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16. Abstract

The National Highway Traffic Safety Administration has rigorously evaluated its major programs as a matter of policy since 1970. The evaluation of the effectiveness of the Federal Motor Vehicle Safety Standards began in 1975. The Government Performance and Results Act of 1993 and Executive Order 12866, "Regulatory Planning and Review," issued in October 1993, oblige Federal agencies to evaluate their existing programs and regulations. This five-year plan for the Evaluation Division of the Office of Regulatory Analysis and Evaluation (ORAE) in NHTSA's National Center for Statistics and Analysis presents and discusses the vehicle and behavioral programs, regulations, technologies, and related areas ORAE proposes to evaluate, and it summarizes the findings of ORAE's past evaluations. ORAE is one of several NHTSA units that perform data analysis and evaluative work. These groups work together for a data-driven, quantitative approach to identifying safety problems and evaluating potential remedies. ORAE generally concentrates on statistical analyses of national or multi-State crash data to evaluate the effectiveness and benefits of existing vehicle safety regulations and technologies, and to study behavioral safety trends. Vehicle safety evaluations in this plan address crash avoidance, crashworthiness, compatibility, and recalls. They study cars, light trucks and vans, heavy trucks, and motorcycles. Behavioral safety evaluations address impaired driving, occupant protection, child passenger safety, motorcycle safety, pedestrians, and emergency care (injury survivability). NHTSA welcomes public comments on the plan.

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PREFACE

The National Highway Traffic Safety Administration has rigorously evaluated its major programs as a matter of policy since 1970. The evaluation of the effectiveness of the Federal Motor Vehicle Safety Standards (FMVSS) began in 1975. The Government Performance and Results Act of 1993 and Executive Order 12866, "Regulatory Planning and Review," issued in October 1993, now oblige all Federal agencies to evaluate their existing programs and regulations. Previously, Executive Order 12291, issued in February 1981, also required reviews of existing regulations. Even before 1981, however, NHTSA was a leader among Federal agencies in evaluating the effectiveness of existing regulations and technologies. There are large databases of motor vehicle crashes that can be analyzed to find out what vehicle and behavioral safety programs work best.

This five-year plan for the Evaluation Division of the Office of Regulatory Analysis and Evaluation (ORAE) in NHTSA's National Center for Statistics and Analysis presents and discusses the vehicle and behavioral programs, regulations, technologies, and related areas ORAE proposes to evaluate, and it summarizes the findings of ORAE's past evaluations. Depending on scope, evaluations typically take a year or substantially more, counting initial planning, contracting for support, OMB clearance for surveys, data collection, analysis, internal review, approvals, publication, review of public comments, and the last phase of preparing recommendations for subsequent agency action:

- A few evaluations based on relatively simple analyses of existing data (FARS, CDS) can be completed within a year.
- Many evaluations involving fairly complex statistical analyses of existing data require closer to two years from start to finish, including all planning and reviews.
- At least two and up to four years are needed if new data must be collected by a contractor; the longer time applies if survey data require additional clearances.
- Long-term evaluations involving several phases as technologies evolve or that call for periodic follow-up studies can take five years or more.

Most of NHTSA's crashworthiness and several crash avoidance standards have been evaluated at least once since 1975. A number of consumer-oriented regulations, e.g., bumpers, theft protection, fuel economy and NCAP also have been evaluated. So have promising safety technologies that were at the time not mandatory under Federal regulations, such as electronic stability control for passenger vehicles. Based on these evaluations, NHTSA estimated that vehicle safety technologies had saved an estimated 328,551 lives from 1960 through 2002 and that the FMVSS added an average of $839 (in 2002 dollars) to the cost of a new passenger car and $711 to an LTV in model year 2001.[*]

The Office of Regulatory Analysis and Evaluation is one of several NHTSA units that perform data analysis and evaluative work. These groups work together for a data-driven, quantitative

[*] *Summaries of Completed Evaluation Reports* may be found at the end of this plan; note, specifically, the 2004 publications DOT HS 809 833 and DOT HS 809 834.

approach to identifying safety problems and evaluating potential remedies. The Evaluation Division of ORAE generally concentrates on statistical analyses of national or multi-State crash data to evaluate the effectiveness and benefits of existing vehicle safety regulations and technologies, and to study behavioral safety trends.

ORAE's plan for calendar years 2008-2012 includes evaluations of new and existing vehicle and behavioral safety programs, regulations, technologies and consumer information programs. Vehicle safety evaluations address crash avoidance, crashworthiness, compatibility and recalls. They study passenger cars, LTVs, heavy trucks, and motorcycles. Behavioral safety evaluations address impaired driving, occupant protection, child passenger safety, motorcycle safety, pedestrians and emergency care (injury survivability).

Future evaluations have been subdivided into two groups. The evaluation topics that, as of June 2008, appear to be top priorities are tentatively scheduled to start in 2008, 2009, 2010, 2011, or 2012. Sometimes, the order of the evaluations is rearranged as new priorities emerge. "Other Potential Evaluations" address topics that now seem a lower priority, or where there is considerable uncertainty about the availability of data by 2012, but depending on circumstances at least some of them are likely to supplement or replace projects in the first group. As stated above, evaluations take at least a year, and sometimes many years from start to finish; the write-ups discuss approximately how long each evaluation will require.

The agency welcomes public comments on the plan. The plan will be periodically updated in response to public and agency needs, with a complete revision scheduled every five years. The most recent plan before this one was published on January 27, 2004 (*Federal Register*, Volume 69, p. 3992).

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LIST OF ABBREVIATIONS

ABS	Antilock Brake System
ACN	Automatic Crash Notification
ADL	Automatic Door Locks
BAC	Blood Alcohol Concentration
BMW	Bayerische Motoren Werke
CBS	Combined Braking System for motorcycles, automatically activates the rear brake if the rider activates the front brake, and vice-versa
CDS	Crashworthiness Data System, a part of NASS, a probability sample of police-reported crashes in the United States since 1979, investigated in detail
CHMSL	Center High-Mounted Stop Lamp
CIREN	Crash Injury Research & Engineering Network of centers performing in-depth crash investigations
CODES	Crash Outcome Data Evaluation System, selected State crash files supplemented with medical, hospital and EMS information
CRS	Child Restraint System – i.e., child safety seat
DOT	United States Department of Transportation
EDR	Event Data Recorder, devices that record the belt use, delta V, status of air bags, and other information about vehicles involved in crashes
EMS	Emergency Medical Services
EMT	Emergency Medical Technician
EPA	Environmental Protection Agency
ESC	Electronic Stability Control
EWR	Early Warning Reporting system for notifying NHTSA about possible vehicle defects
FARS	Fatality Analysis Reporting System, a census of fatal crashes in the United States since 1975

FCW	Forward Collision Warning system
FMCSA	Federal Motor Carrier Safety Administration
FMCSR	Federal Motor Carrier Safety Regulation
FMVSS	Federal Motor Vehicle Safety Standard
GES	General Estimates System, a part of NASS, a probability sample of police-reported crashes in the United States
GM	General Motors
GTR	Global Technical Regulation
GVWR	Gross Vehicle Weight Rating (specified by the manufacturer, equals the vehicle's curb weight plus maximum recommended loading)
HIC	Head Injury Criterion
HID	High Intensity Discharge headlamp
LATCH	Lower Anchors and Tethers for CHildren
LDWS	Lane Departure Warning System
LTV	Light Trucks and Vans (includes pickup trucks, SUVs, minivans and full-sized vans)
MCOD	Multiple Cause of Death, a supplement to FARS that lists injuries contributing to a person's death, based on a file of death certificates maintained by the National Center for Health Statistics
MIL	Malfunction Indicator Lamp for heavy-truck ABS
mph	Miles per hour
MY	Model Year
NAFTA	North American Free Trade Agreement
NASS	National Automotive Sampling System, consists of two NHTSA databases, CDS and GES (see above)
NCAP	New Car Assessment Program, a consumer information supplied by NHTSA on the safety of new cars and LTVs, based on test results, since 1979, renamed in 2008 as the Five-Star Government Safety Ratings program.
NEMSIS	National Emergency Medical Services Information System

NHTSA	National Highway Traffic Safety Administration
NMVCCS	National Motor Vehicle Crash Causation Survey, a nationally representative 2005-2007 sample of passenger-vehicle crashes that provides information on the events and associated factors related to a crash
NPRM	Notice of Proposed Rulemaking
NSUBS	National Survey of the Use of Booster Seats
PCI	Passenger Compartment Intrusion
RSC	Roll Stability Control
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users, which went into effect on August 10, 2005
SAS	Statistical analysis software produced by SAS Institute, Inc.
SSF	Static Stability Factor
SUV	Sport Utility Vehicle
TPMS	Tire Pressure Monitoring System
TREAD	Transportation Recall, Enhancement, Accountability and Documentation Act of 2000
TTI(d)	Thoracic Trauma Index for the dummy in a side-impact test
TTMA	Truck Trailer Manufacturers Association
UMTRI	University of Michigan Transportation Research Institute
VIN	Vehicle Identification Number

EVALUATIONS NEARING COMPLETION

Crashworthiness

Cost of advanced frontal air bags

Background: In 2000, NHTSA amended FMVSS No. 208 to make future air bags substantially less hazardous to out-of-position occupants, but also more effective for correctly positioned occupants. These "advanced" air bags are being implemented step-by-step. Model years 2004 to 2006 phased in air bags that either do not deploy at all for children ("suppression"), deploy only at a low level of force ("low-risk deployment"), or track an occupant's motion and suppress the air bag if they are too close ("dynamic automatic suppression"). Their technology includes sensors that detect the weight and/or position of an occupant. Furthermore, these air bags need to pass barrier and offset tests with 5^{th} percentile female dummies in addition to a barrier test with a 50^{th} percentile male dummy.

Objective: Perform and establish reliable consumer cost and weight estimates for technology associated with the entire driver and passenger frontal air bag systems (including knee air bag systems) in model year 2007 production vehicles.

Approach: The cost of components used in advanced frontal air bags is estimated by "teardown" studies of the assembly that are performed in reverse order of the manufacturing assembly process. At each step, the assembly, subassembly, or component is identified, weighed, and photographed. Information, such as type of operator, cycle time, tooling definition, and equipment definition, is recorded on a process sheet. When all of the process sheets have developed for a system, cost data (i.e., variable manufacturing cost, end user cost) for each step and ultimately for the complete assembly is calculated. The "teardown" studies include an air bag system used on a passenger vehicle produced in each of the three major automobile manufacturing areas: U.S. (domestic), Asia, and Europe. The studies also include an air bag system used on a domestic SUV.

Status: Completion of the cost study is expected in Summer 2008.

Crash avoidance

Cost to maintain and repair ABS on heavy tractors and trailers

Background: FMVSS Nos. 121 and 105 mandated antilock braking systems on all vehicles with a GVWR over 10,000 pounds, with a 1997-1999 phase-in. This was the second time FMVSS No. 121 had gone into effect. An earlier mandate, in 1975 was rescinded, partly because ABS systems with the technology then available were not durable and not maintained in service. Therefore, the durability and repair costs of current ABS are of particular interest. In advance of the mandate, NHTSA published reports that assessed the maintenance and repair expenses of prototype ABS systems. Also underway is a related project to assess the crash-avoidance abilities of ABS-equipped heavy vehicles (see below).

Objectives: Estimate the average monthly cost to maintain and repair the ABS system on tractors and trailers. This analysis differs from earlier NHTSA assessments because it addresses production ABS, not prototypes. For that reason, the numbers of fleets and vehicles are also much larger in the present study.

Approach: A contractor assembled a database with a census of repair receipts from 13 trucking fleets from about 2000 to 2003, with over 4,000 vehicles total. The monthly cost of repairing and maintaining ABS is calculated from the database. Moreover, the effect of ABS, if any, on maintenance expenses to the brake system as a whole is assessed by comparing expenses for ABS-equipped vehicles to those for non-ABS-equipped vehicles.

Status: A report is currently circulating for comment in NHTSA.

Behavioral safety/injury control

How States achieve high seat belt use rates

Background: Seat belt use is the single most important factor in preventing serious crash-related injuries and fatalities and in reducing economic costs associated with traffic-related crashes, injuries, and deaths. Lap/shoulder seat belts, when used, reduce the risk of fatal injury to front-seat passenger car occupants by 45 percent and the risk of moderate to critical injury by 50 percent. While 49 States, the District of Columbia, and Puerto Rico have laws requiring seat belt use, in 2006 belt usage in individual States varied substantially, with usage ranging from a low of 63 percent to a high of 96 percent.

Objectives: NHTSA would like to discover the ingredients that contribute to seat belt use in high-belt-use States, as well as to identify strategies that other States could employ to increase belt use.

Approach: Statistical analyses of demographic and geographic data in high-belt-use States and in comparison low-belt-use States were performed to identify components that may contribute to belt use increase. Additional statistical analyses were completed to analyze the relationship between media campaigns, enforcement and seat belt use, as well as the relationship between seat belt law/use and fatality rates. Site visits were conducted with State personnel in 10 high-belt-use States to outline program and other characteristics of these high-belt-use States.

Status: The report is undergoing final review within NHTSA.

EVALUATIONS UNDERWAY, STARTED BEFORE 2008

Crashworthiness

Effectiveness of head injury protection (FMVSS No. 201 upgrade)

Background: FMVSS No. 201 – Occupant Protection in Interior Impact – was upgraded in 1995, with phase-in during model years 1999 to 2003, to reduce occupants' risk of head injury from contact during crashes with a vehicle's upper interior, including its pillars, roof headers, and side rails, and the upper roof. Initially, energy-absorbing materials alone were used to meet the standard; by model year 2005, over 25 percent of new vehicles were also equipped with head-curtain air bags. NHTSA has evaluated the cost of the FMVSS No. 201 upgrade (2003 and 2004) and the effectiveness of head curtains based on statistical analysis of crash data (2007). In 2006, *HIC Test Results before and after the 1999-2003 Head Impact Upgrade of FMVSS 201* were analyzed. The results showed that energy-absorbing materials had reduced the Head Injury Criterion on headform impact tests by an average of 242 units of HIC. However, the agency has not yet evaluated energy-absorbing materials based on statistical analyses of crash data.

Objective: Estimate the effect of FMVSS No. 201 padding and energy-absorbing materials on the risk of fatal and serious head injuries in cars and LTVs. (A follow-up evaluation of the effect of head curtains on these injuries is a separate project. See "Side air bags and head-protection air bags: follow-up study.")

