0%** | **0%** |
| 28 | 44% | 16% | 0.0337 | 3,574 | 120 | 0% | **0%** | **0%** |
| 29 | 43% | 15% | 0.0281 | 3,528 | 99 | 0% | **0%** | **0%** |
| 30 | 42% | 14% | 0.0235 | 3,486 | 82 | 0% | **0%** | **0%** |
| 31 | 41% | 13% | 0.0000 | 3,449 | 0 | 0% | **0%** | **0%** |
| 32 | 39% | 12% | 0.0000 | 3,449 | 0 | 0% | **0%** | **0%** |
| 33 | 38% | 11% | 0.0000 | 3,449 | 0 | 0% | **0%** | **0%** |
| 34 | 37% | 10% | 0.0000 | 3,449 | 0 | 0% | **0%** | **0%** |
| 35 | 36% | 10% | 0.0000 | 3,449 | 0 | 0% | **0%** | **0%** |
| 36 | 35% | 9% | 0.0000 | 3,449 | 0 | 0% | **0%** | **0%** |
| 37 | 34% | 8% | 0.0000 | 3,449 | 0 | 0% | **0%** | **0%** |
| 38 | 33% | 8% | 0.0000 | 3,449 | 0 | 0% | **0%** | **0%** |
| 39 | 32% | 7% | 0.0000 | 3,449 | 0 | 0% | **0%** | **0%** |
| 40 | 31% | 7% | 0.0000 | 3,449 | 0 | 0% | **0%** | **0%** |
|  |  |  |  |  |  |  | 0.8354 | 0.6816 |

Table 103: Survival Rates and Vehicle Miles Traveled (VMT) by Vehicle Age for Light Trucks and Vans (LTV)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **RAW DISCOUNT FACTOR 3%** | **RAW DISCOUNT FACTOR 7%** | **LTV Survival** | **LTV Exposure** | **LTV Aggregate Exposure** | **LTV Exposure Proportion** | **LTV Weighted Discount Factor 3%** | **LTV Weighted Discount Factor 7%** |
| 1 | 99% | 97% | 1.0000 | 16,502 | 16,502 | 11% | **10%** | **10%** |
| 2 | 96% | 90% | 0.9776 | 14,828 | 14,496 | 9% | **9%** | **8%** |
| 3 | 93% | 84% | 0.9630 | 14,552 | 14,013 | 9% | **8%** | **8%** |
| 4 | 90% | 79% | 0.9428 | 14,279 | 13,461 | 9% | **8%** | **7%** |
| 5 | 88% | 74% | 0.9311 | 13,783 | 12,833 | 8% | **7%** | **6%** |
| 6 | 85% | 69% | 0.9152 | 13,039 | 11,933 | 8% | **6%** | **5%** |
| 7 | 83% | 64% | 0.8933 | 12,103 | 10,811 | 7% | **6%** | **4%** |
| 8 | 80% | 60% | 0.8700 | 11,034 | 9,600 | 6% | **5%** | **4%** |
| 9 | 78% | 56% | 0.8411 | 9,891 | 8,319 | 5% | **4%** | **3%** |
| 10 | 76% | 53% | 0.7963 | 8,730 | 6,952 | 4% | **3%** | **2%** |
| 11 | 73% | 49% | 0.7423 | 7,612 | 5,650 | 4% | **3%** | **2%** |
| 12 | 71% | 46% | 0.6916 | 6,804 | 4,706 | 3% | **2%** | **1%** |
| 13 | 69% | 43% | 0.6410 | 5,931 | 3,802 | 2% | **2%** | **1%** |
| 14 | 67% | 40% | 0.5833 | 5,180 | 3,022 | 2% | **1%** | **1%** |
| 15 | 65% | 37% | 0.5350 | 4,979 | 2,664 | 2% | **1%** | **1%** |
| 16 | 63% | 35% | 0.4861 | 4,839 | 2,352 | 2% | **1%** | **1%** |
| 17 | 61% | 33% | 0.4422 | 4,706 | 2,081 | 1% | **1%** | **0%** |
| 18 | 60% | 31% | 0.3976 | 4,580 | 1,821 | 1% | **1%** | **0%** |
| 19 | 58% | 29% | 0.3520 | 4,463 | 1,571 | 1% | **1%** | **0%** |
| 20 | 56% | 27% | 0.3092 | 4,353 | 1,346 | 1% | **0%** | **0%** |
| 21 | 55% | 25% | 0.2666 | 4,252 | 1,134 | 1% | **0%** | **0%** |
| 22 | 53% | 23% | 0.2278 | 4,158 | 947 | 1% | **0%** | **0%** |
| 23 | 51% | 22% | 0.2019 | 4,071 | 822 | 1% | **0%** | **0%** |
| 24 | 50% | 20% | 0.1750 | 3,993 | 699 | 0% | **0%** | **0%** |
| 25 | 48% | 19% | 0.1584 | 3,922 | 621 | 0% | **0%** | **0%** |
| 26 | 47% | 18% | 0.1452 | 3,860 | 560 | 0% | **0%** | **0%** |
| 27 | 46% | 17% | 0.1390 | 3,805 | 529 | 0% | **0%** | **0%** |
| 28 | 44% | 16% | 0.1250 | 3,758 | 470 | 0% | **0%** | **0%** |
| 29 | 43% | 15% | 0.1112 | 3,718 | 413 | 0% | **0%** | **0%** |
| 30 | 42% | 14% | 0.1028 | 3,687 | 379 | 0% | **0%** | **0%** |
| 31 | 41% | 13% | 0.0933 | 3,660 | 341 | 0% | **0%** | **0%** |
| 32 | 39% | 12% | 0.0835 | 3,660 | 305 | 0% | **0%** | **0%** |
| 33 | 38% | 11% | 0.0731 | 3,660 | 267 | 0% | **0%** | **0%** |
| 34 | 37% | 10% | 0.0619 | 3,660 | 227 | 0% | **0%** | **0%** |
| 35 | 36% | 10% | 0.0502 | 3,660 | 184 | 0% | **0%** | **0%** |
| 36 | 35% | 9% | 0.0384 | 3,660 | 141 | 0% | **0%** | **0%** |
| 37 | 34% | 8% | 0.0273 | 3,660 | 100 | 0% | **0%** | **0%** |
| 38 | 33% | 8% | 0.0000 | 3,660 | 0 | 0% | **0%** | **0%** |
| 39 | 32% | 7% | 0.0000 | 3,660 | 0 | 0% | **0%** | **0%** |
| 40 | 31% | 7% | 0.0000 | 3,660 | 0 | 0% | **0%** | **0%** |
|  |  |  |  |  |  |  | 0.8216 | 0.6626 |

## Appendix B

The comprehensive value of societal impacts from fatalities and injuries includes a variety of cost components. Table 104 summarizes the cost components and corresponding unit costs in 2019 dollars. As shown, the cost components included medical, EMS, market productivity, household productivity, insurance administration, workplace, legal, congestion, travel delay, and the nontangible value of physical pain and loss of quality of life (i.e., quality adjusted life years, QALYs). The unit costs were revised from those published in the agency’s 2015 report (Blincoe, 2015 et al).[[79]](#footnote-80) Blincoe et al reported unit costs in 2010 dollars. The current established DOT VSL is $11.9 million (in 2020 dollars) which was based on the most current 2020 DOT Guidance on VSL (DOT, 2020).

Table 104: Comprehensive Unit Costs (2020 $)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Components** | **PDO** | **MAIS0** | **MAIS1** | **MAIS2** | **MAIS3** | **MAIS4** | **MAIS5** | **FATAL** |
| Medical | $0 | $0 | $3,739 | $15,299 | $64,947 | $182,093 | $513,315 | $15,117 |
| EMS | $71 | $45 | $129 | $264 | $496 | $999 | $1,020 | $1,076 |
| Market Prod | $0 | $0 | $3,424 | $24,318 | $80,820 | $176,891 | $424,096 | $1,172,349 |
| Household Prod | $75 | $57 | $1,083 | $8,926 | $28,500 | $47,158 | $119,849 | $364,180 |
| Ins. Adm. | $228 | $171 | $3,933 | $5,557 | $18,332 | $33,666 | $86,497 | $33,778 |
| Workplace | $78 | $58 | $428 | $3,321 | $7,256 | $7,991 | $13,932 | $14,802 |
| Legal | $0 | $0 | $1,410 | $3,997 | $14,791 | $31,806 | $98,644 | $127,003 |
| *Congestion* | $2,643 | $1,779 | $1,791 | $1,822 | $1,872 | $1,899 | $1,921 | $7,186 |
| *Property Damage* | $4,293 | $3,211 | $9,492 | $10,149 | $19,114 | $19,474 | $18,000 | $13,372 |
| QALYs | $0 | $0 | $30,606 | $479,493 | $1,071,207 | $2,713,724 | $6,049,769 | $10,201,971 |
| **Total Avoidance comprehensive cost\*** | $7,388 | $5,321 | $25,429 | $73,653 | $236,128 | $501,977 | $1,277,274 | $1,748,863 |

\*Note: Exclude “Congestion” and “Property Damage” when crashworthiness FMVSSs are considered.

Table 105 presents the baseline used in 2010 dollars.

Table 105: Unit Costs in 2010 $ for Police-Reported Crashes

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cost Components** | **PDO** | **MAIS0** | **MAIS1** | **MAIS2** | **MAIS3** | **MAIS4** | **MAIS5** | **FATAL** |
| Medical | $0 | $0 | $2,799 | $11,453 | $48,620 | $136,317 | $384,273 | $11,317 |
| EMS | $59 | $38 | $109 | $221 | $416 | $838 | $855 | $902 |
| Market Prod | $0 | $0 | $2,726 | $19,359 | $64,338 | $140,816 | $337,607 | $933,262 |
| Household Prod | $60 | $45 | $862 | $7,106 | $22,688 | $37,541 | $95,407 | $289,910 |
| Ins. Adm. | $191 | $143 | $3,298 | $4,659 | $15,371 | $28,228 | $72,525 | $28,322 |
| Workplace | $62 | $46 | $341 | $2,644 | $5,776 | $6,361 | $11,091 | $11,783 |
| Legal | $0 | $0 | $1,182 | $3,351 | $12,402 | $26,668 | $82,710 | $106,488 |
| Congestion | $2,104 | $1,416 | $1,426 | $1,450 | $1,490 | $1,511 | $1,529 | $5,720 |
| Property Damage | $3,599 | $2,692 | $7,959 | $8,510 | $16,027 | $16,328 | $15,092 | $11,212 |
| QALYs | $0 | $0 | $23,241 | $364,113 | $813,444 | $2,060,724 | $4,594,020 | $7,747,082 |
| Total | $6,075 | $4,380 | $43,943 | $422,866 | $1,000,572 | $2,455,332 | $5,595,109 | $9,145,998 |
| Relative QALYS | 0.0000 | 0.0000 | 0.0030 | 0.0470 | 0.1050 | 0.2660 | 0.5930 | 1.0000 |

Source: Blincoe, L. J., Miller, T. R., Zaloshnja, E., & Lawrence, B. A. (2014, May), The economic and societal impact of motor vehicle crashes, 2010

(Report No. DOT HS 812 013), Washington, DC: National Highway Traffic Safety Administration, Revised 2015

## Appendix C

Table 106 presents the actual and estimated installation rates for ESC from the FRIA for FMVSS No. 126.

Table 106: Actual and Estimated Installations in FMVSS No. 126 (ESC) Final Regulatory Analysis (% of the fleet)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Model Year** | **DOM PC** | | **DOM LTV** | | **IMP PC** | | **IMP LTV** | | **PC % ESC** | **LTV % ESC** |
| **ESC** | **Total Sales** | **ESC** | **Total Sales** | **ESC** | **Total Sales** | **ESC** | **Total Sales** |
| **MY 2012\*\*\*** | RULE | RULE | RULE | RULE | RULE | RULE | RULE | RULE | **100%** | **100%** |
| **MY 2011** | 4,330,505 | 4,585,547 | 6,463,723 | 6,949,740 | 1,533,344 | 1,770,020 | 889,532 | 905,791 | **92%** | **94%** |
| **MY 2010** | 3,562,541 | 4,581,253 | 4,553,214 | 5,292,861 | 1,225,309 | 1,707,630 | 764,025 | 794,923 | **76%** | **87%** |
| **MY 2009** | 1,686,766 | 3,889,910 | 3,331,665 | 4,053,417 | 891,631 | 1,592,770 | 756,237 | 777,459 | **47%** | **85%** |
| **MY 2008** | 960,866 | 6,100,396 | 4,599,369 | 7,017,596 | 1,133,612 | 2,314,757 | 1,005,679 | 1,070,490 | **25%** | **69%** |
| **MY 2007** | 692,593 | 5,815,347 | 3,553,966 | 7,637,550 | 1,077,576 | 2,178,494 | 1,220,006 | 1,289,031 | **22%** | **53%** |
| **MY 2006** | 845,532 | 5,866,837 | 2,413,279 | 7,774,175 | 760,049 | 2,054,405 | 565,432 | 1,077,652 | **20%** | **34%** |
| **MY 2005** | 508,924 | 5,814,342 | 1,490,704 | 8,377,820 | 595,381 | 1,902,880 | 561,113 | 1,128,336 | **14%** | **22%** |
| **MY 2004** | 411,487 | 5,574,175 | 1,021,330 | 8,370,398 | 826,937 | 1,970,685 | 585,734 | 1,169,647 | **16%** | **17%** |
| **MY 2003** | 209,843 | 6,432,180 | 652,441 | 8,370,398 | 759,230 | 2,076,711 | 369,101 | 1,153,783 | **11%** | **11%** |

\*DOM = Domestic Vehicles, IMP = Imported Vehicles

\*\* MY2003 (2004 Wards) did NOT list Stability control for MY2003 DOM LTVs. We'll approximate with a 64% decrease compared to MY2004, to match IMP LTVs. This matches the ratio of the MY2004 IMP LTV change (50%) and the MY2003 IMP LTV change (32%). Thus, the domestic LTV numbers for MY2003 are estimated, and all other numbers in the table come *directly* from Wards.

\*\*\* MY 2012 data not taken from Wards as 100% of vehicles will be equipped to meet the rule.

Table 107 and Table 108 present the procedure used to derive ESC adjustment factors for PC and LTV, respectively. This procedure first makes use of the survival probability for a given year. That survival probability for a given year is divided by the sum of all survival probabilities to create a “survival proportion.” The corresponding values of the adjustment factor for ESC by vehicle type and crash type are then multiplied by the proportion of vehicles surviving which did not have ESC. To calculate the resulting adjustment factor that value is added to the exposure with ESC value.[[80]](#footnote-81) Lastly, these four columns which account for the four crash types consider are each summed, respectively, across all years. The sum for each column is the adjustment factor for the given vehicle and crash type.

