Fourth Report to Congress

Effectiveness of Occupant Protection Systems and Their Use

National Highway Traffic Safety Administration
U. S. Department of Transportation
Washington, D. C. 20590

May 1999

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, enacted by Congress on December 18, 1991, directed the Secretary of Transportation to report on the effectiveness of occupant protection systems based on their actual use, and on lap and shoulder belt use by the public and various groups at both the state and national levels (Section 2508 (e)). This is the fourth report on the effectiveness of occupant protection systems and safety belt use.

The major findings of this report are presented below.

System Effectiveness

- Air bags provide **fatality protection** in potentially fatal crashes. Drivers protected by air bags experienced reduced fatality risk of 31 percent in purely frontal crashes (12:00 point of impact on the vehicle), 19 percent in all frontal crashes (10:00 to 2:00), and 11 percent in all crashes.

- Based on 11 percent effectiveness in all crashes, it is estimated that air bags have saved 2,263 lives from 1987 through 1997, including 842 lives saved in 1997 alone.

- Driver air bags appear to be about as effective in reducing fatality risk in purely frontal crashes for light trucks (36 percent) as they are in passenger cars (31 percent).

- With the increase in available numbers of fatal crashes involving driver air bag-equipped cars over the past few years, it is possible to estimate, separately, the effects of driver air bags when the driver was belted and when the driver was unbelted. Air bags provide about a 9 percent reduction in fatality risk for the belted driver (relative to a belted driver without air bags), and 14 percent for the unbelted driver in all crashes.

- The 9 percent effectiveness of air bags for belted drivers, coupled with the 45 percent effectiveness of lap-shoulder belts, yields an estimated 50 percent fatality-reducing effectiveness for the air bag plus lap-shoulder belt system when safety belts are used.

- In purely frontal crashes, passenger air bags appear to be about as effective (32 percent) for right-front passengers age 13 and older as driver air bags (31 percent) are for drivers.

- For right-front passengers less than 13 years old, analysis of frontal crashes shows a higher fatality risk in cars with dual air bags than for children in comparable cars without passenger air bags. Given the limited data, it is impossible to quantify the increase in risk accurately at this time.

- As early as December 1991, the agency issued a consumer advisory warning against placing rear-facing child safety seats in front of passenger side air bags.

- Concerning **overall injury reduction for drivers**, for serious injury, the air bag plus lap-shoulder belt (when used) and manual lap-shoulder belts alone each provided about 64 percent reduction in injury risk, while automatic belts exhibited 49 percent effectiveness when they were used. The estimated effectiveness of the air bag alone was 42 percent (not statistically significant). The number of occupants in passenger air bag seating positions is still relatively small, and thus, no analyses were conducted.

- The combination of an air bag plus use of the lap-shoulder belt provides the greatest moderate injury protection (66 percent) followed by manual lap-shoulder belts (53 percent), automatic belts (51 percent) and the air bag alone (10 percent, nonsignificant).

- Exploratory analyses of these data indicate that current air bags involve a trade-off among certain types of injury. The addition of an air bag to the lap-shoulder belt user increases head injury protection at both the moderate and serious injury levels, as well as chest injury protection at the moderate injury level, while at the same time increasing the risk of moderate and serious arm injury. However, injuries to the head and chest pose much greater threat to life than do arm injuries.

- Certain challenges regarding air bag deployment have materialized, which are discussed in this report. The first involves the increased risk of upper extremity injury associated with air bag deployment. The second, and more challenging issue, involves the child-passenger air bag interaction. On November 22, 1996, NHTSA announced a comprehensive approach to preserve the safety benefits of air bags while minimizing their danger to children and at-risk adults. Its approach centers on accelerating the development of advanced air bag technology for future vehicles with the intent of having systems available for 1999 models. More immediate measures include adopting enhanced warning labels, reducing the aggressivity of air bags, continuing to allow the use of manual on-off switches in vehicles without a rear safety to protect children, and allowing dealers to install a manual on-off switch for any eligible owner who requests it and receives approval from NHTSA.

- As of September 1, 1998, NHTSA has confirmed 90 crashes where the deployment of the passenger-side air bag resulted in 24 serious injuries, one fatal abdomen injury, and 65 fatal head or neck injuries to infants or children. Twenty-four involved infants in rear-facing child seats, including fifteen deaths. Of the remaining 51 fatalities (children not in rear facing child safety seats), 2 were in forward facing child safety seats that were improperly secured to the vehicle. Forty six of the 51 were out position, unrestrained or improperly restrained at the time of the crashes, 42 of which involved pre-impact braking and/or out-of-position children, placing the child in proximity to the deploying air bag. Three of the 51 fatally injured children, not in a rear facing child safety seat, were determined to have been wearing the lap and shoulder belt. However, it is unknown whether the children were seated in a correct posture position and if the belts were snug. Pre-impact braking, coupled with improper or no safety belt use, generally results in the child moving forward into proximity with the passenger-side air bag prior to the actual crash and subsequent air bag deployment

Public Information and Rulemaking

- o In addition to pursuing technological advancements, NHTSA has launched a comprehensive public education program designed to: (1) alert the public to the dangers air bags pose to children and at-risk adults, (2) increase the correct use of safety belts, and (3) increase the proper positioning and use of child safety seats.
- o To ensure that infants and children ride safely, with or without a passenger-side air bag, NHTSA issued a strong warning in a press release dated October 27, 1995. This warning and advisory urged care givers to follow three "rules":

  -- Make sure ***all*** infants and children are properly restrained in child safety seats or lap and shoulder belts for every trip.
  -- The ***back seat*** is the safest place for children of any age.
  -- Infants riding in rear-facing child safety seats should ***never*** be placed in the front seat of a vehicle with a passenger-side air bag.

- o On November 9, 1995, NHTSA published a request for comments to inform the public about its efforts to reduce the adverse effects of air bags and to invite the public to share information and views with the agency (60 FR 56554). The request for comments focused on possible technological changes to air bags to reduce their adverse effects, including possible regulatory changes.

- o In early 1996, the Department and NHTSA successfully led the effort to create a private-public partnership which would undertake and fund a national program to address air bag safety issues. The resulting coalition, now called the Air Bag and Seat Belt Safety Campaign (ABSBSC), and NHTSA worked closely together on a comprehensive set of program activities designed to preserve the lifesaving benefits of air bags, to alert the public to the proper use of those devices, and to increase the correct use of safety belts and child safety seats.

- o On August 6, 1996, NHTSA published a notice of proposed rulemaking, proposing amendments to NHTSA's occupant crash protection standard and child restraint standard to reduce the adverse effects of air bags, especially those on children. The agency proposed that vehicles without advanced passenger-side air bags would be required to have new, attention-getting warning labels and permitted deactivation of the passenger-side air bag. NHTSA also proposed to require rear-facing child seats to bear new, enhanced warning labels. Finally, this notice discussed the agency's research on other air bag issues, such as technology to reduce arm and other injuries to drivers.

- o On November 27, 1996, NHTSA published a final rule (61 FR 60206) requiring vehicles with air bags to bear three new warning labels. Two of the labels replace existing labels on the sun visor. The third is a temporary label on the dash. These labels would not be required on vehicles having an advanced passenger-side air bag. This rule also requires rear-facing child seats to bear a new, enhanced warning label. The domestic and import

vehicle manufacturers are sending letters to the owners of passenger air bag-equipped vehicles apprising them of the adverse effects of air bags. The sun visor labels will be included with the letter.

- Continuing the Department of Transportation's comprehensive effort to preserve the benefits of air bags and minimize their risk, a Notice of Proposed Rulemaking was published in January, 1997, offering proposals for deactivating air bags. In parallel with this effort, rulemaking deliberations proceeded concurrently on the issue of reducing the aggressivity of air bags. At the same time, a final rule was issued, extending until September 1, 2000, the time period during which vehicle manufacturers would be permitted to offer manual cut-off switches for the passenger-side air bag for vehicles without rear seats or with rear seats that are too small to accommodate rear-facing infant seats.

- On March 19, 1997 (62 FR 12960) the final rule, allowing manufacturers to quickly implement redesigned air bags, was issued. The new rule paved the way for manufacturers to install air bags that were redesigned, with the goal of mitigating the injurious effects of air bags, while maintaining their proven benefits. Manufacturers responded by installing air bags that are 20 percent to 35 percent less powerful. The new rule also provides manufacturers and suppliers with additional time to develop a variety of advanced air bag technologies to tailor air bag deployment more appropriately to crash severity, occupant size and position, seat belt use and other vehicle factors. This rule provided changes that would affect new production vehicles. The issue of what to do about vehicles already on the road came next. In addition, this release repeated prior agency warnings of the dangers of placing a rear-facing infant seat in front of an air bag, and broadened the previous warnings to apply to older children and even adults who may ride unrestrained.

- On November 21, 1997, the agency announced the final rule permitting deactivation. Auto dealers and service outlets could begin deactivating air bags on January 19, 1998.

- To give manufacturers and suppliers the maximum benefits of currently unproven but promising advanced air bag technology, the agency has decided that the optimal path for future rulemaking should be performance-based requirements. This approach would permit varied choices and options in order to provide manufacturers with utmost flexibility to design new systems. Toward this end, the agency published a Notice of Proposed Rulemaking dealing with advanced air bags on September 18, 1998, with a Final Rule to be published one year later.

Safety Belt Use

In April, 1997, the Department and NHTSA presented to President Clinton a comprehensive set of program initiatives designed to increase national seat belt and child safety seat use: The Presidential Initiative to Increase Seat Belt Use Nationwide. Strategies supporting the initiative include: (1) the formation of public-private partnerships, (2) improved seat belt and child passenger safety legislation, (3) high visibility enforcement of those laws, and (4) intensive public information and education programs. This initiative was launched in October 1997 as the Buckle

Up America campaign. This campaign encourages the increased use of seat belts and child safety seats through more effective public education about and enforcement of existing seat belt and child safety seat use laws and the passage of standard (primary) enforcement provisions in state belt use laws, including other improvements to strengthen those laws.

As of December, 1997, state surveys indicated safety belt use rates ranging from 48 percent in Arkansas and Mississippi to 88 percent in California. An estimate of national safety belt use is derived through a population-weighted average of these state use rates. **The national safety belt use rate as of December 1997 was estimated to be 69 percent.**

Belt use information is not routinely collected for the military, government employees, or law enforcement personnel. However, based upon the existence of mandatory use policies, training programs, and promotional campaigns, use among these groups is expected to be higher than in the general population.

The overall observed safety belt use rate in NHTSA's 1996 National Occupant Protection Use Survey (NOPUS) moving traffic study was 61.3 percent, compared to the 58.0 percent observed in 1994. Shoulder belt use observed in the 1996 moving traffic study was 64.4 percent for passenger car occupants compared to 62.8 percent in 1994 and 56.4 percent for light truck occupants, compared to 50.2 percent in 1994.

Direct comparison of findings between the NOPUS and state surveys is difficult, primarily because of the differences in vehicle and occupant coverage. However, a rough comparison of overall use can be made between the state-based estimate for 1996 of 68 percent and the NOPUS estimate for passenger car drivers and passengers of 64.4 percent. In this comparison, the state based estimate falls within the 95 percent confidence interval of the NOPUS estimate.

The combination of surveys that has been used to measure safety belt use over the past several years also provides insight with regard to changes in use rates. Until 1990, the 19 cities survey was used as the index of national use. In 1990, that index for passenger car drivers was 49 percent. The NOPUS estimate of belt use among passenger car drivers in 1996 is 65.1 percent. The difference of 16 percentage points between the 19 cities index and the NOPUS estimate is consistent with the 15 percentage point change in use indicated by the aggregate of state surveys between 1990 and 1996 (i.e., 53 percent in 1990 and 68 percent in 1996).

State surveys provide an essential source of information for monitoring progress in the states. The NOPUS provides a probability-based sample of national use with the ability to estimate statistical error. In addition, the NOPUS provides a unique source of detailed information concerning restraint use by vehicle type, age, gender, race, geographic area, time of day, day of week, urbanization, etc.

Section I -- BACKGROUND

History of FMVSS 208 Requirements

Federal Motor Vehicle Safety Standard (FMVSS) 208 ("Occupant Crash Protection"), as amended on July 17, 1984, required that automatic occupant protection, such as air bags or automatic belts, be phased into passenger cars during 1987-1990. When the National Highway Traffic Safety Administration (NHTSA) issued FMVSS 208, it also began a continuing, nationwide effort to increase belt use through encouragement of state buckle-up laws, enforcement and public education. Use of manual lap-shoulder belts reduces the risk of fatal injury to front-seat occupants by 45 percent, but in 1983, only 14 percent of the general driver population buckled up. Initially, automatic belts installed in response to FMVSS 208 helped increase belt use. In the long run, however, NHTSA believed that the best protection would come from air bags in combination with state buckle-up laws to ensure high rates of belt use.

FMVSS 208's phase-in requirement for automatic occupant protection was: 10 percent of model year 1987 passenger cars, 25 percent of model year 1988, 40 percent of model year 1989, and all cars manufactured after September 1, 1989 (or model year 1990). FMVSS 208 was later amended to allow an exclusion from the automatic protection requirement for the right-front passenger position until September 1, 1993, if an air bag was installed for the driver. All vehicles manufactured after September 1, 1993, are required to have automatic protection for the driver and right-front passenger. The 1987-1990 phase-in schedule of the automatic occupant protection requirement was met or exceeded.

The two components of NHTSA's occupant protection program have reinforced each other. FMVSS 208 offered a "choice" between automatic protection and safety belt laws, and therefore, became the catalyst for the adoption of state "buckle-up" laws. In 1983, prior to FMVSS 208 (as amended), no state had a belt use law. Currently, 49 states (all except New Hampshire) plus the District of Columbia, Puerto Rico, and the Territories have safety belt use laws. In addition, national safety belt use has risen dramatically from 14 percent in 1983 to 69 percent as of December 1997.

The Intermodal Surface Transportation Efficiency Act (ISTEA), passed by the Congress in 1991, required all passenger cars manufactured after September 1, 1997, and light trucks manufactured after September 1, 1998, to have driver and passenger air bags, plus manual lap-shoulder belts. Also in 1991, NHTSA extended the automatic occupant protection requirements to light trucks and vans, on a phased-in basis for model years 1995, 1996, 1997, and 1998.

Descriptions of Occupant Protection Systems

Several distinct types of automatic occupant protection systems are available currently in the on-road fleet, including automatic safety belts, manual safety belts, air bags, and various combinations of the air bag with either manual or automatic belts. For the purpose of conducting the analysis of injury-reducing effectiveness, these systems were restricted to drivers only, and grouped as follows:

(1) *Frontal air bag plus safety belts*: If a frontal air bag was available for the driver (the vehicle was equipped with either driver-only or dual air bags) plus the driver used the available safety belt system.

(2) *Any air bag alone*: If a frontal air bag was available for the driver, and no belt system was used.