Approach: Head injury rates due to contact with the upper interior are compared in CDS data for pre-standard vehicles versus post-standard vehicles with energy-absorbing padding. Head injury rates are also compared for pre- versus post-standard vehicles in the FARS Multiple Cause of Death (MCOD) file. (The FARS-MCOD file does not indicate the source of the injury.)

Status: CDS and FARS-MCOD analyses are underway. A report will be issued by 2009, or later if these files did not yet contain sufficient data for statistically meaningful analyses.

Injury vulnerability and adequacy of current vehicle interiors for older occupants

Background: Older occupants have high injury and fatality risk in crashes. For each year of increasing age, the probability of severe injury or death, given the same physical insult, increases by several percent. The increase, however, is not uniform, but depends on the type of injury, the design of the vehicle, and the crash configuration. NHTSA evaluations found that some safety devices, such as seat belts (especially in the back seat) and perhaps the early frontal air bags, may be less effective for older occupants. These considerations suggest comprehensive review of older occupants' vulnerability to injury and of the adequacy of current vehicle interiors and safety devices for protecting older occupants.

Objectives: Compare the injury sources, types, and severities of older and younger occupants in various types of crashes, and identify situations where older occupants are especially vulnerable. Estimate the effectiveness of various safety devices as a function of the occupant's age.

Approach: Statistical analyses of CDS data compare the injury sources and patterns of younger and older occupants, by crash type. FARS analyses compare occupant fatality risk by occupant age and crash type. The FARS-MCOD file permits these analyses to also consider the type of injury. Effectiveness analyses for specific safety technologies are repeated, with the same methods and data as earlier NHTSA evaluations, expanding the data sets when necessary to permit statistically meaningful separate estimates for various occupant age groups.

Status: CDS, FARS, and FARS-MCOD analyses are underway. Completion is expected in 2009.

Effectiveness of seat belt pretensioners and load limiters

Background: Some seat belts may be more effective than others. Two technologies for improving the performance or use of belts, pretensioners and load limiters, are becoming more widely available in the current fleet of vehicles. Although they are not mandatory for meeting NHTSA standards, the agency regards them with favor and provides consumer information on their availability for drivers and right-front passengers, by make and model, in *Buying a Safer Car*. Seat belt pretensioners (installed in the front-outboard seats on 83% of MY 2005 light vehicles) retract the seat belt to remove any slack almost instantly in a crash. Load limiters (installed on 89% of MY 2005 light vehicles) prevent belt forces from reaching unsafe levels by causing parts of the seat belt to stretch or deform at a predetermined, safe force level. NHTSA's Phase 1 evaluation showed that the combination of pretensioners and load limiters significantly reduces HIC, chest acceleration, and chest deflection scores on 35 mph frontal NCAP tests.

Objectives: Compare the overall fatality- and serious-injury-reducing effectiveness of conventional seat belts and the effectiveness of belts equipped with one or more of these improvements, in all crashes and in frontal crashes, for drivers and right-front passengers. Estimate the effect of pretensioners and load limiters on fatal and serious head, chest, and abdominal injuries. Look at the effectiveness of each technology by seating position, to determine whether they perform differently.

Proposed Approach: Information will be obtained from NHTSA's *Buying a Safer Car* about the initial installation dates of these technologies, by make and model, and manufacturers will be contacted if necessary for clarification. Statistical analyses of FARS data, such as double-pair comparison analyses, will be used to estimate overall belt effectiveness before and after the introduction of the belt improvements, in all crashes and in frontal crashes. Injury rates by body region, before and after the belt improvements, will be compared in CDS data and in the enhanced FARS file that includes cause-of-death information (FARS-MCOD).

Status: The Phase 1 evaluation, "NCAP Test Improvements with Pretensioners and Load Limiters" was published in March 2003. Preliminary FARS analyses have been attempted for several years, but so far there is insufficient data for statistically meaningful results. The proposed evaluation will be completed when sufficient FARS data accumulates.

Effectiveness of integrated seat belts

Background: Integrated seat belt systems mount the entire seat belt directly to the seat, rather than to the floor or pillar. Integrated systems are intended to provide a more consistent and comfortable fit and more effectively hold occupants in their seats during crashes. NHTSA does not require integrated seat belt systems, but some manufacturers are installing these systems in some of their vehicles in several seating positions. In MY 2005, approximately 26 percent of all light vehicles were equipped with integrated seat belts for drivers and right-front passengers, with some vehicles also offering them in the second row for the inboard seating position.

Objective: Determine the effectiveness of integrated seat belts in reducing fatalities and injuries for drivers and right-front passengers. Compare the fatality and injury rates of occupants using integrated seat belts, non-integrated seat belts, and no belts. Examine effectiveness by type of crash (frontal, side, rear-end and rollover). If possible, compare the use rates of integrated and nonintegrated seat belts.

Proposed Approach: Statistical analyses of FARS and CDS crash data will be used to compare fatality and injury risk of occupants using integrated seat belts, nonintegrated seat belts, and no belts. Compare NCAP test performance of dummies protected by integrated versus nonintegrated seat belts. If any States will be collecting make-model information in their belt use surveys, compare belt use in the make-models with integrated and non-integrated seat belts. Preliminary FARS analyses have been attempted for several years, but so far there is insufficient data for statistically meaningful results. The proposed evaluation will be completed when sufficient FARS data accumulate.

Belt effectiveness and use in fatal crashes, based on EDR

Background: The number of manufacturers and vehicle models with event data recorders continues to grow. They have generally been widespread in the General Motors fleet since 1995, Ford since 2001, Toyota since 2003, and Chrysler since 2005. NHTSA uses data from EDRs to enhance its crash reconstruction and analysis. As the newer, EDR-equipped vehicles enter the active fleet, the supply of EDR data should increase. Questions of data ownership and privacy are still being resolved, as States enact legislation. Generally, ownership of the EDR data is granted to the owner of the vehicle, with permission for researchers to access the data provided that the owner is unidentifiable. NHTSA published a Final Rule applicable to vehicles produced after September 1, 2012. It stipulates a list of data elements that must be recorded if a vehicle has an EDR, but the rule does not require that an EDR be installed. If a manufacturer does not wish to comply with the data elements, vehicles can be produced and sold without an active EDR. Belt use on crash data files has long been considered over-reported, especially for uninjured and slightly injured occupants. EDR data make it possible to check belt use reported on crash files. For example, in the case of CDS, a DOT report showed many reported belt users were actually unrestrained according to the EDR.

Objective: Obtain EDR data on belt use for as many fatal crashes as possible. Compare belt use, as reported in FARS and by EDRs, as a function of fatality outcome, occupant age, crash type, vehicle type and environmental conditions. Assess the fatality-reducing effectiveness of seat belts in FARS by using EDR-reported belt status in place of FARS-reported belt usage. If survivors are using seat belts *less frequently* than reported, then the effectiveness for those who are truly buckled would be lower than the estimates obtained based on FARS-reported belt use.

Proposed Approach: A research group at Virginia Polytechnic Institute collects EDR data from CDS and CIREN cases. There are 2,269 CDS records available for 2000-2005. These cases are a starting point for comparing FARS-reported and EDR belt use. However, relatively few of these cases will be on FARS, precluding more detailed analyses such as effectiveness estimates. Therefore, NHTSA will continue to search for other sources of EDR readouts of crash-involved vehicles.

Rear impact guards for heavy trailers (underride protection, FMVSS Nos. 223 and 224)

Background: NHTSA issued FMVSS Nos. 223 and 224 in January 1996 to reduce the number of deaths and serious injuries that occur when light-duty vehicles collide with the rear end of trailers and semi-trailers. FMVSS No. 223 specifies the height, width, length, and strength requirements for rear impact guards for trailers and semi-trailers; FMVSS No. 224 establishes requirements for the installation of rear-impact guards on trailers and semi-trailers with GVWRs of 10,000 pounds or more manufactured on or after January 24, 1998. However, the Truck Trailer Manufacturers Association had already issued a voluntary Recommended Practice in April 1994 that included all the essential elements of the subsequent NHTSA standards except for the energy absorption requirement. Between January 1952 and January 1998, trailers and semi-trailers were federally regulated by Federal Motor Carrier Safety Regulations (FMSCR) or their predecessors that mandated rear-impact guards. These regulations allowed substantially smaller guards than the current NHTSA standard and the TTMA recommended practice, and imposed no strength tests on the guards. FMVSS Nos. 223 and 224 do not apply to pole trailers, pulpwood trailers, low-chassis vehicles, special purpose vehicles, “wheels back” vehicles, or temporary living quarters.

Objectives: Evaluate the effectiveness of the new rear-impact guard safety standard. Compare the crash performance of guards on trailers meeting the NHTSA standard and/or TTMA recommended practice to the smaller “pre-TTMA” guards on trailers meeting only the 1952 FMSCR standard. Compare the striking vehicle (car, pickup truck, SUV, or van) passenger compartment intrusion (PCI) underride rate of the “pre-TTMA” guard and the PCI underride rate of the new NHTSA and/or TTMA guard for trailers. Examine the crash performance of the rear-end structures of single-unit trucks. Estimate the cost per vehicle for the initial installation and subsequent maintenance of the rear-impact guard.

Approach: NHTSA obtained medium- and heavy-truck crash data from the North Carolina State Highway Patrol for a period of two to three years. Because some type of rear impact guard was installed on most trailers even before FMVSS Nos. 223 and 224 were in effect, a conventional “before versus after” statistical study is unlikely to show significant differences. Statistical analyses of the effectiveness of the new NHTSA rear impact guard will be assessed using the North Carolina State Police accident reports and the NHTSA supplemental crash report forms, along with statistical analyses of Florida crash data (which specify the model year of the trailer). In addition, the long-term trends of fatalities in underride and rear-impact crashes will be studied in FARS. The cost for the initial installation of the rear impact guard will be estimated from “teardown” analyses or from information provided by manufacturers.

Status: Collection of North Carolina crash data was successfully completed in September 2007. Creation of a SAS database is underway. Statistical analyses will begin in fall 2008. A draft report addressing the maintenance and repair costs for rear impact guards is currently circulating for comment in NHTSA.

Fatalities in frontal impacts despite seat belts and air bags

Background: The combination of seat belt use and frontal air bags is highly effective in frontal impacts, reducing front-seat occupants' fatality risk by an average of 61 percent compared to an unbelted occupant in a vehicle without air bags. Nevertheless, that means 39 percent of the fatalities are not being prevented. Whereas the safety community is generally aware of factors that make specific crashes fatal – e.g., extreme crash severity, compartment intrusion, frailty of the occupant – there is a need for quantitative information on the relative frequency of these factors, and how often they occur in combination.

Objective: Analyze a nationally representative set of fatalities of belted occupants in frontal impacts of late-model vehicles equipped with air bags. Identify the primary and secondary factors that made each impact fatal, including the crash configuration, the performance of the vehicle structure and restraint systems, the crash partners (other vehicles or objects struck) and the condition of the occupant.

Approach: The CDS file for 1999-2007 contains a nationally representative sample of well over 100 belted fatality cases in frontal impacts of model year 2000 and later vehicles. A team of NHTSA researchers including crashworthiness engineers and crash investigation specialists will review the cases, identify the factors that resulted in a fatality, and quantify the relative frequency of these factors.

Status: During 2007, based on reviewing a subset of the cases, NHTSA developed a team approach, strategy, and template for reviewing CDS cases and identifying factors that resulted in fatal injuries. The full set of CDS cases will be reviewed during calendar year 2008.

Inflatable curtain air bags with rollover sensors

Background: By MY 2005, over 25 percent of new vehicles were equipped with head curtain air bags to enhance protection against head injuries, meeting requirements of FMVSS No. 201, and to help prevent occupant ejection through side windows. Rollovers, however, did not always trigger the deployment of these head curtains, and even when deployed, the head curtains did not always stay inflated until the vehicle stopped rolling over. Given the large number of fatalities in rollover crashes, particularly among SUVs, many of these inflatable curtains have been coupled with rollover sensors that deploy the airbags when they detect the possibility that the vehicle is rolling over. Inflatable curtains with rollover sensors are not mandatory, but NHTSA regards them with favor and provides consumer information on their availability, by make and model, in *Buying a Safer Car*. They are also a technology potentially useful for meeting a future ejection mitigation standard. The SAFETEA-LU legislation requires NHTSA to issue a Final Rule no later than October 1, 2009, to reduce ejections of vehicle occupants from outboard seating positions.

Objectives: Study the effect of inflatable curtains with rollover sensors on fatality rates, head-injury rates, and occupant ejection rates in rollovers. Estimate the added cost of the rollover sensors and any other features added or enhanced in curtain bags to make them effective in rollovers.

Proposed Approach: FARS, GES, and CDS data will be analyzed by methods developed in earlier evaluations of side air bags to determine the effect of inflatable curtains with rollover sensors on fatality and serious-injury risk, as well as the effect of inflatable curtains with rollover sensors on occupant ejection. The cost of these air bags will be estimated from "teardown" analyses. The evaluation may require two to three years or more until sufficient FARS data accumulate for a definitive, final report.

Crash avoidance

ABS for heavy trucks, tractors and trailers (FMVSS No. 121)

Background: In 1996, NHTSA amended FMVSS No. 105 (hydraulic brake system) and FMVSS No. 121 (air brake system) to require ABS and a malfunction indicator lamp on all new heavy vehicles (GVWR greater than 10,000 pounds). Implementation was performed over a three-year period: air-brake truck tractors manufactured on or after March 1, 1997, air-brake trailers and single-unit trucks manufactured on or after March 1, 1998, and hydraulic-brake trucks manufactured on or after March 1, 1999. The purpose of ABS is to help maintain directional stability and control during braking and possibly reducing stopping distances on some road surfaces, especially on wet roads. ABS may prevent crashes involving loss of control, skidding, jackknife, and possibly trucks with conventional brakes unable to stop in time to avoid hitting another vehicle.

Objectives: Estimate the effects of ABS on truck tractors and trailers involved in single-vehicle and multivehicle crashes (especially crashes involving loss of control, skidding, or jackknife) by road surface condition. Estimate the cost per vehicle for the initial installation and subsequent maintenance of ABS and its related control and malfunction warning systems.

Approach: NHTSA has obtained medium- and heavy-truck crash data from the North Carolina Highway State Patrol for a period of 2½ years. Every crash from February 2005 through September 2007 involving a tractor-trailer, a bobtail tractor, or a medium or heavy single-unit truck was investigated. The North Carolina State Police accident reports and NHTSA-supplied supplemental crash report forms were sent to NHTSA. The effectiveness of ABS will be statistically analyzed using the North Carolina data, along with FARS and possibly other State crash data files. Crash involvement rates will be compared for ABS and non-ABS vehicles, for various types of crashes where ABS is likely to be effective (loss-of-control, skidding, jackknife, multivehicle) versus a control group of crash involvements that do not involve braking. In addition, information about what vehicles were equipped with ABS before the standard's effective date will be obtained from truck and trailer manufacturers. The cost for the initial installation of ABS has been estimated from "teardown" analyses. Maintenance costs, durability, and reliability of the ABS are discussed elsewhere in this plan (see "Evaluations Nearing Completion").