Table 107: Calculation for ESC adjustment factor, PCs

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **MY** | **Survival Probability** | **Survival Proportion** | **w/ ESC** | **w/o ESC** | **Survival w/ESC** | **Survival w/o ESC** | **FRONT Adj.** | **REAR Adj.** | **SIDE Adj.** | **ROLLOVER Adj.** | **FRONT** | **REAR** | **SIDE** | **ROLLOVER** |
| 2015 | 1.0000 | 0.0645 | 1.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2014 | 0.9878 | 0.0638 | 1.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2013 | 0.9766 | 0.0630 | 1.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2012 | 0.9614 | 0.0621 | 1.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2011 | 0.9450 | 0.0610 | 0.92 | 0.08 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2010 | 0.9298 | 0.0600 | 0.76 | 0.24 | 0.05 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | **0.06** | **0.06** | **0.06** | **0.05** |
| 2009 | 0.9113 | 0.0588 | 0.47 | 0.53 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.01 | **0.06** | **0.06** | **0.06** | **0.04** |
| 2008 | 0.8912 | 0.0575 | 0.25 | 0.75 | 0.01 | 0.04 | 0.04 | 0.04 | 0.04 | 0.01 | **0.06** | **0.06** | **0.05** | **0.03** |
| 2007 | 0.8689 | 0.0561 | 0.22 | 0.78 | 0.01 | 0.04 | 0.04 | 0.04 | 0.04 | 0.01 | **0.06** | **0.06** | **0.05** | **0.03** |
| 2006 | 0.8397 | 0.0542 | 0.20 | 0.80 | 0.01 | 0.04 | 0.04 | 0.04 | 0.04 | 0.01 | **0.05** | **0.05** | **0.05** | **0.02** |
| 2005 | 0.7999 | 0.0516 | 0.14 | 0.86 | 0.01 | 0.04 | 0.04 | 0.04 | 0.04 | 0.01 | **0.05** | **0.05** | **0.05** | **0.02** |
| 2004 | 0.7556 | 0.0488 | 0.16 | 0.84 | 0.01 | 0.04 | 0.04 | 0.04 | 0.04 | 0.01 | **0.05** | **0.05** | **0.04** | **0.02** |
| 2003 | 0.7055 | 0.0455 | 0.11 | 0.89 | 0.01 | 0.04 | 0.04 | 0.04 | 0.04 | 0.01 | **0.05** | **0.05** | **0.04** | **0.02** |
| 2002 | 0.6527 | 0.0421 | 0.00 | 1.00 | 0.00 | 0.04 | 0.04 | 0.04 | 0.04 | 0.01 | **0.04** | **0.04** | **0.04** | **0.01** |
| 2001 | 0.5946 | 0.0384 | 0.00 | 1.00 | 0.00 | 0.04 | 0.04 | 0.04 | 0.03 | 0.01 | **0.04** | **0.04** | **0.03** | **0.01** |
| 2000 | 0.5311 | 0.0343 | 0.00 | 1.00 | 0.00 | 0.03 | 0.03 | 0.03 | 0.03 | 0.01 | **0.03** | **0.03** | **0.03** | **0.01** |
| 1999 | 0.4585 | 0.0296 | 0.00 | 1.00 | 0.00 | 0.03 | 0.03 | 0.03 | 0.03 | 0.01 | **0.03** | **0.03** | **0.03** | **0.01** |
| 1998 | 0.3832 | 0.0247 | 0.00 | 1.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | **0.02** | **0.02** | **0.02** | **0.01** |
| 1997 | 0.3077 | 0.0199 | 0.00 | 1.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | **0.02** | **0.02** | **0.02** | **0.01** |
| 1996 | 0.2414 | 0.0156 | 0.00 | 1.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.01 | 0.00 | **0.02** | **0.02** | **0.01** | **0.00** |
| 1995 | 0.1833 | 0.0118 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | **0.01** | **0.01** | **0.01** | **0.00** |
| 1994 | 0.1388 | 0.0090 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | **0.01** | **0.01** | **0.01** | **0.00** |
| 1993 | 0.1066 | 0.0069 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | **0.01** | **0.01** | **0.01** | **0.00** |
| 1992 | 0.0820 | 0.0053 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | **0.01** | **0.01** | **0.00** | **0.00** |
| 1991 | 0.0629 | 0.0041 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1990 | 0.0514 | 0.0033 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1989 | 0.0420 | 0.0027 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1988 | 0.0337 | 0.0022 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1987 | 0.0281 | 0.0018 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1986 | 0.0235 | 0.0015 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1985 | 0.0000 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1984 | 0.0000 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1983 | 0.0000 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1982 | 0.0000 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1981 | 0.0000 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1980 | 0.0000 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1979 | 0.0000 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1978 | 0.0000 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1977 | 0.0000 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1976 | 0.0000 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |

Table 108: Calculation for ESC adjustment factor, LTVs

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **MY** | **Survival Probability** | **Survival Proportion** | **w/ ESC** | **w/o ESC** | **Exposure w/ESC** | **Exposure w/o ESC** | **FRONT Adj.** | **REAR Adj.** | **SIDE Adj.** | **ROLLOVER Adj.** | **FRONT** | **REAR** | **SIDE** | **ROLLOVER** |
| 2015 | 1.0000 | 0.0610 | 1.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2014 | 0.9776 | 0.0596 | 1.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2013 | 0.9630 | 0.0588 | 1.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2012 | 0.9428 | 0.0575 | 1.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2011 | 0.9311 | 0.0568 | 0.94 | 0.06 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.06** | **0.06** | **0.06** | **0.05** |
| 2010 | 0.9152 | 0.0558 | 0.87 | 0.13 | 0.05 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | **0.06** | **0.06** | **0.05** | **0.05** |
| 2009 | 0.8933 | 0.0545 | 0.85 | 0.15 | 0.05 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | **0.05** | **0.05** | **0.05** | **0.05** |
| 2008 | 0.8700 | 0.0531 | 0.69 | 0.31 | 0.04 | 0.02 | 0.02 | 0.02 | 0.01 | 0.00 | **0.05** | **0.05** | **0.05** | **0.04** |
| 2007 | 0.8411 | 0.0513 | 0.53 | 0.47 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.00 | **0.05** | **0.05** | **0.05** | **0.03** |
| 2006 | 0.7963 | 0.0486 | 0.34 | 0.66 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.00 | **0.05** | **0.05** | **0.04** | **0.02** |
| 2005 | 0.7423 | 0.0453 | 0.22 | 0.78 | 0.01 | 0.04 | 0.04 | 0.04 | 0.03 | 0.00 | **0.05** | **0.05** | **0.04** | **0.01** |
| 2004 | 0.6916 | 0.0422 | 0.17 | 0.83 | 0.01 | 0.04 | 0.04 | 0.04 | 0.03 | 0.00 | **0.04** | **0.04** | **0.04** | **0.01** |
| 2003 | 0.6410 | 0.0391 | 0.11 | 0.89 | 0.00 | 0.03 | 0.03 | 0.03 | 0.03 | 0.00 | **0.04** | **0.04** | **0.03** | **0.01** |
| 2002 | 0.5833 | 0.0356 | 0.00 | 1.00 | 0.00 | 0.04 | 0.04 | 0.04 | 0.03 | 0.00 | **0.04** | **0.04** | **0.03** | **0.00** |
| 2001 | 0.5350 | 0.0326 | 0.00 | 1.00 | 0.00 | 0.03 | 0.03 | 0.03 | 0.03 | 0.00 | **0.03** | **0.03** | **0.03** | **0.00** |
| 2000 | 0.4861 | 0.0297 | 0.00 | 1.00 | 0.00 | 0.03 | 0.03 | 0.03 | 0.03 | 0.00 | **0.03** | **0.03** | **0.03** | **0.00** |
| 1999 | 0.4422 | 0.0270 | 0.00 | 1.00 | 0.00 | 0.03 | 0.03 | 0.03 | 0.02 | 0.00 | **0.03** | **0.03** | **0.02** | **0.00** |
| 1998 | 0.3976 | 0.0243 | 0.00 | 1.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.02 | 0.00 | **0.02** | **0.02** | **0.02** | **0.00** |
| 1997 | 0.3520 | 0.0215 | 0.00 | 1.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.02 | 0.00 | **0.02** | **0.02** | **0.02** | **0.00** |
| 1996 | 0.3092 | 0.0189 | 0.00 | 1.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.02 | 0.00 | **0.02** | **0.02** | **0.02** | **0.00** |
| 1995 | 0.2666 | 0.0163 | 0.00 | 1.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.01 | 0.00 | **0.02** | **0.02** | **0.01** | **0.00** |
| 1994 | 0.2278 | 0.0139 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | **0.01** | **0.01** | **0.01** | **0.00** |
| 1993 | 0.2019 | 0.0123 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | **0.01** | **0.01** | **0.01** | **0.00** |
| 1992 | 0.1750 | 0.0107 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | **0.01** | **0.01** | **0.01** | **0.00** |
| 1991 | 0.1584 | 0.0097 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | **0.01** | **0.01** | **0.01** | **0.00** |
| 1990 | 0.1452 | 0.0089 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | **0.01** | **0.01** | **0.01** | **0.00** |
| 1989 | 0.1390 | 0.0085 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | **0.01** | **0.01** | **0.01** | **0.00** |
| 1988 | 0.1250 | 0.0076 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | **0.01** | **0.01** | **0.01** | **0.00** |
| 1987 | 0.1112 | 0.0068 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | **0.01** | **0.01** | **0.01** | **0.00** |
| 1986 | 0.1028 | 0.0063 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | **0.01** | **0.01** | **0.01** | **0.00** |
| 1985 | 0.0933 | 0.0057 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | **0.01** | **0.01** | **0.01** | **0.00** |
| 1984 | 0.0835 | 0.0051 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | **0.01** | **0.01** | **0.00** | **0.00** |
| 1983 | 0.0731 | 0.0045 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1982 | 0.0619 | 0.0038 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1981 | 0.0502 | 0.0031 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1980 | 0.0384 | 0.0023 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1979 | 0.0273 | 0.0017 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1978 | 0.0000 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1977 | 0.0000 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1976 | 0.0000 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |

The following tables detail the same calculations for the other FMVSS that were accounted for when adjusting the target population.

**FMVSS No. 214**

Table 109: Calculation for FMVSS No. 214 adjustment factor, PCs

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **MY** | **Survival Probability** | **Exposure VMT** | **Aggregate Exposure** | **Exposure Proportion** | **w/ 214** | **w/o 214** | **Exposure w/214** | **Exposure w/o 214** | **FRONT Adj.** | **REAR Adj.** | **SIDE Adj.** | **ROLLOVER Adj.** | **FRONT** | **REAR** | **SIDE** | **ROLLOVER** |
| 2015 | 1.0000 | 15,861 | 15,861 | 0.1116 | 1.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2014 | 0.9878 | 13,684 | 13,518 | 0.0951 | 1.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2013 | 0.9766 | 13,479 | 13,163 | 0.0926 | 1.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2012 | 0.9614 | 13,218 | 12,708 | 0.0894 | 1.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2011 | 0.9450 | 12,977 | 12,264 | 0.0863 | 0.75 | 0.25 | 0.05 | 0.02 | 0.02 | 0.02 | 0.01 | 0.02 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2010 | 0.9298 | 12,521 | 11,643 | 0.0819 | 0.50 | 0.50 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.03 | **0.06** | **0.06** | **0.05** | **0.06** |
| 2009 | 0.9113 | 11,465 | 10,448 | 0.0735 | 0.20 | 0.80 | 0.01 | 0.05 | 0.05 | 0.05 | 0.03 | 0.05 | **0.06** | **0.06** | **0.05** | **0.06** |
| 2008 | 0.8912 | 10,203 | 9,092 | 0.0640 | 0.00 | 1.00 | 0.00 | 0.06 | 0.06 | 0.06 | 0.04 | 0.06 | **0.06** | **0.06** | **0.04** | **0.06** |
| 2007 | 0.8689 | 8,842 | 7,683 | 0.0541 | 0.00 | 1.00 | 0.00 | 0.06 | 0.06 | 0.06 | 0.04 | 0.06 | **0.06** | **0.06** | **0.04** | **0.06** |
| 2006 | 0.8397 | 7,493 | 6,292 | 0.0443 | 0.00 | 1.00 | 0.00 | 0.05 | 0.05 | 0.05 | 0.04 | 0.05 | **0.05** | **0.05** | **0.04** | **0.05** |
| 2005 | 0.7999 | 6,264 | 5,011 | 0.0353 | 0.00 | 1.00 | 0.00 | 0.05 | 0.05 | 0.05 | 0.04 | 0.05 | **0.05** | **0.05** | **0.04** | **0.05** |
| 2004 | 0.7556 | 5,266 | 3,979 | 0.0280 | 0.00 | 1.00 | 0.00 | 0.05 | 0.05 | 0.05 | 0.04 | 0.05 | **0.05** | **0.05** | **0.04** | **0.05** |
| 2003 | 0.7055 | 4,906 | 3,461 | 0.0244 | 0.00 | 1.00 | 0.00 | 0.05 | 0.05 | 0.05 | 0.03 | 0.05 | **0.05** | **0.05** | **0.03** | **0.05** |
| 2002 | 0.6527 | 4,644 | 3,031 | 0.0213 | 0.00 | 1.00 | 0.00 | 0.04 | 0.04 | 0.04 | 0.03 | 0.04 | **0.04** | **0.04** | **0.03** | **0.04** |
| 2001 | 0.5946 | 4,604 | 2,738 | 0.0193 | 0.00 | 1.00 | 0.00 | 0.04 | 0.04 | 0.04 | 0.03 | 0.04 | **0.04** | **0.04** | **0.03** | **0.04** |
| 2000 | 0.5311 | 4,497 | 2,388 | 0.0168 | 0.00 | 1.00 | 0.00 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | **0.03** | **0.03** | **0.03** | **0.03** |
| 1999 | 0.4585 | 4,394 | 2,015 | 0.0142 | 0.00 | 1.00 | 0.00 | 0.03 | 0.03 | 0.03 | 0.02 | 0.03 | **0.03** | **0.03** | **0.02** | **0.03** |
| 1998 | 0.3832 | 4,296 | 1,646 | 0.0116 | 0.00 | 1.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | **0.02** | **0.02** | **0.02** | **0.02** |
| 1997 | 0.3077 | 4,203 | 1,293 | 0.0091 | 0.00 | 1.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.01 | 0.02 | **0.02** | **0.02** | **0.01** | **0.02** |
| 1996 | 0.2414 | 4,114 | 993 | 0.0070 | 0.00 | 1.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.01 | 0.02 | **0.02** | **0.02** | **0.01** | **0.02** |
| 1995 | 0.1833 | 4,030 | 739 | 0.0052 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1994 | 0.1388 | 3,951 | 548 | 0.0039 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1993 | 0.1066 | 3,877 | 413 | 0.0029 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1992 | 0.0820 | 3,807 | 312 | 0.0022 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | **0.01** | **0.01** | **0.00** | **0.01** |
| 1991 | 0.0629 | 3,741 | 235 | 0.0017 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1990 | 0.0514 | 3,681 | 189 | 0.0013 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1989 | 0.0420 | 3,625 | 152 | 0.0011 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1988 | 0.0337 | 3,574 | 120 | 0.0008 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1987 | 0.0281 | 3,528 | 99 | 0.0007 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1986 | 0.0235 | 3,486 | 82 | 0.0006 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1985 | 0.0000 | 3,449 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1984 | 0.0000 | 3,449 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1983 | 0.0000 | 3,449 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1982 | 0.0000 | 3,449 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1981 | 0.0000 | 3,449 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1980 | 0.0000 | 3,449 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1979 | 0.0000 | 3,449 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1978 | 0.0000 | 3,449 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1977 | 0.0000 | 3,449 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1976 | 0.0000 | 3,449 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |

Table 110: FMVSS 214 Adjustment Factors for PC

|  |  |  |  |
| --- | --- | --- | --- |
| **Front** | **Rear** | **Side** | **Rollover** |
| 1.0000 | 1.0000 | 0.8259 | 1.0000 |

Table 111: Calculation for FMVSS No. 214 adjustment factor, LTVs

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **MY** | **Survival Probability** | **Exposure VMT** | **Aggregate Exposure** | **Exposure Proportion** | **w/ 214** | **w/o 214** | **Exposure w/214** | **Exposure w/o 214** | **FRONT Adj.** | **REAR Adj.** | **SIDE Adj.** | **ROLLOVER Adj.** | **FRONT** | **REAR** | **SIDE** | **ROLLOVER** |
| 2015 | 1.0000 | 16,502 | 16,502 | 0.1057 | 1.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2014 | 0.9776 | 14,828 | 14,496 | 0.0929 | 1.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2013 | 0.9630 | 14,552 | 14,013 | 0.0898 | 1.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2012 | 0.9428 | 14,279 | 13,461 | 0.0862 | 1.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2011 | 0.9311 | 13,783 | 12,833 | 0.0822 | 0.75 | 0.25 | 0.04 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.06** | **0.06** | **0.05** | **0.06** |
| 2010 | 0.9152 | 13,039 | 11,933 | 0.0765 | 0.50 | 0.50 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.03 | **0.06** | **0.06** | **0.05** | **0.06** |
| 2009 | 0.8933 | 12,103 | 10,811 | 0.0693 | 0.20 | 0.80 | 0.01 | 0.04 | 0.04 | 0.04 | 0.03 | 0.04 | **0.05** | **0.05** | **0.04** | **0.05** |
| 2008 | 0.8700 | 11,034 | 9,600 | 0.0615 | 0.00 | 1.00 | 0.00 | 0.05 | 0.05 | 0.05 | 0.04 | 0.05 | **0.05** | **0.05** | **0.04** | **0.05** |
| 2007 | 0.8411 | 9,891 | 8,319 | 0.0533 | 0.00 | 1.00 | 0.00 | 0.05 | 0.05 | 0.05 | 0.04 | 0.05 | **0.05** | **0.05** | **0.04** | **0.05** |
| 2006 | 0.7963 | 8,730 | 6,952 | 0.0445 | 0.00 | 1.00 | 0.00 | 0.05 | 0.05 | 0.05 | 0.04 | 0.05 | **0.05** | **0.05** | **0.04** | **0.05** |
| 2005 | 0.7423 | 7,612 | 5,650 | 0.0362 | 0.00 | 1.00 | 0.00 | 0.05 | 0.05 | 0.05 | 0.03 | 0.05 | **0.05** | **0.05** | **0.03** | **0.05** |
| 2004 | 0.6916 | 6,804 | 4,706 | 0.0301 | 0.00 | 1.00 | 0.00 | 0.04 | 0.04 | 0.04 | 0.03 | 0.04 | **0.04** | **0.04** | **0.03** | **0.04** |
| 2003 | 0.6410 | 5,931 | 3,802 | 0.0244 | 0.00 | 1.00 | 0.00 | 0.04 | 0.04 | 0.04 | 0.03 | 0.04 | **0.04** | **0.04** | **0.03** | **0.04** |
| 2002 | 0.5833 | 5,180 | 3,022 | 0.0194 | 0.00 | 1.00 | 0.00 | 0.04 | 0.04 | 0.04 | 0.03 | 0.04 | **0.04** | **0.04** | **0.03** | **0.04** |
| 2001 | 0.5350 | 4,979 | 2,664 | 0.0171 | 0.00 | 1.00 | 0.00 | 0.03 | 0.03 | 0.03 | 0.02 | 0.03 | **0.03** | **0.03** | **0.02** | **0.03** |
| 2000 | 0.4861 | 4,839 | 2,352 | 0.0151 | 0.00 | 1.00 | 0.00 | 0.03 | 0.03 | 0.03 | 0.02 | 0.03 | **0.03** | **0.03** | **0.02** | **0.03** |
| 1999 | 0.4422 | 4,706 | 2,081 | 0.0133 | 0.00 | 1.00 | 0.00 | 0.03 | 0.03 | 0.03 | 0.02 | 0.03 | **0.03** | **0.03** | **0.02** | **0.03** |
| 1998 | 0.3976 | 4,580 | 1,821 | 0.0117 | 0.00 | 1.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | **0.02** | **0.02** | **0.02** | **0.02** |
| 1997 | 0.3520 | 4,463 | 1,571 | 0.0101 | 0.00 | 1.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | **0.02** | **0.02** | **0.02** | **0.02** |
| 1996 | 0.3092 | 4,353 | 1,346 | 0.0086 | 0.00 | 1.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.01 | 0.02 | **0.02** | **0.02** | **0.01** | **0.02** |
| 1995 | 0.2666 | 4,252 | 1,134 | 0.0073 | 0.00 | 1.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.01 | 0.02 | **0.02** | **0.02** | **0.01** | **0.02** |
| 1994 | 0.2278 | 4,158 | 947 | 0.0061 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1993 | 0.2019 | 4,071 | 822 | 0.0053 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1992 | 0.1750 | 3,993 | 699 | 0.0045 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1991 | 0.1584 | 3,922 | 621 | 0.0040 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1990 | 0.1452 | 3,860 | 560 | 0.0036 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1989 | 0.1390 | 3,805 | 529 | 0.0034 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1988 | 0.1250 | 3,758 | 470 | 0.0030 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1987 | 0.1112 | 3,718 | 413 | 0.0026 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | **0.01** | **0.01** | **0.00** | **0.01** |
| 1986 | 0.1028 | 3,687 | 379 | 0.0024 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | **0.01** | **0.01** | **0.00** | **0.01** |
| 1985 | 0.0933 | 3,660 | 341 | 0.0022 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | **0.01** | **0.01** | **0.00** | **0.01** |
| 1984 | 0.0835 | 3,660 | 305 | 0.0020 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | **0.01** | **0.01** | **0.00** | **0.01** |
| 1983 | 0.0731 | 3,660 | 267 | 0.0017 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1982 | 0.0619 | 3,660 | 227 | 0.0015 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1981 | 0.0502 | 3,660 | 184 | 0.0012 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1980 | 0.0384 | 3,660 | 141 | 0.0009 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1979 | 0.0273 | 3,660 | 100 | 0.0006 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1978 | 0.0000 | 3,660 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1977 | 0.0000 | 3,660 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1976 | 0.0000 | 3,660 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |

Table 112: FMVSS No. 214 Adjustment Factors for LTV

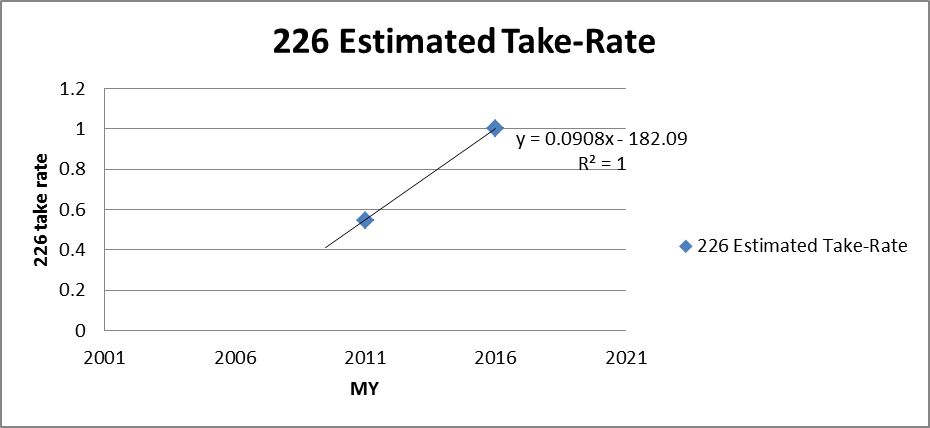
|  |  |  |  |
| --- | --- | --- | --- |
| **Front** | **Rear** | **Side** | **Rollover** |
| 1.0000 | 1.0000 | 0.8199 | 1.0000 |

**FMVSS No. 226**

According to the FMVSS No. 226 FRIA, 55% (54.59) of MY 2011 light vehicles are equipped with curtain air bags that are in compliance with the final rule. In addition, it is predicted that all new light vehicles would be equipped with the air bags in MY 2016. For the analysis, we estimated the air bag take rates by MY using a linear approximation.

Table 113 : FMVSS 226 take rate, based on FMVSS FRIA

|  |  |
| --- | --- |
| **MY** | **% take-rate** |
| 2011 | 0.5459 |
| 2016 | 1.0000 |

Figure 4: Estimated Take Rate for FMVSS. No. 226

In addition to the take rates, we derived an overall effectiveness of the curtain air bags for fatal and non-fatal injury crashes. For potentially fatal crashes, we estimated that the air bags would save 338 lives from the 3,779 fatalities in the FMVSS No. 226 target population. The overall fatal effectiveness, therefore, was estimated to be 8.9% (0.089442). Similarly, the overall non-fatal effectiveness was estimated to be 9.6% (377/3,920 = 0.09617, 9.6%).

Table 114: Adult Lives Saved in Rollover Crashes without Side Impacts with Weighted Risk of Ejection Method

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Ref: Table IV-67** | | | | |
| **Occupant** | **Fatality** | **Adj. fatality** | **System effectiveness** | **Benefits (lives)** |
| Restrained partial | 486 | 87 | 55% | 48 |
| Restrained complete | 50 | 0 | 0% | 0 |
| Unrestrained partial | 603 | 125 | 50% | 63 |
| Unrestrained complete | 2,640 | 535 | 43% | 228 |
| Total | 3,779 | 747 | n/a | 338 |
| **Overall Fatal effectiveness** | |  |  | **0.089442** |

Table 115: Adult Injuries Prevented in Rollover Crashes without Side Impacts with Weighted Risk of Ejection Method

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Occupant** | **Injuries** | **Adj. injuries** | **System effectiveness** | **Benefits (MAIS 3-5)** |
| Restrained partial | 1,079 | 205 | 44% | 90 |
| Restrained complete | 99 | 19 | 0% | 0 |
| Unrestrained partial | 525 | 115 | 40% | 46 |
| Unrestrained complete | 2,217 | 477 | 50% | 241 |
| Total | 3,920 | 816 | n/a | 377 |
| **Serious Injury effectiveness** | |  |  | **0.096173** |

Note: Values may not sum due to rounding

Furthermore, we derived the overall fatal and non-fatal combined curtain air bag effectiveness based on the individual effectiveness values and the number of fatal and non-fatal injuries in the target population. The target population (used in the FMVSS No. 226 FRIA) shows that 49% (0.49084) are fatal injuries and 52 percent (0.50916) are serious injuries when only fatal and serious injuries are considered. Accordingly, the weighted effectiveness was calculated to be 9.3% (0.092869). For the analysis, we used the weighted effectiveness as a proxy for the overall effectiveness.

Table 116: Weighted FMVSS No. 226 air bag effectiveness

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Injury** | **No. of** | **% of** | **Effectiveness** | **% x Effectiveness** |
| Fatal injuries | 3,779 | 49% (0.490843) | 8.9% (0.089442) | 0.043902 |
| Serious injuries | 3,920 | 51% (0.509157) | 9.6% (0.096173) | 0.048967 |
| Total | 7,699 | 100% (1.000000) | Weighted Effectiveness: | 0.092869 |

Next, we used the survival probability and the vehicle miles traveled (VMT) of passenger cars to calculate the proportion of a particular model year (MY) vehicle on the road. For particular MY vehicles, we estimated the percentage of vehicles with the FMVSS No. 226 countermeasure based on the 226 air bag sales previously discussed. After that, we applied the air bag effectiveness to the vehicles with the FMVSS No. 226 air bags to remove potential safety benefits resulting from the FMVSS No. 226 final rule from the seat belt analysis. Finally, the FMVSS No. 226 adjustment factor was derived by comparing the total exposure rate with and without the FMVSS No. 226 potential benefits. We note that the FMVSS No. 226 adjustment factor developed for passenger cars was used as a proxy for light trucks that were considered in the analysis based on recent PCs & LTs sales reported by Ward’s, vehicle survivability and VMT.

Table 117: FMVSS No. 226 Installation Rate, based upon linear regression of 226 FRIA

|  |  |
| --- | --- |
| **Year** | **Installation rate** |
| 2016 | 100% |
| 2015 | 91% |
| 2014 | 82% |
| 2013 | 73% |
| 2012 | 64% |
| 2011 | 1% |
| 2010 | 0% |

Table 118 : Calculation for FMVSS No. 226 Adjustment Factor, PCs

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **MY** | **Survival Probability** | **Exposure VMT** | **Aggregate Exposure** | **Exposure Proportion** | **w/ 226** | **w/o 226** | **Exposure w/226** | **Exposure w/o 226** | **FRONT Adj.** | **REAR Adj.** | **SIDE Adj.** | **ROLLOVER Adj.** | **FRONT** | **REAR** | **SIDE** | **ROLLOVER** |
| 2015 | 1.0000 | 15,861 | 15,861 | 0.1116 | 0.91 | 0.09 | 0.06 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2014 | 0.9878 | 13,684 | 13,518 | 0.0951 | 0.82 | 0.18 | 0.05 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2013 | 0.9766 | 13,479 | 13,163 | 0.0926 | 0.73 | 0.27 | 0.05 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2012 | 0.9614 | 13,218 | 12,708 | 0.0894 | 0.64 | 0.36 | 0.04 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2011 | 0.9450 | 12,977 | 12,264 | 0.0863 | 0.01 | 0.99 | 0.00 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2010 | 0.9298 | 12,521 | 11,643 | 0.0819 | 0.00 | 1.00 | 0.00 | 0.06 | 0.06 | 0.06 | 0.06 | 0.05 | **0.06** | **0.06** | **0.06** | **0.05** |
| 2009 | 0.9113 | 11,465 | 10,448 | 0.0735 | 0.00 | 1.00 | 0.00 | 0.06 | 0.06 | 0.06 | 0.06 | 0.05 | **0.06** | **0.06** | **0.06** | **0.05** |
| 2008 | 0.8912 | 10,203 | 9,092 | 0.0640 | 0.00 | 1.00 | 0.00 | 0.06 | 0.06 | 0.06 | 0.06 | 0.05 | **0.06** | **0.06** | **0.06** | **0.05** |
| 2007 | 0.8689 | 8,842 | 7,683 | 0.0541 | 0.00 | 1.00 | 0.00 | 0.06 | 0.06 | 0.06 | 0.06 | 0.05 | **0.06** | **0.06** | **0.06** | **0.05** |
| 2006 | 0.8397 | 7,493 | 6,292 | 0.0443 | 0.00 | 1.00 | 0.00 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | **0.05** | **0.05** | **0.05** | **0.05** |
| 2005 | 0.7999 | 6,264 | 5,011 | 0.0353 | 0.00 | 1.00 | 0.00 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | **0.05** | **0.05** | **0.05** | **0.05** |
| 2004 | 0.7556 | 5,266 | 3,979 | 0.0280 | 0.00 | 1.00 | 0.00 | 0.05 | 0.05 | 0.05 | 0.05 | 0.04 | **0.05** | **0.05** | **0.05** | **0.04** |
| 2003 | 0.7055 | 4,906 | 3,461 | 0.0244 | 0.00 | 1.00 | 0.00 | 0.05 | 0.05 | 0.05 | 0.05 | 0.04 | **0.05** | **0.05** | **0.05** | **0.04** |
| 2002 | 0.6527 | 4,644 | 3,031 | 0.0213 | 0.00 | 1.00 | 0.00 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | **0.04** | **0.04** | **0.04** | **0.04** |
| 2001 | 0.5946 | 4,604 | 2,738 | 0.0193 | 0.00 | 1.00 | 0.00 | 0.04 | 0.04 | 0.04 | 0.04 | 0.03 | **0.04** | **0.04** | **0.04** | **0.03** |
| 2000 | 0.5311 | 4,497 | 2,388 | 0.0168 | 0.00 | 1.00 | 0.00 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | **0.03** | **0.03** | **0.03** | **0.03** |
| 1999 | 0.4585 | 4,394 | 2,015 | 0.0142 | 0.00 | 1.00 | 0.00 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | **0.03** | **0.03** | **0.03** | **0.03** |
| 1998 | 0.3832 | 4,296 | 1,646 | 0.0116 | 0.00 | 1.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | **0.02** | **0.02** | **0.02** | **0.02** |
| 1997 | 0.3077 | 4,203 | 1,293 | 0.0091 | 0.00 | 1.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | **0.02** | **0.02** | **0.02** | **0.02** |
| 1996 | 0.2414 | 4,114 | 993 | 0.0070 | 0.00 | 1.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | **0.02** | **0.02** | **0.02** | **0.01** |
| 1995 | 0.1833 | 4,030 | 739 | 0.0052 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1994 | 0.1388 | 3,951 | 548 | 0.0039 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1993 | 0.1066 | 3,877 | 413 | 0.0029 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1992 | 0.0820 | 3,807 | 312 | 0.0022 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | **0.01** | **0.01** | **0.01** | **0.00** |
| 1991 | 0.0629 | 3,741 | 235 | 0.0017 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1990 | 0.0514 | 3,681 | 189 | 0.0013 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1989 | 0.0420 | 3,625 | 152 | 0.0011 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1988 | 0.0337 | 3,574 | 120 | 0.0008 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1987 | 0.0281 | 3,528 | 99 | 0.0007 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1986 | 0.0235 | 3,486 | 82 | 0.0006 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1985 | 0.0000 | 3,449 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1984 | 0.0000 | 3,449 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1983 | 0.0000 | 3,449 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1982 | 0.0000 | 3,449 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1981 | 0.0000 | 3,449 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1980 | 0.0000 | 3,449 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1979 | 0.0000 | 3,449 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1978 | 0.0000 | 3,449 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1977 | 0.0000 | 3,449 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1976 | 0.0000 | 3,449 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |

Table 119: FMVSS No. 226 Adjustment Factors for PC

|  |  |  |  |
| --- | --- | --- | --- |
| **Front** | **Rear** | **Side** | **Rollover** |
| 1.0000 | 1.0000 | 1.0000 | 0.9254 |