(3) *Automatic safety belts*: The driver used either the available motorized 2-point (torso) belt (with or without a manual lap belt), a nonmotorized 3-point (lap/shoulder) belt, or a nonmotorized 2-point belt (with or without a manual lap belt).

(4) *Manual 3-point safety belts*: The driver used the available traditional lap-and-shoulder belt system.

(5) *Unrestrained*: The driver did not use any safety belt and no frontal air bag was available.

How Air Bags Work

Air bags, an automatic crash protection system that deploys quicker than the blink of an eye, are the result of extensive research to provide maximum crash protection. Air bags by themselves protect only in frontal crashes, and offer maximum protection when used in conjunction with safety belts. Air bags should NOT be used as the only form of occupant protection; they are intended to provide supplemental protection for belted front-seat occupants in frontal crashes.

Typical air bag systems consist of three components: an air bag module, crash sensor(s), and a diagnostic unit. The air bag module, containing an inflator and a vented or porous, lightweight fabric air bag, is located in the hub of the steering wheel on the driver side or in the instrument panel on the passenger side. Crash sensor(s), located on the front of the vehicle or in the passenger compartment, measure deceleration, the rate at which a vehicle slows down. When these sensor(s) detect decelerations indicative of a crash severity that exposes the occupants to a high risk of injury, they send an electronic signal to the inflator to trigger or deploy the bag. The diagnostic unit is an electronic device that monitors the operational readiness of the air bag system whenever the vehicle ignition is turned on and while the ignition is powered. The unit uses a warning light to alert the driver if the air bag system needs service.

Air bags are designed to deploy (inflate) in moderate-to-severe frontal and near-frontal crashes. They inflate when the crash forces are about equivalent to striking a brick wall head-on at 10-15 miles per hour or a similar sized vehicle head-on at 20-30 mph. Frontal air bags are not designed to deploy in side, rear, or rollover crashes. Rollover crashes can be particularly injurious to vehicle occupants because of the unpredictable motion of the vehicle. In a rollover crash, unbelted occupants can be thrown against the interior of the vehicle and strike hard surfaces such as steering wheels, windows and other interior components. They also have a great risk of being ejected, which usually results in very serious injuries. Ejected occupants also can be struck by their own or other vehicles. Since air bags provide supplemental protection only in frontal crashes, safety belts should always be used to provide maximum protection in rollovers and all crashes.

The bag inflates within about 1/20 of a second after impact. The inflated air bag creates a protective cushion between the occupant and the vehicle's interior (i.e., steering wheel, dashboard, and windshield). At 4/20 of a second following impact, the air bag begins to deflate. The entire deployment, inflation, and deflation cycle is over in less than one second.

After deployment, the air bag deflates rapidly as the gas escapes through vent holes or through the porous air bag fabric. Initial deflation enhances the cushioning effect of the air bag by maintaining approximately the same internal pressure as the occupant strokes into the bag. Subsequent rapid and total deflation enables the driver to maintain control if the vehicle is still moving after the crash and ensures that the driver and/or the right-front passenger is not trapped by the inflated air bag.

Dust-like particles present during the inflation cycle primarily come from dry powder that is often used to lubricate the tightly packed air bag to ease rapid unfolding during deployment. Small amounts of particulate produced from combustion within the inflator also are released as gas is vented from the air bag. These dust particles may produce minor throat and/or eye irritation. Once an air bag is deployed, it cannot be reused. Air bag system parts must be replaced by an authorized service dealer for the system to once again be operational.

To ensure that infants and children ride safely, with or without a passenger-side air bag, NHTSA urges care givers to follow three "rules":

-- Make sure ***all*** infants and children are properly restrained in child safety seats or lap and shoulder belts for every trip.
-- The ***back seat*** is the safest place for children of any age.
-- Infants riding in rear-facing child safety seats should ***never*** be placed in the front seat of a vehicle with a passenger-side air bag.

Warning labels with such information are posted on vehicle visors and, as shown here, on child safety seats.

Market Shares of the Various Occupant Protection Systems

Americans are using safety belts more than ever before, and air bags are offered in virtually all new cars, and in many light trucks, vans and sport utility vehicles in advance of the Federal requirement. Their market share is nearly universal. The dramatic increase in belt use over the past 10 years enables the combination of air bags and manual belts to yield significant life-saving results.

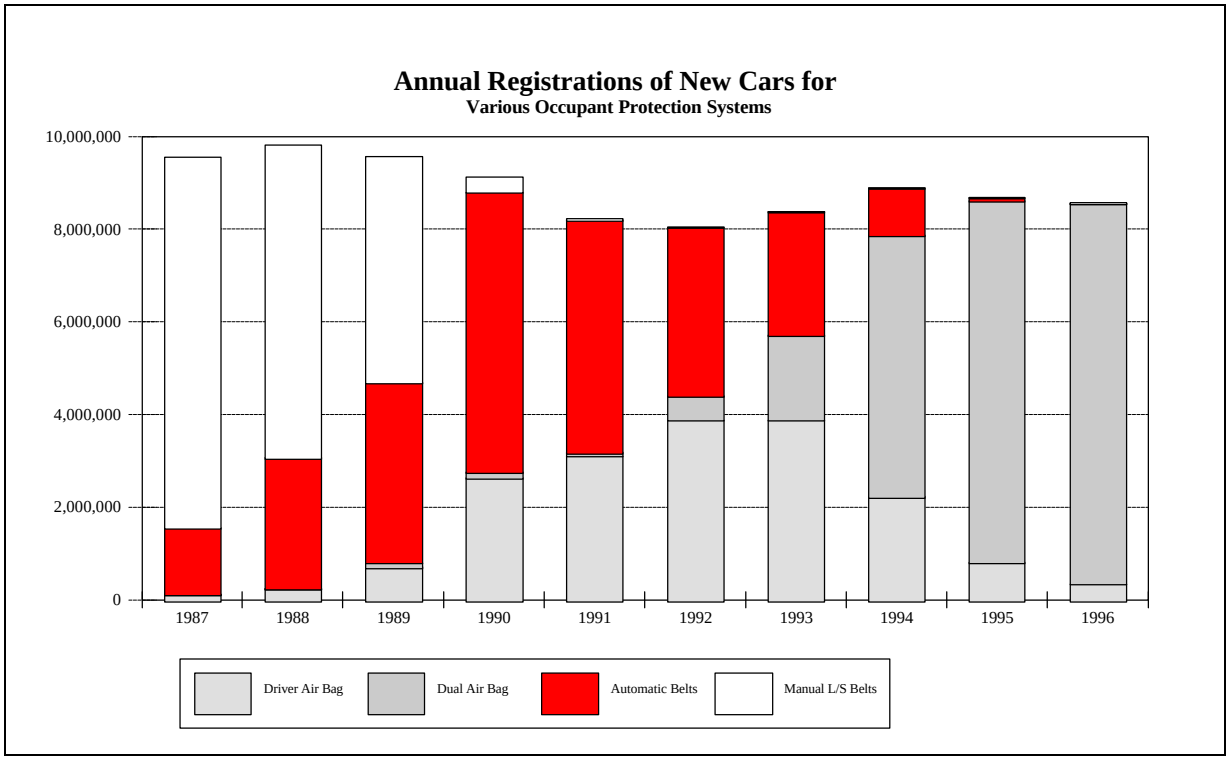
Exhibit 1

Cumulative Registrations of Cars
Equipped with Various Occupant Protection Systems
1987 - 1996 (No Attrition Included)

Driver Air Bags	17,975,331
Dual Air Bags	24,289,847
Automatic Belts	26,634,138
Manual Belts	19,998,385

As of December 31, 1996 over 42 million air bag-equipped new cars had been registered since 1987, 18 million of which were equipped with driver air bags and another 24.3 million equipped with dual air bags. Exhibit 2 presents the distribution of occupant protection systems in new cars registered each year between 1987 and 1996.

Exhibit 2



During the phase-in (1987-1990) of automatic occupant protection, automatic belts were the most frequently sold automatic occupant protection system. During 1990 to 1993, manufacturers equipped more and more new cars with driver air bags, which became increasingly popular among new car buyers. By 1995, cars equipped with driver or dual air bag systems represented over 98 percent of new cars sold, with 84 percent of all model year 1995 cars sold being equipped with dual air bags.

Section II -- ESTIMATING EFFECTIVENESS

The Analytical Challenge

Assessing the benefits of occupant protection systems, that is, their effectiveness in reducing the chances of occupant mortality and morbidity, is not a simple task. While it would be quite easy to compare the observed injury and fatality rates for occupants protected by the various systems, differences in fatality- and injury-reducing effectiveness can be masked by a multitude of factors not directly related to the air bag or automatic belt systems.

For example, air bags originally were offered in the larger, more expensive and the sporty, high-performance model lines. These vehicles may be driven much differently than, for example, station wagons or family-size sedans. The different use patterns of these vehicles will result in a different mix of crashes; for example, some make/models will experience more single-vehicle crashes on rural, higher speed roads, which tend to be more severe than the average two-vehicle crash in an urban, lower speed environment. Also, scientific studies have demonstrated that heavier cars, on average, offer greater protection to their occupants than do lighter cars (which were generally not included during the early introduction of air bags). These and other factors need to be identified and accounted for in any analysis of system effectiveness and are among the challenges of conducting an accurate assessment.

Other challenges include the identification and availability of appropriate data for conducting this assessment, in terms of relevance, sufficient numbers of cases for study, and quality. Safety belt use laws were critical to increasing belt use to the levels we have achieved. However, repeated analyses have demonstrated that self-reported safety belt use, such as that contained in most police accident reports, overstates the level of safety belt use in these crashes. This may be due to penalties for nonuse of safety belts, discounts offered by some automobile insurance companies for a signed commitment that the policyholder will always use his or her safety belt, or other reasons. What has been observed is a tendency for surviving drivers and passengers (especially those receiving no or only minor injury) to say that they were wearing their belts at the time of the crash when actually they were unrestrained. This causes higher reported safety belt use rates for occupants in police-reported crashes than for those in the general population. It is very unlikely that crash-involved occupants could have higher safety belt use rates than the general public since the very behavior which leads to increased risk of crash involvement is hypothesized to be associated with an increased tolerance for risk, such as not wearing safety belts, or driving after drinking too much alcohol.

The effect of higher reported safety belt use, especially among the less seriously injured and uninjured vehicle occupants, *is to make safety belts appear safer than they actually are*. If some of the unbelted, uninjured people had been incorrectly reported as belted, this would increase the computed injury rate among unbelted occupants (fewer uninjured persons) and decrease the injury rate among the belted occupants, artificially increasing the “gap” between belted and unbelted occupants and inflating the estimated advantage of using safety belts.

Analysis Overview -- Fatality-Reducing Effectiveness

The database used to conduct the assessment of the fatality-reducing effectiveness of air bags is NHTSA's Fatality Analysis Reporting System (FARS). FARS is a census of all fatal traffic crashes that occur in the U.S., on roads customarily open to the public, where at least one person dies from crash-related causes within 30 days of the crash. Depending on the state, the information entered into the FARS database by state analysts includes the following:

- police accident reports,
- state vehicle registration files,
- state driver licensing files,
- state highway department data,
- vital statistics,
- death certificates,
- coroner/medical examiner reports,
- hospital medical records, and
- emergency medical service reports.

One of the important ways to group drivers is by their safety belt use. Separate estimates are presented for the fatality-reducing effectiveness of air bags plus manual lap-shoulder belts **and** air bags alone, relative to an unrestrained occupant, as requested in the 1991 ISTEA legislation. At the same time, an updated estimate of the effectiveness of manual lap-shoulder belts alone was not developed for this report -- it has been known for some time that manual safety belts are 45 percent effective in reducing fatality risk. Also, with the phasing out of automatic safety belts, no fatality-reducing effectiveness estimates of these systems were computed.

As of February 1998, NHTSA's Fatality Analysis Reporting System contained records of nearly 11,000 fatally injured front-seat occupants of cars and light trucks who were sitting at positions equipped with air bags.

For the analysis of the fatality-reducing effects of air bags, the ability to control for the various crash circumstances by comparing drivers and right-front passengers involved in precisely the same crashes alleviated the need for detailed statistical modeling. A second approach compared the driver fatality experience in air bag-equipped vehicles in frontal fatal crashes (for which air bags were specifically designed) to their experience in nonfrontal fatal crashes. This analysis assumes that air bags have no effect in nonfrontal crashes, such as side and rear impacts and rollovers.

Analysis Overview -- Injury-Reducing Effectiveness

The database selected to conduct the assessment of injury-reducing effectiveness for manual and automatic occupant protection systems is NHTSA's National Automotive Sampling System (NASS) Crashworthiness Data System (CDS). Data from 1988 through 1996, the most current year available, were used. This database is the most comprehensive, nationally representative crash investigation system available, and has the most accurate safety belt use reporting of any file available to NHTSA. Assessments of safety belt use in the current analysis are based on the

judgment of trained, professional accident investigators, after having inspected the vehicles involved, reviewed the injury patterns based on hospital records, and conducted interviews with crash-involved parties. Even so, occupant-reported safety belt use in the NASS CDS is higher than the observed safety belt use of drivers on the road. This is true for both manual and automatic safety belt systems. To a lesser extent, this is also true for investigator-reported belt use, which was used in the injury-reduction analysis. In the majority of crashes in the NASS CDS, safety belt use is determined by the preponderance of evidence obtained from inspection of the vehicles involved, particularly in moderate to high-severity crashes.

Overreporting of safety belt use is more likely in low damage severity and low occupant injury crashes, which provide little in the way of hard evidence of safety belt use or nonuse. These crashes are low frequency crashes in the NASS CDS sample but comprise a larger proportion of the on-road crashes (NASS CDS oversamples more serious crashes, since these are where the more serious injuries occur). Unlike other postcrash surveys, the NASS CDS investigator does not rely primarily on self-reporting of safety belt use by the person involved in the crash, which is generally the source for the information cited on police accident reports. It is for this reason that the NASS CDS is believed to provide the most reliable indications of the use of safety belts by crash-involved parties.

There continue to be too few cases of *fatal injury* in the NASS sample to conduct an analysis of fatalities alone. Inasmuch as NASS consists of a sample of towaway passenger vehicle crashes in the United States, the file contains detailed information on a broad range of crash severities. In the NASS sample, as in the population of traffic crashes, less serious injuries occur much more often than do fatalities. To achieve a sufficiently large sample size, the analyses in the first two reports to Congress estimated system effectiveness in reducing the likelihood of moderate and greater injury (level 2 and greater on the Abbreviated Injury Scale (AIS)[1]). Fatal injuries, although relatively rare, are included in this category. In addition, only drivers were used in the analysis of air bag effectiveness in injury prevention. The sample size for front-seat passengers with air bags is still relatively small for this type of statistical technique.