Status: Collection of North Carolina crash data was successfully completed in September 2007. Creation of a SAS database is underway. Statistical analyses will begin in fall 2008. The cost study for the initial installation of ABS has been completed.

ABS: long-term effectiveness in cars and LTVs

Background: Initial studies of existing ABS for LTVs (1993) and passenger cars (1995) did not show a significant overall fatality reduction. Benefits for multivehicle crashes on wet roads and for pedestrian crashes were offset by increases in run-off-road crashes including rollovers. Extensive research by NHTSA and others never really explained the observed increase in run-off-road crashes (although one study hinted at a combination of impaired driving and inexperience with ABS). Subsequent crash analyses (1998-2001) suggest these negative effects may have waned, but still didn't show a significant net fatality reduction. ABS is due for a follow-up evaluation, because the public has received extensive information about how to use ABS, and many years of on-the-road experience with the systems. The design of ABS may also have changed over the years.

Objectives: Determine the effect of ABS, if any, on fatal and non-fatal crashes, by crash type, vehicle type and model year, vehicle age, driver characteristics, and roadway/environmental characteristics. Track the effect of ABS on run-off-road crashes over time. Identify groups of drivers, if any that currently experience significant reductions in crashes or fatalities with ABS.

Proposed Approach: Statistical analyses of the effectiveness of FARS and State crash data files and registration data: crash involvement rates will be compared for recent-ABS, early-ABS and non-ABS vehicles, for various types of crashes where ABS might have an effect relative to a control group of crash involvements that do not involve braking, or on a per-vehicle-year basis.

Status: Statistical analyses are underway. Completion of a draft report is expected in summer 2009.

Behavioral safety/injury control

Review of State motorcycle safety programs

Background: More than 100,000 motorcyclists have died in traffic crashes since the enactment of the Highway Safety Act of 1966. The number of motorcyclist fatalities greatly decreased from 1980 to 1997, but from 1997 to 2006, fatalities more than doubled. In 2006, 4,810 motorcyclists were killed and an additional 88,000 were injured in traffic crashes in the United States. Both fatalities and injuries increased from 2005 totals. NHTSA's focus in the motorcycle safety arena centers on preventing motorcycle crashes, decreasing motorcycle crash injuries and fatalities, increasing the proportion of properly licensed motorcyclists, promoting motorcycle safety education, supporting helmet laws, and encouraging use of helmets and other protective gear. Rider education has been a priority in NHTSA grants and State motorcycle safety programs.

Objective: Collect information regarding motorcycle safety programs, especially regarding the effectiveness of rider training programs and efforts to reduce alcohol-related motorcycle fatalities. Investigate the relationship between State spending on motorcycle safety programs and motorcycle-related fatalities and injuries. Determine if funding is effectively focused on motorcycle safety issues.

Proposed Approach: Survey State Motorcycle Safety Administrators and/or State Highway Safety Offices on program management, licensing, training, grants and funding, impaired riding enforcement and other topics. Possibly interview and/or visit officials involved with the State's motorcycle safety program, for further information and/or collection of related material (training manuals, public service announcement videos, etc.). Review State Motorcycle Assessment recommendations and examine their implementation (which recommendations were adopted, which were not, and, in either case, why). Review motorcycle crash data. Correlate available spending data with the crash data. Compare motorcycle crash rates and characteristics, especially those of young drivers, in States with extensive rider education programs and States without such programs (taking into account external factors such as climate and population density). The evaluation may require three years, depending on the extent of data collected about State programs.

Status: A contract was awarded in September 2006. The study is in progress, expected to be completed by spring 2009.

Effectiveness of booster seats/effectiveness of child safety seats with LATCH

Background: NHTSA seeks to ensure that all children up to age 16 are properly restrained in the correct restraint system for their age and size every time they travel in a motor vehicle. Child restraint systems (CRSs) are the preferred method of restraint for the youngest children up to around age 4 and 40 pounds, but CRSs need to be correctly installed in order to provide the greatest benefit. CRSs installed with seat belts are not always installed as tightly as recommended. Lower Anchors and Tethers for Children (LATCH) is an installation system created (with an amendment to FMVSS No. 213 and the establishment of FMVSS No. 225) to help standardize the way CRSs are attached to vehicles without using seat belts, and to increase correct installation of CRSs. NHTSA recommends that children who have outgrown child safety seats, are less than 8 years old, and are less than 4'9" tall should be in booster seats. When properly used, booster seats can help prevent injury to older children by making adult-sized seat belts fit more effectively. Without a belt-positioning booster seat, the lap belt can ride up over the child's stomach and cause serious internal injuries in a crash, and the shoulder belt can cross the face, causing the child to slide out from underneath it, resulting in serious injury to the head, face, and neck.

Objective: Estimate the effectiveness of LATCH in reducing fatality and injury risk to children who are involved in crashes. Compare the fatality and injury rates of children up to 4 years old in CRSs attached to vehicles with seat belts and CRSs attached to the vehicles with LATCH. Estimate the effectiveness of booster seats in reducing fatality and injury risk to children. Compare the fatality and injury rates of children 4 to 7 years old in booster seats, seat belts, and no belts.

Proposed Approach: Statistical analysis of FARS, CDS, and State crash data, by methods similar to those used in the 1986 evaluation of safety seats, in order to assess the relative fatality and injury risk to children up to 4 years in CRSs attached with seat belts and/or LATCH, and to assess the relative fatality and injury risk to children 4 to 7 years old restrained with booster seats, or with the vehicle's seat belts only, or not at all. Other sources of CRS and booster seats use data such as the National Survey of the Use of Booster Seats (NSUBS) will also be explored.

Status: Preliminary analyses have been begun in-house. The evaluation may require several years until sufficient data accumulates.

EVALUATIONS STARTED/PLANNED TO START IN 2008

Crash avoidance

Red versus amber rear turn signals

Background: FMVSS No. 108 requires red stop lamps but permits rear turn signals to be either red or amber in color. Standardization to amber could serve to reduce ambiguity in determining whether a leading vehicle was slowing down or turning. There has been no research, either laboratory-based or with crash data, suggesting that *red* turn signals could be more effective than amber. Nonetheless, statistical studies in the 1980s did not favor *amber* enough to warrant a rule that all turn signals be amber. The fact that color discrimination decreases in peripheral vision could limit the advantage of amber. Apparent benefits for amber may also be confounded by rear turn signal construction: red turn signals sometimes share the housing and function with the brake lights, whereas amber turn signals are always physically separated from the brake lights. NHTSA has reopened the question of red versus amber turn signals by sponsoring a research study at the University of Michigan Transportation Research Institute.

Objective: Determine if cars/LTVs with amber rear turn signals are less likely to be struck in the rear during maneuvers when the turn signal is typically engaged (i.e., turning, merging, changing lanes, parking), compared to cars/LTVs with red turn signals.

Approach: Analyses of State data files that complement the methods of the UMTRI study. In order to control for driver demographics and between-model differences in turn signal configuration, NHTSA will limit its analyses to specific models that changed signal color from red to amber, or vice versa, and to at most two model years before and after the change. Because the analyses are limited to these specific makes and models, it will need to include data from a large number of States over many years.

Cost of Tire Pressure Monitoring Systems (TPMS)

Background: FMVSS No. 138 requires TPMS that warn the driver when a tire is significantly underinflated. Improperly inflated tires pose a safety risk, increasing the chance of skidding, hydroplaning, longer stopping distances, and crashes due to flat tires and blowouts. The Final Rule was issued on April 8, 2005, and a phase-in period from October 5, 2005, to September 1, 2007. A vehicle's TPMS must warn the driver when the pressure in one or more of the vehicle's tires, up to a total of four tires, has fallen to 25 percent or more below the placard pressure, or a minimum level of pressure specified in the standard, whichever pressure is higher.

Objectives: Perform and establish reliable consumer cost and weight estimates of TPMS that meet NHTSA's Final Rule in production vehicles.

Approach: The cost of components used in TPMS will be estimated by "teardown" studies. They will include a system used in passenger cars (i.e., small, mid-size, and high-end cars) and LTVs (i.e., sports utility vehicles, extended-cab pickups, and large vans) produced in each of the three major automobile manufacturing areas: U.S. (domestic), Asia, and Europe. Completion of the cost study is expected in early 2009.

Windshield wiper headlamp activation

Background: Particularly during daylight hours, drivers may be unaware of their own vehicles' lack of conspicuity when it rains. Requiring headlights to be on whenever it rains, or when a vehicle has its windshield wipers on, can increase a vehicle's visibility, thus reducing collisions with other vehicles sharing the road. Currently 20 States have laws requiring vehicle headlights be on whenever it is raining and/or windshield wipers are active. In 1988 South Carolina became the first State to enact such a law. Kansas was the most recent State to adopt this law, in May 2006.

Objectives: To determine whether vehicles with headlights on are substantially more visible in the rain during daylight hours, and whether this translates into fewer crashes, injuries, and fatalities when a law requires headlights be active at such times.

Proposed Approach: Using State data for those States with such laws, examine the ratio of multivehicle to single-vehicle crashes, during daylight hours when it is raining, before and after the law took effect. Examine crash rates during rain, in States with such laws and comparable States without such a law. In addition, NHTSA may test the conspicuity of vehicles in the rain (lights on versus lights off) in a laboratory or other controlled situation.

Behavioral safety/injury control

Characteristics of hit-and-run pedestrian crashes

Background: The proportion of pedestrian/bicyclist fatalities in which the driver of the striking vehicle fled the scene (hit-and-run) has increased significantly from about 16 to 17 percent in the late 1990s to over 19 percent in 2005 and 2006. While it is not known for what reasons drivers flee the scene, some hypotheses can be made to their reasons—impairment from alcohol and/or drugs, fear of stopping in a particular neighborhood, illegal aliens' fear of dealing with police and fears of people with criminal records or outstanding warrants. From

1997 to 2006, the percentage of pedestrian/bicyclist fatalities for hit-and-run crashes varied by State with the highest percentage of fatalities in Washington, DC (32%) and the lowest in Maine (6%). However, there is a strong tendency for States with the highest apprehension rates to also have the lowest proportion of hit-and-run drivers.

Objectives: Develop a profile of hit-and-run drivers and their victims. Determine whether there are common characteristics or trends within this crash type, as well as what kinds of penalties are implemented. Identify potential countermeasures to reduce this crash type.

Proposed Approach: A contractor will conduct an assessment of hit-and-run pedestrian crashes, as well as the resulting enforcement and judicial responses. A review of the literature on hit-and-run crashes will be conducted. Analysis of FARS, State, and other data, along with a review of enforcement and court records will be conducted for up to nine States. An expert panel meeting will be convened at which time findings will be presented/reviewed before a final report is prepared. The final report will include a series of profiles of hit-and-run drivers and victims, along with selected countermeasures that are most likely to influence the pre-crash behaviors of the drivers and victims.

Effect of EMS response and transport time on fatality risk/automatic crash notification

Background: NCSA plans to analyze the effect of Emergency Medical Services' (EMS) response times – i.e., the time lapse from crash to medical care – on fatality risk and injury severity. By extension, these results could identify situations where automatic crash notification (ACN) confers the greatest benefit, as it may result in faster EMS response time to crash scenes. There is a belief that ACN is of greatest benefit in rural settings, where crashes are more likely to be unobserved and thus allowing more time to elapse before EMS is contacted. The "Golden Hour" is a long-established medical concept that holds that patient survival rates are highest when medical care is administered as promptly as possible. The precise benefits depend on the type of injury/illness, and this project would help quantify life-saving benefits of reduced response time to motor vehicle crashes. General Motors' OnStar subscription service has been available on some models since 2002 and is available on more than 50 2008 GM models. OnStar can automatically place a call to an operator, who in turn contacts emergency services, in the event of an air bag deployment.

Objective: Investigate relationships between EMS response time and survival rates for specific types of injuries. Data is needed to assess whether EMS contact and response times vary by setting and to test for a correlation between the time lapse from crash to medical care and the fatality risk/cost of specific injuries. Crash characteristics will be evaluated to determine when/where ACN could have the greatest benefits (e.g., urban versus rural, interstate versus local roadway, day versus night).

Approach: Two data sources have been identified which may be used to assess EMS response times. A request was submitted to determine the feasibility of acquiring data from the Crash Outcome Data Evaluation System (CODES). The National EMS Information System (NEMSIS) should become accessible within this proposal's timeframe, as more States join and submit data. Because of variability in EMS organization among municipalities, the coordination of data reporting, first to State-level and then nationally, is complicated.

EVALUATIONS STARTED/PLANNED TO START IN 2009

Crashworthiness

Effectiveness of advanced air bags

Background: In 2000, NHTSA amended FMVSS No. 208 to make future air bags substantially less hazardous to out-of-position occupants, but also more effective for correctly positioned occupants. These "advanced" air bags are being implemented step-by-step. MY 2004 to 2006 vehicles phased in air bags that do not deploy at all for children ("suppression"), deploy only at a low level of force ("low-risk deployment"), or track occupants' motion and suppress the air bags if they are too close ("dynamic automatic suppression"). Their technology includes sensors that detect the weight and/or position of an occupant. Furthermore, these air bags need to pass a barrier and offset test with 5th percentile female dummies in addition to a barrier test with the 50th percentile male dummy. A 35 mph barrier test with the belted 50th percentile male dummy, an increase in velocity from the current 30 mph, is being phased in for MY 2008 to 2010. MYs 2010 to 2012 will phase in the same velocity increase for the belted 5th percentile female dummy.

Objective: Monitor the overall fatality-reducing effectiveness of advanced air bags, and compare it to pre-2004 air bags. Estimate their effectiveness for child passengers, small adult drivers, and in offset or oblique frontal crashes. Monitor the performance of suppression and low-risk deployment systems in actual crashes. Compare the seating distribution of child passengers with advanced air bags and pre-2004 air bags to find out if more children are sitting in the front seats.