Table 120: Calculation for FMVSS No. 226 Adjustment Factor, LTVs

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **MY** | **Survival Probability** | **Exposure VMT** | **Aggregate Exposure** | **Exposure Proportion** | **w/ 226** | **w/o 226** | **Exposure w/226** | **Exposure w/o 226** | **FRONT Adj.** | **REAR Adj.** | **SIDE Adj.** | **ROLLOVER Adj.** | **FRONT** | **REAR** | **SIDE** | **ROLLOVER** |
| 2015 | 1.0000 | 16,502 | 16,502 | 0.1057 | 0.91 | 0.09 | 0.06 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2014 | 0.9776 | 14,828 | 14,496 | 0.0929 | 0.82 | 0.18 | 0.05 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2013 | 0.9630 | 14,552 | 14,013 | 0.0898 | 0.73 | 0.27 | 0.04 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2012 | 0.9428 | 14,279 | 13,461 | 0.0862 | 0.64 | 0.36 | 0.04 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | **0.06** | **0.06** | **0.06** | **0.06** |
| 2011 | 0.9311 | 13,783 | 12,833 | 0.0822 | 0.01 | 0.99 | 0.00 | 0.06 | 0.06 | 0.06 | 0.06 | 0.05 | **0.06** | **0.06** | **0.06** | **0.05** |
| 2010 | 0.9152 | 13,039 | 11,933 | 0.0765 | 0.00 | 1.00 | 0.00 | 0.06 | 0.06 | 0.06 | 0.06 | 0.05 | **0.06** | **0.06** | **0.06** | **0.05** |
| 2009 | 0.8933 | 12,103 | 10,811 | 0.0693 | 0.44 | 0.56 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | **0.05** | **0.05** | **0.05** | **0.05** |
| 2008 | 0.8700 | 11,034 | 9,600 | 0.0615 | 0.36 | 0.64 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | **0.05** | **0.05** | **0.05** | **0.05** |
| 2007 | 0.8411 | 9,891 | 8,319 | 0.0533 | 0.29 | 0.71 | 0.01 | 0.04 | 0.04 | 0.04 | 0.04 | 0.03 | **0.05** | **0.05** | **0.05** | **0.05** |
| 2006 | 0.7963 | 8,730 | 6,952 | 0.0445 | 0.19 | 0.81 | 0.01 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | **0.05** | **0.05** | **0.05** | **0.04** |
| 2005 | 0.7423 | 7,612 | 5,650 | 0.0362 | 0.10 | 0.90 | 0.00 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | **0.05** | **0.05** | **0.05** | **0.04** |
| 2004 | 0.6916 | 6,804 | 4,706 | 0.0301 | 0.01 | 0.99 | 0.00 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | **0.04** | **0.04** | **0.04** | **0.04** |
| 2003 | 0.6410 | 5,931 | 3,802 | 0.0244 | 0.00 | 1.00 | 0.00 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | **0.04** | **0.04** | **0.04** | **0.04** |
| 2002 | 0.5833 | 5,180 | 3,022 | 0.0194 | 0.00 | 1.00 | 0.00 | 0.04 | 0.04 | 0.04 | 0.04 | 0.03 | **0.04** | **0.04** | **0.04** | **0.03** |
| 2001 | 0.5350 | 4,979 | 2,664 | 0.0171 | 0.00 | 1.00 | 0.00 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | **0.03** | **0.03** | **0.03** | **0.03** |
| 2000 | 0.4861 | 4,839 | 2,352 | 0.0151 | 0.00 | 1.00 | 0.00 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | **0.03** | **0.03** | **0.03** | **0.03** |
| 1999 | 0.4422 | 4,706 | 2,081 | 0.0133 | 0.00 | 1.00 | 0.00 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | **0.03** | **0.03** | **0.03** | **0.02** |
| 1998 | 0.3976 | 4,580 | 1,821 | 0.0117 | 0.00 | 1.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | **0.02** | **0.02** | **0.02** | **0.02** |
| 1997 | 0.3520 | 4,463 | 1,571 | 0.0101 | 0.00 | 1.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | **0.02** | **0.02** | **0.02** | **0.02** |
| 1996 | 0.3092 | 4,353 | 1,346 | 0.0086 | 0.00 | 1.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | **0.02** | **0.02** | **0.02** | **0.02** |
| 1995 | 0.2666 | 4,252 | 1,134 | 0.0073 | 0.00 | 1.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | **0.02** | **0.02** | **0.02** | **0.01** |
| 1994 | 0.2278 | 4,158 | 947 | 0.0061 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1993 | 0.2019 | 4,071 | 822 | 0.0053 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1992 | 0.1750 | 3,993 | 699 | 0.0045 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1991 | 0.1584 | 3,922 | 621 | 0.0040 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1990 | 0.1452 | 3,860 | 560 | 0.0036 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1989 | 0.1390 | 3,805 | 529 | 0.0034 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1988 | 0.1250 | 3,758 | 470 | 0.0030 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1987 | 0.1112 | 3,718 | 413 | 0.0026 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1986 | 0.1028 | 3,687 | 379 | 0.0024 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1985 | 0.0933 | 3,660 | 341 | 0.0022 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.01** | **0.01** | **0.01** | **0.01** |
| 1984 | 0.0835 | 3,660 | 305 | 0.0020 | 0.00 | 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | **0.01** | **0.01** | **0.01** | **0.00** |
| 1983 | 0.0731 | 3,660 | 267 | 0.0017 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1982 | 0.0619 | 3,660 | 227 | 0.0015 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1981 | 0.0502 | 3,660 | 184 | 0.0012 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1980 | 0.0384 | 3,660 | 141 | 0.0009 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1979 | 0.0273 | 3,660 | 100 | 0.0006 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1978 | 0.0000 | 3,660 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1977 | 0.0000 | 3,660 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |
| 1976 | 0.0000 | 3,660 | 0 | 0.0000 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.00** | **0.00** | **0.00** |

Table 121: FMVSS No. 226 Adjustment Factors for LTV

|  |  |  |  |
| --- | --- | --- | --- |
| **Front** | **Rear** | **Side** | **Rollover** |
| 1.0000 | 1.0000 | 1.0000 | 0.9309 |

## Appendix D

This section presents the unadjusted target population for both front and rear seat occupants. Table 122 presents a summary of the unadjusted target population for rear seat occupants by age group. The unadjusted target population reflects the annual average of fatalities from the 2011-2015 FARS data and non-fatal injuries from 2011-2015 NASS/CDS data.

Table 122: Summary of Unadjusted Target Population for Rear Seat Occupants

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Injury Severity** | **6 – 10 years old** | | **11+ years old** | |
| **Restrained** | **Unrestrained** | **Restrained** | **Unrestrained** |
| MAIS 1 | 6,655 | 975 | 19,997 | 4,438 |
| MAIS 2 | 238 | 91 | 721 | 1,738 |
| MAIS 3 | 35 | 33 | 64 | 289 |
| MAIS 4 | 4 | 11 | 70 | 239 |
| MAIS 5 | 0 | 0 | 3 | 7 |
| **Fatal** | **105** | **61** | **420** | **941** |

Note: Values may not sum due to rounding.

\* Occupant injuries with unknown belt use were distributed and included in the table.

\*\* MAIS 1 & 2 injuries are considered as minor injuries and MAIS 3 – 5 are serious injuries.

Table 123 presents the unadjusted target population for rear seat occupants by age group and crash type.

Table 123: Unadjusted Target Population for Rear Seat Occupants by Crash Type

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Injury Severity** | **6 – 10 years old** | | **11+ years old** | |
| **Restrained** | **Unrestrained** | **Restrained** | **Unrestrained** |
| ***Front Impact*** | | | | |
| MAIS 1 | 4,212 | 765 | 5,867 | 3,000 |
| MAIS 2 | 128 | 89 | 359 | 1,131 |
| MAIS 3 | 35 | 0 | 35 | 49 |
| MAIS 4 | 4 | 11 | 42 | 77 |
| MAIS 5 | 0 | 0 | 0 | 7 |
| Fatal | 35 | 13 | 140 | 249 |
| ***Side Impact*** | | | | |
| MAIS 1 | 1,808 | 2 | 11,473 | 363 |
| MAIS 2 | 8 | 2 | 84 | 74 |
| MAIS 3 | 0 | 0 | 7 | 77 |
| MAIS 4 | 0 | 0 | 10 | 18 |
| MAIS 5 | 0 | 0 | 0 | 0 |
| Fatal | 30 | 12 | 114 | 177 |
| ***Rollover*** | | | | |
| MAIS 1 | 634 | 143 | 1,275 | 603 |
| MAIS 2 | 101 | 0 | 220 | 435 |
| MAIS 3 | 0 | 33 | 15 | 152 |
| MAIS 4 | 0 | 0 | 19 | 37 |
| MAIS 5 | 0 | 0 | 3 | 0 |
| Fatal | 23 | 34 | 105 | 455 |
| ***Rear Impact*** | | | | |
| MAIS 1 | 38 | 29 | 1,383 | 471 |
| MAIS 2 | 0 | 0 | 57 | 99 |
| MAIS 3 | 0 | 0 | 6 | 11 |
| MAIS 4 | 0 | 0 | 0 | 107 |
| MAIS 5 | 0 | 0 | 0 | 0 |
| Fatal | 17 | 2 | 62 | 60 |

Note: Values may not sum due to rounding.

Table 124 and Table 125 present the unadjusted fatalities by crash type for drivers and right front seat occupants, respectively. The unadjusted target population reflects the annual average of fatalities from the 2011-2015 FARS data.

Table 124: Unadjusted Target Population for Drivers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Crash type** | **Restrained** | **Unrestrained** | **Total** |
| **PC** | Rollover | 781 | 1,290 | 2,071 |
| Front | 2,304 | 1,634 | 3,938 |
| Side | 1,561 | 667 | 2,228 |
| Rear | 255 | 105 | 360 |
| **Total** | **4,895** | **3,695** | **8,596** |
| **LTV** | Rollover | 932 | 2,162 | 3,094 |
| Front | 1,359 | 1,253 | 2,612 |
| Side | 478 | 344 | 822 |
| Rear | 84 | 48 | 132 |
| **Total** | **2,837** | **3,824** | **6,661** |

Table 125: Unadjusted Target Population for Right Front Seat Occupants

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Crash type** | **Restrained** | **Unrestrained** | **Total** |
| **PC** | Rollover | 212 | 256 | 468 |
| Front | 509 | 296 | 805 |
| Side | 484 | 171 | 655 |
| Rear | 72 | 28 | 100 |
| **Total** | **1,275** | **754** | **2,028** |
| **LTV** | Rollover | 236 | 429 | 665 |
| Front | 257 | 191 | 448 |
| Side | 129 | 69 | 198 |
| Rear | 32 | 12 | 44 |
| **Total** | **650** | **704** | **1,354** |

Note: Values may not sum due to rounding.

Table 126: Unadjusted Fatalities for Front Center Seat Passengers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Crash type** | **Restrained** | **Unrestrained** | **Total** |
| **PC** | Rollover | 1 | 1 | 2 |
| Front | 1 | 2 | 3 |
| Side | 1 | 1 | 2 |
| Rear | 0 | 1 | 1 |
| Total | 3 | 4 | 7 |
| **LTV** | Rollover | 3 | 23 | 25 |
| Front | 2 | 9 | 11 |
| Side | 1 | 3 | 4 |
| Rear | 0 | 1 | 1 |
| Total | 6 | 35 | 4 |

Note: Values may not sum due to rounding. Fatalities in which the occupant’s seat belt status was unknown were distributed and the resulting estimates were then rounded to the nearest whole number.

## Appendix E

The agency is unaware of any recent study that specifically looks at the effect of a basic SBWS for the front outboard passenger. The studies conducted in the 1970s found that a basic SBWS (i.e., non-enhanced system not exceeding the requirements of FMVSS No. 208 for the driver position) had a small effect (up to five percent increase in belt usage)[[81]](#footnote-82) to no effect[[82]](#footnote-83) on the driver’s seat belt use. However, these studies were conducted when seat belt usage was significantly lower (12 to 15 percent versus the most current 90 percent per the 2017 NOPUS) and thus the results would not necessarily be reflective of current behavior. As a result, they would not be usable for the benefits analysis.

NHTSA conducted an internal analysis of seat belt use data from the NASS-CDS for front outboard passenger seat occupants in MY 2006-2010 vehicles with (i.e., GM and Ford) and without (i.e., Chrysler) a front outboard passenger SBWS. The front outboard passenger SBWSs in these vehicles were enhanced systems at the time of introduction. NHTSA found that the seat belt use of front outboard passengers in vehicles without front outboard passenger SBWSs was approximately six percentage points lower than the restraint use of front outboard passengers in vehicles with an enhanced SBWS.

In the mid-2000s, the agency conducted an observational study on the effectiveness and acceptability of several different types of front SBWSs.[[83]](#footnote-84) This study found that the overall effect of an enhanced SBWS was an increase in the front outboard passenger seat belt usage by three to four percentage points compared to vehicles with a basic (i.e., non-enhanced) front SBWSs.

Therefore, for the front outboard occupant analysis, we assumed that a front outboard passenger SBWS meeting the same requirements as the basic driver SBWS would result in two to three percentage point increase in belt usage among front outboard passengers (six percentage points between no-SBWS and enhanced SBWSs and three to four percentage points between basic SBWSs and enhanced SBWSs) based on the simple assumed arithmetic.[[84]](#footnote-85) We request comment on this assumption.

In addition, when compared to the front seat belt use rates, the observed rear seat belt use rates fluctuate much more. For example, the belt use rates decreased from 78 percent in 2013 to 73 percent in 2014.[[85]](#footnote-86) To minimize potential impacts of any fluctuation on the analysis, we used four years of data, 2011 to 2014 NOPUS, to estimate the overall observed front seat belt use rate in the rear SBWS analysis.

Since the front seat belt usage data in the 2014 NOPUS report is a pooled estimate, we do not have it separated by driver and passenger. Note that the 2014 NOPUS report shows that seat belt use is lower among drivers driving alone than for drivers driving with passengers. (For example, it shows 86 percent of drivers use seat belts when no passenger is in the vehicle whereas 89 percent of drivers use seat belts when at least one passenger is in the vehicle in 2014.) Overall, the 2014 NOPUS report reports 87 percent of front occupants used seat belts in 2014.

In order to estimate the front passenger seat belt use rate, we examined 2006 to 2015 NASS GES data. The GES data show that on average driver injuries without occupants in the vehicle are 58.36 percent of the total injuries. With occupants, the driver injuries are 20.82 percent. In addition, the GES data show that 20.82 percent of all occupant injuries are from passengers.

Table 127: Estimate of Front Seat Passenger Vehicle Occupants Injured

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Year** | **Drivers**  **(D)** | **Passengers**  **(P)** | **Drivers w/Pass**  **(DP)** | **Drivers No Pass**  **(DA)** | **Occupants**  **(O)** |
| 2011 | 1,392,835 | 362,981 | 362,981 | 1,029,854 | 1,755,816 |
| 2012 | 1,461,407 | 396,095 | 396,095 | 1,065,312 | 1,857,502 |
| 2013 | 1,424,355 | 386,538 | 386,538 | 1,037,817 | 1,810,893 |
| 2014 | 1,493,068 | 371,865 | 371,865 | 1,121,203 | 1,864,933 |
| Avg | 1,442,916 | 379,370 | 379,370 | 1,063,547 | 1,822,286 |

Table 128: Percentage of injuries to total injury for driver without passenger, driver with passenger, and all passengers

|  |  |  |
| --- | --- | --- |
| **Weight** | **% ratio to total** | |
| W1 | DA/O | 58.36% |
| W2 | DP/O | 20.82% |
| W3 | P/O | 20.82% |

Table 129: Estimated Front Outboard Passenger Belt Use Rate, with 2014-2015 NOPUS[[86]](#footnote-87)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Year** | **Driver belt use** | | **Overall belt use Front seats (RF)** | **Estimated front passenger belt use rate (RP)** |
| **without passenger (RDA)** | **with passenger (RDP)** |
| 2011 | 83% | 87% | 84.0% |  |
| 2012 | 85% | 89% | 86.0% |  |
| 2013 | 87% | 90% | 87.0% |  |
| 2014[[87]](#footnote-88) | 86.1% | 89.0% | 86.7% |  |
| 2015 | 88.3% | 90.2% | 88.5% |  |
| Average | 85.9% | 89.0% | 86.4% | 85.41% |

Based on the NOPUS and GES data, the front passenger belt use rate was estimated to be 85.41percent using the equation below:

W1\*RDA + W2\*RDP + W3\*RP = RF – (1)

(RF - (W1\*RDA + W2\*RDP))/W3 = RP – (2)

In summary, due to limited data, we used the estimated front seat belt use rate of 85.41 percent (0.854097) as a proxy for the front outboard seating position in the analysis. Further, as discussed later in the document, the front seat belt use rate was used to derive rear SBWS effectiveness.

As previously discussed, the NHTSA Phase 1 study showed that an enhanced front SBWS resulted in a three to four percentage point increase in belt use rate for front seat occupants (driver and front outboard passenger) when compared to a basic SBWS. In addition, the internal NASS-CDS analysis showed that an enhanced front outboard passenger SBWS resulted in a six percentage point increase in belt use for the front outboard passenger when compared to without any SBWS. Based on the NHTSA study and the NASS-CDS analysis, we assumed that a basic SBWS could result in a two to three percentage point increase in belt usage among front outboard passengers (i.e., 6% - 4% = 2%, 6% - 3% = 3%).[[88]](#footnote-89)

## Appendix F

To illustrate the methodology used to estimate the increase in seat belt use resulting from the requirements for the indefinite warning for front seat occupants, we include a sample calculation.

Overall, for the target population, we grouped applicable crashes into three groups that are represented by three seat belt warning systems with a warning duration of seven-seconds, 90 seconds, and indefinite. Further, we determined the belt use rate for each group based on the overall combined belt use rate we observed in crashes and a IIHS study that shows that the longer warning systems increase the belt use rate of the seven-second warning system. For each system in the baseline, i.e., not-treated condition, we determined the percentage of drivers who used seat belts “always”, “sometimes,” and “never” based on a literature review of a study by May Chu. For the treated condition, e.g., replacing a seven-second warning system with an indefinite warning system, based on the IIHS study, we calculated the effect of the longer warning period on the belt use rate for both drivers who “sometimes” or “never” used seat belts. According to the IIHS study, for example, replacing a seven-second warning system with an indefinite warning system would increase the belt use rate of “sometimes” users by 34 percent. Finally, the incremental benefits were derived based on the increase in belt use rate utilizing a previous study of the effectiveness of seat belts in crashes.

For the actual calculation, we first begin by presenting the data used in the analysis. Table 130 presents the characterization of seat belt use habits from the study by May Chu titled “STATISTICAL BRIEF #62: Characteristics of Persons Who Seldom or Never Wear Seat Belts, 2002.”[[89]](#footnote-90) We make use of the findings from that study to establish that under the baseline 87.7 percent of drivers always use seat belts, 5.4 percent of drivers never use seat belts, and 6.9 percent sometimes use seat belts.

Table 130: Characterization of Seat Belt Use Habits

|  |  |
| --- | --- |
| **Belt user and related items** | **Rate** |
| A reported "sometimes using seat belts," | 6.9% |
| A reported "seldom or never using seat belts when driving or riding in a car” | 5.4% |
| Percentage of drivers who always use seat belts, calculated | 87.7% |
| Total | 100.0% |

Table 131 presents the observed seat belt use rate relative to the percentage of those who always use seat belts. Taking into account the overall use rate of 0.9060 and that 87.7 percent of drivers always wear seat belts, this ratio is approximately 0.97.