Additional exploratory analyses were conducted in the third report to investigate a broader range of issues related to occupant injury. The presence of very detailed information in the NASS CDS makes it possible to conduct these investigations. In addition to effectiveness in preventing a maximum injury of severity AIS 2 and greater (MAIS 2+, or moderate and greater injury), analyses were conducted to estimate effectiveness in preventing serious and greater injury (MAIS 3+), both overall and in frontal crashes. **For ease of discussion, these will be referred to as *moderate injury* and *serious injury* in the remainder of this report.** Analyses were also

[1]The AIS, first developed by the Association for the Advancement of Automotive Medicine in 1971, is a consensus-derived, anatomically based system that ranks individual injuries by body region on a scale of 1 to 6 as follows: 1=minor, 2=moderate, 3=serious, 4=severe, 5=critical, and 6=maximum/currently untreatable. The AIS is intended as a measure of the severity of the injury itself and not as a measure of impairments or disabilities that may result from the injury. It does not assess the combined effects of multiple injuries to a patient. The AIS was revised and updated several times, with the most recent revision in 1990. In this report, reference to an AIS level (i.e., AIS of 2 or greater) refers to the maximum AIS level for any injury suffered by a vehicle occupant; that is, the most severe injury. MAIS represents the maximum injury severity (AIS) of any injury received by a person, regardless of the nature or location of the injury.

conducted to investigate the moderate and serious injury-reducing effects for the following body regions: head (includes head injuries as well as those to the neck, face, and cervical region of the spine), chest (thorax, abdomen, and thoracic and lumbar spinal injuries), upper extremities (arm, elbow, forearm, wrist) and lower extremities (pelvis, leg, thigh, knee, ankle).

For the injury-reducing effectiveness, the analysis developed statistical models for estimating system effectiveness that permit the analyst to account for the potentially confounding effects of other factors, such as crash type and severity, occupant age, and sex, etc. Two patterns of vehicle damage were studied. Effectiveness was measured for cars that experienced damage to any part of the vehicle and those receiving damage to the front of the vehicle. Frontal damage is the area where safety belts, and especially air bags, would prove most beneficial at protecting vehicle occupants. For a more detailed discussion of the specific statistical models employed to conduct these analyses, the reader is referred to NHTSA's first report to the Congress[2] on this subject.

One of the more important variables determined and reported by the NASS investigators is delta-v, a measure of crash severity representing the change in velocity to which vehicle occupants are exposed. Delta-v has been shown to be a significant factor in determining injury severity, with higher levels of delta-v indicating a greater likelihood of more serious injury. The inclusion of delta-v in the statistical model yields a large improvement in explaining why some vehicle occupants were injured.

The following section presents the estimates of effectiveness developed as a result of these analyses. The injury-reducing effectiveness estimates presented cover four basic groups of automatic occupant protection: air bag plus manual lap/shoulder belts, air bags used alone, manual lap/shoulder belts used without the presence of an air bag, and all automatic belts (without an air bag) considered as a single group.

Amendments to FMVSS 208 required the installation of air bags and manual lap/shoulder belts in all new passenger cars manufactured in September 1997 and later (model year 1998) and all new light trucks manufactured in September 1998 and later (model year 1999). Air bags have already proven to be the system of choice among consumers, so the trend already had been established before this requirement was implemented. Automatic safety belts have essentially been phased out of the new car market. Therefore, all the various 2-point and 3-point automatic safety belt systems have been combined into a single group, automatic belts. As stated earlier, no estimates of the fatality-reducing effectiveness of manual or automatic safety belts were estimated.

Results of Analysis of Fatality-Reducing Effectiveness of Air Bags

As of February 1998, NHTSA's Fatality Analysis Reporting System contains records of nearly 11,000 fatally injured front-seat occupants of cars and light trucks who were sitting at positions equipped with air bags. The agency has enough data for preliminary estimates of the fatality reduction by air bags plus safety belts, and air bags without safety belts, relative to an unrestrained occupant, as requested in the 1991 ISTEA legislation. There are also enough data to compare the

[2] *First Report to Congress, Effectiveness of Occupant Protection Systems and Their Use*, DOT-HS-808-019, January 1993.

fatality reduction by air bags in purely frontal crashes for car drivers, car passengers, and drivers of light trucks and to compare the fatality-reducing effectiveness of air bags for drivers of small and large cars, and for younger and older occupants[3].

The basic analyses of data from the Fatality Analysis Reporting System are updates of the findings in NHTSA's *Third Report to Congress*. These analyses estimate the fatality reduction by air bags for drivers of passenger cars, and they are measured on the combined population of belted and unbelted occupants of cars equipped with driver air bags. The analyses studied the fatality experience of drivers in frontal crashes vs. two select comparison groups: their right-front passengers and the drivers in nonfrontal crashes.

The first analysis considers crash-involved passenger cars equipped with air bags and 3-point belts at the driver's seat, but only 3-point belts at the right-front seat and with both front outboard seats occupied. The ratio of driver fatalities (with the air bag) to right-front passenger fatalities (without the air bag) is calculated, and it is compared to the corresponding ratio in earlier cars of the same makes and models, equipped only with 3-point belts at both seating positions. The fatality-reducing effectiveness of air bags is estimated by the relative difference in the two ratios. This analysis includes all drivers and right-front passengers of the cars, both belted and unbelted.

In purely frontal crashes (principal impact of 12:00, excluding cases where the most harmful event was a rollover), air bags are now associated with a statistically significant fatality-reducing effectiveness of 33 percent. This result is essentially unchanged from the 34 percent cited in NHTSA's *Third Report to Congress*. In all frontal crashes (including pure and partial frontals; principal and/or initial impact point of 10:00 to 2:00), the analysis now indicates a statistically significant 19 percent reduction in fatality risk for air bags. For all types of crashes combined, including nonfrontals, the fatality reduction is a statistically significant 10 percent.

The second analysis utilizes another distinctive characteristic of air bags: that they are primarily designed for action in frontal crashes. With an inclusive definition of "frontal and partially frontal" crashes (initial or principal impact location between 10:00 and 2:00), it can be assumed that air bags have little effect, relative to manual belt use alone, in the remaining "nonfrontal" crashes. These nonfrontal fatalities represent an exposure-based *control group* for the current analysis.

The ratio of frontal to nonfrontal driver fatalities in cars equipped with driver air bags is compared to the corresponding ratio in earlier cars of the same makes and models, equipped only with 3-point belts. The fatality-reducing effectiveness of air bags in frontal crashes is estimated by the relative difference in the two ratios. This approach has the disadvantage of relying on the unproven assumption of zero effectiveness for air bags in nonfrontal crashes, but it allows a larger

[3] *Fatality Reduction by Air Bags -- Analyses of Accident Data through Early 1996*, DOT-HS-808-470, August 1996.

sample size than the preceding method, since it is not limited to cases where the right-front seat was occupied.

When driver fatalities in purely frontal crashes (principal point of impact of 12:00, excluding cases where the most injurious or damaging event was a rollover) are compared to those in nonfrontal crashes, the fatality reduction for air bags is a statistically significant 28 percent. For all frontal or partially frontal crashes (principal and/or initial impact point of 10:00 to 2:00), there is an estimated 19 percent reduction of fatality risk (statistically significant). With the assumption that air bags have negligible effect in nonfrontal crashes, the combined fatality reduction for air bags in all types of crashes is estimated at 13 percent, by this analysis method.

Air bags did not have a statistically significant effect in partially frontal crashes (principal and/or initial point of impact between 10:00 and 2:00, excluding purely frontal crashes with 12:00 point of principal impact) by either analysis method. The first method yielded a 2 percent fatality decrease with air bags, the second, an 8 percent reduction.

Exhibit 3 summarizes the results of these two analytical approaches and presents the set of estimates that result from computing the average of the two approaches, which is the final estimate of effectiveness.

Exhibit 3

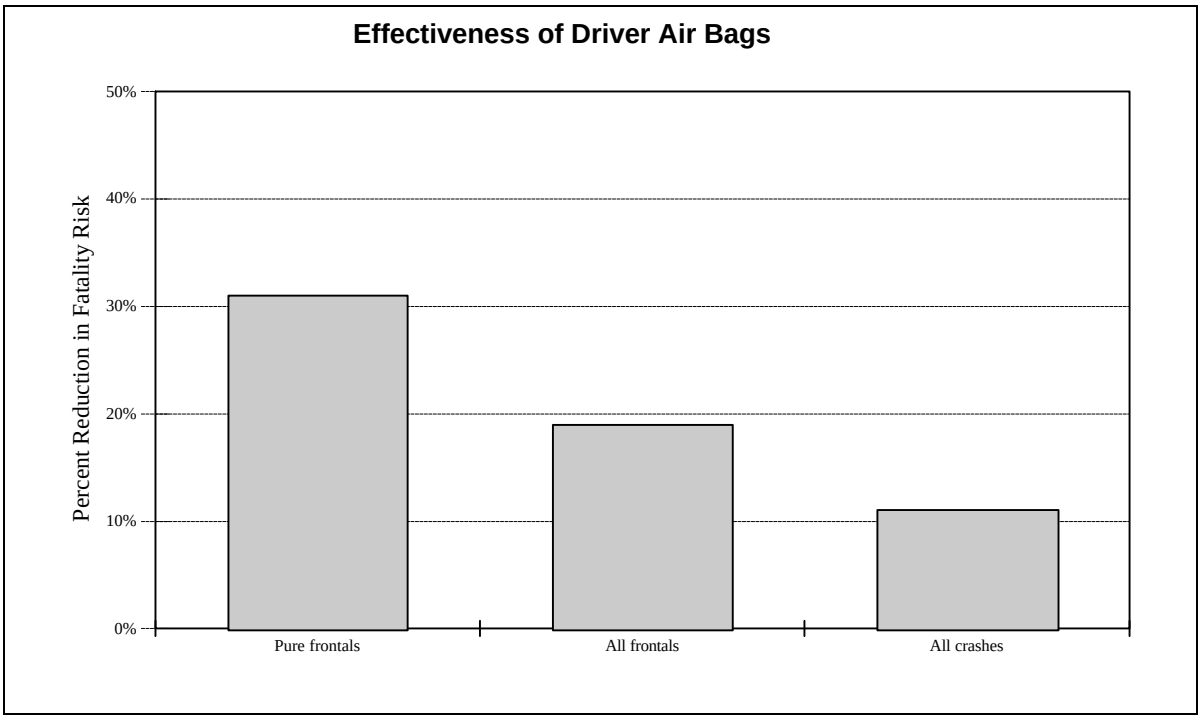
Fatality-Reducing Effectiveness of Driver Air Bags

	Comparison Group Right-Front Passengers	Nonfrontal Crashes	Final (Average) Effectiveness
Purely frontal crashes (12:00)	***33%***	***28%***	***31%***
All frontal crashes	***19%***	***19%***	***19%***
All crashes (frontals plus nonfrontals)	***10%***	***13%***	***11%***

Note: ***Bold italics*** indicates that the estimate is statistically significantly different from zero.

The final estimates are presented graphically in Exhibit 4. The analyses indicate that the life-saving benefits of air bags derive almost entirely from purely frontal crashes; that their benefit in partially frontal crashes, if any, is quite limited; and that the fatality reduction in all types of crashes is slightly more than one-third of the reduction in purely frontal crashes.

Exhibit 4



It has become possible to apply the same analytical methods to certain subgroups of the driver or vehicle population and to calculate the fatality reduction by air bags for those subgroups. The analyses that follow primarily estimate the effectiveness of air bags in purely frontal crashes, where the effect of air bags is usually statistically significant.

One of the most important ways to group drivers is by their belt use. Belted drivers in cars equipped with air bags experienced a statistically significant 21 percent fatality reduction in purely frontal crashes, relative to belted drivers in comparable cars without air bags. Unbelted drivers with air bags experienced a statistically significant 34 percent fatality reduction in purely frontal crashes, relative to unbelted drivers without air bags. In other words, air bags have significant life-saving benefits in purely frontal crashes for belted **and** unbelted drivers; however, the benefit appears to be somewhat larger, relatively speaking, for the unbelted driver.

The two preceding estimates need to be carefully interpreted. The 21 percent reduction for the belted driver with an air bag is measured relative to the belted driver without an air bag; it does not include the very substantial effect of belts, but represents the increment of air bags plus belts over belts alone. Both estimates are for purely frontal crashes; the fatality reduction in all types of crashes is slightly more than one-third of the reduction in purely frontal crashes -- i.e., about 9 percent for the belted driver (relative to a belted driver without air bags) and 14 percent for the unbelted driver. NHTSA estimates that safety belts alone reduce fatality risk by 45 percent. Thus, if an unrestrained driver has a fatality risk of 100, a driver protected by both a safety belt and an air bag will have a risk of:

100 x (1-.45) x (1-.09) = 50.

Based on these considerations, NHTSA can now update the Third Report's estimates of the *when-used* fatality reduction for three types of occupant protection systems, for passenger car drivers in crashes of all types, as requested by the 1991 ISTEA legislation, and presented in Exhibit 5.

Exhibit 5

Estimated Effectiveness of Occupant Protection Systems
in Reducing Fatality Risk for Passenger Car Drivers

System Used	**Fatality Reduction**
Air bag plus lap-shoulder belt	50%
Air bag alone	14%
Manual lap-shoulder belt	45%

For example, if 100 drivers of cars not equipped with air bags were killed in crashes, 14 of them would have been saved (86 would still have been killed) had their cars been equipped with a driver air bag. Had these fatally injured drivers been using their lap-shoulder belt in their air bag-equipped car, 50 of them would have been saved.

While the estimates presented in Exhibit 5 are based on *when* safety belts actually were or were not used, the fatality-reducing effectiveness estimates that follow combine both belted and unbelted drivers, or passengers as noted, and are therefore considered *as used*, in the same spirit as the overall effectiveness estimates presented earlier in Exhibit 3.

Another important way to group drivers is by their age. Drivers age 29 or less experienced a statistically significant 30 percent fatality reduction with air bags in purely frontal crashes, relative to drivers of that age in comparable cars without air bags. The fatality reduction for drivers age 30-55 was a statistically significant 34 percent. For drivers age 56-69, the observed effectiveness is also a significant 34 percent, and for drivers age 70 or older, it dropped to a nonsignificant 16 percent. These statistics, although based on too few cases to be definitive, suggest that air bags are less effective for the oldest drivers than for younger adults.

Cars can be grouped by their weight; specifically, the cars on the Fatality Analysis Reporting System were subdivided, by car weight, into three groups containing equal numbers of crash records. The weight ranges for these three groups were: up to 2778 pounds, 2779-3119 pounds, 3120 pounds or greater. The observed fatality reduction by air bags in purely frontal crashes is a statistically significant 31 percent in the light cars, a statistically significant 25 percent in the medium-weight cars, and a statistically significant 39 percent in the heavy cars. In other words, air bags are effective in cars of all sizes, and there are not enough data, at this time, to reveal any trend in effectiveness by car size.

There are now enough crash data involving light trucks -- pickup trucks, vans or sport utility vehicles -- for analyses of fatality reduction by driver air bags. Drivers of light trucks equipped with air bags experienced a statistically significant 36 percent fatality reduction in purely frontal crashes, relative to drivers of trucks of the same makes and models, but without air bags. This is essentially the same effectiveness as for passenger car drivers (31 percent), and it suggests that driver air bags may be as effective in light trucks as they are in passenger cars.