Proposed Approach: Statistical analyses of FARS data, similar to those in NHTSA's *Evaluation of the 1998-1999 Redesign of Frontal Air Bags*, will be used to estimate the fatality-reducing effectiveness of advanced air bags, overall and for selected populations or crash types. The NASS Crashworthiness Data System, possibly supplemented with additional data elements, will provide data on the crash performance of suppression and low-risk deployment technologies. The Special Crash Investigations program will furnish initial results on a case-by-case basis. State crash data will show if there has been any change in the distribution of child passengers' seating positions. This evaluation will continue for five years or more, as new designs of advanced air bags are phased in; however, NHTSA will issue interim reports for important findings.

Crash avoidance

Survey of TPMS effect on tire pressure

Background: Tire pressure monitoring systems were mandated in FMVSS No. 138 and are now required on all light vehicles as of September 1, 2007, after a phase-in that began on October 5, 2005. Before this, in February 2001, NHTSA conducted a survey of 11,530 passenger vehicles (6,442 passenger cars and 5,088 LTVs). The data was collected at a sample of gas stations located within the sites of the NASS CDS. In the 2001 survey, 26 percent of the cars and 29 percent of LTVs had at least one tire more than 25 percent below the pressure indicated on the placard. The placard is the marker on the inside of the driver side door that specifies the tire pressure recommended by the manufacturer. The goal of TPMS is to increase driver awareness of tire pressure, and promote regular tire inflation. Improperly inflated tires pose a safety risk, increasing the chance of skidding, hydroplaning, longer stopping distances and crashes due to flat tires and blowouts.

Objectives: Conduct another survey of tire pressure relative to placarded tire pressure and compare results to 2001 survey. Compare the results of the new survey for vehicles with and without TPMS. In addition, inquire as to the driver's familiarity with the TPMS warning and their action, if any after the warning had been given.

Proposed Approach: Conduct the survey again at gas stations within the NASS CDS sites, a follow-up of the 2001 survey. That will allow comparison of data before and after the regulation went into effect. The project may be completed in one year if the survey is limited to pressure monitoring, or two years if interviews are included.

Roll Stability Control and ESC for heavy trucks, tractors, and trailers

Background: Roll stability control and electronic stability control systems assist drivers to better control their vehicles before getting into or during dangerous situations such as sliding sideways and rollovers. RSC automatically applies brakes and reduces the engine throttle to counteract the tendency of a vehicle to tip over while cornering at high speed. ESC also reduces the throttle and selectively applies the appropriate individual brakes, when it senses yawing, to reduce the speed of the vehicle below the rollover risk threshold and to guide the vehicle back to its appropriate path of travel. RSC and ESC have been emphasis areas in NHTSA's safety research for heavy vehicles. Studies have shown that ESC is highly effective in reducing single-vehicle crashes including run-off-roads and rollovers in passenger cars and SUVs. We want to determine whether these systems have similar significant effects on rollover and loss-of-control crashes involving large trucks with GVWR greater than 10,000 pounds. During the last several years, the Federal Motor Carrier Safety Administration has collaborated with the trucking industry to test and evaluate several vehicular stability systems including RSC and ESC for commercial motor vehicles. On July 2005, FMCSA published a report promoting voluntary adoption of these systems on commercial motor vehicles.

Objectives: Evaluate the effectiveness of RSC, ESC, and combined systems on rollovers and loss of control crashes.

Proposed Approach: Statistical analyses of the effectiveness of vehicular stability systems in vehicles with these systems and those without will be assessed using FARS and State crash data (if VIN information is available). If not, NHTSA plans to collect heavy-truck crash data from one or more large State police agencies to obtain additional information including the VINs. Information on installation of these systems will be obtained from manufacturers. The timeframe of the study depends on the installation rate during the next few years.

Effectiveness of ESC: follow-up

Background: Electronic stability control systems are a safety technology designed to enhance a vehicle's stability and control in all driving situations. NHTSA's 2007 evaluation report showed that ESC significantly reduced single-vehicle crashes, especially run-off-road and rollover involvements. ESC might also be helpful in reducing culpable involvements in multi-vehicle crashes. Data in that report and other initial studies were limited to mostly luxury vehicles. Moreover, only passenger cars and SUVs had been equipped with ESC – no pickup trucks or minivans. On April 6, 2007, NHTSA issued a Final Rule to establish a new FMVSS No. 126 that requires ESC systems on passenger cars, multipurpose vehicles, trucks, and buses with a GVWR of 10,000 pounds or less. This rule requires installation of ESC systems in 100 percent of light vehicles by MY 2012.

Objectives: Study the effects of ESC systems on fatal and nonfatal single-vehicle crashes, including rollovers and impacts with fixed objects, as well as multivehicle crashes – by crash type, vehicle type and model year, vehicle age, and roadway/environmental characteristics.

Proposed Approach: ESC will be due for a follow-up evaluation in 2009. By then, a large portion of vehicles in the fleet will be equipped with ESC systems and crash data with ESC will also be more available and sufficient for detailed statistical studies. The statistical analysis could be completed within 1 year. FARS and State crash data and Polk registration data will be analyzed to compare single-vehicle as well as multivehicle crash involvement rates on vehicles with ESC and those without ESC. The cost of ESC by "teardown" studies may also be repeated if there are indications that cost has changed over time.

Behavioral safety/injury control

National historical statistical analysis of injury survivability

Background: In recent years, EMS systems, which provide crash scene services, transportation to the hospitals, and en-route life support, have vastly improved due to the technological advancement of transport vehicles and equipments. Numbers of trained and certified EMTs have increased as well. Furthermore, due to the incredible advances in biomedical engineering, pharmacology, and medical research, physicians in trauma centers/hospitals are highly skilled and better equipped with the most advanced instruments and the most effective medicines. Injury survivability is believed to have increased over the years due to the quality of medical care.

Objectives: Determine if occupants' survival rates have improved over the past two to four decades, given the same injury and controlling for occupant age/gender. Track survival rates over time for specific types of crash injuries, similar to the National Cancer Institute's statistics on survival rates since 1960 for various types of cancer, or the National Heart Institute's statistics on the survival rates for people hospitalized with heart attacks.

Proposed Approach: CDS data dating back to 1979 identifies specific crash injuries, and in theory permits calculation of the survival rate year-by-year. However, CDS is unlikely to contain enough cases of any specific injury to produce statistically meaningful trend lines for survival rates. Changes in the injury coding scheme and the fact that people often have two or more life-threatening injuries present additional challenges for the analysis. CDS will serve as a starting point for preliminary analyses. However, larger databases will be sought, containing records of people with specific injuries or combinations of injuries, including survivors and fatalities, preferably but not necessarily limited to people involved in motor vehicle crashes.

EVALUATIONS STARTED/PLANNED TO START IN 2010

Crashworthiness

LTV modifications to improve compatibility in crashes with cars

Background: When LTVs hit cars head-on or front-to-side, the fatality rates of the car occupants are in many cases even higher than would be expected, given the mass ratio of the two vehicles. This phenomenon is called "LTV-car aggressivity," and its mitigation is called "LTV-car compatibility." NHTSA has been researching LTV-car compatibility since 1993. The Alliance of Auto Manufacturers has developed guidelines for improved compatibility and expects all new LTVs will meet them by 2009. Vehicle modifications include "blocker beams" (Ford) and "compatibility brackets" (GM) designed to improve the engagement between the LTV's and the car's frames during a crash, and reductions in the height of LTV frames.

Objective: Determine if specific LTV modifications such as blocker beams, compatibility brackets, and reductions of frame height have reduced LTV-car aggressivity in head-on and front-to-side collisions.

Proposed Approach: Previous NHTSA analyses have defined several baseline "aggressivity metrics" for LTVs in collisions with cars, based on statistical analyses of FARS data in combination with GES nonfatal crash data or Polk registration files. For the specific makes and models of LTVs that have been modified to enhance compatibility, these metrics will be computed and compared before and after the change. CDS cases will be reviewed to compare the structural performance of cars struck by LTVs with and without the modifications.

Side air bags and head-protection air bags: follow-up

Background: In model year 2005, 27 percent of new cars and LTVs were equipped with head-curtain air bags, and a total of 33 percent were equipped with head curtains and/or some other type of side air bags. NHTSA's 2007 *Evaluation of Side Impact Protection* estimated that torso bags plus any type of head-protection air bags (head curtains or combination bags) reduce fatality risk for near-side occupants in side impacts by an estimated 24 percent; torso bags alone, by 12 percent. Based on the relatively limited crash data available at that time, the report also found that head curtains significantly reduced the fatality risk of far-side occupants and the risk of fatal ejection in side impacts. The 2007 evaluation promised that findings would be "updated periodically during the next five years" as more data become available. In 2007, the agency amended FMVSS No. 214, adding a crash test of a 20 mph side impact with a pole, at a 75-degree angle (i.e., 15 degrees forward of a purely lateral impact). The three-year phase-in begins on September 1, 2010. NHTSA anticipates that head-protection air bags will generally be installed to meet the new requirement.

Objective and Approach: Update the analyses and findings of the 2007 evaluation with the latest FARS and GES data, prior to the phase-in of the pole test in FMVSS No. 214. Refine the estimates of fatality reduction in near-side impacts. Obtain more definitive results for far-side impacts and ejection reduction. Compare the effect of head curtains with torso bags, head curtains without torso bags, and head-torso combination bags in near-side impacts. Estimate the effectiveness of side air bags in LTVs.

Crash avoidance

Motorcycle brake systems

Background: FMVSS No. 122 (Motorcycle Braking Systems) went into effect on January 1, 1974, and specifies performance requirements for motorcycle brake systems. On November 15, 2006, the NHTSA Administrator voted on behalf of the United States for the establishment of a global technical regulation for motorcycle brake systems. Motorcycle fatalities more than doubled from 1997 to 2006. Motorcycle brake systems, and the riders' misuse/underuse of the systems, are potential factors in many crashes. Two promising technologies are available in production motorcycles: antilock brake systems, and combined braking systems. CBS technology applies the brakes on both wheels when only one lever/pedal is applied. In 2003, NHTSA conducted a joint research project with Transport Canada to quantify the performance of a various motorcycle brake systems, including ABS and CBS, based on a series of stopping tests, on dry and adverse surfaces, with straight-line braking and braking in a curve (this study and other information can be viewed in Docket NHTSA-2002-11950). In addition, *Motorcycle Accident Cause Factors and Identification of Countermeasures* (Hurt et al., 1981), a study conducted in the late 1970s of 900 motorcycle crashes, is considered the most comprehensive study of motorcycle crash causation to date, and can provide useful information on motorcycle crash types.

Objectives: Determine the proportion of motorcycles in recent model years that are equipped with ABS or CBS, and classify the fleet by stopping-distance performance. Estimate the crash-reducing effectiveness of ABS and CBS. Determine the relationship between motorcycle stopping distances, brake types, and crash rates.

Proposed Approach: Building on the current NHTSA/Transport Canada study, develop a more comprehensive database by motorcycle make-model to determine the influence of stopping distance/brake type on motorcycle crashes. Work with the motorcycle manufacturers to (1) obtain statistics on motorcycle sales by brake type (ABS, CBS, front and rear hydraulic brakes, a combination of hydraulic and cable brakes, all cable brakes); (2) identify the brake types of crash-involved motorcycles from their VINs. Based on FARS, State crash data, and registration data, compare the crash rates/distributions of motorcycles with ABS, CBS, and conventional brakes, and of make-models with different performance levels in stopping-distance tests. Examine types of crashes in which ABS and/or CBS may help, such as rear-end, loss of control, and vehicle crossing path crashes. Estimate the effectiveness of ABS and CBS relative to conventional brakes. Estimate the effectiveness of disc/disc, disc/drum, and drum/drum configurations. The evaluation is likely to take 3 years, since it combines extensive data collection and statistical analyses.

Recent trends in the static stability factor and rollover risk

Background: Rollover crashes are one of the most significant safety problems for all classes of passenger vehicles, especially LTVs. According to the 2006 FARS, there were 11,473 vehicles involved in fatal crashes that rolled over as an initial or subsequent event. FARS shows that 22 percent of passenger vehicles in fatal crashes involved rollover. The proportion differs greatly by vehicle type: 17 percent of passenger car vehicles were involved in rollover, compared to 28 percent for pickup trucks, 17 percent for vans, and 35 percent for SUVs. The 2006 GES estimates that 274,000 vehicles were involved in rollover crashes. Nearly 85 percent of rollover crashes are single-vehicle crashes. The TREAD Act of 2000 specified that the agency develop and promulgate consumer information on the rollover performance of light trucks and SUVs. This measure of rollover resistance, the Static Stability Factor (SSF), was added to the MY 2001 NCAP tests and is reported in *Buying a Safer Car* on a scale of 1 to 5 stars. The SSF is a measure that equals one half of the track width divided by the height of the center of gravity above the road. This measurement identified the location of the center of gravity of the vehicle and correlated this to the risk of a tripped rollover crash. Linear and logistic regressions were run in 2000, using MY 1994 to 1998 vehicles, to determine and verify the relationship between SSF and rollover rate. It was found that the correlation of SSF to rollovers per single vehicle crash is remarkably robust. In 2005, NHTSA published *Trends in the Static Stability Factor of Passenger Cars, Light Trucks, and Vans*. The report tracked the trend of the SSF to determine if later models had a higher SSF (and were therefore less prone to rollover), looking in particular at changes in various passenger vehicle types. It was found that passenger cars, as a group, had the highest average SSF, and these have remained high over the years examined. SUVs have substantially improved their SSF values over time, especially after model year 2000, whereas those of pickup trucks have remained consistent over the years. Minivans showed considerable improvement since they were first introduced, while full-size vans showed a small but steady improvement.

Objectives: Update *Trends in the Static Stability Factor of Passenger Cars, Light Trucks, and Vans* to include the most current model year, again looking at both the overall trend in SSF as well as changes by type of passenger vehicle. In addition, examine crash data to look at whether there has been a trend of lower rollover rates in recent models, and compare SSF and rollover rates for earlier and later vehicles when there has been a major model redesign.

Proposed Approach: Update the earlier report using the same methods as had been used previously. Use State crash data to determine rollover rates of current as well as earlier model year vehicles. Obtain track width and height of center of gravity data on earlier model year vehicles for which NHTSA has current SSF measures, particularly those that have undergone a major design change.