Table 131: Observed Seat Belt Use Relative to Percentage of those who Always Use Seat Belts

|  |  |
| --- | --- |
| **Category** | **Percent** |
| Overall, observed belt use rate, | 90.6% |
| Overall, Percentage of drivers who always use seat belts | 87.7% |
| Ratio | 96.8% |

Table 132 presents the observed seat belt use rate relative to the seat belt use rate in potentially fatal crashes based on NHTSA’s Belt Use Regression Model.[[90]](#footnote-91) Taking into account the overall use rate of 0.9060 and a use rate in potentially fatal crashes of 0.7842, this ratio is approximately 0.8656.

Table 132: Observed Seat Belt Use Relative to Seat Belt Use Rate in Potentially Fatal Crashes

|  |  |
| --- | --- |
| **Category** | **Use Rate** |
| Overall, observed belt use rate, | 0.906 |
| Belt use rate in potentially fatal crashes | 0.7842 |
| Ratio | 0.8656 |

Table 133 presents the vehicle sales data by warning type which is used as a proxy for crash exposure. The sales data indicate that approximately 7.63 percent of vehicles are equipped with a SBWS that provides a seven-second warning, 85.14 percent are equipped with a SBWS that provides a 90-second warning, and 7.20 percent are equipped with a SBWS that provides an indefinite warning. We make the assumption that that distribution also represents the crash exposure for vehicles with each type of warning system.

Table 133: Vehicle Sales and Estimated Crash Exposure by Warning Type

|  |  |  |  |
| --- | --- | --- | --- |
| **Bin** | **Warning type** | **Sales, (rounded)** | **Crash Exposure, Proxy, (rounded)** |
| #1 | 7-second | 0.0763 | 7.63% |
| #2 | 90-second | 0.8514 | 85.14% |
| #3 | Indefinite | 0.0720 | 7.20% |
| Total |  | 1.000 | 100% |

Table 134 presents the findings of the IIHS study titled “The effects of persistent audible seat belt reminders and a speed-limiting interlock on the seat belt use of drivers who do not always use a seat belt” referred to as the Kidd study.[[91]](#footnote-92) The findings of the study indicated that when moving from a seven-second warning to a 90-second warning drivers increased their seat belt use by 30 percent. Furthermore, the study also found that when moving from a seven-second warning to an indefinite warning drivers increased their seat belt use by 34 percent.

Table 134: Relative Increase in belt use rate by Warning Duration

|  |  |
| --- | --- |
| **Warning type** | **Belt use rate, relative** |
| 7-second | Base rate |
| 90-second | 1.30 times higher than base rate |
| Indefinite | 1.34 times higher than base rate |

We then make use of the overall average seat belt use rate in potentially fatal crashes of approximately 0.7842 along with information provided in Table 133 to establish the seat belt use rate in potentially fatal crashes for each of the three specific warning durations. The following equation represents the relationship between the overall average seat belt use rate to the seat beat use rates for each specific warning type:

.

Furthermore, based on the information provided in Table 134, we can define the seat belt use rates for each specific warning type. Making use of the available information,

Let

Then, and .

We then plug these values into the original equation:

.

Solving for x, we find that the seat belt use rate in potentially fatal crashes for the seven-second warning is approximately 0.6127. Increasing the seat belt by 30 percent, we find that the seat belt use rate in potentially fatal crashes for the 90-second warning is approximately 0.7965. Lastly, reflecting a 34 percent increase, we find that the seat belt use rate in potentially fatal crashes for the indefinite warning is approximately 0.8210.

For the benefits analysis, we examined each group one at a time. In this example, we focus on the increase in seat belt use for drivers resulting from moving from a seven-second warning to an indefinite warning as presented in Table 38 in the main analysis.

Taking into account the seat use rate in potentially fatal crashes with a seven-warning which was established above, we establish the corresponding use rate of 0.7663 based on the model from NHTSA’s study. Furthermore, we reflect the ratio of overall seat belt use to the percentage of always users from Table 131 to establish the percentage of always users for the seven-second warning. Therefore, reflecting the ratio of approximately 0.97, we find that approximately 74.2 percent of drivers always wear seat belts for the seven-second warning.

As we have established the percentage of drivers that always wear seat belts for the seven-second warning, we then use the available information to establish the percentage of drivers who sometimes and never use seat belts for the seven-second warning. In doing so, we make use of the information provided in Table 130 to establish the distribution of sometimes and never users.

Table 135 presents the distribution of sometimes and never seat belt users based on the information from the Chu study. In the study, 87.7 percent of drivers always used seat belts and the remaining 12.3 percent either sometimes or never used seat belts. Of that total 12.3 percent, approximately 56.1 percent sometimes used seat belts and 43.9 percent never used seat belts.

Table 135: Distribution of Sometimes and Never Users

|  |  |  |
| --- | --- | --- |
| **Category** | **Percent of Drivers** | **Percent of those Who Sometimes or Never use Seat Belts** |
| The reported "sometimes using seat belts", from the overall | 6.9% | 56.1% |
| The reported "seldom or never using seat belts” from the overall | 5.4% | 43.9% |
| Total | 12.30% | 100.0% |

This analysis makes use of that established distribution of 56.1 percent sometimes users and 43.9 percent never users to establish the percentage of sometimes and never users specific to the seven-second warning. Earlier we established that 74.2 percent of drivers always wear seat belts for the seven-second warning. This reflects a 13.5 percent decrease from the 87.7 percent of drivers who always use seat belts given the current distribution of the three systems. Therefore, we must allocate that 13.5 percent of drivers between the sometimes and never use groups. Based on the established distribution in Table 135, we establish that 56.1 percent of that 13.5 percent would be attributed to the sometimes group and the remaining 43.9 would be attributed to the never use group.

Table 136 presents the calculation of the percentage of drivers that sometimes and never use seat belts specific to the seven-second warning SBWS. This calculation reflects the original established distributions from the Chu study, as well as the reallocation associated with the lower percentage of drivers who always use seat belts specific to the seven-second warning. Overall, we establish that for the baseline seven-second warning 14.49 percent of drivers sometimes use seat belts, 11.34 percent never use seat belts, and 74.2 percent always use seat belts.

Table 136: Seat Belt Use Groups for the 7-Second Warning

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **Overall Distribution** | **Redistribution** | **Distribution for 7-second Warning** |
| A reported "sometimes using seat belts" | 6.9% | +7.59% | 14.49% |
| A reported "seldom or never using seat belts when driving or riding in a car" | 5.4% | +5.94% | 11.34% |
| Percentage of drivers who always use seat belts | 87.7% | -13.5% | 74.2% |
| Total |  |  | 100.0% |

Note: Values may not sum due to rounding.

We now use this information to establish the seat belt use rate among those drivers who sometimes use seat belts. Using the overall seat belt use rate of 0.7663, we establish the following equation which reflects the percentages of always, sometimes, and never users:

Where x represents the seat belt use rate for those who sometimes use seat belts. Solving for x, we find that the seat belt use rate for those who sometimes use seat belts is approximately 0.17.

As we have now established the seat belt use for the baseline seven-second warning, we can now reflect the increase in seat belt use resulting from moving to an indefinite warning. The IIHS study shows that the indefinite warning would increase the belt use rate of “sometimes using seat belts” by 34 percent. This analysis makes the assumption that the indefinite warning would have the same impact on those who never use seat belts.

For those who never use seat belts, we account for the impact of the indefinite warning by estimating the percentage of those drivers who would transition to the always use seat belt group.[[92]](#footnote-93) Therefore, we reflect that the 11.4 percent of never users would decrease by 34 percent to 7.5 percent of drivers. As a result, the percent of drivers who always use seat belts would increase from 74.2 percent to 78.0 percent.

For those who sometimes use seat belts, we reflect the 34 percent increase in seat belt use on the established seat belt use rate of 0.17. Therefore, we establish that as a result of the indefinite warning the seat belt use rate for those drivers who sometimes use seat belts would increase to approximately 0.227.

As we have established the distribution of the always, sometimes, and never groups as well as the use rate for the sometimes group for the indefinite warning, we can now calculate the overall seat belt use rate for the indefinite warning:

.

Therefore, for the overall seat belt use rate for the indefinite warning is 0.8132.

We then calculate the increase in the overall seat belt use rate when moving from the baseline seven-second warning to the indefinite warning:

.

Therefore, moving from the from the baseline seven-second warning to the indefinite warning increase the seat belt use rate by approximately 4.69 percent. We then reflect the ratio of observed use rate to use rate in potentially fatal crashes from Table 132 to find the corresponding increase in seat belt use in potentially fatal crashes is approximately 4.06 percent.

We then return to the original established seat belt use rate in potentially fatal crashes for the seven-second warning of 0.6127 and reflect the increase when moving to the indefinite warning. When reflecting that increase in seat belt use, we find that the seat belt use rate in potentially fatal crashes for the indefinite warning is estimated at approximately 0.6533. Therefore, the ratio increase between the use rate for the seven-second warning and the indefinite warning is approximately 1.066247.

## Appendix G

This section presents the ratio of increase in seat belt use from a 90-second warning to an indefinite warning for drivers and right front seat occupants, respectively. The calculation of the increase in seat belt use resulting from moving from a 90-second warning to an indefinite warning follows the same procedure as moving from the seven-second warning to an indefinite warning (as shown in the previous section).

Table 137: Summary of Increase in Seat Belt Use for Drivers 90-Second Warning to Indefinite Warning

|  |  |
| --- | --- |
| **Belt user and related items** | **Rate** |
| The reported "sometimes using seat belts", calculated | 0.063875123 |
| The reported "seldom or never using seat belts when driving or riding in a car", calculated | 0.049989227 |
| Percentage of drivers who always use seat belts, calculated | 0.88613565 |
| Driver overall belt use rate without an indefinite SBWS alert, observed | 0.915437741 |
| Probability of using belt use for part time seat belt user while in a vehicle, calculated | 0.458740268 |
| Increase in belt use due to an indefinite warning only for part time belt users, based on the IIHS report | 0.04 |
| Increase in belt use due to an indefinite warning for never use belt users, assumed | 0.04 |
| Percentage of the "seldom or never using belts" group, with an indefinite warning | 0.047989658 |
| Percentage of drivers who always use seat belts with an indefinite warning | 0.888135219 |
| Belt use rate (i.e., increased) due to an indefinite warning for part time belt users | 0.477089879 |
| Driver overall belt use rate with the indefinite SBWS alert, observed | 0.918609394 |
| Overall increase in belt use rate, observed | 0.003171653 |
| Overall increase in belt use rate, in potentially fatal crashes, using a ratio, actual | 0.002745338 |
| Existing belt use rate in potentially fatal crashes | 0.796472193 |
| Overall belt use rate, in potentially fatal crashes, estimated | 0.799217531 |
| **Increase in belt use, in potentially fatal crashes, ratio** | **1.003446872** |

Table 138: Summary of Increase in Seat Belt Use for Right Front Seat Occupants 90-Second Warning to Indefinite Warning

|  |  |
| --- | --- |
| **Belt user and related items** | **Rate** |
| The reported "sometimes using seat belts", calculated | 0.055852 |
| The reported "seldom or never using seat belts when driving or riding in a car", calculated | 0.04371 |
| Percentage of Front-Passengers who always use seat belts, calculated | 0.900438 |
| Driver overall belt use rate without an indefinite SBWS alert, observed | 0.917892 |
| Probability of using belt use for part time seat belt user while in a vehicle, calculated | 0.312511 |
| Increase in belt use due to an indefinite warning only for part time belt users, based on the IIHS report | 0.04 |
| Increase in belt use due to an indefinite warning for never use belt users, assumed | 0.04 |
| Percentage of the "seldom or never using belts" group, with an indefinite warning | 0.041962 |
| Percentage of front-passengers who always use seat belts with an indefinite warning | 0.902186 |
| Belt use rate (i.e., increased) due to an indefinite warning for part time belt users | 0.325011 |
| Driver overall belt use rate with the indefinite SBWS alert, observed | 0.920339 |
| Overall increase in belt use rate, observed | 0.002447 |
| Overall increase in belt use rate, in potentially fatal crashes, using a ratio, actual | 0.002104 |
| Existing belt use rate in potentially fatal crashes | 0.799672 |
| Overall belt use rate, in potentially fatal crashes, estimated | 0.801776 |
| **Increase in belt use, in potentially fatal crashes, ratio** | **1.002631** |

## Appendix H

The following tables present the calculation of discounted fatal equivalents and monetized benefits for rear seat and front seat occupants, respectively.

Table 139: Discounted Rate by Vehicle Type

|  |  |  |
| --- | --- | --- |
| **Vehicle Type** | **Discount Rate** | |
| **3%** | **7%** |
| Passenger Car | 0.8354 | 0.6816 |
| Light Truck | 0.8216 | 0.6626 |

Table 140: Calculation of Discounted Benefits Rear Seat Occupants 11 Years and Older

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Vehicle Type** | **Injury Severity** | **Undiscounted Incremental Benefits** | | **Discounted at 3%** | | **Discounted at 7%** | |
| **Lo** | **Hi** | **Lo** | **Hi** | **Lo** | **Hi** |
| **PC** | MAIS 1 | 15.7 | 23.6 | 13.1 | 19.7 | 10.7 | 16.1 |
| MAIS 2 | 27.1 | 40.8 | 22.7 | 34.1 | 18.5 | 27.8 |
| MAIS 3 | 5.2 | 7.9 | 4.4 | 6.6 | 3.6 | 5.4 |
| MAIS 4 | 4.3 | 6.4 | 3.6 | 5.4 | 2.9 | 4.4 |
| MAIS 5 | 0.1 | 0.2 | 0.1 | 0.2 | 0.1 | 0.1 |
| **Fatality** | 10.8 | 16.2 | 9.0 | 13.6 | 7.3 | 11.1 |
| **LTV** | MAIS 1 | 5.9 | 8.9 | 4.9 | 7.3 | 3.9 | 5.9 |
| MAIS 2 | 12.5 | 18.8 | 10.3 | 15.4 | 8.3 | 12.4 |
| MAIS 3 | 0.2 | 0.3 | 0.2 | 0.3 | 0.1 | 0.2 |
| MAIS 4 | 1.1 | 1.7 | 0.9 | 1.4 | 0.8 | 1.1 |
| MAIS 5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Fatality** | 11.1 | 16.8 | 9.2 | 13.8 | 7.4 | 11.1 |

Note: Values may not sum due to rounding.

Table 141: Calculation of Discounted Benefits Rear Seat Occupants 6 to 10 Years old

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Vehicle Type** | **Injury Severity** | **Undiscounted Incremental Benefits** | | **Discounted at 3%** | | **Discounted at 7%** | |
| **Lo** | **Hi** | **Lo** | **Hi** | **Lo** | **Hi** |
| **PC** | MAIS 1 | 0.26 | 0.38 | 0.22 | 0.32 | 0.18 | 0.26 |
| MAIS 2 | 0.34 | 0.49 | 0.28 | 0.41 | 0.23 | 0.34 |
| MAIS 3 | 0.13 | 0.19 | 0.11 | 0.16 | 0.09 | 0.13 |
| MAIS 4 | 0.04 | 0.05 | 0.03 | 0.04 | 0.02 | 0.04 |
| MAIS 5 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Fatality** | 0.14 | 0.22 | 0.12 | 0.18 | 0.10 | 0.15 |
| **LTV** | MAIS 1 | 0.33 | 0.49 | 0.27 | 0.40 | 0.22 | 0.32 |
| MAIS 2 | 0.21 | 0.31 | 0.17 | 0.25 | 0.14 | 0.20 |
| MAIS 3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| MAIS 4 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| MAIS 5 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Fatality** | 0.26 | 0.39 | 0.22 | 0.32 | 0.17 | 0.26 |

Note: Values may not sum due to rounding.

Table 142: Discounted Safety Benefits for Rear Seat Occupants 11 Years and Older

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Injury Severity** | **Discounted at 3%** | | **Discounted at 7%** | |
| **Lo** | **Hi** | **Lo** | **Hi** |
| MAIS 1 | 17.99 | 27.03 | 14.63 | 21.98 |
| MAIS 2 | 32.93 | 49.49 | 26.77 | 40.23 |
| MAIS 3 | 4.55 | 6.83 | 3.71 | 5.57 |
| MAIS 4 | 4.52 | 6.79 | 3.68 | 5.53 |
| MAIS 5 | 0.13 | 0.20 | 0.11 | 0.16 |
| Fatality | 18.15 | 27.35 | 14.72 | 22.19 |

Note: Values may not sum due to rounding.

Table 143: Discounted Safety Benefits for Rear Seat Occupants 6 to 10 Years Old

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Injury Severity** | **Discounted at 3%** | | **Discounted at 7%** | |
| **Lo** | **Hi** | **Lo** | **Hi** |
| MAIS 1 | 0.49 | 0.72 | 0.40 | 0.59 |
| MAIS 2 | 0.45 | 0.66 | 0.37 | 0.54 |
| MAIS 3 | 0.11 | 0.16 | 0.09 | 0.13 |
| MAIS 4 | 0.03 | 0.04 | 0.02 | 0.04 |
| MAIS 5 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fatality | 0.34 | 0.50 | 0.27 | 0.41 |

Note: Values may not sum due to rounding.