There are also enough crashes involving passenger cars with dual air bags for analyses of the effect of passenger air bags. However, it is important to distinguish between two quite different groups of right-front passengers: pre-teen children (including infants and toddlers), as opposed to teenagers and adult passengers. In-depth investigations of individual crashes have shown that air bags of current design have fatally injured a number of pre-teen children in frontal crashes, especially unrestrained children and infants in rear-facing safety seats. The crash data involving child passengers age 0-12 on the Fatality Analysis Reporting System are sufficient for limited statistical analyses, and the results support the unfavorable findings of the in-depth crash investigations. Every analysis that includes frontal crashes shows a higher fatality risk for the children in cars with dual air bags than for children in comparable cars without passenger air bags. Depending on the analytical method, some, but not all, of the increases are statistically significant. In other words, although a specific numerical value on the effect of passenger air bags on children 0-12 years old cannot yet be determined, the results are consistent with the conclusion, from special crash investigations, that child passengers are experiencing problems with air bags.

On the other hand, for right-front passengers age 13 or older, passenger air bags have significant benefits. Passengers of cars equipped with dual air bags experienced a statistically significant 32 percent fatality reduction in purely frontal crashes, relative to passengers of cars of the same makes and models, but equipped only with driver air bags. This is essentially the same effectiveness as for car drivers (31 percent), and it suggests that passenger and driver air bags may be equally effective for occupants age 13 or older.

Exhibit 6 summarizes the fatality-reducing effects of air bags for the subgroups discussed above.

Exhibit 6

Estimates of the Fatality-Reducing Effects of Air Bags in Purely Frontal Crashes (12:00)

Group	Fatality Reduction
Drivers of passenger cars	***31%***
Belted drivers of passenger cars	***21%***
Unbelted drivers of passenger cars	***34%***
Drivers age 29 years and younger	***30%***
Drivers age 30-55 years old	***34%***
Drivers age 56-69 years old	***34%***
Drivers age 70 years and older	16%
Drivers of light cars (up to 2778 pounds)	***31%***
Drivers of medium cars (2778-3119 pounds)	***25%***
Drivers of heavy cars (3120 pounds or greater)	***39%***
Drivers of light trucks (pickups, vans, utility vehicles)	***36%***
Right-front passengers age 13 and older	***32%***
Right-front passengers under age 13	(increased risk, but no reliable numerical estimate)

Note: ***Bold italics*** indicates the estimate is statistically significantly different from zero.

Results of Analysis of Injury-Reducing Effectiveness

While most of the fatality-reducing effectiveness estimates presented in the previous section were based on the combination of belted and unbelted occupants, without regard to whether the available safety belts actually were used (that is, *as-used*), ALL of the estimates of injury-reducing effectiveness presented in this report are based on **when** safety belts actually were or were not used.

Overall and Frontal Crash Effectiveness Estimates for Moderate Injury

The results of statistical modeling of the 1988 through 1996 NASS crash data are presented in Exhibit 7 and graphically in Exhibit 8. Effectiveness was estimated for two vehicle damage populations: all damage areas combined and damage to the front of the vehicle.

Effectiveness means that an occupant using the particular system will experience the cited percentage reduction in the chance of injury, given that a crash has occurred, compared to an unrestrained occupant.

Exhibit 7

Estimated Effectiveness of Occupant Protection Systems
in Reducing the Likelihood of Driver Moderate Injury (MAIS 2+)

System Used	All Damage Areas	Front Damage
Air bag plus lap-shoulder belt	***66%***	***67%***
Air bag alone	10%	10%
Automatic (2-point and 3-point) belt	***51%***	***53%***
Manual lap-shoulder belt	***53%***	***57%***

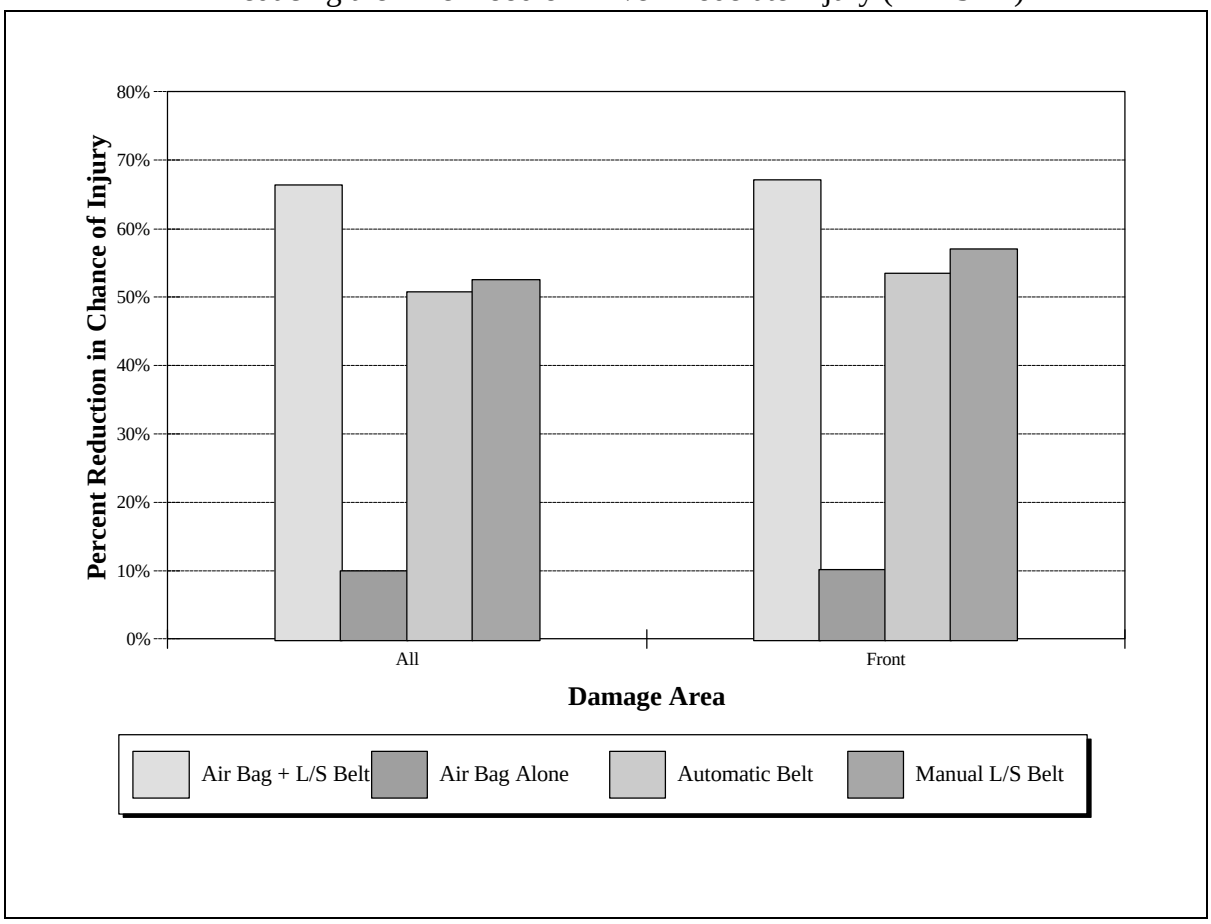
*Note: **Bold italics** means statistically significant difference from the risk of unrestrained occupants.*

As can be seen in Exhibit 7, both automatic and manual safety belt systems provide significant overall injury-reducing benefits compared to being unrestrained. The estimates for these two safety belt systems are very close, 51 percent for automatic belts and 53 percent for manual lap-shoulder belts. The air bag plus lap-shoulder belt system provides the greatest injury protection, 66 percent (although the difference vs. safety belts alone is not statistically significant). The injury-reducing effectiveness of the air bag alone, without the use of safety belts, was estimated to be 10 percent, and was not significantly better than being unrestrained.

For vehicles with frontal damage, the air bag plus manual lap-shoulder belts provides the greatest protection against moderate injury (again, the differences compared to the other systems are not significant). For air bags with manual belts, the effectiveness in reducing the chance of moderate injury is about the same in frontal crashes as in all crashes (67 percent). The effectiveness of the air bag alone was the same in frontal crashes (10 percent) as in all crashes. The above results are presented graphically in Exhibit 8.

When looking at protection from moderate injury, the estimates of effectiveness are similar to those presented in the Third Report to Congress. Even more important is the consistency of significant results - as before, air bag with manual belt, automatic belt, and manual lap-shoulder belt were all found to provide significantly more protection than being unrestrained. Only the air bag alone did not provide protection significantly different than being unrestrained.

Exhibit 8
Estimated Effectiveness of Occupant Protection Systems
in Reducing the Likelihood of Driver Moderate Injury (MAIS 2+)



Overall and Frontal Crash Effectiveness Estimates for Serious Injury

In addition to the analysis of system effectiveness in preventing moderate injury, investigations were conducted to assess system effectiveness in preventing serious injury, which occurs less frequently. The results of this analysis are presented in Exhibits 9 and 10.

Exhibit 9

Estimated Effectiveness of Occupant Protection Systems
in Reducing the Likelihood of Driver Serious and Greater Injury (MAIS 3+)

System Used	All Damage Areas	Front Damage
Air bag plus lap-shoulder belt	***64%***	***71%***
Air bag alone	42%	50%
Automatic (2-point and 3-point) belt	***49%***	***44%***
Manual lap-shoulder belt	***67%***	***77%***

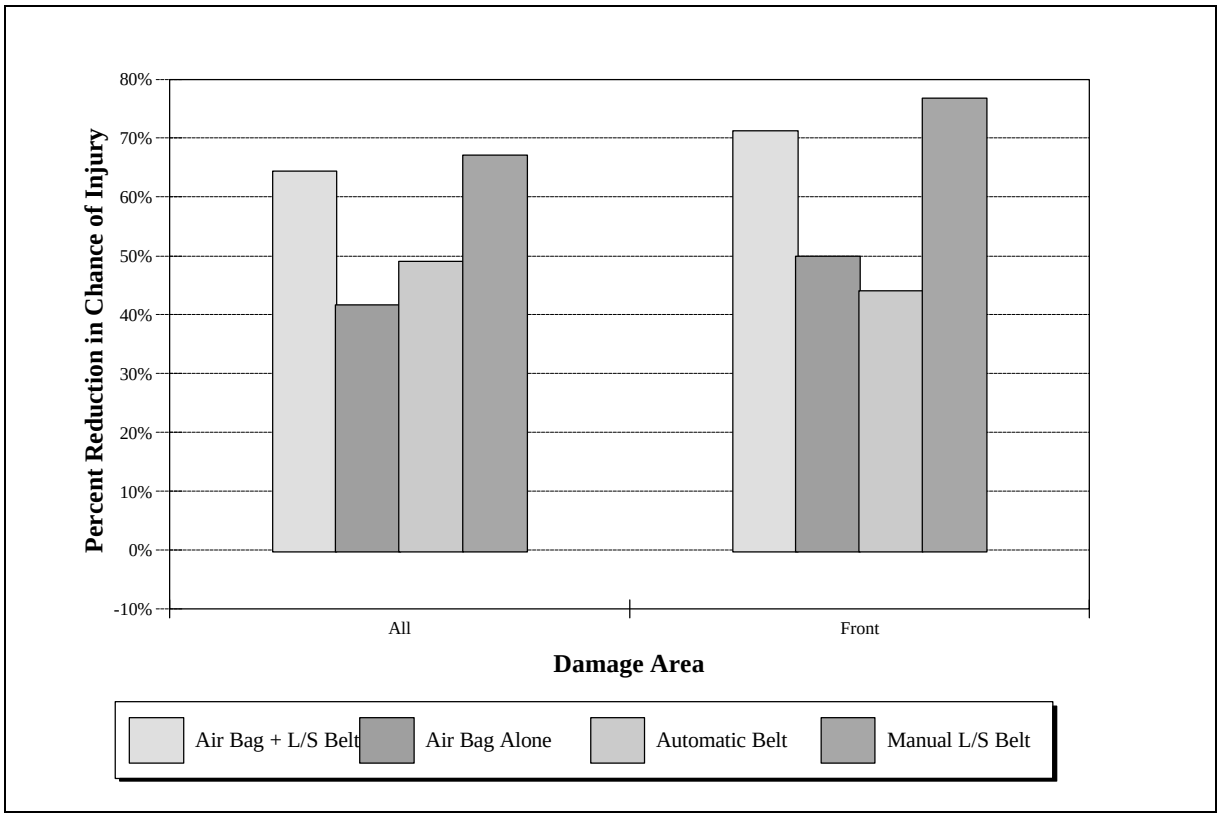
*Note: **Bold italics** means statistically significant difference from the risk of unrestrained occupants.*

As can be seen in Exhibit 9, manual lap-shoulder belts, both with and without an air bag, provide significant overall injury protection at the serious injury level, compared to being unrestrained (about 65 percent reduction in serious injury risk for both systems). Thus, the air bag did not appear to provide additional protection to a driver who was already using his/her belts for overall injury level. The serious injury protection afforded by automatic belts (49 percent) also was statistically significant. The injury-reducing effectiveness of the air bag alone, without the use of safety belts, is a nonsignificant 42 percent in all crashes and a nonsignificant 50 percent in frontal crashes. The results in Exhibit 9 are presented graphically in Exhibit 10.

Comparing these data to those presented in the Third Report to Congress, no change is seen in the significance of the results. Again, air bag with lap-shoulder belts, automatic belts, and manual lap-shoulder belt provide protection which is significantly better than being unrestrained, for all damage areas as well as specifically frontal crashes. The effectiveness estimates for air bag alone presented in this report, however, while still nonsignificant, are much more favorable than those presented in the previous report (7% for all damage areas, -8% in frontal crashes).

In an effort to determine the cause of this rather large increase in estimated effectiveness, a logistic regression was run excluding model year 1996 and later vehicles. Little difference was seen from this adjustment, leading to the conclusion that any change in effectiveness estimates is not due to changes in air bags in more recent model year vehicles. The most likely explanation is the instability of small sample sizes: the previous estimate was based on 92 MAIS 3+ cases with air bag alone, while the current estimate is based on 138 such cases, an increase of 50 percent. This is still a relatively small sample, one which may continue to be unstable, but overall it probably provides a better estimate than the previous one, given the increase in size. Additionally this points out the importance of significance testing, and why, regardless of any actual estimate, and whether positive or negative, it is the significance of that estimate that is the important factor.