Behavioral safety/injury control

Impact of LATCH on safety seat use: follow-up survey

Background: LATCH (Lower Anchors and Tethers for Children) is an installation system created to help standardize the way child restraints are attached to vehicles without using a seat belt. In March 1999, the Agency amended FMVSS No. 213 (Child Restraint Systems) and established FMVSS No. 225 (Child Restraint Anchorage Systems) in order to require two lower attachments and an upper tether on a child safety seat that anchors and connects with two lower anchors and a top tether anchor built into a vehicle's back seat. The system, which was phased in by September 1, 2002, is designed to make child safety seats easier to install correctly and to increase their effectiveness. However, in the NHTSA 2005 survey of LATCH use, it was found that 61 percent of upper tether nonusers and 55 percent of lower attachments nonusers cited their lack of knowledge – not knowing what they were, that they were available in the vehicle, the importance of using them, or how to properly use them - as the reason for not using them. In response to the report findings, NHTSA held a February 2007 public meeting to bring together a roundtable of child restraint and vehicle manufacturers, retailers, technicians, researchers and consumer groups to discuss ways to improve child safety through improving the design and increasing the use of child restraint anchorage systems. The agency developed new ease-of-use ratings for child safety seats and initiated a consumer education campaign. NHTSA's Office of Vehicle Safety is studying the ease of use of child safety seats.

Objectives: Determine if there has been a change in LATCH usage since the 2005 LATCH survey. Specifically, update the statistics on the proportion of child safety seats being installed with LATCH, the proportion of parents who find the seats easy to install, and the percent installed correctly (and if they are not being installed correctly, what types of misuse are being seen). Find out where people obtain information about LATCH installation (e.g., vehicle manufacturers, safety seat manufacturers, doctor's offices), whether the information obtained from these sources is consistent or conflicting, and what types/methods of consumer education would assist users in obtaining the information needed to use LATCH correctly. In addition, find out if there are differences in use by rural/urban designation and if the appropriate child safety seat for a child's age, weight, and height is being used.

Proposed Approach: A follow-up survey to the NHTSA 2005 survey of LATCH use will be conducted at fast-food restaurants, shopping center parking lots and similar locations, as well as at child safety seat inspection stations. The interview will include questions to the drivers about their knowledge and usage of LATCH systems, as well as their sources of education about these systems. Information on the manufacturer/type of child restraint being used will also be collected. Cost of the anchorage system in vehicles and on child safety seats will be estimated from "teardown" analyses or from information provided by manufacturers.

EVALUATIONS STARTED/PLANNED TO START IN 2011

Crash avoidance

New crash-avoidance technologies for cars and LTVs

Background: Several crash-avoidance technologies exist for informing a driver of his position in the road and alerting him to the presence of nearby vehicles. These are generally based on either a video camera or a radar device, with software used to recognize the pertinent road conditions.

Forward Collision Warning (FCW) is one such technology. When another vehicle is detected in front of the driver, an alert is given, in varying levels of intensity depending on the intervening distance. The system discriminates relevant vehicles traveling in the same lane and same direction from non-relevant vehicles and roadside objects such as barrels or embankments. The optimal environment is a straight road with a constant grade – the typical conditions on interstate highways. As a secondary benefit, the severity of crashes may be reduced if the driver is able to reduce speed prior to an unavoidable collision.

A related technology is Adaptive Cruise Control. The detection system of FCW could be integrated with the conventional cruise control to slow down automatically, if that is needed to maintain a safe distance between vehicles. The frequency of "hard-braking" events could be reduced, conferring some benefit towards reduced maintenance and repair expenses.

The Lane Departure Warning System (LDWS) is designed to alert the driver of unintended drift from the desired travel lane. The alert does not activate if the turn signal is engaged. The system should inform the driver of inoperability due to conditions such as poorly-marked roads or adverse weather conditions. LDWS could reduce the frequency of several types of crashes: (1) Center-line crossovers, leading to head-on collisions with oncoming vehicles; (2) Sideswipes and/or forced roadway departures of vehicles traveling in the same direction on multi-lane roadways; (3) Roadway departure, resulting in collisions with fixed objects (e.g., trees, barriers); (4) Rollovers, in situations where lane departures lead to over-correction. A secondary behavioral adjustment may lead to increased use of turn signals in intentional lane changes / merges, to avoid false alarms in the LDWS.

For model year 2008, FCW and/or LDWS are available on some high-end passenger vehicles from the following manufacturers: Audi, BMW, Buick, Cadillac, Infiniti, Lexus, Mercedes-Benz, Toyota, and Volvo.

Objective: These technologies would be evaluated on the basis of reducing the frequency and/or severity of crashes. Separate analysis would be conducted for cars and LTVs to determine if differences in driver characteristics, vehicle usage, and vehicle construction confer different benefits. Estimate the cost of the technologies.

Proposed Approach: As these technologies are not yet widespread, an evaluation would require special identification of equipped vehicles, e.g., retrospectively by contacting manufacturers based on the VIN of crash-involved vehicles. Because these systems mitigate specific types of crashes, any analysis would occur towards the end of this Evaluation Plan, in order to accumulate sufficient sample size for statistically meaningful results. The cost of the technologies will be estimated from "teardown" studies.

New crash-avoidance technologies for heavy vehicles

Background: FCW and LDWS are being installed on heavy vehicles as well as cars and LTVs (see above). In addition, side-object/blind-spot detection systems are designed to supplement side- and rear-view mirrors in situations where adjacent vehicles are not fully visible. Generally, a light is activated when another vehicle is detected in the blind spot. So that the driver is not distracted in irrelevant situations, the light is of low intensity and situated near the rear-view mirrors. If the turn signal is engaged while another vehicle is detected in the blind spot, a supplementary warning would activate. The Eaton VORAD® system can be installed which packages all of the above technologies. Freightliner and Volvo offer LDWS as a factory option.

Objective: These technologies would be evaluated on the basis of reducing the frequency and/or severity of crashes. Separate analysis would be conducted by vehicle type – heavy trucks, tractors, trailers – to determine if differences in driver characteristics, vehicle usage, and vehicle construction confer different benefits. Estimate the cost of the technologies.

Proposed Approach: As these technologies are not yet widespread, an evaluation would require special identification of equipped vehicles, e.g., retrospectively by contacting manufacturers based on the VIN of crash-involved vehicles. Because these systems mitigate specific types of crashes, any analysis would occur towards the end of this Evaluation Plan, in order to accumulate sufficient sample size for statistically meaningful results. The cost of the technologies will be estimated from "teardown" studies.

Behavioral safety/injury control

Lives saved by vehicle safety equipment, 1960-2009 (follow-up)

Background: NHTSA's 2004 report, *Lives Saved by the Federal Motor Vehicle Safety Standards and Other Vehicle Safety Technologies, 1960-2002* estimated that vehicle safety technologies had saved an estimated 328,551 lives through 2002. The report is based on a model that augments the actual fatality cases on FARS to estimate the number of fatalities that would have occurred if none of the FMVSS or safety technologies existed. For example, one actual belted fatality case on FARS, given that 3-point belts reduce fatality risk by 45 percent, corresponds to 1.82 hypothetical fatalities if seat belts did not exist. Case counts are expanded one step at a time, starting with removal of the most recent applicable FMVSS and working back to the earliest. The expansion factors are based on NHTSA's published effectiveness evaluations, summarized in the last section of this document. Since 2002, important new safety technologies (electronic stability control, side air bags) have been evaluated, and the earlier safety technologies have saved many additional lives.

Objective and Approach: Update the estimates in the 2004 report through the 2009 calendar year, based on analyses of FARS data and the findings of NHTSA effectiveness evaluations published since 2004.

Cost of NHTSA vehicle safety standards, 1968-2009 (follow-up)

Background: Since the late 1970s, NHTSA has sponsored many cost studies of safety equipment to meet the FMVSS. Cost studies are based on a detailed engineering "teardown" analysis of the individual pieces and assemblies of which the system is composed, employing a process known as "reverse engineering". The system components are physically torn down into their most elemental parts to identify the process operation by which each elemental part is made in terms of labor minutes; direct materials and scrap, machine occupancy hours or stations times; and machinery, equipment, and tooling utilized. NHTSA's 2004 report, *Cost and Weight Added by the FMVSS for Model Years 1968-2001 in Passenger Cars and Light Trucks* estimated that the FMVSS added an average of $839 (in 2002 dollars) and 125 pounds to the average passenger car in model year 2001; an average of $711 and 86 pounds to the average LTV. Since 2001, important new FMVSS or upgrades of existing FMVSS have already gone into effect (e.g., head impact protection, tire pressure monitoring systems) or will soon go into effect (e.g., electronic stability control, side impact pole test). Furthermore, the cost of existing technologies, in current dollars, increases with inflation.

Objective and Approach: Update the analysis in the 2004 report through the 2009 model year, based on NHTSA cost studies published since 2004. Costs will be brought up to 2009 dollars using the gross domestic product implicit price deflator from the Bureau of Economic Analysis.

EVALUATIONS STARTED/PLANNED TO START IN 2012

Crashworthiness

Knee air bags

Background: Knee air bags are additional air bags that deploy from the lower instrument panel on the driver and/or passenger side in a frontal crash in order to cushion the occupant's knee impact. They are designed to reduce loading on the femur, pelvis and lower legs as well as to make the overall restraint system more effective by providing additional energy absorption and aligning the occupant into a position better suited for interaction with the frontal air bag during a frontal impact. Knee air bags are not required by FMVSS No. 208.

Toyota and some other manufacturers equipped many of their vehicles with knee air bags in 2007.

Objectives: Analyze the effect of knee air bags on femur, pelvis and leg injuries. Investigate if the overall fatality-reducing effectiveness of frontal air bags increases when they are supplemented by knee air bags. Determine if knee air bags result in fewer abdomen and/or chest injuries from the lower steering wheel.

Proposed Approach: Analyses of CDS data of the effect of knee air bags on femur, pelvis and leg injuries. Analyses of CDS data on the effect of knee air bags on chest and abdominal injury. Analyses of FARS data, using methods similar to the 2006 evaluation of redesigned air bags (see below), of the overall effectiveness of frontal air bags with and without knee air bags.

Crash avoidance

Effect of TPMS on crashes

Background: Tire Pressure Monitoring Systems (TPMS) were mandated in FMVSS No. 138 and are now required on all light vehicles as of September 1, 2007, after a phase-in that began on October 5, 2005. Improperly inflated tires pose a safety risk, increasing the chance of skidding, hydroplaning, longer stopping distances and crashes due to flat tires and blowouts.

Objectives: Analyze the relationship between the presence of TPMS systems and the occurrence of crashes involving skidding, hydroplaning, flat tires and blowouts.

Proposed Approach: Analyses of FARS, CDS and State data of the proportion of crashes involving skidding, hydroplaning, or tire failure. Only CDS provides information about whether the tire was the cause of the crash or was damaged during the crash.

Behavioral safety/injury control

Factors associated with decreased fatalities in selected States

Background: State efforts to reduce fatal crashes have had varied results. Fatality rates per 100,000 inhabitants in 2004-2006 decreased 10 percent or more from 2000-2003 in 8 States (DC, CO, UT, AK, MN, MI, TX, and CT) while it increased 10 percent or more in other States. Often efforts to reduce fatalities are directed toward one or more specific sub-populations, such as younger or older drivers, drivers who are speeding or impaired, adults or children not wearing safety restraints, motorcyclists, bicyclists and/or pedestrians. NHTSA would like to discover the factors that address the interrelated nature of real-word crashes where there is often more than one issue area involved. In addition, NHTSA would like to identify cross-cutting strategies that other States could employ to decrease fatalities.

Objective: Determine if there are certain factors that are effective in preventing crashes with fatalities and to identify strategies that other States could employ to decrease fatalities.

Proposed Approach: Select up to nine States with which to conduct interviews with personnel knowledgeable about a broad range of topics, including not only those in the area of justice and enforcement, but also adult and child passenger safety. States should be selected to include a mix of States, including some with large decreases and some with large increase of fatalities in the past few years. Conduct interviews and obtain relevant supporting information such as highway safety plans and project reports. Obtain information related to the State's background and history, current activities, special situations or programs, and plans for the future. In particular, address cross-cutting efforts in which the States participate and creative ways that new programs are developed, supported, and financed.

OTHER POTENTIAL EVALUATIONS

Crashworthiness

NCAP follow-up evaluation (cars and LTVs with air bags)

Background: In 1994, NHTSA published a study that showed significant correlations between New Car Assessment Program (NCAP) scores - HIC, chest g's and femur loads - and the fatality risk of belted drivers in actual head-on collisions. The crash database for that study included model year 1979-91 passenger cars. Only 5 percent of the cars in that database were equipped with frontal air bags, and LTVs were not included. Today, all new passenger vehicles sold in the United States are equipped with frontal air bags, and LTVs account for over 50 percent of new-vehicle sales.

Objective: Study the relationship between NCAP scores and fatality risk in actual head-on collisions for passenger cars and LTVs equipped with frontal air bags.

Proposed Approach: The analyses in the 1994 study will be repeated with a database that includes LTVs as well as passenger cars and contains a large proportion of vehicles equipped with air bags. The 1994 study compared the fatality risk of the two belted drivers in a head-on collision between a car with "good" NCAP scores and a car with "poor" scores, after adjustment for differences in the weights of the cars and the drivers' age and sex. The follow-up study will investigate if similar correlations between NCAP scores and fatality risk exist in vehicles equipped with air bags. This evaluation can probably be completed within a year, since it is based on analyses of existing data.

Effectiveness, use and cost of rear-center 3-point belts

Background: Given equal safety equipment, the rear-center seat is the safest place in a vehicle. However, until recently, lap/shoulder belts were only required at all outboard seats, while lap belts, a less effective device, were required at rear-center seats. On December 4, 2002, the President signed into law "Anton's Law", P.L. 107-318, which directed NHTSA to issue, by December 2004, a regulation requiring lap/shoulder belts for each rear seating position in passenger motor vehicles with a GVWR of 10,000 pounds or less. On December 8, 2004, NHTSA announced a Final Rule that amended FMVSS No. 208 to require the phase-in of lap/shoulder seat belts in rear center seats in all new passenger vehicles to start on September 1, 2005, and to be completed by September 1, 2007. In practice, manufacturers already began installing 3-point belts at rear-center seats of many vehicles well in advance of the new requirement. By 2001, the majority of new passenger cars had 3-point belts at the rear-center seats. NHTSA's 1999 evaluation found that rear outboard lap/shoulder belts are 15 percent more effective in reducing fatalities than lap belts alone, but it is not known how effective rear-center lap/shoulder belts are.

Objectives: Estimate the effectiveness of lap/shoulder belts in reducing fatality and injury risk of back center seat occupants – in frontal crashes and overall. Compare the rates of overall injury and serious abdominal injuries of back center seat occupants wearing lap/shoulder belts, lap belts only, and no belts. Compare belt use rates of back center seat occupants in cars equipped with lap/shoulder belts versus cars equipped with lap belts only. Estimate overall safety benefits of sitting in the back seat, relative to sitting in the front seat of a vehicle. Find out if occupancy of the rear-center seat increases for adults and adolescents when lap/shoulder belts are available, making it the safest place in the vehicle.