Table 144: Calculation of Equivalent Lives Saved Discounted at 3% for Rear Seat Occupants 11 Years and Older

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Injury Severity** | **Lo** | **Relative Disutility Factors** | **Equivalent Lives Saved** | **Injury Severity** | **Hi** | **Relative Disutility Factors** | **Equivalent Lives Saved** |
| MAIS 1 | 17.99 | 0.0038 | 0.0683 | MAIS 1 | 27.03 | 0.0038 | 0.1027 |
| MAIS 2 | 32.93 | 0.0454 | 1.4951 | MAIS 2 | 49.49 | 0.0454 | 2.2467 |
| MAIS 3 | 4.55 | 0.1078 | 0.4902 | MAIS 3 | 6.83 | 0.1078 | 0.7366 |
| MAIS 4 | 4.52 | 0.2677 | 1.2094 | MAIS 4 | 6.79 | 0.2677 | 1.8174 |
| MAIS 5 | 0.13 | 0.6125 | 0.0804 | MAIS 5 | 0.20 | 0.6125 | 0.1208 |
| Fatalities | 18.15 | 1.0000 | 18.1478 | Fatalities | 27.35 | 1.0000 | 27.3520 |
| **Total** |  |  | **21.4912** | **Total** |  |  | **32.3763** |

Note: Values may not sum due to rounding.

Table 145: Calculation of Fatal Equivalents Discounted at 7% for Rear Seat Occupants 11 Years and Older

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Injury Severity** | **Lo** | **Relative Disutility Factors** | **Equivalent Lives Saved** | **Injury Severity** | **Hi** | **Relative Disutility Factors** | **Equivalent Lives Saved** |
| MAIS 1 | 14.63 | 0.0038 | 0.0556 | MAIS 1 | 21.98 | 0.0038 | 0.0835 |
| MAIS 2 | 26.77 | 0.0454 | 1.2154 | MAIS 2 | 40.23 | 0.0454 | 1.8265 |
| MAIS 3 | 3.71 | 0.1078 | 0.3997 | MAIS 3 | 5.57 | 0.1078 | 0.6007 |
| MAIS 4 | 3.68 | 0.2677 | 0.9844 | MAIS 4 | 5.53 | 0.2677 | 1.4793 |
| MAIS 5 | 0.11 | 0.6125 | 0.0654 | MAIS 5 | 0.16 | 0.6125 | 0.0983 |
| Fatalities | 14.72 | 1.0000 | 14.7205 | Fatalities | 22.19 | 1.0000 | 22.1864 |
| **Total** |  |  | **17.4411** | **Total** |  |  | **26.2748** |

Note: Values may not sum due to rounding.

Table 146: Calculation of Equivalent Lives Saved Discounted at 3% for Rear Seat Occupants 6 to 10 Years Old

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Injury Severity** | **Lo** | **Relative Disutility Factors** | **Equivalent Lives Saved** | **Injury Severity** | **Hi** | **Relative Disutility Factors** | **Equivalent Lives Saved** |
| MAIS 1 | 0.49 | 0.0038 | 0.0019 | MAIS 1 | 0.72 | 0.0038 | 0.0028 |
| MAIS 2 | 0.45 | 0.0454 | 0.0206 | MAIS 2 | 0.66 | 0.0454 | 0.0302 |
| MAIS 3 | 0.11 | 0.1078 | 0.0118 | MAIS 3 | 0.16 | 0.1078 | 0.0173 |
| MAIS 4 | 0.03 | 0.2677 | 0.0081 | MAIS 4 | 0.04 | 0.2677 | 0.0119 |
| MAIS 5 | 0.00 | 0.6125 | 0.0000 | MAIS 5 | 0.00 | 0.6125 | 0.0000 |
| Fatalities | 0.34 | 1.0000 | 0.3352 | Fatalities | 0.50 | 1.0000 | 0.5029 |
| **Total** |  |  | **0.3776** | **Total** |  |  | **0.5651** |

Note: Values may not sum due to rounding.

Table 147: Calculation of Equivalent Lives Saved Discounted at 7% for Rear Seat Occupants 6 to 10 Years Old

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Injury Severity** | **Lo** | **Relative Disutility Factors** | **Equivalent Lives Saved** | **Injury Severity** | **Hi** | **Relative Disutility Factors** | **Equivalent Lives Saved** |
| MAIS 1 | 0.40 | 0.0038 | 0.0015 | MAIS 1 | 0.59 | 0.0038 | 0.0022 |
| MAIS 2 | 0.37 | 0.0454 | 0.0167 | MAIS 2 | 0.54 | 0.0454 | 0.0245 |
| MAIS 3 | 0.09 | 0.1078 | 0.0096 | MAIS 3 | 0.13 | 0.1078 | 0.0141 |
| MAIS 4 | 0.02 | 0.2677 | 0.0066 | MAIS 4 | 0.04 | 0.2677 | 0.0097 |
| MAIS 5 | 0.00 | 0.6125 | 0.0000 | MAIS 5 | 0.00 | 0.6125 | 0.0000 |
| Fatalities | 0.27 | 1.0000 | 0.2715 | Fatalities | 0.41 | 1.0000 | 0.4073 |
| **Total** |  |  | **0.3060** | **Total** |  |  | **0.4579** |

Note: Values may not sum due to rounding.

Table 148: Calculation of Monetized Benefits Discounted at 3% for Rear Seat Occupants 11 Years and Older

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Injury Severity** | **Lo** | **Comprehensive Unit Costs** | **Monetized Benefits** | **Injury Severity** | **Hi** | **Comprehensive Unit Costs** | **Monetized Benefits** |
| MAIS 1 | 17.99 | $56,035 | $1,007,844 | MAIS 1 | 27.03 | $56,035 | $1,514,551 |
| MAIS 2 | 32.93 | $553,146 | $18,215,634 | MAIS 2 | 49.49 | $553,146 | $27,373,770 |
| MAIS 3 | 4.55 | $1,307,335 | $5,944,502 | MAIS 3 | 6.83 | $1,307,335 | $8,933,175 |
| MAIS 4 | 4.52 | $3,215,701 | $14,527,679 | MAIS 4 | 6.79 | $3,215,701 | $21,831,650 |
| MAIS 5 | 0.13 | $7,327,043 | $961,491 | MAIS 5 | 0.20 | $7,327,043 | $1,444,892 |
| Fatalities | 18.15 | $11,950,834 | $216,881,905 | Fatalities | 27.35 | $11,950,834 | $326,879,426 |
| **Total** |  |  | **$257,539,055** | **Total** |  |  | **$387,977,464** |

Note: Values may not sum due to rounding.

Table 149: Calculation of Monetized Benefits Discounted at 7% for Rear Seat Occupants 11 Years and Older

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Injury Severity** | **Lo** | **Comprehensive Unit Costs** | **Monetized Benefits** | **Injury Severity** | **Hi** | **Comprehensive Unit Costs** | **Monetized Benefits** |
| MAIS 1 | 14.63 | $56,035 | $819,722 | MAIS 1 | 21.98 | $56,035 | $1,231,847 |
| MAIS 2 | 26.77 | $553,146 | $14,808,545 | MAIS 2 | 40.23 | $553,146 | $22,253,726 |
| MAIS 3 | 3.71 | $1,307,335 | $4,847,851 | MAIS 3 | 5.57 | $1,307,335 | $7,285,168 |
| MAIS 4 | 3.68 | $3,215,701 | $11,824,694 | MAIS 4 | 5.53 | $3,215,701 | $17,769,705 |
| MAIS 5 | 0.11 | $7,327,043 | $782,797 | MAIS 5 | 0.16 | $7,327,043 | $1,176,358 |
| Fatalities | 14.72 | $11,950,834 | $175,922,641 | Fatalities | 22.19 | $11,950,834 | $265,146,564 |
| **Total** |  |  | **$209,006,250** | **Total** |  |  | **$314,863,368** |

Note: Values may not sum due to rounding.

Table 150: Calculation of Monetized Benefits Discounted at 3% for Rear Seat Occupants 6 to 10 Years Old

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Injury Severity** | **Lo** | **Comprehensive Unit Costs** | **Monetized Benefits** | **Injury Severity** | **Hi** | **Comprehensive Unit Costs** | **Monetized Benefits** |
| MAIS 1 | 0.49 | $56,035 | $27,650 | MAIS 1 | 0.72 | $56,035 | $40,554 |
| MAIS 2 | 0.45 | $553,146 | $250,615 | MAIS 2 | 0.66 | $553,146 | $367,569 |
| MAIS 3 | 0.11 | $1,307,335 | $143,192 | MAIS 3 | 0.16 | $1,307,335 | $210,015 |
| MAIS 4 | 0.03 | $3,215,701 | $97,837 | MAIS 4 | 0.04 | $3,215,701 | $143,495 |
| MAIS 5 | 0.00 | $7,327,043 | $0 | MAIS 5 | 0.00 | $7,327,043 | $0 |
| Fatalities | 0.34 | $11,950,834 | $4,006,513 | Fatalities | 0.50 | $11,950,834 | $6,009,770 |
| **Total** |  |  | **$4,525,808** | **Total** |  |  | **$6,771,403** |

Note: Values may not sum due to rounding.

Table 151: Calculation of Monetized Benefits Discounted at 7% for Rear Seat Occupants 6 to 10 Years Old

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Injury Severity** | **Lo** | **Comprehensive Unit Costs** | **Monetized Benefits** | **Injury Severity** | **Hi** | **Comprehensive Unit Costs** | **Monetized Benefits** |
| MAIS 1 | 0.40 | $56,035 | $22,415 | MAIS 1 | 0.59 | $56,035 | $32,875 |
| MAIS 2 | 0.37 | $553,146 | $203,584 | MAIS 2 | 0.54 | $553,146 | $298,590 |
| MAIS 3 | 0.09 | $1,307,335 | $116,830 | MAIS 3 | 0.13 | $1,307,335 | $171,350 |
| MAIS 4 | 0.02 | $3,215,701 | $79,825 | MAIS 4 | 0.04 | $3,215,701 | $117,077 |
| MAIS 5 | 0.00 | $7,327,043 | $0 | MAIS 5 | 0.00 | $7,327,043 | $0 |
| Fatalities | 0.27 | $11,950,834 | $3,244,667 | Fatalities | 0.41 | $11,950,834 | $4,867,001 |
| **Total** |  |  | **$3,667,322** | **Total** |  |  | **$5,486,894** |

Note: Values may not sum due to rounding.

Table 152: Summary Of Discounted Fatal Equivalents for Rear Seat Occupants

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Category** | **Discounted at 3%** | | **Discounted at 7%** | |
| **Lo** | **Hi** | **Lo** | **Hi** |
| 11 Years and Older | 21.4912 | 32.3763 | 17.4411 | 26.2748 |
| 6 to 10 Years Old | 0.3776 | 0.5651 | 0.3060 | 0.4579 |
| Total | 21.8688 | 32.9413 | 17.7471 | 26.7327 |

Note: Values may not sum due to rounding.

Table 153: Summary Of Discounted Monetized Benefits for Rear Seat Occupants

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Category** | **Discounted at 3%** | | **Discounted at 7%** | |
| **Lo** | **Hi** | **Lo** | **Hi** |
| 11 Years and Older | $257.54 | $387.98 | $209.01 | $314.86 |
| 6 to 10 Years Old | $4.53 | $6.77 | $3.67 | $5.49 |
| Total | $262.06 | $394.75 | $212.67 | $320.35 |

Note: Values may not sum due to rounding.

Table 154: Calculation of Discounted Benefits for Drivers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Injury Severity** | **Undiscounted Incremental Benefits** | **Discounted at 3%** | **Discounted at 7%** |
| **PC** | MAIS 1 | 12.07 | 10.0810 | 8.2250 |
| MAIS 2 | 77.08 | 64.3896 | 52.5353 |
| MAIS 3 | 21.28 | 17.7769 | 14.5041 |
| MAIS 4 | 15.40 | 12.8662 | 10.4975 |
| MAIS 5 | 0.37 | 0.3051 | 0.2489 |
| **Fatality** | 25.03 | 20.9131 | 17.0629 |
| **LTV** | MAIS 1 | 8.66 | 7.1153 | 5.7383 |
| MAIS 2 | 42.93 | 35.2692 | 28.4438 |
| MAIS 3 | 0.27 | 0.2247 | 0.1812 |
| MAIS 4 | 2.02 | 1.6557 | 1.3353 |
| MAIS 5 | 0.14 | 0.1143 | 0.0922 |
| **Fatality** | 40.86 | 33.5715 | 27.0746 |

Note: Values may not sum due to rounding.

Table 155: Calculation of Discounted Benefits for Right Front Seat Occupants

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Injury Severity** | **Undiscounted Incremental Benefits** | **Discounted at 3%** | **Discounted at 7%** |
| **PC** | MAIS 1 | 2.27 | 1.89 | 1.54 |
| MAIS 2 | 13.89 | 11.52 | 9.40 |
| MAIS 3 | 3.84 | 3.18 | 2.59 |
| MAIS 4 | 2.77 | 2.31 | 1.88 |
| MAIS 5 | 0.07 | 0.06 | 0.05 |
| **Fatality** | 4.82 | 4.02 | 3.28 |
| **LTV** | MAIS 1 | 1.39 | 1.13 | 0.91 |
| MAIS 2 | 6.59 | 5.37 | 4.33 |
| MAIS 3 | 0.05 | 0.03 | 0.03 |
| MAIS 4 | 0.31 | 0.26 | 0.21 |
| MAIS 5 | 0.02 | 0.02 | 0.02 |
| **Fatality** | 6.56 | 5.39 | 4.34 |

Note: Values may not sum due to rounding.

Table 156: Calculation of Equivalent Lives Saved for Drivers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Injury Severity** | **Undiscounted Incremental Benefits** | **Relative Disutility Factors** | **Equivalent Lives Saved** |
| **PC** | MAIS 1 | 12.07 | 0.0038 | 0.0459 |
| MAIS 2 | 77.08 | 0.0454 | 3.4993 |
| MAIS 3 | 21.28 | 0.1078 | 2.2939 |
| MAIS 4 | 15.40 | 0.2677 | 4.1229 |
| MAIS 5 | 0.37 | 0.6125 | 0.2237 |
| **Fatality** | 25.03 | 1.0000 | 25.0336 |
| **Total PC** |  |  | **35.2192** |
| **LTV** | MAIS 1 | 8.66 | 0.0038 | 0.0329 |
| MAIS 2 | 42.93 | 0.0454 | 1.9489 |
| MAIS 3 | 0.27 | 0.1078 | 0.0295 |
| MAIS 4 | 2.02 | 0.2677 | 0.5395 |
| MAIS 5 | 0.14 | 0.6125 | 0.0852 |
| **Fatality** | 40.86 | 1.0000 | 40.8612 |
| **Total LTV** |  |  | **43.4972** |
| **Total Drivers** | |  |  | **78.7164** |

Note: Values may not sum due to rounding.

Table 157: Calculation of Equivalent Lives Saved for Right Front Seat Occupants

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Injury Severity** | **Undiscounted Incremental Benefits** | **Relative Disutility Factors** | **Equivalent Lives Saved** |
| **PC** | MAIS 1 | 2.27 | 0.0038 | 0.008529061 |
| MAIS 2 | 13.89 | 0.0454 | 0.630291491 |
| MAIS 3 | 3.84 | 0.1078 | 0.41360929 |
| MAIS 4 | 2.77 | 0.2677 | 0.742095943 |
| MAIS 5 | 0.07 | 0.6125 | 0.04011975 |
| **Fatality** | 4.82 | 1.0000 | 4.82 |
| **Total PC** |  |  | **6.658869194** |
| **LTV** | MAIS 1 | 1.39 | 0.0038 | 0.005209821 |
| MAIS 2 | 6.59 | 0.0454 | 0.29880348 |
| MAIS 3 | 0.05 | 0.1078 | 0.004855605 |
| MAIS 4 | 0.31 | 0.2677 | 0.083307669 |
| MAIS 5 | 0.02 | 0.6125 | 0.012537422 |
| **Fatality** | 6.56 | 1.0000 | 0.005209821 |
| **Total LTV** |  |  | **6.968699931** |
| **Total Right Front Seat** | |  |  | **13.62756913** |

Note: Values may not sum due to rounding.

Table 158: Calculation of Monetized Benefits for Drivers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Injury Severity** | **Undiscounted Incremental Benefits** | **Comprehensive Unit Cost** | **Monetized Benefits** |
| **PC** | MAIS 1 | 12.07 | $56,035 | $676,187 |
| MAIS 2 | 77.08 | $553,146 | $42,634,502 |
| MAIS 3 | 21.28 | $1,307,335 | $27,819,500 |
| MAIS 4 | 15.40 | $3,215,701 | $49,525,654 |
| MAIS 5 | 0.37 | $7,327,043 | $2,675,836 |
| **Fatality** | 25.03 | $11,950,834 | $299,172,355 |
| **Total PC** |  |  | $422,504,035 |
| **LTV** | MAIS 1 | 8.66 | $56,035 | $485,280 |
| MAIS 2 | 42.93 | $553,146 | $23,745,175 |
| MAIS 3 | 0.27 | $1,307,335 | $357,556 |
| MAIS 4 | 2.02 | $3,215,701 | $6,480,441 |
| MAIS 5 | 0.14 | $7,327,043 | $1,019,558 |
| **Fatality** | 40.86 | $11,950,834 | $488,325,015 |
| **Total LTV** |  |  | $520,413,025 |
| **Total Drivers** | |  |  | **$942,917,061** |

Note: Values may not sum due to rounding.