Exhibit 10
Estimated Effectiveness of Occupant Protection Systems
in Reducing the Likelihood of Driver Serious Injury (MAIS 3+)



Effectiveness Estimates for Major Body Regions (Moderate and Serious Injury)

A number of additional analyses were conducted to estimate, in greater detail, the effectiveness of occupant protection systems in preventing injury to the following major body regions: head, chest, upper extremity, and lower extremity. It should be emphasized that these analyses required further subsetting of the database, which considerably reduced the available number of cases for analysis. Therefore this analysis was done for all crashes, and not just frontal crashes. As a result, many of these estimates are not statistically significant. In addition, the small sample sizes result in some substantial changes in estimates from the previous report. However, for the purposes of conducting exploratory analyses, this series of estimates may provide *suggestive* evidence of patterns that might be indicative of the need for further research and analysis. None of the estimates that differ markedly from those presented in the previous report are or were significant. Therefore, even though there may appear to be a large change in the estimate of protection offered by the restraint system in question, in all cases the result is the same - that as before, there is no significant difference from being unrestrained. The focus of these analyses was to investigate the performance of air bags plus lap-shoulder belts contrasted with lap-shoulder belt use only, and air

bag alone contrasted with totally unrestrained. Thus, no analysis of automatic safety belt performance is reported.

The effectiveness estimates in each column of Exhibit 11 represent the percentage reduction in the risk of moderate or serious injury to the respective major body region, without regard to other body regions that may have been injured. Thus, the 82 percent effectiveness for the air bag plus lap-shoulder belt in the column titled **head** means that drivers protected by that system experienced an 82 percent reduction in the risk of moderate head injury, compared to if that driver had been unrestrained, without an air bag.

Exhibit 11

Estimated Effectiveness of Occupant Protection Systems
in Reducing the Likelihood of Driver Moderate and Serious Injury
to the Head, Chest, Upper Extremity and Lower Extremity

	Major Body Region			
System Used				
Moderate Injury Reduction	Head	Chest	Upper Extremity	Lower Extremity
Air bag plus lap-shoulder belt	***82%***	***64%***	***45%***	47%
Air bag alone	***54%***	17%	32%	-51%
Manual lap-shoulder belt	***62%***	25%	***57%***	44%
Serious Injury Reduction				
Air bag plus lap-shoulder belt	***81%***	52%	20%	***78%***
Air bag alone	58%	17%	57%	36%
Manual lap-shoulder belt	***60%***	***50%***	58%	***83%***

*Note: **Bold italics** means statistically significant difference from the risk of unrestrained drivers.*

HEAD -- Manual lap-shoulder safety belts provide significant injury-reducing benefits for moderate and serious head injury. The addition of an air bag to a lap-shoulder belt appeared to result in increased head injury protection at both injury levels. The estimated effectiveness of the air bag alone is a statistically significant 54 percent in reducing moderate head injury. This 54 percent effectiveness for the air bag alone is much greater than the 10 percent effectiveness in reducing moderate injury to **any** body region (Exhibit 7) and suggests that the air bag alone affords good protection in reducing head injury. However, much can be gained from the addition of a lap-shoulder belt (effectiveness increased from 54 percent to 82 percent). Further analysis indicates that the air bag alone provides some measure of protection in preventing serious head injury (a relatively high, yet nonsignificant, 58 percent), while the protective benefits of the air bag plus lap-shoulder belt remains high. The combination of the air bag with manual lap-shoulder belt provides

the best protection against moderate or greater head injury. The estimate for protection from serious head injury by the air bag alone is the only one of these estimates that differs drastically from the last report's estimate (from 16 percent effectiveness to 58), and like previously mentioned, may be due to the small sample size (38 such occupants, in this case). This may also be the source of the dramatic increase in serious injury-reducing effectiveness from the results reported in the third report to Congress.

CHEST -- The air bag plus lap-shoulder belt provided the only statistically significant injury protection to drivers at the moderate injury level. The estimated effectiveness of the manual lap-shoulder belt system in reducing moderate chest injury was 25 percent, indicating that drivers experienced slightly less risk of a moderate chest injury (but not significantly so) if they wore their lap-shoulder belts compared to being unrestrained. However, at the serious injury level, manual lap-shoulder belt effectiveness increased to a significant 50 percent. The air bag alone was associated with a nonsignificant 17 percent decrease in the risk of both moderate and serious chest injuries. One possible explanation for the large benefit of the air bag plus lap-shoulder belt at the moderate level may be that the restraining effect of safety belt systems, inhibiting drivers from moving forward in a crash, may result in fractured ribs or sternum, bruised diaphragm, or minor bruises and lacerations to abdominal organs, all classified as AIS 2 injuries. The addition of the air bag to a lap-shoulder belt may serve to cushion the driver's forward movement, resulting in the driver "striking" the safety belt with less force and thus, a lesser chance of these AIS 2 chest and abdominal injuries. The most dramatic change from the previous report is in the estimate of protection from moderate injury afforded by the air bag alone, a change from -13 percent to 17 percent. Again, this fluctuation is likely due to the small size of the sample.

UPPER EXTREMITIES -- Manual safety belts provide statistically significant protection against moderate injury. Drivers wearing manual lap-shoulder belts experienced an estimated 57 percent reduction in the risk of moderate arm injury and a (nonsignificant) 58 percent reduction of serious arm injury, compared to if they had been unrestrained. However, the addition of an air bag reduced this benefit from 57 percent to 45 percent at the moderate level and from a nonsignificant 58 percent to 20 percent at the serious level. It appears that restrained drivers face a higher risk of serious arm injury from the deploying air bag than do unbelted drivers. The unrestrained driver in a crash experiences forward movement of his/her body into the bag, while a belted driver's torso is held in place, possibly allowing his/her arms to flail forward into the path of a deploying air bag. The expanding air bag may then injure the driver's arm, or propel the arms upward or laterally into hard passenger compartment surfaces. Another arm injury mechanism involves the positioning of the arm across the steering wheel, directly in the path of a deploying air bag, while the vehicle is turning left or right. Estimates at the serious injury level for all three restraint systems show dramatic improvement over those presented in the previous report. Whether this change is due to statistical fluctuations due to the small sample size or represent an actual improvement in air bag redesign cannot be determined at this time. Further reports will continue to monitor this trend.

LOWER EXTREMITIES -- For serious lower extremity injury (which is very high severity for lower extremities, since AIS 4 is the highest possible coding for a lower extremity injury, e.g., severing of the femoral artery), manual lap-shoulder belts, with and without the air bag, provide a very high degree of protection, about 80 percent effectiveness (statistically significant). The air bag plus lap-shoulder belt provided a nonsignificant 47 percent reduction in moderate injury risk,

while the manual belt alone provided a nonsignificant 44 percent reduction in the risk of moderate lower extremity injury. At the same time, the effectiveness of the air bag alone is 36 percent for serious injury and -51 percent for moderate injury, suggesting the possibility of some increase in risk of moderate lower extremity injury (neither of these two estimates is statistically significant). For the air bag alone, some degree of submarining, similar to unbelted drivers without an air bag, probably occurs. The knee bolster that accompanies the air bag may increase the risk of lower extremity injury. Looking at occupants who received an AIS 2 or greater lower extremity injury, for those with an available air bag, seven percent of those belted and four percent of those unbelted received such an injury with the knee bolster as the injury source. For those without an air bag, regardless of type of belt or even use of belt, the percent was less than one percent. Estimates for the air bag alone, for both moderate and serious injuries, are considerably different from those in the previous report.

Many of the estimates presented by the exploratory analysis of injury by body region are not statistically significant. However, the patterns that emerge are suggestive that the addition of an air bag to a lap-shoulder belt system appears to involve a beneficial trade-off: reductions in the more life-threatening moderate and serious injury to the head and chest, at the risk of increased likelihood of upper and lower extremity injury. The air bag system alone (without the use of a safety belt) appears to be associated with increased risk of moderate injury to the lower extremities, while providing less protection to the head and upper extremity than any of the three safety belt systems. This is further evidence of the need to always use safety belts, whether or not the vehicle is equipped with air bags.

Section III -- CHILD-AIR BAG INTERACTION CRASH INVESTIGATIONS

As noted earlier in the section on estimating effectiveness, NHTSA has made an exhaustive effort through the Special Crash Investigations program to locate, document and confirm air bag deployment-related life threatening and fatal injuries to children. This section discusses, in some detail, the results of in-depth crash investigation activities conducted by NHTSA as part of its Special Crash Investigations program.

In October 1996, NHTSA began publishing summary tables for each confirmed air bag-related fatality and seriously injured child. Currently, the tables are published during the first week of the month, and are available on NCSA's web site at http://www.nhtsa.dot.gov/people/ncsa/scireps.html. These summary tables contain basic information about air bag deployment-related serious injuries and fatalities sustained in minor, low and moderate severity crashes by:

(1) infants in rear facing child safety seats (RFCSS); and
(2) children not in RFCSS;

NHTSA has defined children as occupants 12 years of age and under. Serious injury has been defined as a level sufficient to be a threat to life. The injuries that are considered a threat to life have a significant effect on mortality.

As of September 1, 1998, NHTSA has confirmed 90 crashes where the deployment of the passenger-side air bag resulted in 24 serious injury, one fatal abdomen injury, and 65 fatal head or neck injuries to infants or children. Twenty-four involved infants in rear-facing child seats, including fifteen deaths. Of the remaining 51 fatalities (children not in rear-facing child safety seats), 2 were in forward-facing child safety seats that were improperly secured to the vehicle. Forty six of the 51 were out of position, unrestrained or improperly restrained at the time of the crashes, 42 of which involved pre-impact braking and/or out-of-position children, placing the child in proximity to the deploying air bag. Three of the 51 fatally injured children, not in a rear facing child safety seat, were determined to have been wearing the lap and shoulder belt. However, it is unknown whether the children were seated in a correct posture position and if the belts were snug. Pre-impact braking, coupled with improper or no safety belt use, generally results in the child moving forward into proximity with the passenger-side air bag prior to the actual crash and subsequent air bag deployment.

The Department of Transportation has formed a coalition with manufacturers, insurance companies and other organizations to prevent injuries and fatalities which may be inadvertently caused by air bags, especially to children. The May 21, 1996, press release announcing the coalition offers the following safety guidelines for child passengers:

> "Infants in rear-facing child safety seats should never be placed in the front seat if the vehicle has a passenger-side air bag. The safest place for children of all ages is the back seat. If riding in the back seat is not an option, toddlers and older children may ride in the front seat of a vehicle with a passenger-side air bag, but only if buckled up properly and with the seat moved as far back as possible."

This section of the report provides a discussion of the passenger kinematics and injury mechanisms associated with the air bag-induced injuries. In all cases, the crash investigators have identified the passenger air bag and/or cover flap as the source of the critical-to-fatal injuries. Little to no intrusion of the occupant compartment was reported, and the vast majority of the crashes would be considered minor or moderate in severity, as estimated by delta-v (simply put, the crash-induced change in the vehicle's speed). Delta-v's of 10 mph or less would be considered minor severity, delta-v's of 11 to 18 mph would be considered low severity, and delta-v's of 19-24 mph would be considered moderate severity. Given the level of the crash severities involved, one would not expect that these children would have sustained critical-to-fatal injuries had there been no air bag deployment.

The child-air bag problem is most logically broken down into two distinct situations: infants in rear-facing child safety seats and children facing forward in the right-front passenger seat. A discussion of the injury mechanisms for each group are provided below.

Rear-Facing Infants

All the infants, with four exceptions, were restrained in an appropriate infant seat, and the seats were secured to the vehicle. However, this is not considered properly restrained since one should never place a rear-facing child safety seat in the front seat of a vehicle equipped with a passenger air bag. In some cases the investigators have pointed out some departures from owner manual specifications, such as not using a locking clip. However, these discrepancies probably had little effect on the outcome. In all cases, the vehicle's driver and/or other adult passengers ignored the warning labels located on the sun visor and owner's manual and placed the infant in the right-front seat.

The crash scenario for air bag involvement with rear-facing infant seats is similar for all cases. Upon impact, the deploying passenger air bag interacts violently with the back of the rear-facing infant seat, typically with sufficient force to crack or break the plastic shell. The force and rapid acceleration of this impact are carried through the seat and into the child's head causing skull fractures and associated brain injuries. Cervical spine (neck) injuries are difficult to diagnose in infants due to the developmental immaturity of their bones and joints. It is therefore possible that neck injuries existed in these cases but were not reported.

Forward-Facing Children

The crash scenario for air bag involvement with forward-facing children focuses on the fact that all of the children, with three exceptions, were either unrestrained or improperly restrained by the available safety belt system. All of the cases, with five exceptions, involved pre-impact braking, which causes the child to move forward into proximity of the stored air bag prior to deployment. Occupant contact with the instrument panel prior to deployment has been confirmed for some of the cases by the identification of tissue, fluid, and/or clothing transfers on the air bag cover flap and/or instrument panel.

Upon impact, the air bag deploys into the out-of-position child's chest, neck, and face. As the air bag expands, it results in the rapid translation and rotation of the child's skull, causing a number of

injuries. These include fractures of the cervical spine, bruising and laceration of the spinal cord, and brain stem injuries. Brain injuries are also commonly reported, but skull fractures were typically not observed. These head injuries are consistent with large and rapid rotations of the head produced by a large distributed force. Mandibular (jaw bone) fractures and avulsed (knocked-out) teeth have also been reported as a result of air bag or cover flap impact with the chin and face. Although not common in this scenario, injuries to the lungs and heart have been reported.

Section IV -- MAJOR REGULATORY ACTIONS AND PUBLIC ANNOUNCEMENTS

Earlier Events

On May 23, 1995, NHTSA published a final rule (60 FR 27233), effective June 22, 1995, that allowed manufacturers the option of deactivating the front passenger-side air bag in vehicles in which infant restraints can be used in the front seat only. The affected vehicles were passenger cars and light trucks without rear seats, and vehicles with rear seats that are too small to accommodate typical rear-facing infant seats. Deactivation is needed because when rear-facing infant restraints are used in the front seats of dual air bag vehicles, they extend forward to a point near the dashboard where they can be struck by a deploying air bag, with the potential for serious injury or death to the infant.

On October 27, 1995, because of the incidence of several fatalities to improperly restrained children in air bag-equipped positions, NHTSA issued a strong warning in a press release, "SAFETY AGENCY ISSUES WARNING ON AIR BAG DANGER TO CHILDREN." It "warned that children who are not protected by a safety belt could be seriously injured or killed by an air bag, and in the strongest possible terms urged parents to insist that their children ride belted in the back seat whenever possible." This release repeated prior agency warnings of the dangers of placing a rear-facing seat in front of an air bag and **broadened** the previous warnings to apply to older children and even adults who may ride unrestrained. To ensure that infants and children ride safely, with or without a passenger-side air bag, this warning and advisory urges care givers to follow three "rules":

- Make sure ***all*** infants and children are properly restrained in child safety seats or lap and shoulder belts for every trip.
- The ***back seat*** is the safest place for children of any age.
- Infants riding in rear-facing child safety seats should ***never*** be placed in the front seat of a vehicle with a passenger-side air bag.

On November 9, 1995, NHTSA published a request for comments to inform the public about its efforts to reduce the adverse effects of air bags and to invite the public to share information and views with the agency (60 FR 56554). The request for comments focused on possible technological changes to air bags to reduce their adverse effects, including possible regulatory changes.