Proposed Approach: Statistical analyses of FARS and State crash data, by methods similar to those used in the 1999 evaluation of back outboard lap/shoulder belts (e.g., double-pair comparison), to assess the relative fatality and injury risks of lap-belted, lap/shoulder-belted and unrestrained occupants, and to compare occupancy rates for back-center and back-outboard seats. The evaluation may require several years until sufficient data accumulate.

Automatic door locks – cost and effectiveness

Background: NHTSA is concerned with door latch integrity, mainly to prevent ejection in a crash, particularly rollover crashes. The agency is also concerned about the potential for vehicle doors to jam, which would increase the risk of injury in the event that a crash resulted in a fire. In addition, FMVSS Nos. 208 and 214 currently test vehicles with the doors in the unlocked position. During the side-impact test, the doors of vehicles with ADL have become unlatched and swung open when tested in the unlocked position, but not when tested in the locked position. Safety benefits of ADLs that have been mentioned are: they improve the likelihood that doors will stay closed in the event of a crash, retaining the structural integrity of the vehicle and lowering the chance of occupant ejection; and they prevent doors from being opened inadvertently and/or by children.

Objectives: Compare vehicles with and without ADL in crash data files to determine if ADL prevent or mitigate occupant ejections, as well as determining whether there is a tendency for doors with ADL to jam more or less frequently than those without ADL. Estimate the cost to manufacturers for installing ADL.

Proposed Approach: Information will be obtained about which makes, models, and model years of vehicles are equipped with ADL. For those vehicles on which ADL are an option, information on the percent of vehicles equipped with them will need to be obtained from manufacturers. Examine and analyze CDS, FARS and State crash data to determine whether vehicles equipped with ADL have a lower incidence of occupant ejections and "fell from moving vehicle" cases. Use CDS data to determine rates of correct door operation, coming open during collision, and becoming jammed for vehicles with and without ADL. The study should be controlled for vehicle type, vehicle weight, occupant age, and gender. In addition, since the feature can be disabled, and in some cases are factory-set at "No doors lock/none unlock," detailed CDS information on the actual setting used would be necessary to determine a "when used" effectiveness. Where this is not possible, an "as used" effectiveness can be estimated. A teardown study will be used to determine cost. The evaluation may require several years until sufficient crash data accumulate.

Trends in protection of 5^{th} percentile female occupants by air bags

Background: Drivers of small stature and light weight are at somewhat greater risk from frontal air bags because they sit closer to the bag and are more easily displaced toward the bag during minor impacts prior to the main impact that deploys the bag. Because their seated height is lower than the average person, the air bag may contact them higher on the body. Their smaller, lighter bones may fracture more easily. In response to these possible areas of vulnerability, NHTSA's regulation on advanced air bags phased in barrier and offset tests with 5^{th} percentile female dummies in model years 2004-2006.

Objectives: Track the fatality-reducing effectiveness of air bags for drivers with height and weight similar to 5^{th} percentile females and compare it to effectiveness for other adults. Specifically, determine if effectiveness increase after the tests with 5^{th} percentile female dummies were added. Review the injury sources and mechanisms of small adult occupants in frontal crashes in vehicles equipped with air bags.

Proposed Approach: FARS began to report the height and weight of drivers in calendar year 1998. Track the effectiveness of air bags for small drivers, using the same statistical methods as in previous NHTSA evaluations, from the first generation of air bags to the present. CDS cases – with early and current air bags – will be reviewed to find the injury mechanisms of small adult occupants.

Crash avoidance

Brake-assist systems – cost and effectiveness

Background: Brake assist systems monitor the driver's use of the brake pedal during emergency situations – such as when the driver applies the brake quickly but without making a full application of the brake pedal, which may lead to dangerously long stopping distances. It then automatically activates the brake booster or the hydraulic unit to generate maximum braking power. When used together with anti-lock braking systems, brake assist systems have been shown to reduce stopping distance and thus potentially reduce the incidence of rear-end collisions as well as other multi-vehicle crash involvements. Only a few automakers in the industry have installed this system on their product lines. In the next few years, crash data on vehicles equipped with brake assist systems will become more widely available for statistical studies.

Objectives: Study the effect of brake assist systems on rear-end collisions, other multi-vehicle crash involvements and collisions with pedestrians, by crash type, vehicle type and roadway condition. Estimate the consumer cost of this system.

Proposed Approach: FARS and State crash data and Polk registration data will be used to compare multi-vehicle crash involvement rates on vehicles with brake assist systems and those of the same make models without brake assist systems. The analysis method will be similar to the ESC and ABS evaluations. The long-term effects of ABS and the actual benefits of ESC must be taken into consideration when analyzing the effectiveness of brake assist systems. The cost of brake assist systems will be estimated by "teardown" studies. The evaluation may require 3-4 years until sufficient crash data accumulate for a definitive statistical analysis.

Glare problems with LTV headlamps and auxiliary lamps (FMVSS No. 108)

Background: FMVSS No. 108 specifies requirements for original and replacement lamps, reflective devices, and associated equipment. The goal is to reduce traffic crashes and related deaths and injuries by providing adequate roadway illumination. The agency wants to enhance the conspicuity of motor vehicles so that their presence is perceived and their signals understood, in daylight, in darkness and in other conditions of reduced visibility. However, with the introduction of high intensity discharge headlamps (HIDs) and look-alike halogen bulbs, the high-mounted headlamps on the popular LTVs, and the upswing in auxiliary lamp use, consumers have registered complaints about glare issues. Glare, whether at levels that are annoying or disabling, increases the stress for drivers at night and can result in a greater safety risk.

Objective: Quantify the range of glare problems from lamps in today's passenger vehicles. Determine if the effects of glare from HIDs, high-mounted headlamps, and auxiliary lamps increases crashes, injuries, and fatalities.

Proposed Approach: Examine and analyze crash data from the FARS, NASS, and State data files to identify crash cases impacted by glare. Measure the headlight aim and the headlamp mounting height on LTVs. Develop a laboratory test setup to assess the degree of glare from various passenger vehicles (based on quantitative measurement and/or judgment by volunteers). Determine if specific LTV make-models have more issues/complaints with glare. Determine if there is a difference in glare from direct view (headlamps shining directly into the eyes of oncoming drivers) or from indirect view (headlamps shining into the mirrors of vehicles in front of them). Determine which type of glare produces more stress for drivers in the nighttime environment. Determine which type of glare increases the possibility of crashes. Determine if specific age groups are more affected by glare. Review consumer complaints. Battelle Memorial Institute, under contract to NHTSA, is currently conducting research which should provide information about the performance of current lamps. The evaluation is likely to take 3 years, since it combines extensive data collection and statistical analyses.

Safety problem ID based on NMVCCS data analysis

Background: The National Motor Vehicle Crash Causation Survey (NMVCCS) is a nationally representative survey of light passenger motor vehicle traffic crashes that provides information on the events and associated factors related to a crash. Data for NMVCCS were collected from 2005 through 2007. NMVCCS used the NASS/CDS infrastructure of data collection locations, but very different information was collected. It includes on-scene data collection, an element that is not part of the NASS/CDS data collection process. Data sources include interviews, scene inspection, vehicle inspection, and official records. The on-scene investigation, as opposed to a reactive approach (follow-up investigation), provides significantly more detail in scene and vehicle evidence, as well as higher reliability in interview data. Driver related data were collected in areas such as critical non-performance, recognition (including inattention – e.g., daydreaming – internal distraction, external distraction, and inadequate surveillance), decision (e.g., misjudgment of gap or other's speed), and performance errors. Vehicle-related factors, such as failed brakes and degraded braking capability, are also investigated.

Objectives: NMVCCS was created to assist in the development and evaluation of crash avoidance technologies. Two areas of current interest are older driver crashes (particularly relating to braking issues) and driver distraction. NMVCCS can be used to evaluate the extent to which braking (i.e., misapplication of brakes, failure of brakes, etc.) is a factor in older driver crashes. The recognition variables, in particular, provide a rich source from which to learn more about driver distraction, and how it contributes to light vehicle crashes.

Proposed Approach: Using NMVCCS data, evaluate the extent of braking issues with older drivers, comparing misjudgment of gap and other related variables by age group. Examine the various distraction variables to determine how prevalent they are in different types of crash configurations.

Effect of Early Warning Reporting systems on recalls

Background: The TREAD Act of 2000 empowered NHTSA to expand its sources of information about potential vehicle defects in order to strengthen and expedite the process of discovering, investigating, and remedying defects. By 2002, NHTSA had established an Early Warning Reporting (EWR) system whereby vehicle and equipment manufacturers notify the agency when they receive claims about potential defects resulting in fatality, injury or property-damage crashes, consumer complaints, warranty damage claims, and safety recalls in other countries. Manufacturers began sending quarterly EWR reports in 2003. The agency recently issued an interim report that recommended modifying the reporting thresholds. A Notice of Proposed Rulemaking (NPRM) is due to be out shortly, and NHTSA anticipates a minimum 1 year lead time for manufacturers to adjust to the changes before the modified data would be provided. The majority of recall campaigns are voluntary, initiated by manufacturers. The additional information generated with EWR ought to enable manufacturers to identify needs for voluntary recalls more thoroughly and promptly.

Objective: Review the voluntary and NHTSA-initiated recall campaigns since the implementation of EWR (emphasizing the period after the revised rule goes into effect) and find out in what proportion of them NHTSA or a manufacturer used data from EWR as a primary or secondary source for triggering the investigation. Compare recall campaigns before and after EWR in terms of: number of campaigns per year, number of vehicles or parts recalled per year, percent voluntary versus NHTSA-initiated recalls, average time from manufacture until NHTSA or a manufacturer learns about a potential defect, average time from initial notification to implementation of the recall campaign.

Proposed Approach: NHTSA Statistical analyses of databases compiled and maintained by the Office of Defects Investigation, NHTSA. The evaluation may require waiting 2-3 years or more after the revised rule is in effect, until sufficient case histories accumulate for a report.

Harm unbelted occupants cause to others

Background: Unrestrained occupants in the rear seats of vehicles can impact the safety of their fellow occupants in the front row. Upon a frontal impact, these passengers hit the back of the front seats, potentially increasing the severity of injury sustained by the driver and any other front row passenger. The proportion of unbelted rear seat occupants is not highlighted in NHTSA's published statistics. An increased awareness of the dangers of passengers becoming "back seat bullets" may motivate increased belt use for rear seat and other unbuckled passengers, if not for their own sake, then for the safety of those in front of them. Part of the cause of lower belt use for rear seat occupants may be due to legislation in some States exempting rear seat occupants from seat belt legislation.

Objectives: Study the relationship between the presence of unbelted occupants and the injury severity of other occupants. Determine if there is a significant increase to injury/fatality for front seat passengers based on the restraint use of the rear seat passengers.

Proposed Approach: Create statistical analyses of the FARS and CDS databases. Most of the data already exist. Completion in one year is possible. Compare rear seat belt use for States that require rear seat belt use versus States that do not.

Fuel system integrity (FMVSS No. 301 upgrade)

Background: FMVSS No. 301, the fuel systems integrity standard, aims to reduce post-crash fires. It places limits on the amount of fuel spillage allowed in frontal, side and rear-impact tests and in a static rollover test. The test speed for the side impact was raised from 20 to 33 mph, with a phase-in during model years 2005-2007. The test speed for the rear impact is increasing from 30 to 50 mph, with a phase-in during model years 2007-2009. Many cases of fire were reported, especially in fatal crashes. In 2000, NHTSA estimated that approximately 310 deaths per year were caused by post-collision vehicle fires, prior to the upgrade. The largest cause of these fire-related fatalities is rear impacts, which account for approximately 143 of these fatalities (46%). Many more deaths and injuries may be partly attributed to vehicle fires. CDS estimates that 670 burn injuries due to vehicle fires occur each year.

Objectives: Identify modifications to vehicles to improve fuel system integrity, in response to or in advance of the upgraded requirements. Determine the effect the fuel system integrity upgrade has on fires in crashes, burn injuries, and fatalities. Monitor the long-term trend in the rate of fatal crashes involving fire per million registered vehicles, by vehicle age and model year.

Proposed Approach: The effectiveness of a previous upgrade of FMVSS No. 301 and the long-term trend in post-crash fires were evaluated in 1990 (see the next section), using State data and FARS. Similar analysis procedures will be used here, supplemented by FARS-MCOD and CDS data. The problem with identifying fire-related injuries and fatalities from crash databases is that there are limited number of fire injuries and fatalities in GES. FARS data includes all fatalities, including all burns, but the data typically do not describe the crash scenario that caused the fire. FARS-MCOD data is needed to identify the cause of death. Therefore NHTSA has increased the sampling rate for fire-related crashes from CDS and has conducted an in-depth case study of 214 fatal fire crashes. If similar data continue to be collected after the standard is upgraded, it would add a great deal of information.

SUMMARIES OF PUBLISHED EVALUATION REPORTS

May 2008

A systematic program to evaluate the effectiveness of the Federal Motor Vehicle Safety Standards (FMVSS) was initiated in 1975, when NHTSA was just beginning to establish its own crash databases. The first "preliminary" evaluation of a standard was published in 1979 (side door strength) and the first "final" evaluations in 1981 (energy-absorbing steering assemblies, bumpers). Since 1979, 59 comprehensive evaluations of regulations, safety programs, consumer information programs, or safety technologies have been published. Here is a list of the 59 studies including summaries of principal findings [except where findings were superseded in a follow-up evaluation]:

2008

Statistical Analysis of Alcohol-Related Driving Trends, 1982-2005 (NHTSA Publication DOT HS 810 942)

> The percentage of drivers involved in fatal crashes who had blood alcohol concentrations (BACs) of .08 grams per deciliter or above steadily decreased from 1982 to 1997 and then leveled off. Legislation (.10 BAC, .08 BAC, administrative license revocation, and minimum-legal-drinking-age laws), demographic factors (median age of the population and the proportion of female drivers grew from 1982 to 1997), and changes in per capita alcohol consumption largely explain both the initial decrease in BAC ≥ .08 and its leveling off after 1997. The leveling off does not imply that laws are becoming less effective. On the contrary, they have effectively maintained the proportion of drivers in fatal crashes with BAC ≥ .08 at the lowest level since 1982.