Table 159: Calculation of Monetized Benefits for Right Front Seat Occupants

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Injury Severity** | **Undiscounted Incremental Benefits** | **Comprehensive Unit Cost** | **Monetized Benefits** |
| **PC** | MAIS 1 | 2.27 | $56,035 | $127,409 |
| MAIS 2 | 13.89 | $553,146 | $7,685,887 |
| MAIS 3 | 3.84 | $1,307,335 | $5,014,976 |
| MAIS 4 | 2.77 | $3,215,701 | $8,912,647 |
| MAIS 5 | 0.07 | $7,327,043 | $479,945 |
| **Fatality** | 4.82 | $11,950,834 | $57,653,496 |
| **Total PC** |  |  | $79,874,359 |
| **LTV** | MAIS 1 | 1.39 | $56,035 | $77,889 |
| MAIS 2 | 6.59 | $553,146 | $3,645,232 |
| MAIS 3 | 0.05 | $1,307,335 | $65,367 |
| MAIS 4 | 0.31 | $3,215,701 | $996,867 |
| MAIS 5 | 0.02 | $7,327,043 | $146,541 |
| **Fatality** | 6.56 | $11,950,834 | $78,397,471 |
| **Total LTV** |  |  | $83,329,367 |
| **Total Right Front Seat** | |  |  | **$163,250,343** |

Note: Values may not sum due to rounding.

Table 160: Calculation of Discounted Equivalent Lives Saved for Drivers

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **Undiscounted** | **Discounted at 3%** | **Discounted at 7%** |
| PC | 35.21 | 29.42 | 24.01 |
| LTV | 43.50 | 35.74 | 28.82 |
| **Total Drivers** | **78.72** | **65.16** | **52.83** |

Note: Values may not sum due to rounding.

Table 161: Calculation of Discounted Equivalent Lives Saved for Right Front Seat Occupants

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **Undiscounted** | **Discounted at 3%** | **Discounted at 7%** |
| PC | 6.66 | 5.56 | 4.54 |
| LTV | 6.97 | 5.73 | 4.62 |
| **Total Right Front Seat** | **13.63** | **11.29** | **9.16** |

Note: Values may not sum due to rounding.

Table 162: Calculation of Discounted Monetized Benefits for Drivers

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **Undiscounted** | **Discounted at 3%** | **Discounted at 7%** |
| PC | $422.5 | $353.0 | $288.0 |
| LTV | $520.4 | $427.6 | $344.8 |
| **Total Drivers** | **$942.9** | $780.5 | $632.8 |

Note: Values may not sum due to rounding.

Table 163: Calculation of Discounted Monetized Benefits for Right Front Seat Occupants

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **Undiscounted** | **Discounted at 3%** | **Discounted at 7%** |
| PC | $79.87 | $66.72 | $54.44 |
| LTV | $83.32 | $68.46 | $55.21 |
| **Total Right Front Seat** | **$163.25** | $135.2 | $109.7 |

Note: Values may not sum due to rounding.

Table 164: Summary of Discounted Equivalent Lives Saved for Front Seat Occupants

|  |  |  |
| --- | --- | --- |
| **Category** | **Discounted at 3%** | **Discounted at 7%** |
| Driver | 65.2 | 52.8 |
| Right Front Seat Occupant | 11.3 | 9.2 |
| **Total** | 76.4 | 62.0 |

Note: Values may not sum due to rounding.

Table 165: Summary of Discounted Monetized Benefits for Front Seat Occupants

|  |  |  |
| --- | --- | --- |
| **Category** | **Discounted at 3%** | **Discounted at 7%** |
| Driver | $780.5 | $632.8 |
| Right Front Seat Occupant | $135.2 | $109.7 |
| **Total** | $915.8 | $742.5 |

Note: Values may not sum due to rounding.

## Appendix I

Table 166: Selection Criteria by Category for FARS Data2011-2015

| **Category** | **Selection Criteria** |
| --- | --- |
| Occupant Fatalities | PER\_TYP IN (1,2,9) and INJ\_SEV=4 |
| ***Vehicle Type for Passenger Vehicles*** | |
| Passenger Cars | BODY\_TYP IN (1-11, 17) |
| Light Trucks | BODY\_TYP IN (14,15,16,19,20,21,22,24,25,28,29, 30,31,32,33,34,39, 40,41,45,48,49) OR (BODY\_TYP=79 AND TOW\_VEH IN (0,9)) |
| ***Seating Position*** | |
| Front Seat – Left (Driver’s Side) | SEAT\_POS=11 |
| Front Seat - Middle | SEAT\_POS=12 |
| Front Seat - Right | SEAT\_POS=13 |
| Front Seat – Other/Unknown | SEAT\_POS IN (18,19) |
| Rear Seats | SEAT\_POS IN (21,22,23,28,29, 31,32,33,38,39,41,42,43,48,49) |
| Other | SEAT\_POS IN (50-55) |
| Unknown | SEAT\_POS IN (98,99) |
| ***Restraint Use*** | |
| Restrained | REST\_USE IN (1,2,3,4,8,10,11,12,97) |
| Unrestrained | REST\_USE IN (0,5,7,16,17,19,20) |
| Unknown Restraint Use | REST\_USE IN (29,98,99) |
| ***Rollover/Area of Impact – Initial Contact Point*** | |
| Rollover | ROLLOVER IN (1,2,9) |
| ***ELSE*** |  |
| Front Impact | IMPACT1 IN (11,12,1) |
| Side Impact | IMPACT1 IN (2,3,4,8,9,10,61,62,63,81,82,83) |
| Rear Impact | IMPACT1 IN (5,6,7) |

Table 167: Selection Criteria by Category for NASS CDS Data2011-2015

| **Category** | **Selection Criteria** |
| --- | --- |
| ***Vehicle Type for Passenger Vehicles*** | |
| Passenger Cars | BODYTYPE IN (1-13) |
| Light Trucks | BODYTYPE IN (14-49) |
| ***Seating Position*** | |
| Front Seat – Left (Driver’s Side) | SEATPOS=11 |
| Front Seat - Right | SEATPOS=13 |
| Front Seat – Other/Unknown | SEATPOS IN (12,18,19) |
| Rear Seats | SEATPOS IN (21-59) |
| Other | SEATPOS IN (97,98) |
| Unknown | SEATPOS=99 |
| ***Restraint Use*** | |
| Restrained | MANUSE IN (2,3,4,5,8,12,13,14,15,18) |
| Unrestrained | MANUSE IN (0,1) |
| ***Rollover/Direction of Force (Highest)*** | |
| Rollover | ROLLOVER IN (1-17,98,99,.U) |
| ***ELSE*** |  |
| Front Impact | DOF1 IN (1,11,12,21,31,32,41,51,52,61,71,72,81,91,92) |
| Side Impact | DOF1 IN (2,3,4,8,9,10,22,23,24,28,29,30,42,43,44,48,49,50, 62,63,64,68,69,70,82,83,84,88,89,90) |
| Rear Impact | DOF1 IN (5,6,7,25,26,27,45,46,47,65,66,67,85,86,87) |

## Appendix J

Fatality Reduction by 3-Point Belts for Rear Seat Passengers

Children 6 to 10 Years Old Versus Other Passengers

Chuck Kahane

August 31, 2018

The database is the same as in the 2017 evaluation of seat belts in the center rear seat, except for extension from 1990-to-2014 FARS to 1990-to-2016 FARS.[[93]](#footnote-94) The database consists of driver-rear passenger pairs, riding in the same vehicle; 3-point belts are available for the driver and the passenger, and a frontal air bag for the driver. The analysis compares the fatality status of the driver and passenger, when either one, both, or none are belted.

Fatality reduction for 3-point belts in the rear seat can be estimated by double pair comparison analysis or by logistic regression that mimics double-pair comparison. The logistic regressions are the primary estimates because they control for driver and passenger age and gender and they establish confidence bounds and allow statistical tests. However, I also present the double pair comparisons because they are a simpler technique and provide corroboration for the logistic regressions.

Fatality Reduction (%)

Double Pair

Comparison Passenger Cars LTVs

All rear seat passengers 57 74

Outboard 57 74

Center 63 75

6-10 (all rear seats) 48 70

11+ (all rear seats) 56 74

Outboard

6-10 48 70

11+ 56 74

Center

6-10 53 79

11+ 62 74

Fatality Reduction (%) With 95% Confidence Bounds

Logistic

Regression Passenger Cars LTVs

All rear seat passengers 55 (52 to 57) 74 (72 to 76)

Outboard 54 (52 to 57) 74 (72 to 76)

Center 58 (44 to 69) 73 (60 to 82)

6-10 (all rear seats) 46 (35 to 54) 69 (63 to 75)

11+ (all rear seats) 55 (53 to 58) 75 (73 to 77)

χ2 for test: lower for 6-10? 3.02 (borderline[[94]](#footnote-95)) 3.19 (borderline)

Outboard

6-10 46 (34 to 56) 69 (62 to 75)

11+ 55 (52 to 58) 75 (73 to 77)

χ2 for test: lower for 6-10? 2.78 (borderline) 3.14 (borderline)

Center

6-10 52 ( 2 to 77) 75 (39 to 90)

11+ 60 (45 to 72) 74 (59 to 83)

χ2 for test: lower for 6-10? .41 (not sig.) .06 (not sig.)

**Conclusions**

* 3-point belts are effective for both age groups at both seating positions: all estimates of fatality reduction are statistically significant (as evidenced by positive confidence bounds). Definitely OK to include a benefit for reminder systems for the younger (6 to 10) passengers.
* Effectiveness for outboard and center seats is similar (especially taking into account the wider confidence bounds for the center seat). Seems OK to just use the combined effectiveness estimate for both the outboard and center seats.
* Not clear if you should use the same effectiveness for younger (6 to 10) and older (11+) passengers, or separate estimates. Could go either way. The difference is never significant, so you are not forced to use separate estimates. But effectiveness is generally lower for the younger children, and the difference is borderline significant on two independent measurements (namely, for cars and for LTVs). I think it would be conservative to use the lower estimate for the 6-to-10 year old children when calculating benefits for that group, if this is an entirely separate calculation, but you can use a single effectiveness for both ages if you are computing benefits for both ages simultaneously.