Since publishing its October 1995 warning and November 1995 request for comments, NHTSA has intensified its efforts to educate the public about air bag performance and the campaign to properly restrain children. A large part of the agency's plan is to increase information to the affected public through the traffic safety community throughout the country. With this support, the agency will be able to extend the reach of its safety messages to a wider population.

On May 21, 1996, Secretary of Transportation Federico Peña announced the formation of a coalition of automobile manufacturers, air bag suppliers, insurance companies, safety organizations, and the Federal government to prevent injuries and fatalities which may be inadvertently caused by air bags, especially to children. NHTSA served a central role in uniting

these private-sector partners to form the National Automotive Occupant Protection Campaign (now known as the Air Bag and Seat Belt Safety Campaign). Coalition members pledged almost $10 million to pursue a three-point program:

- o An extensive national effort to educate drivers, parents and care-givers about safety belt and child safety seat use in all motor vehicles, with special emphasis on those equipped with air bags.
- o A campaign to assist states to pass "primary" safety belt use laws.
- o Activities at state and local levels to increase enforcement of all safety belt and child seat use laws, such as increased public information and use of belt checkpoints.

On November 22, 1996, NHTSA announced a comprehensive approach to preserve the safety benefits of air bags while minimizing their danger to children and at-risk adults. Its approach centers on accelerating the development of advanced air bag technology for future vehicles with the intent of having systems available for 1999 models. More immediate measures included adopting enhanced warning labels, reducing the aggressivity of air bags and continuing to allow the use of deactivation in vehicles without a rear seat to protect children, and allowing dealers to deactivate the air bags for any owner who requests it.

On November 27, 1996, NHTSA published a final rule requiring vehicles with air bags to bear three new warning labels. Two of the labels replace existing labels on the sun visor. The third is a temporary label on the dash. These labels would not be required on vehicles having an advanced passenger-side air bag. This rule also requires rear-facing child seats to bear a new, enhanced warning label.

Recent Events

Visor in Up Position

Visor in Down Position

The major rulemaking actions during the reporting period were directed at making air bags already installed in motor vehicles less aggressive under certain specified circumstances, and to pave the way for manufacturers to install air bags that were redesigned. Continuing the Department of Transportation's comprehensive effort to preserve the benefits of air bags and minimize their risk, a Notice of Proposed Rulemaking was published early in January, 1997, offering proposals for deactivating air bags. This effort was to take almost one year to develop satisfactory responses from each of the many issues surrounding the topic of air bag deactivation. In parallel with this effort, rulemaking deliberations proceeded concurrently on facilitating the development of redesigned air bags, with the goal of mitigating the injurious effects of air bags, while maintaining their proven benefits. At the same time, a final rule was issued, extending until September 1, 2000,

the time period during which vehicle manufacturers would be permitted to offer manual cut-off switches for the passenger-side air bag for vehicles without rear seats or with rear seats that are too small to accommodate rear-facing infant seats.

During March, 1997, the agency's rulemaking deliberations regarding redesigned air bags came to a conclusion. On March 19, 1997 (62 FR 12960) the final rule was issued. Although air bags had saved more than 1,750 lives from 1986 to early 1997, the agency at that time had identified 52 crashes in which the deployment of the air bag resulted in fatal injuries to a driver or passenger, including 38 children. The new rule stimulated manufacturers to install redesigned air bags. These air bags are, among other things, 20-35% less powerful, and should provide a significant improvement to air bags that were previously too aggressive. The new rule also provided manufacturers and suppliers with additional time to develop a variety of advanced air bag technologies to tailor air bag deployment more appropriately to crash severity, occupant size and position, safety belt use and other vehicle factors. Because these changes were effective immediately, manufacturers were given maximum opportunity to install less aggressive air bags that should reduce the risk of air bag-induced injury during a vehicle crash. The rule provided changes that would affect new production vehicles. The issue of what to do about vehicles already on the road came next.

On November 21, 1997, the agency announced the final rule permitting deactivation in certain situations. This rulemaking was perhaps the most complex in the history of Federal Motor Vehicle Safety Standard No. 208, Occupant Crash Protection, and incorporated resolutions to the many issues raised by manufacturers, safety groups, the public and other interested parties.

Transportation Secretary Rodney E. Slater stated: "This is the practical solution that allows you to turn off the air bag for someone at risk and turn it back on to preserve the lifesaving benefits for everyone else." Air bags provide life-saving benefits for the vast majority of people, who can virtually eliminate any risk from deployments by following basic safety rules:

Always buckle your seat belt.

Never place a rear-facing infant seat in front of an air bag.

Keep approximately 10 inches between your breastbone and the air bag.

Place children in the back seat and make sure they are properly restrained, either in a seat belt or a child safety seat appropriate for their size and weight.

Few people would need an air bag deactivated. To guide the general populace in their actions regarding deactivation, the agency issued guidelines describing the eligibility groups. The eligibility profiles are:

- Those who cannot avoid placing rear-facing infant seats in the front passenger seat.
- Those who have a medical condition that places them at specific risk.

- Those who cannot adjust their driver's position to keep back approximately 10 inches from the steering wheel.

- Those who cannot avoid situations -- such as a car pool -- that require a child 12 or under to ride in the front seat.

Auto dealers and service outlets could begin deactivating air bags on January 19, 1998.

To obtain a switch, consumers must follow a simple four-step process. First, they must obtain an information brochure and a request form from NHTSA, both of which are available from the agency and at vehicle dealerships, repair shops, state motor vehicle offices, and other locations. The form and brochure can also be downloaded from the NHTSA web site at http://www.nhtsa.dot.gov/airbags .

Second, they must fill out the request form and return it to the agency. Vehicle owners must certify on the form that they have read the information brochure and that they, or someone they transport in their vehicle, fit one of four profiles of people at risk.

Third, the agency will send an authorization letter to the vehicle owner.

Finally, the vehicle owner takes the letter to a dealership or other service outlet to have the air bag(s) deactivated. The switch that is installed will only be able to deactivate the air bag(s) that affects the person in the risk group. The service outlet will inform NHTSA when the work is done.

To help consumers make informed and appropriate decisions about air bag safety, the Department of Transportation initiated a major educational effort in partnership with many organizations, including the Air Bag and Seat Belt Safety Campaign, the American Automobile Association, the Centers for Disease Control, the Insurance Institute for Highway Safety, auto dealers, state motor vehicle departments, and many other public and private organizations and individual companies.

These partners will help distribute millions of copies of an information brochure about air bag deactivation, including air bag safety information, and will provide answers to questions from the public regarding requests to deactivate the air bag.

Basis for Regulatory Actions

The previous regulatory actions were aimed at reducing the risks from the current generation of air bags in vehicles already on the road and those that will be built during the next few years. Continued changes and emerging technologies will lead to air bags with improved performance that eliminate risks to all vehicle passengers. A primary focus of regulatory plans will be to require that improvements be made in the ability of air bags to cushion and protect occupants of different sizes, belted and unbelted, and to require that air bags be redesigned to minimize the risks that air bags post to infants, children, and other occupants. To further this effort, the agency

has undertaken an aggressive research program. On September14, 1998, U.S. Transportation Secretary Rodney E. Slater announced a proposal by the department's National Highway Traffic Safety Administration (NHTSA) that would require additional air bag system performance tests for passenger cars and light trucks in order to provide maximum protection for properly seated adults and reduced risks for infants, young children and out-of-position adults. Proposed crash tests would incorporate a new crash test dummy family with improved injury criteria that better represents human tolerances. The family includes 1-, 3- and 6-year-old child dummies, a small (5th percentile) female dummy, and an average size (50th percentile) male dummy. The proposal also includes full car crash tests to preserve and enhance the current level of air bag protection.

In order to establish benchmarks that delineate the current state of the art, several efforts were initiated to obtain appraisals of current technology. Two programs were initiated together to find out more about current commercial efforts to develop advanced air bag technology. The first program was a joint effort between the NHTSA and National Aeronautics and Space Administration (NASA). NHTSA and NASA signed a memorandum of understanding for NASA to assess the capability of advanced technology to reduce air bag inflation-induced injuries and increase air bag effectiveness. NASA designated the Jet Propulsion Laboratory (JPL) to conduct the research effort. JPL provided the agency with a list of critical parameters affecting air bag performance, a survey of advanced technologies, and their state of readiness.

The second program involved Management Engineering Associates of Washington state . MEA was assigned to identify current advanced air bag designs and to determine, where possible, the feasibility of near term (two years) or long term (more than two years) production readiness. Both reports have been received by the agency. Much of the information reported by JPL and MEA corroborates and substantiates the agency's previous understanding about where the technology was headed. The reports indicate that there are no known sciences that are being ignored as candidates for advanced air bag technology.

As discussed in the previous report to Congress, the agency is conducting a comprehensive research program aimed at improving advanced air bag technology. The assessments made by JPL and MEA are being incorporated into this program. The opportunities for advancing the state of the art of air bags are indicated by the range of technological candidates identified by JPL and MEA for possible future use in developing complete systems. Some of these systems may require advances in anthropomorphic test devices, and could require additional effort to develop test dummies that are suitable for being detected by the new systems, such as, for example, warm dummies that simulate a real person more closely, or dummies that have dielectric properties more closely resembling live occupants. In the interim, the agency is making every effort to incorporate as many different standard dummy configurations as possible into the on-going regulatory changes for advanced air bags. These dummies include the 3-year old, the 6-year old, the 5th percentile female, the 95th percentile male and the 12-month old infant dummy to augment our testing capabilities.

This agency's ongoing research is continually being upgraded to refine our advanced air bag regulatory strategy. The upgraded information includes not only the results of our own research efforts, but also the research done by other interested parties, such as insurance institutes. Transport Canada, a transportation technology and regulatory department of the Canadian

government, is also working in conjunction with NHTSA on a cooperative research program to develop advanced crash test procedures and to investigate the efficacy of advanced air bags and different test protocols. The joint program with Transport Canada has been a valuable resource in evaluating the biofidelity of the 5th percentile female Hybrid III test dummy, the assessment of redesigned air bag performance, and the understanding of vehicle crash sensor performance in low severity crashes.

A wide variety of technical approaches are currently being considered as candidates for advanced air bag technology by both government and industry. While it was apparent that some manufacturers are currently capable of implementing dual-stage or multi-stage inflators, it was not apparent that all manufacturers would choose this course of action when alternative and possibly more advanced systems are available, such as automatic suppression technology. Systems that resort to more advanced technology to control the restraining forces acting on the occupant during an air bag crash seem to be well enough along in the development cycle to merit careful consideration by vehicle manufacturers.

Advanced air bag technology stands today at a crossroads in engineering development. Many scientific technologies and complex disciplines interact currently to make the state of the art in advanced air bag development an evolving science that is in a state of flux. Concepts such as recessed mounting, variable venting, lighter air bag covers, non-aggressive fold patterns, lighter mass fabrics, tailorable inflator output, the use of neural networks and fuzzy logic, the allocation of ultrasonic, infrared, and electric field sensing technology to new sensor designs, and weight sensing technologies represent a widely diverse array of potential candidates for eventual use in advanced air bag systems.

Future Possibilities

To account for all of these technologies, and to give manufacturers and suppliers the maximum benefits of currently unproven but promising hardware, the agency has decided that the optimum path for future rulemaking should be performance-based requirements. This approach would permit varied choices and options in order to provide manufacturers with utmost flexibility to design new systems. The architecture of future rulemaking proposals will be based on maximizing the availability of these options in order to provide design flexibility and to promote widespread opportunities to develop innovative solutions to a difficult problem.

In any future rulemaking concerning advanced air bags, the agency wishes to avoid:

- inadvertently preventing the use of superior air bag designs;
- favoring one viable technology or design over another, where either would meet the need for safety;
- requiring an expensive solution, where an inexpensive one will work; or
- requiring implementation of a particular technology before it can be appropriately developed.

On Friday, September 18, 1998, a Notice of Proposed Rulemaking was published in the Federal Register (63 FR 49958), proposing a new series of crash tests that would incorporate a new crash test dummy family with improved injury criteria to better represent human tolerances. The new dummy family includes 1-, 3- and 6- year old child dummies, a small (5th percentile) female dummy and an average size (50th percentile) male dummy. The NPRM offers a series of options that preserve and enhance the benefits of air bags while reducing risks, to ensure that a wide variety of occupants are protected in a wide variety of crash conditions

The proposed requirements are planned to become effective during a phase in, with 25% of each manufacturers production required to meet the new standard beginning in Model Year 2003, 40% in Model Year 2004, then 70% in Model Year 2005 with full implementation scheduled for Model Year 2006.

Interested parties have until December 17, 1998 to comment on the proposals.

Section V -- SEAT BELT USE DATA AND ANALYSES

In addition to reporting on the effectiveness of occupant protection systems, Section 2508(e) of ISTEA requests that the Secretary of Transportation, in consultation with the Secretary of Labor and the Secretary of Defense, provide a biannual report of seat belt use by Federal, state and local law enforcement officers, military personnel, Federal and state employees other than law enforcement officers, and the public at the national and state levels. This chapter presents currently available information on seat belt use by a number of these sub-populations.

PRESIDENTIAL INITIATIVE TO INCREASE SEAT BELT USE NATIONWIDE

As a new initiative to regain momentum achieved during the 1980s, on January 23, 1997, the President directed the Secretary of Transportation to prepare a plan to increase seat belt use. On April 16, 1997, that plan, entitled *Presidential Initiative to Increase Seat Belt Use Nationwide* was submitted to the President.

The *Presidential Initiative to Increase Seat Belt Use Nationwide* set bold, ambitious seat belt and child safety seat goals. The goals established by the President include increasing seat belt use to 85 percent by the year 2000 and 90 percent by 2005. The second goal calls for reducing child occupant fatalities (0-4 years) by 15 percent in 2000 and by 25 percent in 2005. When achieved, these goals will save an estimated 5,500 lives each year.

NHTSA, as the lead DOT agency, is responsible for overall coordination of the *Presidential Initiative* and its public awareness and informational campaign called *Buckle Up America*. As such, NHTSA sees its role in three parts: (1) Get its **DOT house in order** by educating its own employees; (2) **energize and mobilize** its partners and constituencies; and (3) **praise the good** to recognize outstanding efforts and encourage others to join the effort.

The Plan has four basic elements to reach the President's seat belt and child safety seat goals. These include: (1) Organizations and individuals must join together to **build the public-private partnerships** necessary to help America reach its potential to save lives and prevent injuries through the use of seat belts and child safety seats; (2) States must **enact strong seat belt and child safety seat legislation;** (3) State and local police departments must embrace **active, high visibility law enforcement;** and, (4) communities must conduct well-coordinated **effective public education**.

Seat belt Use by the Public

Of the groups for which seat belt use information has been requested (i.e., law enforcement, military, government employees, and the public), the group for which the most complete information is available is the public. Until late 1991, the NHTSA 19-city survey had been used to track national seat belt use rate trends. This survey utilized observations at locations in 19 cities in 16 states across the country to derive an index of seat belt use which, while not representative of seat belt use nationwide, was useful for assessing changes in seat belt use over time. Beginning in 1991, with the implementation of NHTSA's National "70% by '92" Seat Belt Program, the agency replaced the 19-city survey with a measure based upon an aggregate of

individual statewide surveys. This aggregate of state surveys is weighted by each state's population to produce an estimate of national seat belt use and is sensitive to changes in each of the 50 states, the District of Columbia, and Puerto Rico.