2007

Statistical Analysis of the Effectiveness of Electronic Stability Control (ESC) Systems – Final Report (NHTSA Publication DOT HS 810 794)

> ESC systems detect when a vehicle is about to go out of control and automatically intervene by applying the brakes to individual wheels and possibly reducing engine torque to help the driver stay on course. Statistical analyses found statistically significant crash reductions in the passenger cars and LTVs currently equipped with ESC systems. Single-vehicle crashes were reduced by 26 percent in passenger cars and by 48 percent in LTVs. Fatal single-vehicle crashes were reduced by 36 percent in cars and by 63 percent in LTVs. Culpable involvements in multivehicle crashes were reduced by 13 percent in passenger cars and by 16 percent in LTVs.

An Evaluation of Side Impact Protection – FMVSS 214 TTI(d) Improvements and Side Air Bags (NHTSA Publication DOT HS 810 748)

A dynamic crash test was added to FMVSS No. 214 and phased into new passenger cars during 1994-1997. Manufacturers first upgraded side structures and affixed padding, then equipped many vehicles with side air bags designed to protect the occupant's torso, the head, or both. The test criterion TTI(d) improved in 2-door cars from an average of 114 in 1981-1985 to 44 in cars with side air bags, and from 85 to 48 in 4-door cars. Upgraded structures and padding reduced fatality risk for near-side occupants in multi-vehicle crashes by an estimated 33 percent in 2-door cars and 17 percent in 4-door cars. Torso plus head air bags further reduce fatality risk for near-side occupants by 24 percent; torso bags alone, by 12 percent.

2006

HIC Test Results before and after the 1999-2003 Head Impact Upgrade of FMVSS 201 (NHTSA Publication DOT HS 810 739)

Upgraded requirements in FMVSS No. 201 were phased into new vehicles in 1999-2003 to reduce occupants' risk of head injury from contact with the upper interior, including the pillars, roof headers, side rails, and upper roof. Initially, energy-absorbing materials alone were added; later, some vehicles also received head-protection air bags. NHTSA conducted impact tests in pre- and post-standard vehicles, without head-protection air bags, of the same makes and models. The Head Injury Criterion, HIC(d) averaged 909.9 pre-standard and 667.5 post-standard: a statistically significant average improvement of 242.4 units of HIC.

An Evaluation of the 1998-1999 Redesign of Frontal Air Bags (NHTSA Publication DOT HS 810 685)

In 1998 and 1999, air bags were redesigned to make deployments less harmful to child passengers and other out-of-position occupants by removing some of the propellant or gas from their inflators and/or by reducing volume or rearward extent, positioning them further from occupants, tethering, and hybrid inflators. Compared to earlier air bags, these redesigned air bags reduced fatalities to infants and children by 83 percent and to out-of-position drivers by 70 percent in low-to-moderate speed crashes. Yet they entirely preserved the overall life-saving benefits of earlier air bags for belted drivers and for passengers age 13 and older.

Child Restraint Use Survey – LATCH Use and Misuse (NHTSA Publication DOT HS 810 679)

LATCH (Lower Anchors and Tethers for Children) consists of an upper tether that provides an additional point of attachment for greater safety, and lower attachments that simplify installation of child safety seats. NHTSA's 2005 survey found 55 percent use of the upper tether and 60 percent use of the lower attachments. (People who did not use the lower attachments used the vehicle's seat belts to install the child safety seat.) Most of the non-users said they hadn't heard of LATCH, didn't realize their vehicle was equipped with it, didn't know why it was important, or didn't know how to use it.

2005

Trends in the Static Stability Factor of Passenger Cars, Light Trucks and Vans (NHTSA Publication DOT HS 809 868)

The static stability factor is a measurement of a vehicle's resistance to rollover. NHTSA has included rollover information as part of its NCAP ratings since model year 2001. Passenger cars have the highest average SSF, and they have remained high. SUVs have substantially improved their SSF values over time, especially after model year 2000, whereas those of pickup trucks have remained consistent over the years. Minivans showed considerable improvement since they were first introduced. In model year 2003, the sales-weighted average SSF was 1.41 for passenger cars, 1.17 for SUVs, 1.18 for pickup trucks, 1.24 for minivans, and 1.12 for full-size vans.

2004

Cost Per Life Saved by the Federal Motor Vehicle Safety Standards (NHTSA Publication DOT HS 809 835)

NHTSA has evaluated the life-saving benefits as well as the consumer cost for a substantial “core” group of safety technologies for passenger cars and LTVs (pickup trucks, SUVs, and vans). In 2002, these technologies added an estimated $11,353,000,000 (in 2002 dollars) to the consumer cost of new cars and LTVs of that model year, while saving 20,851 lives in the vehicles on the road during that calendar year. That amounts to $544,482 per life saved in 2002. They added $189,842,000,000 to the cost of new cars and LTVs over model years 1968-2002, while saving 252,989 lives in model year 1968 and later vehicles during calendar years 1968-2002. That amounts to $750,782 per life saved in 1968-2002.

Cost and Weight Added by the Federal Motor Vehicle Safety Standards for Model Years 1968-2001 in Passenger Cars and Light Trucks (NHTSA Publication DOT HS 809 834)

NHTSA performs engineering “teardown” analyses to estimate how much a specific FMVSS adds to the weight and the retail price of vehicles. NHTSA has evaluated virtually all the cost-and weight-adding technologies introduced by 2001 in cars and LTVs in response to the FMVSS. NHTSA estimates that the FMVSS added an average of $839 (in 2002 dollars) and 125 pounds to the average passenger car in model year 2001. This was approximately 4 percent of the cost and 4 percent of the weight of a new car. An average of $711 (in 2002 dollars) and 86 pounds was added to the average LTV in model year 2001. This was approximately 3 percent of the cost and 2 percent of the weight of a new LTV.

Lives Saved by the Federal Motor Vehicle Safety Standards and Other Vehicle Safety Technologies, 1960-2002 – Passenger Cars and Light Trucks – With a Review of 19 FMVSS and their Effectiveness in Reducing Fatalities, Injuries and Crashes (NHTSA Publication DOT HS 809 833)

NHTSA has evaluated the effectiveness of virtually all the life-saving technologies introduced in passenger cars, pickup trucks, SUVs, and vans from about 1960 up through the later 1990s. A statistical model estimates the number of lives saved from 1960 to 2002 by the combination of these technologies – including safety equipment meeting specific FMVSS, equipment installed in advance of the FMVSS, and noncompulsory improvements such as the redesign of mid and lower instrument panels. Vehicle safety technologies saved an estimated 328,551 lives from 1960 through 2002. The annual number of lives saved grew steadily from 115 in 1960 to 24,561 in 2002.

Impaired-Driving Program Assessments: A Summary of Recommendations (1991 to 2003) (NHTSA Publication DOT HS 809 815)

NHTSA's assessment process allows States to have their impaired-driving programs reviewed by outside teams of nationally recognized experts. NHTSA examined 38 State assessment reports. Most of the teams' 2,982 individual recommendations fit into 10 thematic areas: (1) enforcement and the arrest, prosecution, and adjudication process; (2) public information and education; (3) DUI data and records; (4) enacting or revising laws; (5) enhanced training for personnel; (6) program evaluation; (7) resources for treatment and rehabilitation; (8) inter/intra-governmental coordination; (9) sources of funding; and (10) task forces and/or community involvement.

Preliminary Results Analyzing the Effectiveness of Electronic Stability Control (ESC) Systems (NHTSA Publication DOT HS 809 790)

[Findings have been superseded by the 2007 evaluation - see above.]

Evaluation of Rear-Window Defrosting and Defogging Systems (NHTSA Publication DOT HS 809 724)

Almost all new cars, minivans and SUVs have rear-window defoggers, even though Federal standards do not require them. Analyses of crashes where drivers were backing up or changing lanes during rain or snow, early morning hours, or in the winter did not show a statistically significant reduction with defoggers. Nevertheless, NHTSA would expect consumers to continue wanting rear-window defoggers for their vehicles because they conveniently clear condensation, frost, ice, and snow from the back window.

Evaluation of FMVSS 214 Side Impact Protection for Light Trucks: Crush Resistance Requirements for Side Doors (NHTSA Publication DOT HS 809 719)

LTVs were required to meet a crush resistance standard for side doors beginning September 1, 1993. Side door beams were installed to reduce the velocity and depth of door intrusion in side impact crashes. The beams are estimated to reduce fatalities by 19 percent in single vehicle side impacts. When all LTVs on the road have head restraints, they will save an estimated 151 lives per year. Little or no fatality reduction was found in multivehicle crashes.

2003

Results of the Survey on the Use of Passenger Air Bag On-Off Switches (NHTSA Publication DOT HS 809 689)

On-off switches allow drivers to temporarily deactivate air bags when children must ride in the front seats of pickup trucks and other vehicles that cannot accommodate rear-facing child safety seats in the back seats. NHTSA recommends that the passenger air bag be turned off when a child 12 or younger must ride in the front seat, and turned on if all front-seat occupants are 13 or older. In a 2000 survey, switches were left on for 14 percent of infants and 26 percent of child passengers age 1 to 6, but turned off for 17 percent of the adult passengers.

Vehicle Weight, Fatality Risk and Crash Compatibility of Model Year 1991-99 Passenger Cars and Light Trucks (NHTSA Publication DOT HS 809 662)

There is little association between vehicle weight and fatal-crash rates in the heavier LTVs. However, in other groups of model year 1991-99 vehicles, fatality rates increased as weights decreased. Pickup trucks and SUVs of these model years had, on the average, higher fatality rates than passenger cars or minivans of comparable weight. Model year 1991-99 LTVs, especially those with high, rigid frontal structures, were more aggressive than cars when they struck other vehicles.

NCAP Test Improvements with Pretensioners and Load Limiters (NHTSA Publication DOT HS 809 562)

Seat belt pretensioners pull belts snug as a crash begins. Load limiters allow belts to yield slightly during a crash to reduce the force on the wearer's chest. In the New Car Assessment Program's frontal barrier crashes at 35 mph, the combination of pretensioners and load limiters reduced average Head Injury Criterion by 232, chest acceleration by 6.6 g's and chest deflection by 10.6 mm, for driver and right-front passenger dummies, relative to cars and LTVs of the same makes and models without these features.

2002

Evaluation of Child Safety Seat Registration (NHTSA Publication DOT HS 809 518)

Since March 1993, manufacturers of child safety seats have been required to provide a postage-paid registration form with each new child safety seat. Seat registration has increased from 3 percent prior to 1993 to 27 percent in 1996-2000. The repair rate for recalled child safety seats increased from 13.8 percent prior to 1993 to 21.5 percent in 1993-2000.

Preliminary Report: The Incidence Rate of Odometer Fraud (NHTSA Publication DOT HS 809 441)

There are an estimated 452,000 cases of odometer rollback per year in the United States. The difference between the inflated prices that consumers paid for rolled-back vehicles and the prices they would have been willing to pay if they had known the true mileage average $2,336 per case of odometer rollback, amounting to $1,056 million per year in the United States.

2001

The Effectiveness of Head Restraints in Light Trucks (NHTSA Publication DOT HS 809 247)

The purpose of a head restraint is to prevent whiplash injuries in rear-impact crashes. Head restraints reduce overall injury risk in LTVs in rear impacts by a statistically significant 6 percent. When all LTVs on the road have head restraints, they will be preventing approximately 15,000 nonfatal injuries per year. (See also the 1982 evaluation of head restraints in passenger cars.)

The Effectiveness of Retroreflective Tape on Heavy Trailers (NHTSA Publication DOT HS 809 222)

Retroreflective tape enhances the visibility of heavy trailers in the dark. The tape reduces side and rear impacts by other vehicles into trailers by 29 percent in dark conditions (including dark-not-lighted, dark-lighted, dawn and dusk). In dark-not-lighted conditions, the tape reduces side and rear impacts by 41 percent. When all heavy trailers have the tape, it will prevent an estimated 191 to 350 fatalities, 3,100 to 5,000 injuries and 7,800 crashes per year.

Evaluation of the American Automobile Labeling Act (NHTSA Publication DOT HS 809 208)

In a survey of 646 recent or imminent new-vehicle buyers, over 75 percent were unaware of the existence of automobile parts content labels. Among those who had read the labels, many said they used the country-of-assembly information, but none said they used the numerical U.S./Canadian parts content score. Overall U.S./Canadian parts content in new cars and LTVs dropped from an average of 70 percent in model year 1995 to 67.6 percent in 1998. However, it increased from 47 to 59 percent in transplants while dropping from 89 to 84 percent in Big 3 vehicles: trends undoubtedly influenced by the 1995 U.S.-Japan Agreement on Autos and Auto Parts and the North American Free Trade Agreement.

2000

Fatality Reduction by Safety Belts for Front-Seat Occupants of Cars and Light Trucks: Updated and Expanded Estimates Based on 1986-99 FARS Data (NHTSA Publication DOT HS 809 199)

Manual three-point belts reduce fatality risk, relative to the unrestrained front-seat occupant, by 45 percent in passenger cars and by 60 percent in pickup trucks, vans, and sport utility vehicles. The analyses reconfirm the agency's earlier (1984-89) estimates of fatality reduction.

1999

Evaluation of FMVSS 214 - Side Impact Protection: Dynamic Performance Requirement; Phase 1: Correlation of TTI(d) With Fatality Risk in Actual Side Impact Collisions of Model Year 1981-1993 Passenger Cars (NHTSA Publication DOT HS 809 004)

[Findings have been superseded by the 2007 evaluation - see above.]

Effectiveness of Lap/Shoulder Belts in the Back Outboard Seating Positions (NHTSA Publication DOT HS 808 945)

Lap/shoulder belts reduce fatality risk by 44 percent relative to unrestrained back-seat occupants of passenger cars, and by 15 percent relative to lap-belted occupants. Lap belts reduce fatality risk by 32 percent relative to unrestrained occupants. Lap/shoulder belts are effective in all crashes, but lap belts only in nonfrontal crashes. Lap-belted occupants have substantially higher abdominal-injury risk than unrestrained back-seat occupants in frontal crashes, but lap/shoulder belts reduce abdominal injuries by 52 percent and head injuries by 47 percent relative to lap belts.

1998

Highway Safety Assessment: A Summary of Findings in Ten States (NHTSA Publication DOT HS 808 796)

Assessment of 1980-1993 safety programs in 10 States showed that Federal grants and technology were used to address safety priorities as intended by Congress. Federal grants, amounting to less than 2 percent of total safety spending by States and communities, have acted as seed money to resolve important highway safety problems. Programs started with Federal funds were often extended or replicated elsewhere with State funds. Occupant protection programs, however, remain heavily dependent on Federal funds.