1. SBWS is defined as a warning system designed to provide a seat belt warning for vehicle occupants. [↑](#footnote-ref-2)
2. *See, e.g.*, Transportation Research Board Study at 8, 25; Mark Freedman et al., Effectiveness and Acceptance of Enhanced Seat Belt Reminder Systems: Characteristics of Optimal Reminder Systems Final Report. DOT HS 811 097 at 2 (Feb. 2009) (hereinafter “DOT 2009 Seat Belt Study”). [↑](#footnote-ref-3)
3. NHTSA Traffic Safety Facts, “Belt Use Regression Model” Jing-Shiam Wang and Lawrence Blincoe, <http://www-nrd.nhtsa.dot.gov/Pubs/809639.PDF> [↑](#footnote-ref-4)
4. The model uses the national observed belt use rate to predict lives-saved by seat belts. In the model, the following equation is used to estimate the seat belt use rate in potentially fatal crashes = 0.43751\*(Observed belt use rate) + 0.47249\*(Observed belt use rate^2) [↑](#footnote-ref-5)
5. Vehicle information collected in accordance with information collection request approved by OMB (Control No. 2127-0629) View Information Collection Request (ICR) Package (reginfo.gov) [↑](#footnote-ref-6)
6. In order to get a better sense of the warning durations in currently sold vehicles, NHTSA analyzed data on the seat belt warning durations for MY 2022 vehicle models provided to the agency by vehicle manufacturers for NCAP; this data covers most vehicles offered for sale in the U.S. for MY 2022 with a GVWR of 4,536 kg (10,000 lbs.) or less. This included a total of over 500 different vehicle models. [↑](#footnote-ref-7)
7. Haseltine, P. W. Seat Belt Use in Motor Vehicles: The U.S. Experience. 2001 Seat Belt Summit Report, Automotive Coalition for Traffic Safety, Inc., Arlington, VA, 2001. [↑](#footnote-ref-8)
8. National Highway Traffic Safety Administration. Occupant crash protection in passenger cars, multipurpose passenger vehicles, trucks, and buses. Federal Register. Washington, DC: Office of the Federal Register, National Archives and Records Administration, 1971;36:4605 (March 10). [↑](#footnote-ref-9)
9. National Highway Traffic Safety Administration. Occupant crash protection. Federal Register. Washington, DC: Office of the Federal Register, National Archives and Records Administration, 1972;37:3912 (February 24). [↑](#footnote-ref-10)
10. Codified at 49 U.S.C. § 30124. As discussed below, this statutory limitation was repealed in 2012. [↑](#footnote-ref-11)
11. See 49 U.S.C. § 30111 (“Each standard shall be practicable, meet the need for motor vehicle safety, and be stated in objective terms.”) [↑](#footnote-ref-12)
12. Westefeld, A., and B. M. Phillips. Effectiveness of Various Safety Belt Warning Systems. DOT-HS-801-953. National Highway Traffic Safety Administration, U.S. Department of Transportation, July 1976. [↑](#footnote-ref-13)
13. In 2005, the Safe, Accountable, Flexible, and Efficient Transportation Equity Act – Legacy for Users (SAFETEA-LU) legislation required that NHTSA evaluate the effectiveness and acceptability of several different types of enhanced SBRSs currently being offered by a number of manufacturers. See Pub. L. No. 109-59, § 10306 (2005). In addition, prior to this, in 2001 Congress directed NHTSA to contract with the Transportation Research Board of the National Academy of Sciences to conduct a study to examine the potential benefits of technologies to increase seat belt use, determine how drivers view the acceptability of the technologies, and consider whether legislative or regulatory actions were necessary to enable their installation on passenger vehicles. The study found that seat belt warning technologies show promise for increasing seat belt use, and it developed eight recommendations for the continued development of these technologies. Two of the recommendations advocated the use of SBWSs for front and rear seat passengers. See “Buckling Up, Technologies to Increase Seat Belt Use,” Special Report 278, Committee for the Safety Belt Technology Study, www.TRB.org We note that the examined systems were enhanced. [↑](#footnote-ref-14)
14. A “basic” seat belt warning system is a system that provides a warning only for the for the driver’s seat belt, with the warning meeting only the minimum durational requirements of FMVSS No. 208. An “enhanced” seat belt warning system is a seat belt warning system with warning signals that exceed the maximum durational requirements of FMVSS No. 208 S7.3 (e.g., audible warnings lasting longer than 8 seconds). All enhanced warning systems have a warning for the driver’s seat belt; many, but not all, also have a warning specifically for the front outboard passenger seat belt. However, even warning systems without a passenger seat belt warning, can prompt the passenger to fasten the belt due to “spillover” effects. [↑](#footnote-ref-15)
15. Freedman, M.; Levi, S.; Zador, P.; Lopdell, J.; and Bergeron, E. 2007. The effectiveness of enhanced seat belt warning systems: observational field data collection methodology and findings. Report no. DOT HS-810-844. Washington, DC: National Highway Traffic Safety Administration. [↑](#footnote-ref-16)
16. Lerner, N., Singer, J., Huey, R., and Jenness, J., “Acceptability and Potential Effectiveness of Enhanced Seat Belt Warning System Features,” Report #: DOT HS 810 848, December 2007. [↑](#footnote-ref-17)
17. Freedman, M., Lerner, N., Zador, P., Singer, J., and Levi, S. Effectiveness and Acceptance of Enhanced Seat Belt Warning Systems: Characteristics of Optimal Warning Systems. Report #: DOT HS 811 097, February 2009. [↑](#footnote-ref-18)
18. Participants were mainly part-time seat belt users. Non-users of seat belts may be more opposed to enhanced SBRSs. [↑](#footnote-ref-19)
19. Lerner, N., Singer, J., Robinson, E., Huey, R., Walrath, J., and Freedman, M. Acceptability and Potential Effectiveness of Enhanced Seat Belt Warning System Features for Teenage Drivers and Passengers. June 2009. [↑](#footnote-ref-20)
20. The previously active data systems of CDS and the General Estimates System(GES) have been retired. Data for these systems is still available and searchable, but future years are only available in other database structures. For further information about NHTSA’s evolving data systems, NHTSA’s crash data collection program now consists of the Crash Report Sampling System (CRSS), the Fatality Analysis Reporting System (FARS), the Crash Investigation Sampling System (CISS), Special Crash Investigations (SCI), Non-Traffic Surveillance (NTS), the Crash Injury Research & Engineering Network (CIREN), and special studies conducted to address various safety topics. [↑](#footnote-ref-21)
21. GM, Ford, and Chrysler produce the majority of vehicles sold in the U.S. GM and Ford were the first vehicle manufacturers to equip their vehicles with an enhanced seat belt warning system in the U.S. [↑](#footnote-ref-22)
22. Robertson LS. Safety belt use in automobiles with starter-interlock and buzzer-light warning systems. Am J Public Health. 1975 Dec; 65:1319–1325. [↑](#footnote-ref-23)
23. A year earlier IIHS conducted a similar observational study on the required SBRS for the front outboard seats and its effect on the driver’s belt usage and did not find a statistically significant difference in the driver’s belt usage for vehicles with and without the system. Robertson, L. S., and Haddon, W., Jr. The Buzzer-light Warning System and Safety Belt Use. Am. J. Public Health 64:814-815, 1974. As noted above, earlier seat belt usage studies do not reflect current occupant behavior. [↑](#footnote-ref-24)
24. Kidd, D.G. and McCartt, A.T. 2013. Drivers' attitudes toward front or rear child passenger belt use and seat belt warnings at these seating positions. Insurance Institute for Highway Safety, January 2013. [↑](#footnote-ref-25)
25. SAE paper 2012-01-0050 “Assessment Method of Effectiveness of Passenger Seat Belt Warning,” April 2012. [↑](#footnote-ref-26)
26. The one exception to this group was an audiovisual signal provided to both the driver and passenger that used an audible signal that was a melody. [↑](#footnote-ref-27)
27. “The effects of persistent audible seat belt reminders and a speed-limiting interlock on the seat belt use of drivers who do not always use a seat belt,” April 2019, David G. Kidd of Insurance Institute for Highway Safety, Jeremiah Singer of Westat, Inc. [↑](#footnote-ref-28)
28. The IIHS study states or implies multiple times that the BMW was equipped with a 90-second audible reminder. However, at one point the study later states that the BMW system provided a warning almost every second for 100 seconds. [↑](#footnote-ref-29)
29. Note that (1) all the reductions are statistically significant at the 0.05 level, (2) the control group included crash involvements in which a vehicle: (i) was stopped, parked, backing up, or entering/leaving a parking space prior to the crash (ii) traveled at a speed less than 10 mph, (iii) was struck in the rear by another vehicle, or (iv) was a non-culpable party in a multi-vehicle crash on a dry road. [↑](#footnote-ref-30)
30. A passenger car is any automobile (other than an automobile capable of off-highway operation) manufactured preliminarily for use in the transportation of no more than 10 individuals. A light truck is a truck or a truck-based vehicle with a payload capacity of less than 4,000 pounds (1,815 kg). A van is a fully enclosed vehicle as defined in 49 CFR §523.2. [↑](#footnote-ref-31)
31. <https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/esc_fr_03_2007.pdf>, page 42 “and reduced fatal single vehicle crashes involving rollover by 69 percent in passenger cars and 88 percent in SUVs.” [↑](#footnote-ref-32)
32. Under the FMVSS No. 126, “Electronic stability control systems,” almost all model year (MY) 2011 vehicles are equipped with ESC. See the following link for the ESC take rate: <http://www.safercar.gov/Vehicle-Shoppers/Resources/Vehicles-with-ESC> [↑](#footnote-ref-33)
33. Ward's Automotive Yearbook. 2003-2013. Detroit: Ward's Reports, Inc. [↑](#footnote-ref-34)
34. <https://www.regulations.gov/document/NHTSA-2015-0056-0002> [↑](#footnote-ref-35)
35. By applying the ESC effectiveness to the side impacts whether followed by rollovers or not, we are assuming that preventing the side impact would prevent subsequent rollovers. However, we expect some of the subsequent rollovers could occur even if the side impact is prevented. Therefore, by not including these un-prevented rollovers in the target population, we would slightly underestimate the potential benefits. [↑](#footnote-ref-36)
36. <https://www.regulations.gov/document/NHTSA-2007-29134-0004> [↑](#footnote-ref-37)
37. For additional discussion, see FRIA FMVSS No. 214, Docket No. NHTSA-2007-29134-0004, Table V-110 and Table V-104. [↑](#footnote-ref-38)
38. <https://www.regulations.gov/document/NHTSA-2011-0004-0003> [↑](#footnote-ref-39)
39. <https://www.regulations.gov/document/NHTSA-2009-0093-0004> [↑](#footnote-ref-40)
40. These estimates do not imply that restrained occupants are more likely to incur injuries or fatalities. Given that seat belt use rates are generally high, there are more restrained occupants than unrestrained on the road. Therefore, those populations have different exposure and corresponding probabilities of fatalities and non-fatal injuries. Furthermore, there are differences in the make-up, preferences, and risk tolerance for those populations. [↑](#footnote-ref-41)
41. These estimates do not imply that restrained occupants are more likely to incur injuries or fatalities. Given that seat belt use rates are generally high, there are more restrained occupants than unrestrained on the road. Therefore, those populations have different exposure and corresponding probabilities of fatalities and non-fatal injuries. Furthermore, there are differences in the make-up, preferences, and risk tolerance for those populations. [↑](#footnote-ref-42)
42. No previous rear seat injury belt effectiveness was available. However, front seat belt effectiveness for fatalities and injuries were both available. Thus, Rear Seat Fatality effectiveness was multiplied by the ratio of (Front Seat Injury Belt Effectiveness / Front Seat Fatality Belt Effectiveness) to create an estimate of Rear Seat Injury Belt Effectiveness. This was done for MAIS 2-5 as a group. We assumed the same value for MAIS 1 belt effectiveness due to limited data. [↑](#footnote-ref-43)
43. “Lives Saved Calculations for Seat Belts and Frontal Air Bags.” DOT HS 811206, Dec 2009, p 18-19, p. 20 [↑](#footnote-ref-44)
44. As discussed in the Benefits chapter, in the most recent NHTSA report on safety effectiveness report (DOT HS 809 199), the agency did not examine the belt effectiveness against non-fatal injuries. For injuries, the effectiveness is based on a report titled “Estimating the Benefits from Increased Safety Belt Use.” See Appendix J for an expanded explanation of how these belt effectiveness rates were calculated. It shows that age is borderline significant, so it’s reasonable to use one effectiveness estimate for all concerned occupants. [↑](#footnote-ref-45)
45. Assuming that children in booster seats are safer than their peers in simple seat belts, we can speculate that all children in either booster seats or seat belts (because both use the same seat belt for restraint) would benefit from SBWS warning systems similarly. Furthermore, we can underestimate the effectiveness of booster seats in this case to keep the overall child restraint benefits conservative. [↑](#footnote-ref-46)
46. The Effectiveness of Enhanced Seat Belt Reminder December 2007 Systems – Observational Field Data Collection Methodology and Findings, DOT HS 810 844, December 2007. [↑](#footnote-ref-47)
47. Note that while this table shows the values 3.4% to 5.1%, due to the close nature of benefits calculations and balance point calculation, the values internally used in calculations are 3.4105% and 5.1157%, but for brevity these are referred to as “3” and “5” percent, respectively. [↑](#footnote-ref-48)
48. Y Expected future rear seat belt use rate with SBWS = -0.2143x(0.75 rear belt use rate) + 0.2143. Y = 0.05375 (5.1%) [↑](#footnote-ref-49)
49. Traffic Safety Facts Research Note, Belt Use Regression Model - 2003 Update

    https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/809639 [↑](#footnote-ref-50)
50. The calculation of seat belt use rate in potentially fatal crashes makes use of the following formula: [↑](#footnote-ref-51)
51. Greenwell, N. K. (2015, May). Results of the National Child Restraint Use Special Study (NCRUSS) (Report No. DOT HS 812 142). Washington, DC: National Highway Traffic Safety Administration. https://crashstats.nhtsa.dot.gov/ Api/Public/ViewPublication/812142 [↑](#footnote-ref-52)
52. NHTSA Traffic Safety Facts, “Belt Use Regression Model” Jing-Shiam Wang and Lawrence Blincoe, http://www-nrd.nhtsa.dot.gov/Pubs/809639.PDFTraffic Safety Facts Research Note, Belt Use Regression Model - 2003 Update. [↑](#footnote-ref-53)
53. Using the equation Seat belt use in potentially fatal crashes = 0.43751\*(Observed belt use rate) + 0.47249\*(Observed belt use rate^2) [↑](#footnote-ref-54)
54. <https://meps.ahrq.gov/data_files/publications/st62/stat62.shtml> [↑](#footnote-ref-55)
55. “The effects of persistent audible seat belt reminders and a speed-limiting interlock on the seat belt use of drivers who do not always use a seat belt,” April 2019, David G. Kidd Insurance Institute for Highway Safety, Jeremiah Singer Westat, Inc. [↑](#footnote-ref-56)
56. Since the BMW in the Kidd study was equipped with an audible seat belt warning with a duration of 100 seconds, it falls in the “90-second” group which represents audible warning duration of 90 seconds or 90+ seconds but not indefinite as shown in Table 9. [↑](#footnote-ref-57)
57. NHTSA Traffic Safety Facts, “Belt Use Regression Model” Jing-Shiam Wang and Lawrence Blincoe, http://www-nrd.nhtsa.dot.gov/Pubs/809639.PDF [↑](#footnote-ref-58)
58. Traffic Safety Facts Research Note, Belt Use Regression Model - 2003 Update

    <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/809639> [↑](#footnote-ref-59)
59. The calculation of seat belt use rate in potentially fatal crashes makes use of the following formula: [↑](#footnote-ref-60)
60. This analysis will specify these specific system warning durations (seven-second and 90-second) instead of specifying the bins for ease of understanding. [↑](#footnote-ref-61)
61. The IIHS study concluded that an enhanced seat belt reminder with at least 90 seconds of audible tones, but not indefinite, increased the seat belt use by 30% relative to the 7-second warning. This conclusion was based on the results for the BMW system that actually provided a 100-second audible warning. Therefore, in this analysis we reference a 90-second warning since the IIHS report attributed the effectiveness of a 100-second warning to warnings that last at least 90-seconds. [↑](#footnote-ref-62)
62. Kidd, D.G. and McCartt, A.T. 2013. Drivers' attitudes toward front or rear child passenger belt use and seat belt warnings at these seating positions. Arlington, VA: Insurance Institute for Highway Safety. [↑](#footnote-ref-63)
63. S. Peltzman, “The effects of automobile safety regulation,” The Journal

    of Political Economy, pp. 677–725, 1975. [↑](#footnote-ref-64)
64. See the Notice of Proposed Rulemaking (NPRM) for the detailed discussion on the three compliance options. [↑](#footnote-ref-65)
65. Consider a driver placing heavy luggage, or a pet, or groceries on a seat, not buckling the seatbelt, and then being alerted to the belt status throughout the trip. Such an alert (with no correction truly needed) is a false alarm. Similarly, presence of a Child Restraint System (CRS) secured by LATCH would not be buckled by the traditional belt buckle at the same time. Thus, a properly restrained child in a CRS might produce such a false alarm without correction. [↑](#footnote-ref-66)
66. We assumed the cost of additional wiring and visual displays is included in the estimated cost for a seat belt buckle sensor or spool out sensor. [↑](#footnote-ref-67)
67. Ward's Automotive Yearbook. 2003-2013. Detroit: Ward's Reports, Inc. [↑](#footnote-ref-68)
68. Department of Transportation National Highway Traffic Safety Administration Office of Acquisition Management (NPO-320) West Building 51-117 1200 New Jersey Avenue, SE Washington, DC 20590 Contract Number: DTNH2216D00037/0002 Cost and Weight Analysis of Enhanced Seat Belt Reminder Systems Ricardo Inc. Detroit Technical Center Van Buren Twp., MI 48111 USA March 28, 2018. [↑](#footnote-ref-69)
69. Department of Transportation National Highway Traffic Safety Administration Office of Acquisition Management (NPO-320) West Building 51-117 1200 New Jersey Avenue, SE Washington, DC 20590 Contract Number: DTNH2216D00037/0002 Cost and Weight Analysis of Enhanced Seat Belt Reminder Systems Ricardo Inc. Detroit Technical Center Van Buren Twp., MI 48111 USA March 28, 2018. [↑](#footnote-ref-70)
70. Main page for VSL <https://www.transportation.gov/regulations/economic-values-used-in-analysis>

    <https://www.transportation.gov/sites/dot.gov/files/docs/2016%20Revised%20Value%20of%20a%20Statistical%20Life%20Guidance.pdf> [↑](#footnote-ref-71)
71. OMB Circular A-4. [↑](#footnote-ref-72)
72. In the benefit chapter, we estimated approximately 86 percent belt use rate for front passengers and approximately 75 percent belt use rate for rear passengers, with a difference of 11 percent. [↑](#footnote-ref-73)
73. The fatalities rate is higher given the curvilinear relationship between “increases in belt use” and the given belt use at the time. [↑](#footnote-ref-74)
74. *See* Pub. L. No. 112-141. [↑](#footnote-ref-75)
75. *See* 49 U.S.C. § 30111. [↑](#footnote-ref-76)
76. <http://compliance-sec.com/secfilings/company/slnn/link_files/2015/07-14-2015/Form10-K/Form10-K.pdf> [↑](#footnote-ref-77)
77. For a discussion of NHTSA’s certification regulations for final stage manufacturers, see 71 FR 28168, May 15, 2006, Docket No. NHTSA-2006-24664, Response to petitions for reconsideration of a final rule implementing regulations pertaining to multi-stage vehicles and to altered vehicles. The Background section of that document provides concepts and terminology relating to the certification of multi-stage vehicles. [↑](#footnote-ref-78)
78. The raw discount factor for a year is given by the following equation:

    Raw Discount Factor 3% =1/(1+0.03)^([Year]-0.5)

    Raw Discount Factor 7% =1/(1+0.07)^([Year]-0.5) [↑](#footnote-ref-79)
79. Blincoe, L., Miller, T., Zalloshnja, E., Lawrence, B., The economic and Societal Impact of Motor Vehicle Crashes, 2010 (Revised), DOT HS 812 013 National Center for Statistics and Analysis, Washington, D.C., May 2015.

    These economic and societal impact numbers were further adjusted internally before use in this analysis, to provide the most up-to-date expression on comprehensive cost. [↑](#footnote-ref-80)
80. In the analysis, we used the ESC market share rates as proxy to estimate how many vehicles with ESC were in crashes. In addition, we assumed the annual sales remain the same. [↑](#footnote-ref-81)
81. Robertson LS. Safety belt use in automobiles with starter-interlock and buzzer-light warning systems. Am J Public Health. 1975 Dec;65(12):1319–1325. [↑](#footnote-ref-82)
82. Westefeld, A., and B. M. Phillips. Effectiveness of Various Safety Belt Warning Systems. DOT-HS-801-953. National Highway Traffic Safety Administration, U.S. Department of Transportation, July 1976. [↑](#footnote-ref-83)
83. Freedman, M.; Levi, S.; Zador, P.; Lopdell, J.; and Bergeron, E. 2007. The effectiveness of enhanced seat belt warning systems: observational field data collection methodology and findings. Report # DOT HS-810-844. Washington, DC: National Highway Traffic Safety Administration. [↑](#footnote-ref-84)
84. The difference between “no-SBWS” and “enhanced SBWS” = 6 percentage points, and the difference between “enhanced SBWS” and “basic SBWS” = rages 3 to 4 percentage points. Thus, the difference between “no-SBWS” and “basic SBWS” = 2 to 3 percentage points. [↑](#footnote-ref-85)
85. <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812244>. [↑](#footnote-ref-86)
86. Traffic Safety Facts Crash Stats “Seat Belt Use in 2017 – Use Rates in the States and Territories” <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812546> [↑](#footnote-ref-87)
87. 2014 and 2015 data taken from the 2015 NOPUS document which have 3 digit values in Table 1. [↑](#footnote-ref-88)
88. In addition, the IIHS study shows a 2% - 5% point increase in belt usage among front outboard passengers. For rear occupants, the 2012 study by Japanese Automobile Manufacturers Association showed a 4% - 15% point increase in seat belt usage among rear occupants with rear seat belt waring systems. [↑](#footnote-ref-89)
89. <https://meps.ahrq.gov/data_files/publications/st62/stat62.shtml> [↑](#footnote-ref-90)
90. <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/809639> [↑](#footnote-ref-91)
91. “The effects of persistent audible seat belt reminders and a speed-limiting interlock on the seat belt use of drivers who do not always use a seat belt,” April 2019, David G. Kidd Insurance Institute for Highway Safety, Jeremiah Singer Westat, Inc. [↑](#footnote-ref-92)
92. For simplicity, this analysis considered that 34 percent of never users became always users. However, the overall result would be the same if we considered that all never users began using seat belts 34 percent of the time. That is, having 34 percent of never users use seat belts 100 percent of the time has the same impact on the overall seat belt use rate as having 100 percent of never users use seat belts 34 percent of the time. [↑](#footnote-ref-93)
93. Kahane, C. J. (2017, February). *Fatality reduction by seat belts in the center rear seat and comparison of occupants’ relative fatality risk at various seating positions* (Report No. DOT HS 812 369). Washington, DC: National Highway Traffic Safety Administration. Available at [crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812369](https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812369) [↑](#footnote-ref-94)
94. Chi-square must exceed 3.89 for statistical significance; however, a value between 2.71 and 3.89 may be considered “borderline significant.” [↑](#footnote-ref-95)