State seat belt surveys differ in design. Most states utilize probability-based designs which allow the accuracy of the survey to be calculated. Others utilize convenience samples, which may be reasonable indicators of belt use but do not have a known degree of accuracy or precision.

Twenty-eight states (comprising about 73 percent of the U.S. population) conduct probability-based surveys that have been reviewed by NHTSA and meet the minimum design standards that were established by the Section 153 incentive grant program. These states requested that their survey designs be reviewed either to be eligible for the incentive grants or to ensure that their designs were meeting the latest standard of quality.

Another 11 states (comprising 19 percent of the U.S. population) conduct probability-based surveys, but have not demonstrated their compliance with the established guidelines. Seven states (comprising 5 percent of the U.S. population) conduct extensive convenience samples and the remaining 5 states (3 percent of the population) either conduct less extensive surveys or use crash data to estimate state seat belt use.

In addition to the statewide surveys, in late 1996 NHTSA conducted a National Occupant Protection Use Survey, which provides additional information about occupant protection system use by the public. The following discussions address the results of both the state surveys and findings from NHTSA's national survey.

State-Based Survey Use Estimates

The statewide surveys vary in methodology and frequency of observation. For example, some states may collect only driver use, while others may only observe passenger cars, depending on the coverage of their law. However, all except Wyoming are based upon direct observation of seat belt use. Wyoming's data are based upon crash reports. Although many of these state surveys do not constitute probability samples (that is, statistically designed surveys) of the state, they are generally based on a large number of observations from representative sites and provide a reasonable index of seat belt use.

ISTEA provided an opportunity to obtain better documentation of state surveys of seat belt use and to improve their survey methodology. To be eligible to receive second-year incentive grant money under Section 153 of the legislation, states were required to utilize probability-based seat belt use survey designs. Seat belt survey guidelines were developed by NHTSA and published in the *Federal Register* on June 29, 1992. According to these guidelines, a state was required to measure seat belt use with an observational survey wherein observation sites were a probability sample of sites in the state. The sites had to represent all areas in the state, including urban and rural areas, and the resulting seat belt use estimates must meet a specified level of statistical precision. The survey designs and subsequent estimates were to be adequately documented and submitted for approval by NHTSA. Approved surveys provide statewide representative estimates of seat belt use with a known margin of error.

Exhibit 12 lists the most recent state use rates as of February 1998. Forty-three states (plus the District of Columbia and Puerto Rico) conducted surveys in 1997. The population-weighted national average of the use rates in all 50 states, the District of Columbia, and Puerto Rico is 69 percent. Use rates range from 48 percent in Arkansas and Mississippi to 88 percent in California. Differences between state use rates are possibly a reflection of variations in seat belt use laws, enforcement of these laws, and demographics. States with laws requiring seat belt use, usually by drivers and front-seat passengers, typically have higher use rates than do states without such laws. Forty-nine states, the District of Columbia, and Puerto Rico had mandatory use laws in place at the beginning of 1998. The population-weighted average use rate in "law" states was 69 percent. The use rate in New Hampshire, the only remaining non-law state, was 58 percent. It is also possible that state surveys differ due to the sampling frame. Some states may collect only driver use, while others may only observe passenger cars, depending on the coverage of their law.

The manner in which the law is enforced also affects use rates. A *primary enforcement* seat belt law allows officers to make a traffic stop based solely upon observation of a seat belt law violation. A law which prescribes *secondary enforcement* may only be enforced after a traffic stop has been made for another purpose. As of the beginning of 1998, there were 14 states which had primary enforcement seat belt laws. The average use rate in the 11 states which had laws that permit primary enforcement in 1997 was 17 percentage points higher than the average of those states which permit only secondary enforcement (Maryland, Oklahoma, and Indiana had secondary enforcement when their seat belt surveys were conducted). The average use rate among primary law enforcement states in 1997 was 79 percent. The average use rate among secondary law enforcement states in 1997 was 62 percent.

STATE HIGHWAY SAFETY LAWS- KEY PROVISIONS OF SAFETY BELT USE February 27, 1998

State	Effective	Enforcement	Fine	Seats	Vehicle and Coverage by Law	
Alabama	July 18, 1992	Secondary	$25	Front	Passenger car from model year 1965.	52
Alaska	September 12,	Secondary	$15	All	Motor vehicle. Over age 16.	69
American Samoa	January 1, 1989	Primary	$25	All	Passenger car, truck, and van.	81
Arizona	January 1, 1991	Secondary	$10	Front	Passenger car and van from model year 1972.	63
Arkansas	July 15, 1991	Secondary	$25	Front	Passenger car, truck, and van.	48
California	January 1, 1986	Primary	$20	All	Passenger car, van, and small truck.	88
Colorado	July 1, 1987	Secondary	$15	Front	Passenger car, van, taxi, ambulance, RV and small truck.	59
Connecticut	January 1, 1986	Primary	$15	Front	Passenger car, van, and truck.	64
Delaware	January 1, 1992	Secondary	$20	Front	Passenger car.	60
Dist. of Columbia	December 12, 1985	Primary	$50	All	Vehicle seating 8 or less people. 2 points on license	66
Florida	July 1, 1986	Secondary	$30	Front	Motor vehicle and pickup truck.	60
Georgia	September 1, 1988	Primary	$15	Front	Passenger vehicle for under 10 people and pickup for under age 18	68
Guam	November 20,	Primary	$70	Front	Passenger car, truck, and van.	94
Hawaii	December 16, 1985	Primary	$20	Front	All Vehicles manufactured with seat belt or seat belt installed	80
Idaho	July 1, 1986	Secondary	$5	Front	Motor vehicle under 8 thousand pounds.	54
Illinois	July 1, 1985	Secondary	$25	Front	Motor vehicle to carry under 10 people and RV.	64
Indiana	March 13, 1998	Primary	$25	Front	Passenger car, bus, and school bus.	63
Iowa	July 1, 1986	Primary	$10	Front	Passenger car, van, and truck 10 thousand pounds or less.	75
Kansas	July 1, 1986	Secondary	$10	Front	Passenger car and van.	56
Kentucky	July 13, 1994	Secondary	$25	All	Motor vehicles from model year 1965.	54
Louisiana	July 1, 1986	Primary	$25	Front	Passenger car, van, and truck under 6 thousand pounds.	67
Maine	December 27, 1995	Secondary	$25	All	Passenger vehicles.	61
Mariana Islands	April 20, 1990	Primary	$25	All	Passenger car and truck.	80
Maryland	July 1, 1986	Primary	$25	Front	Passenger/multi-purpose vehicle, truck, tractor, and bus.	71
Massachusetts	February 1, 1994	Secondary	$25	All	Passenger car, van, and truck.	53
Michigan	July 1, 1985	Secondary	$25	Front	Motor vehicle.	70
Minnesota	August 1, 1986	Secondary	$25	Front	Passenger car, pickup truck, van, and RV.	65
Mississippi	March 20, 1990	Secondary	$25	Front	Passenger car and van.	48
Missouri	September 28,	Secondary	$10	Front	Passenger car to carry under 10 people.	62
Montana	October 1, 1987	Secondary	$20	All	Motor vehicle.	73
Nebraska	January 1, 1993	Secondary	$25	Front	Motor vehicle.	63
Nevada	July 1, 1987	Secondary	$25	All	Passenger car under 6 thousand pounds.	70
New Jersey	March 1, 1985	Secondary	$20	Front	Passenger car.	62
New Mexico	January 1, 1986	Primary	$25	Front	Motor vehicle under 10 thousand pounds.	87
New York	December 1, 1984	Primary	$50	Front	Passenger car.	74
North Carolina	October 1, 1985	Primary	$25	Front	Passenger motor vehicle to carry under 10 people.	83
North Dakota	July 14, 1994	Secondary	$20	Front	Motor vehicle.	49
Ohio	May 6, 1986	Secondary	$25	Front	Passenger/commercial car, van, tractor, and truck.	65
Oklahoma	November 1, 1997	Primary	$10	Front	Passenger car, van, and pickup truck.	60
Oregon	December 7, 1990	Primary	$75	All	Motor vehicle.	85
Pennsylvania	November 23,	Secondary	$10	Front	Passenger car, truck, and motor home.	65
Puerto Rico	January 19, 1975	Primary	$10	Front	Passenger car. Over age 4.	66
Rhode Island	June 18, 1991	Secondary	No	All	Passenger car. Over age 12.	58
South Carolina	July 1, 1989	Secondary	$10	Front	Passenger car, truck, van, RV, and taxi.	61
South Dakota	January 1, 1995	Secondary	$20	Front	Passenger car, truck, van, RV, and taxi.	59
Tennessee	April 21, 1986	Secondary	$10	Front	Vehicle under 8.5 thousand pounds.	61
Texas	September 1, 1985	Primary	$25	Front	Passenger car, van, and certain trucks.	75
Utah	April 28, 1986	Secondary	$10	Front	Motor vehicle.	63
Vermont	January 1, 1994	Secondary	$10	All	Passenger car.	71
Virgin Islands	October 1, 1991	Primary	$25	Front	Passenger car.	92
Virginia	January 1, 1988	Secondary	$25	Front	Motor vehicle.	67
Washington	June 11, 1986	Secondary	$35	All	Passenger/multi-purpose vehicle, bus, and truck.	82
West Virginia	September 1, 1993	Secondary	$25	Front	Passenger car. Age 18 and under in rear seat.	58
Wisconsin	December 1, 1987	Secondary	$10	All	Motor vehicle.	62
Wyoming	June 8, 1989	Secondary	No	Front	Passenger car, van, and pickup truck.	75

Total Use Laws: 49 States + D.C., Puerto Rico, and the Territories. *Reported February 1998

U.S. Dept. of Trans., National Highway Traffic Safety Admin., Traffic Safety Programs Office (202) 366-4892, Washington D.C. 20590

The national use rate estimate of 69 percent is considerably higher than the estimated 11 percent rate in 1980. The increase reflects the substantial emphasis placed on increasing seat belt use among the general public over the past decade, as well as the implementation of the amendment to Federal Motor Vehicle Safety Standard 208 requiring automatic occupant protection systems on a phased-in schedule beginning in model year 1987. While voluntary methods (i.e., public information and education alone) increased national use to about 15 percent by 1984, it was the enactment of state seat belt use laws that provided the increase to about 50 percent by 1990. Without highly publicized enforcement, however, most state use rates stabilized at about 50 percent. With the implementation of the National "70% by '92" Seat belt Program in early 1991, these rates again started to rise. This rise is thought to be due primarily to the increased emphasis on enforcement and public information and education by state seat belt programs.

The National "70% by '92" Seat Belt Program consisted of two primary components: (a) two summer public awareness campaigns which were conducted during 1991 and 1992, with special emphasis on enforcement during the three summer holiday periods (Memorial Day, July 4th, and Labor Day); and (b) Operation Buckle Down, a program using peer-to-peer outreach to increase law enforcement officer use of seat belts and to increase the effectiveness of seat belt and child passenger safety law enforcement by officers.

Large increases in seat belt use occurred while the "70% by '92" program was in effect. By the end of 1992, 23 states had increased their use rate by 10 percentage points or more, compared with their 1990 level. Another 11 states increased their rate by 5-9 points. A total of 14 states reported use rates of 70 percent or greater, compared to one state in 1990. The national use rate, as measured by the population-weighted average of state survey results, increased to 62 percent by the end of 1992 (an 8-10 percentage point increase since 1990).

Building on the success of the "70% by '92" program, NHTSA initiated a new combined seat belt, alcohol and speed program in the fall of 1994. This initiative, known as Campaign Safe & Sober, complemented highly publicized enforcement, as used in the "70% by '92" program, with legislative and public information and education (PI&E) strategies. The goals for Campaign Safe & Sober were to disseminate information on the three major program areas and to give states and localities the flexibility to adapt the information to their individual needs. This was supported by a 21-state grant assistance program which helped the states conduct repeated state wide waves of highly visible enforcement and education activity. These state programs resulted in seat belt use increases in participating communities. Several other states have used 402 funds to support such programs. Campaign resources are still developed on a quarterly basis and disseminated to over 40,000 highway safety advocates across the U.S.

In early 1996, the Department and NHTSA successfully led the effort to create a private-public partnership which would undertake and fund a national program to address air bag safety issues. The resulting coalition, now called the Air Bag and Seat Belt Safety Campaign (ABSBSC), and NHTSA work closely together on a comprehensive set of program activities designed to preserve the lifesaving benefits of air bags, to alert the public to the proper use of those devices, and to increase the correct use of safety belts and child safety seats.

To date, this collaboration has resulted in several nationwide mobilizations of law enforcement to make the transport of unbuckled children unacceptable. Two major initiatives, in May of 1997 and of 1998, have coincided with and supported NHTSA's Buckle Up America! Week. These mobilizations have been called "Operation ABC - Mobilizing America to Buckle Up Children." Operation ABC's goal is to work with law enforcement in all 50 states to promote compliance with safety belt and child passenger safety laws. The Department's and NHTSA's overall program is now coordinated closely with ABSBSC activities, with efforts focused on informing the public about the danger to unrestrained or improperly restrained children in the front seat of vehicles equipped with passenger-side air bags.

As a result of these efforts and the introduction of new and improved legislation in several states, the national average of surveys reported by the states continued to increase, reaching 69 percent by the end of 1997.

This year, with the development and implementation of the *Presidential Initiative to Increase Seat Belt Use Nationwide*, and its *Buckle Up America* campaign, it is anticipated that national seat belt use will begin to rise again, with the goals of 85 percent use by 2000 and 90 percent by 2005.

Already, a number of national organizations are participating in the Buckle Up America campaign, including the National SAFE KIDS Campaign, the National PTA, the National Automobile Dealers Association (NADA), the Emergency Nurses Association, the American Academy of Pediatrics and the HHS Childcare Bureau.

NHTSA's National Occupant Protection Use Survey (NOPUS)

The first NOPUS was conducted in the Fall of 1994. The previous report to Congress documented the results of the 1994 survey. The second NOPUS was conducted in the Fall of 1996 and initial results have been presented in two research notes.

NOPUS is composed of three separate studies: the ***moving traffic study,*** which provides information on overall shoulder belt use; the ***controlled intersection study,*** which provides more detailed information about shoulder belt use by type of vehicle, characteristics of the belt users and child restraint use; and, the ***shopping center study***, which provides information on rear-seat belt use and shoulder belt misuse.