Auto Theft and Recovery - Effects of the Anti Car Theft Act of 1992 and the Motor Vehicle Theft Law Enforcement Act of 1984 - Report to the Congress (NHTSA Publication DOT HS 808 761)

Theft rates, which had increased during the 1980s, declined from 714 per million in 1990 to 597 in 1995. Parts marking and factory-installed anti-theft devices have had beneficial and complementary effects on auto thefts and/or recoveries. The Acts have given law enforcement tools to deter thefts, trace stolen vehicles and parts, and apprehend and convict thieves.

The Long-Term Effectiveness of Center High-Mounted Stop Lamps in Passenger Cars and Light Trucks (NHTSA Publication DOT HS 808 696)

Throughout 1989-95, cars equipped with center high-mounted stop lamps were 4.3 percent less likely to be struck in the rear than cars without the lamps. (In 1987, when the lamps were first introduced, the reduction was 8.5 percent.) The effectiveness of CHMSL in LTVs is about the same as in cars. At the 1989-95 effectiveness level, when all cars and LTVs on the road have the lamps, they would prevent 194,000-239,000 crashes, 58,000-70,000 nonfatal injuries and $655 million in property damage per year.

1997

Relationship of Vehicle Weight to Fatality and Injury Risk in Model Year 1985-93 Passenger Cars and Light Trucks (NHTSA Publication DOT HS 808 569); **Relationships Between Vehicle Size and Fatality Risk in Model Year 1985-93 Passenger Cars and Light Trucks** (NHTSA Publication DOT HS 808 570)

[Findings have been superseded by the 2003 evaluation - see above.]

1996

Fatality Reduction by Air Bags: Analyses of Accident Data Through Early 1996 (NHTSA Publication DOT HS 808 470)

Driver air bags reduce overall fatality risk by an estimated 11 percent in passenger cars and LTVs (essentially unchanged from the 1994 and 1992 NHTSA analyses). Passenger air bags are beneficial for right-front passengers 13 or older. Air bags provide a life-saving benefit for belted as well as unbelted drivers. The fatality risk for child passengers up to age 12 in cars with passenger air bags is currently higher than in cars without them. Current air bags are significantly less effective for drivers 70 or older than for younger drivers.

1995

Preliminary Evaluation of the Effectiveness of Antilock Brake Systems for Passenger Cars (NHTSA Publication DOT HS 808 206)

ABS significantly reduced multivehicle crashes on wet roads: fatal crashes by 24 percent, and nonfatal crashes by 14 percent. Fatal collisions with pedestrians and bicyclists were down a significant 27 percent. However, these reductions were offset by statistically significant increases in single-vehicle, run-off-road crashes (rollovers or impacts with fixed objects). Fatal run-off-road crashes were up by 28 percent, and nonfatal crashes by 19 percent in the ABS-equipped cars, as compared to similar cars without ABS.

1994

Fatality Reduction by Automatic Occupant Protection in the United States (Proceedings of the 14th Conference on Enhanced Safety of Vehicles)

The fatality risk of front-outboard occupants in cars with motorized 2-point belts (without disconnect) is 6 percent lower than in cars with manual belts; the risk in cars with non-motorized 3-point belts is the same as in cars with manual belts. [This report's findings on air bags have been superseded by the 1996 evaluation - see above.]

An Evaluation of the Effects of Glass-Plastic Windshield Glazing in Passenger Cars (NHTSA Publication DOT HS 808 062)

Following an amendment to the glazing standard (FMVSS No. 205) in 1983, two manufacturers equipped some of their cars with glass-plastic windshields. Crash data indicates the injury reduction potential of these windshields is less than predicted. Fleet and warranty data show that durability problems are greater than anticipated. While glass-plastic windshields add $65 to the cost of a new car, their replacement costs are estimated to exceed $1,700.

Correlation of NCAP Performance With Fatality Risk in Actual Head-On Collisions (NHTSA Publication DOT HS 808 061)

There is a statistically significant correlation between the performance of passenger cars on the NCAP frontal-barrier test and the fatality risk of belted drivers in actual head-on collisions. In a head-on collision between a car with "good" NCAP performance and a car of equal mass with "poor" performance, the driver of the "good" car has, on the average, about 15- to 25-percent lower fatality risk. The steady improvement in NCAP scores during 1979-91 was paralleled by a 20- to 25-percent reduction of fatality risk for belted drivers in actual head-on collisions.

1993

Preliminary Evaluation of the Effectiveness of Rear-Wheel Antilock Brake Systems for Light Trucks (Submitted to NHTSA Docket No. 70-27-GR-026)

Rear-wheel ABS significantly reduced the risk of nonfatal run-off-road crashes in LTVs: rollovers by about 30-40 percent, side impacts with fixed objects by 15 to 30 percent and frontal impacts with fixed objects by 5 to 20 percent. The reductions mostly did not carry over to fatal run-off-road crashes. Collisions with pedestrians and bicyclists were reduced by 5 to 15 percent. Involvements in multivehicle crashes were not reduced, and may even have increased with rear-wheel ABS.

1992

Evaluation of the Effectiveness of Occupant Protection - Federal Motor Vehicle Safety FMVSS 208 - Interim Report (NHTSA Publication DOT HS 807 843)

Air bags and automatic belts have significantly reduced the risk of nonfatal injury and occupant ejection. [This report's findings on fatality reduction for air bags have been superseded by the 1996 evaluation; for automatic belts - by the 1994 evaluation.]

An Evaluation of the Uniform Tire Quality Grading Standards and Other Tire Labeling Requirements (NHTSA Publication DOT HS 807 805)

Consumers and tire dealers were surveyed about their knowledge and use of tire quality grades and other tire information supplied in response to Federal regulations. The ratings for treadwear were viewed as "important" by 29 percent of consumers who had recently purchased tires, and the ratings for traction, by 27 percent. The majority of consumers are not aware that these ratings are printed on the tires.

1991

Auto Theft and Recovery - Effects of the Motor Vehicle Theft Law Enforcement Act of 1984 - Report to the Congress (NHTSA Publication DOT HS 807 703)

[Findings have been superseded by the 1998 evaluation - see above.]

Effect of Car Size on Fatality and Injury Risk

[Findings have been superseded by the 2003 evaluation - see above.]

1990

Motor Vehicle Fires in Traffic Crashes and the Effects of the Fuel System Integrity Standard (NHTSA Publication DOT HS 807 675)

Modifications to fuel systems in response to FMVSS No. 301 reduced the frequency of fires in nonfatal crashes of passenger cars by an estimated 14 percent; fatalities in cars and LTVs, however, were not affected. During 1975-88, the number of fire-related fatalities increased from 1,300 to 1,800, primarily due to an aging vehicle fleet.

1989

An Evaluation of Door Locks and Roof Crush Resistance of Passenger Cars - Federal Motor Vehicle Safety Standards 206 and 216 (NHTSA Publication DOT HS 807 489)

Door latch improvements implemented during 1963-68 (preceding or responding to FMVSS No. 206) save an estimated 400 lives per year, reducing the risk of ejection in rollover crashes by 15 percent. The shift from hardtops to pillared cars with stronger roof support, in response to FMVSS No. 216, saves an estimated 110 lives per year.

An Evaluation of Center High Mounted Stop Lamps Based on 1987 Data (NHTSA Publication DOT HS 807 442)

[Findings have been superseded by the 1998 evaluation - see above.]

1988

An Evaluation of Occupant Protection in Frontal Interior Impact for Unrestrained Front Seat Occupants of Cars and Light Trucks (NHTSA Publication DOT HS 807 203)

During the 1960s and early 1970s, the manufacturers modified instrument panels of cars and LTVs, installing padding, reducing the rigidity of structures and extending the panel downward and toward the passenger. The improvements reduced fatality risk and serious injury risk by nearly 25 percent for unrestrained right-front passengers of cars in frontal crashes, saving up to 700 lives per year.

1987

An Evaluation of the Bumper Standard - As Modified in 1982 (NHTSA Publication DOT HS 807 072)

To reduce regulatory burden on manufacturers, damage resistance requirements for bumpers were relaxed in model year 1983: the impact test speed was lowered from 5 to 2.5 mph. The net costs to consumers did not significantly change. A small increase in the repair cost over the lifetime of the car is offset by a reduction in the initial cost of the lighter bumpers. (See also the 1981 evaluation of bumpers.)

A Preliminary Evaluation of Seat Back Locks for Two-Door Passenger Cars With Folding Front Seatbacks (NHTSA Publication DOT HS 807 067)

FMVSS No. 207 requires a locking device for front seats with folding seatbacks, designed to limit the forward motion of the seatback in a collision. These locks or other seat components often separate at moderate crash speeds when the seatbacks are hit by back-seat occupants in frontal impacts. No statistically significant injury or fatality reductions were found for seat back locks in any of the crash data files or in sled tests.

Fatality and Injury Reducing Effectiveness of Lap Belts for Back Seat Occupants (SAE Paper 870486)

[Findings have been superseded by the 1999 evaluation - see above.]

The Effectiveness of Center High-Mounted Stop Lamps - A Preliminary Evaluation (NHTSA Publication DOT HS 807 076)

[Findings have been superseded by the 1998 evaluation - see above.]

1986

Fuel Economy and Annual Travel for Passenger Cars and Light Trucks: National On-Road Survey (NHTSA Publication DOT HS 806 971)

The actual fuel economy of model year 1978-81 vehicles was measured by a national survey in which drivers maintained log books of mileage and fuel purchases. On-road fuel economy of cars increased by 41 percent during model years 1977-81; the fuel economy of LTVs increased by 17 to 26 percent. However, the actual on-road fuel economy is consistently 15 to 20 percent below laboratory (EPA) ratings.

An Evaluation of Child Passenger Safety: The Effectiveness and Benefits of Safety Seats (NHTSA Publication DOT HS 806 890)

A correctly used safety seat reduces fatality risk by an estimated 71 percent and serious injury risk by 67 percent. But misuse can partially or completely nullify this effect. In 1984, when 39 percent of safety seats were correctly used and 61 percent were misused, the average overall fatality reduction for safety seats (correct users plus misusers) was 46 percent. In all, 192 children were saved by safety seats and lap belts in 1984.

1985

An Evaluation of Windshield Glazing and Installation Methods for Passenger Cars (NHTSA Publication DOT HS 806 693)

The high-penetration-resistant windshield doubled the impact velocity needed for the occupant's head to penetrate the windshield, reducing serious facial lacerations by 74 percent, preventing 39,000 serious lacerations and 8,000 facial fractures per year. Adhesive bonding of the windshield halved the incidence of bond separation and occupant ejection through the windshield portal in crashes, saving 105 lives per year.

1984

Effectiveness - Manual Lap and Lap/Shoulder Belts (Chapter IV-A of "Final Regulatory Impact Analysis - Amendment to Federal Motor Vehicle Safety Standard 208 - Passenger Car Front Seat Occupant Protection," NHTSA Publication DOT HS 806 572)

Manual lap-shoulder belts are estimated to reduce the fatality risk of drivers and right-front passengers by 40 to 50 percent [reconfirmed and superseded by the 2000 evaluation - see above], and serious injury risk by 45 to 55 percent, relative to an unrestrained occupant. The manual lap belt, alone, is estimated to reduce fatality risk by 30 to 40 percent and serious injury risk by 25-35 percent.

1983

An Evaluation of Side Marker Lamps for Cars, Trucks and Buses (NHTSA Publication DOT HS 806 430)

Side marker lamps were installed in response to FMVSS No. 108 to enable a driver to see another vehicle that is approaching at an angle at night. The lamps reduced nonfatal nighttime angle collisions by 16 percent, preventing 106,000 crashes, 93,000 injuries, and $347 million in property damage per year. The lamps have not been effective in reducing fatalities.

A Preliminary Evaluation of Two Braking Improvements for Passenger Cars - Dual Master Cylinders and Front Disc Brakes (NHTSA Publication DOT HS 806 359)

Dual master cylinders, by providing a backup braking system in case of certain types of brake failure, prevent 40,000 crashes, 260 fatalities, 24,000 injuries and $132 million in property damage per year. Front disc brakes, which improve vehicle handling under various braking conditions, are estimated to prevent 10,000 crashes, 64 fatalities, 5,700 injuries and $32 million in property damage per year.

Evaluation of Federal Motor Vehicle Safety Standard 301-75, Fuel System Integrity: Passenger Cars (NHTSA Publication DOT HS 806 335)

[Findings have been superseded by the 1990 evaluation - see above.]

1982

An Evaluation of Side Structure Improvements in Response to Federal Motor Vehicle Safety Standard 214 (NHTSA Publication DOT HS 806 314)

Side door beams were installed in passenger cars to reduce the velocity and depth of door intrusion in side-impact crashes. The beams are especially effective in side impacts with fixed objects, preventing 480 fatalities and 4,500 hospitalizations per year. In vehicle-to-vehicle side impacts, they prevent 4,900 nonfatal hospitalizations per year, but have not reduced fatality risk.

An Evaluation of Head Restraints - Federal Motor Vehicle Safety Standard 202 (NHTSA Publication DOT HS 806 108)

The purpose of a head restraint is to prevent whiplash injury in rear-impact crashes. There are integral (fixed) and adjustable head restraints; 75 percent of adjustable restraints are left in the "down" position by occupants. In 1982, integral head restraints reduced injury risk in rear impacts by 17 percent; adjustable restraints by 10 percent. The 1982 mix of head restraints prevented 64,000 whiplash injuries per year. [Subsequently, manufacturers have enlarged adjustable restraints to provide better protection, even in the "down" position. See also the 2001 evaluation of head restraints in LTVs.]

1981

An Evaluation of the Bumper Standard (NHTSA Publication DOT HS 805 866)

In order to reduce car repair costs for consumers, damage resistance tests were established for bumpers in model year 1973 and upgraded in 1974 and 1979. The bumper standards did not significantly change net costs for consumers: the savings in repair costs over the lifetime of the car are almost equal to the increase in the initial cost of the bumpers. (See also the 1987 evaluation of bumpers.)

An Evaluation of Federal Motor Vehicle Safety Standards for Passenger Car Steering Assemblies: Standard 203 - Impact Protection for the Driver; Standard 204 - Rearward Column Displacement (NHTSA Publication DOT HS 805 705)

Energy-absorbing, telescoping steering columns reduced the risk of serious injury due to steering-assembly contact by 38 percent. Rearward column displacement was reduced by 81 percent. The standards prevent 1,300 fatalities and 23,000 hospitalizations per year. The performance of energy-absorbing steering assemblies is degraded under non-axial impact conditions.

1979

An Evaluation of Standard 214 (NHTSA Publication DOT HS 804 858)

[Findings have been superseded by the 1982 evaluation - see above.]

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