Data collection from the moving traffic study was conducted at almost 3,290 randomly selected sites across the country in October and November 1996. Pairs of observers were stationed for 30 minutes at exit ramps, intersections with stop signs or stop lights, and uncontrolled intersections. One observer counted shoulder belt use for the drivers of passenger cars and light trucks (vans, minivans, sport utility vehicles, and pick-up trucks). The second observer counted shoulder belt use for the right-front passengers of cars and light trucks and helmet use for motorcycle riders and passengers. Every day of the week and all daylight hours (8 a.m. to 6 p.m.) were covered by the study. Commercial and emergency vehicles were excluded.

NOPUS was designed as a multi-stage probability sample to ensure that the results would represent occupant protection use in the country. In the first stage, counties were grouped by

region (northeast, midwest, south, west), level of urbanization (metropolitan or not), and level of belt use (high, medium, or low). Fifty counties or groups of counties were selected based on the vehicle miles of travel in those locations. In the next stage, roadways were selected from two categories: major roads and local roads. Finally, approximately 4,000 intersections or exit ramps were chosen on these roadways. Of the originally selected sites, some were found to be ineligible during mapping and data collection, and at some sites no vehicles were observed. In 1996, more than 176,000 passenger cars, almost 94,000 light trucks, and over 700 motorcycles were observed.

The overall observed safety belt use rate in the 1996 NOPUS moving traffic study was 61.3 percent compared to 58.0 percent observed in 1994. Shoulder belt use observed in the 1996 moving traffic study was 64.4 percent for passenger car occupants compared to 62.8 percent in 1994 and 56.4 percent for light truck occupants compared to 50.2 percent in 1994. Exhibit 13 compares some of the results of the 1994 and 1996 NOPUS studies.

Belt use for drivers of light trucks increased by almost 7 percent from 1994, a statistically significant change. While belt use in all other categories increased, demonstrating an upward trend in the use of safety belts, the changes were not statistically significant.

Exhibit 13
Comparison of 1994 and 1996 NOPUS Moving Traffic Studies
Belt Use for Vehicle and Person Type

Belt Use	1996	1994
Overall Belt Use	61.3%	58.0%
Drivers	62.2%	59.1%
Passengers	58.8%	55.2%
Passenger Cars	64.4%	62.8%
Drivers	65.1%	64.2%
Passengers	62.3%	59.1%
Light Trucks	56.4%	50.2%
Drivers	57.5%	50.7%
Passengers	53.0%	49.1%

Detailed results of the 1996 moving traffic study are presented in Exhibits 14 and 15. Exhibit 14 shows the belt use rate for drivers and occupants of passenger cars and light trucks and the overall helmet use rate for motorcyclists by urbanization. Exhibit 15 shows the belt use rate for drivers and occupants of passenger cars and light trucks and overall helmet use for motorcyclists by day of week and time of day. Each estimate has been statistically weighted according to the sample design. Since these are estimates from a sample, each has an associated margin of error or standard error. Two standard errors are given in parentheses next to each estimate. By simply adding and subtracting the standard errors from the estimates, an approximate 95 percent confidence interval can be created. This means that you can be 95 percent confident that the true use rate lies within this interval. Note: the overall belt use rate does not include motorcycle helmet use.

Exhibit 14
1996 NOPUS: Moving Traffic Results by Region
(Estimates and 2 Standard Errors)

	Overall	Northeast	Midwest	South	West
Shoulder Belt Use (%)	61.3 *(4.0)*	56.6 *(6.6)*	55.4 *(4.4)*	60.8 *(4.8)*	66.8 *(10.2)*
Passenger Cars (%)	64.4 *(4.2)*	57.8 *(8.6)*	58.5 *(4.4)*	67.3 *(4.0)*	68.3 *(10.6)*
Car Drivers (%)	65.1 *(4.2)*	57.9 *(9.0)*	58.5 *(5.2)*	68.6 *(4.4)*	69.6 *(10.6)*
Car Passengers (%)	62.3 *(4.6)*	57.3 *(8.6)*	58.5 *(3.0)*	63.3 *(3.2)*	65.2 *(11.0)*
Light Trucks (%)	56.4 *(4.0)*	53.0 *(5.0)*	50.7 *(5.4)*	50.8 *(6.0)*	64.2 *(9.6)*
Truck Drivers (%)	57.5 *(3.2)*	53.8 *(5.4)*	50.9 *(6.4)*	51.7 *(5.8)*	66.5 *(7.4)*
Truck Passengers (%)	53.0 *(10.4)*	51.0 *(6.6)*	50.0 *(3.2)*	48.0 *(7.2)*	58.3 *(23.6)*

Exhibit 15
1996 NOPUS: Moving Traffic Results by Day of Week and Time of Day
(Estimates and 2 Standard Errors)

	Weekday	**Weekend**	**Rush Hour**	**Non-Rush Hr**
Shoulder Belt Use (%)	61.0 *(3.8)*	62.6 *(6.2)*	61.9 *(4.0)*	61.2 *(4.2)*
Passenger Cars (%)	63.9 *(4.2)*	66.6 *(4.6)*	66.7 *(4.2)*	64.0 *(4.4)*
Car Drivers (%)	64.7 *(4.2)*	67.1 *(4.4)*	67.9 *(4.4)*	64.6 *(4.4)*
Car Passengers (%)	61.3 *(4.4)*	65.5 *(5.2)*	61.9 *(5.0)*	62.4 *(4.8)*
Light Trucks (%)	56.3 *(3.4)*	56.7 *(9.6)*	54.1 *(4.4)*	56.7 *(4.2)*
Truck Drivers (%)	58.0 *(3.4)*	55.0 *(8.6)*	55.4 *(4.4)*	57.9 *(3.2)*
Truck Passengers (%)	50.8 *(8.6)*	59.9 *(11.6)*	50.4 *(6.4)*	53.5 *(11.6)*

Direct comparison of findings between the NOPUS and state surveys is difficult, primarily because of the differences in vehicle and occupant coverage. However, a rough comparison of overall use can be made between the state-based estimate for 1996 of 68 percent and the NOPUS estimate for passenger car drivers and passengers of 64.4 percent. In this comparison, the state-based estimate falls within the 95 percent confidence interval of the NOPUS estimate.

The combination of surveys that have been used to measure safety belt use over the past several years also provides us with some insight with regard to the change in use rates. Until 1990, the

19 cities survey was used as the index of national use. In 1990, that index for passenger car drivers was 49 percent. The NOPUS estimate of belt use among passenger car drivers in 1996 is 65.1 percent. The difference of 16 percentage points between the 19 cities index and the NOPUS estimate is consistent with the 15 percentage point change in use indicated by the aggregate of state surveys between 1990 and 1996 (i.e., 53 percent in 1990 and 68 percent in 1996).

State surveys provide an essential source of information for monitoring progress in the states. The NOPUS provides a probability-based sample of national use with the ability to estimate error. In addition, the NOPUS provides a unique source of detailed information concerning restraint use by vehicle type, age, gender, race, geographic area, time of day, day of week, urbanization, etc. The NOPUS survey will be conducted biennially, with the next NOPUS to be conducted in the Fall of 1998. Annual estimates of belt use progress will continue to be made with the state-based surveys.

Seat belt Use by Federal Employees

On April 16, 1997, President Clinton signed Executive Order 13043, *Increasing Seat Belt Use in the United States*. This Order superseded Executive Order 12566, *Seat Belt Use Requirements for Federal Employees*. Both Orders required Federal employees to use seat belts when traveling on official Government business. The new Order substantially expanded the requirement for DOT to energize, mobilize and recognize our fellow Federal agencies, our contractors and customers in the effort. As a result, NHTSA has significantly increased activities to promote seat belt programs with Federal agencies and the military.

Background

Prior to 1989, NHTSA conducted briefing sessions with all departments and agencies and provided promotional materials to support the seat belt program. Other activities included addressing special meetings at Federal agencies and suggesting activities to motivate employees and family members concerning the importance of seat belt and child safety seat laws. A brief description of some of the more recent efforts follows.

In 1989, NHTSA sponsored a "Saved-By-The-Belt" program that recognized Federal employees and their family members who had been survivors of a motor vehicle crash. NHTSA presented the recipients with a "Saved-By-The-Belt" certificate.

In 1990, NHTSA redesigned the "Saved-By-The-Belt" program to include a plaque for "The Right Choice Award" for making the right choice to buckle up. For participating agencies receiving the Right Choice Award, a ceremony was held at the Department of Transportation highlighting the recipients who were crash survivors.

In 1991, as part of the National "70% by '92" seat belt program, NHTSA urged Federal departments and agencies, including military installations, to participate in the goal set by the President to reach 70 percent seat belt use among Federal employees by the end of 1992. NHTSA developed the "Federal Employees Buckle Up" kit and distributed over 4,000 copies of the promotional kits to Federal agencies. Recognizing that seat belt use is mandatory while

traveling on official business, the objective of this effort was to extend the seat belt use habit to personal travel.

Finally, NHTSA has encouraged Federal and military agencies to participate in awards programs that have provided recognition to agencies, organizations, and cities for reaching specified belt use rate goals. The "70% PLUS" program was established in 1990 to recognize achievement of use rates in excess of 70 percent. By the end of the program in 1992, more than 200 Federal departments and agencies, including military installations, were awarded "70% Award Plaques" and a thank you letter from NHTSA for achieving 70 percent seat belt use.

In 1993, the "70% PLUS" program was superseded by the "National Seat Belt Honor Roll" which provides bronze, silver and gold awards for achieving 70 percent, 80 percent, and 90 percent belt use, respectively. During the first year of this program, awards were made to five Federal agencies and to 70 military organizations. The program is now managed by the NHTSA Regional Offices with additional awards made each year.

In 1995 NHTSA began working with DOT officials to integrate the broad injury prevention effort and the seat belt initiative into the Department's overall safety, health and welfare program. This effort was known as Safety Awareness for Employees of DOT (SAFEDOT). Several employee education efforts were done in 1996 and 1997 (posters, voice mail messages, TV-10 video clips). Courtyard education activities were conducted in conjunction with other events (DOT 30th Anniversary, etc.).

With the implementation of Executive Order 13043, we have revised our internal and external efforts as follows:

SAFEDOT

- Re-drafted and will soon implement a stronger internal DOT Order on seat belt use on official business and on all DOT facilities.

- Developed a DOT implementation plan which addresses all aspects addressed in the Executive Order.

- Conducted numerous briefings of DOT modal administrative and safety and health officials to educate, energize and mobilize.

INTERGOVERNMENTAL

- Developed materials (SAFEDOT Model program) which provide a blue print for their program.

- Developed, and provided to agency fleet managers, a toolkit of alternative promotional ideas and implementation methods for increasing seat belt use in all Federally owned vehicles.

- Conducted marketing briefings at many intergovernmental groups to encourage compliance with provisions of Executive Order 13043.

- Provided assistance, resources and materials to Federal Agencies as they implemented their program.

- Developed guidelines for reporting to Congress and the President on progress made by the Federal agencies. The first report to Congress was submitted in January, 1998. It documents specific actions taken by DOT, NHTSA and the Federal agencies to date.

Seat belt Use by State and Local Government Employees

Few data are currently available for estimating seat belt use among state and local government employees other than law enforcement officers. Although some portion of this population is included in surveys of the general population, specific surveys of use among these groups have not been routinely or consistently conducted. In lieu of consistent survey data, the following anecdotal information presents examples of policies and awards which provide some indication of belt use practices among this group.

In the northeast, the States of Connecticut, Maine, Massachusetts, Rhode Island, and Vermont have seat belt use policies covering all state employees.

In New York, over 100 state agencies have received 70, 80, or 90 percent belt use awards since 1992. The majority of these were in the mid-to-upper 80 percent range.

In the mid-Atlantic area, the Governor of Delaware issued an Executive Order requiring all state employees to use seat belts while on government business. The Virginia Department of Alcohol Beverage Control received an award for reaching 80 percent belt use.

In the southeast, more than 20 state and local government agencies have qualified for 70 percent belt use awards. The Florida Department of Highway Safety and Motor Vehicles has conducted seat belt educational programs in more than 100 government agencies. South Carolina's Department of Highways and Public Transportation has established a similar educational program. The Mississippi Department of Transportation conducted a belt use program among employees, indicating a use rate of 87 percent.

In the Midwest, Illinois, Indiana, Minnesota, Michigan, Ohio, and Wisconsin have established belt use policies covering all state employees.

In the Rocky Mountain and midwest Region, three Colorado entities, City of Sterling, Sterling and Fort Morgan Police Departments, have the distinction of receiving “Platinum Awards” for having 100 percent of their employees buckling up. The Montana Highway Patrol has received the “Traffic Occupant Protection Strategies Training” and plans to conduct the training for all Montana law enforcement agencies during 1998.

In the southwest, New Mexico instituted a joint belt use program among state and Federal employees, achieving use rates above 80 percent. The Texas Departments of Health and Transportation conducted belt use campaigns achieving rates of 70 to 80 percent.

The western states of Alaska, Arizona, California, Idaho, Oregon, and Washington have established seat belt use policies covering all state employees. In addition, many local government agencies in these states have instituted similar policies.

Seat belt Use by State and Local Police

NHTSA has worked with the International Association of Chiefs of Police (IACP) to develop a model program that law enforcement agencies can follow to increase public and officer use of occupant protection. This program originally was promoted as part of "Operation Buckle Down" (OBD) by IACP, the National Sheriff's Association, the Fraternal Order of Police, the International Association of Directors of Law Enforcement Standards and Training (IADLEST), the National Association of Governors' Highway Safety Representatives (NAGHSR), and the Law Enforcement Television Network (LETN).

Currently, this effort is being coordinated under the Operation ABC (Always Buckle Children in back) and the 1998 Spring Mobilization. This effort, which took place May 18- 25, was one of the primary activities highlighted during *Buckle Up America* week.

Concurrently, NHTSA developed and promoted several law enforcement training courses and numerous videotaped presentations suitable for officer roll call training. The training courses include a Traffic Occupant Protection Strategies (TOPS) to inform traffic law enforcement officers about the risks they face from traffic crashes, and how safety belt use can reduce those risks. Hundreds of these courses have been conducted across the country. To institutionalize the courses within ongoing law enforcement in-service and academy training programs, NHTSA works with national and state police training and certification organizations to obtain certification status for occupant protection training.

To support individual agency roll call training on occupant protection, NHTSA continues to distribute roll call videotapes to law enforcement agencies directly, through the state highway safety offices. The TOPS training and other programs and materials are part of the *Buckle Up America* effort.

Finally, NHTSA is working with the International Association of Chiefs of Police to recognize the lifesaving benefits of officer safety belt use and to provide information about all these programs to police chiefs and other law enforcement executives. With NHTSA's support, each year IACP conducts its "National Law Enforcement Saved By The Belt/Air Bag Awards Program" which has presented awards to officers each year. This program differs from the civilian equivalent in that it is based on actual police crash or incident reports and the recipient is only eligible if he or she is not judged to be "at fault" in the crash. Also with NHTSA's assistance, IACP is publishing and distributing monthly newsletters, the Buckle Down Dispatch, to heads of agencies across the country. These newsletters reach over 5,000 chiefs of police and other law enforcement

executives at the state and local levels with information about the importance of safety belt use by the public and by their officers.