

## **AIR BAG CRASH INVESTIGATIONS**

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### **ABSTRACT**

The performance of occupant protection systems, especially air bags, is of high interest to the National Highway Traffic Safety Administration (NHTSA). Since 1972, the NHTSA has operated a Special Crash Investigations (SCI) program, which provides the agency with the flexibility to acquire detailed engineering information quickly on high visibility traffic crashes of special interest. The SCI collects in-depth crash data on new and rapidly changing technologies in real world crashes. NHTSA uses the data collected in this program and others to evaluate rulemaking actions. The data are also used by the automotive industry and other organizations to evaluate the performance of motor vehicle occupant protection systems such as air bags.

This paper presents information from NHTSA's SCI program concerning crash investigations on air bag equipped vehicles. The paper provides information on data collection and findings in the NHTSA sponsored air bag crash investigations, updating and expanding findings from the 17<sup>th</sup> Enhanced Safety of Vehicles (ESV) paper “Air Bag Crash Investigations” by Chidester and Roston [Ref. 3]. Topics include air bag-related fatalities as a whole and by certification status; physical characteristics of occupants fatally injured by a deploying air bag; and an overview of special case studies available on NHTSA's world wide web site.

### **BACKGROUND**

NHTSA performs research and develops safety programs and standards in an effort to reduce the toll of deaths, injuries, and property damage from traffic crashes. In-depth field investigations on crashes with an air bag deployment are conducted in the SCI program under the auspices of the National Center for Statistics and Analysis (NCSA). SCI cases are an anecdotal data set used to examine and evaluate the latest safety systems. These investigations play a vital role by providing data relative to real world events. Added details on SCI investigations can be found in 17<sup>th</sup> ESV, Chidester and Roston [Ref. 3].

From 1972 to 1990, the SCI program investigated all crashes reported to NHTSA that involved an air bag-equipped vehicle. However, due to the rapid growth in the marketplace after 1990, the SCI program shifted to investigating only air bag-related special interest cases, involving such issues as air bag related serious and fatal injuries, driver and passenger air bag performance, interaction between air bags and child safety seats, air bag non-deployment crashes, inadvertent air bag deployments, side air bags, “redesigned” air bags, and advanced occupant protection systems. These cases have been utilized by the agency and the automotive safety community to acquire knowledge in real world performance of new and emerging air bag systems and have been instrumental in influencing improvements to new generations in air bag technologies.

### **HISTORY OF AIR BAG FATALITIES**

In 1991, the SCI program investigated and confirmed the first allegation of a driver air bag related fatality. At that time, the SCI was tasked with locating, investigating, confirming and reporting air bag related life threatening and fatal injury cases. In 1993, the first air bag deployment related child fatality was confirmed. The National Automotive Sampling System (NASS) Crashworthiness Data System (CDS), a probability-based sample of crashes, did not sample an air bag-related fatality case until 1997.

In 1996, the SCI program was significantly expanded in order to perform investigations of all air bag related life threatening or fatal injuries. In October 1996, NHTSA began publishing summary tables for each confirmed air bag related fatality and seriously injured occupant. The tables contain basic information about serious injuries and fatalities related to air bag deployments in crashes of minor to moderate severity to infants in rear facing child safety seats (RFCSS), children not in RFCSS, drivers, and adult passengers.

For the purposes of these air bag investigations, 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. Crashes of minor severity have been defined as those with a speed change less than 19 miles per hour, and crashes of moderate severity have been defined as those with a speed change between 19 and 24 mph.

To be fatally injured by an air bag, the deployment energy of the air bag must be imparted to the occupant, who must be in the path of the deploying air bag or air bag cover flap. In crashes of minor to moderate severity, the occupant is most typically out-of-position (OOP) and in the path of a deploying air bag in one of the following two scenarios:

1. The occupant's initial seating position will place them in the air bag deployment path. Initial positioning may include: small or short-stature occupants seated in close proximity to the air bag, as well as occupants that fall asleep, have passed out or are leaning into the air bag deployment path. This scenario includes both belted and unbelted occupants.
2. The occupant is repositioned to a location within the air bag deployment path just prior to deployment by a pre-impact or at-impact event. The event that repositions the occupant into the deployment path includes a number of factors such as: pre-impact braking, multiple closely spaced near deployment events, running off the road or long crash pulses which also result in late deployments. Unbelted or improperly belted occupants are more likely to become out-of-position in these scenarios.

In an effort to cover as many existing air bag-related fatalities as possible in the SCI, the Fatality Analysis Reporting System (FARS) is queried for possible cases. This process is performed annually and has been ongoing since 1992. In 2000, this process was significantly improved. The FARS coding of confirmed air bag related fatality cases was reviewed in an effort to upgrade the criteria used to locate potential cases. A number of additional cases were identified and investigated. As a result, the SCI files are believed to contain a near census of air bag-related fatalities in crashes of minor to moderate severity.

SCI air bag cases are categorized as “confirmed” or “unconfirmed.” Unconfirmed cases are crashes under active investigation where the air bag is suspected of

being the injury mechanism. It is always possible that the investigation, when completed, will not support a conclusion of an air bag-related injury or fatality. Since 1997, the SCI headquarters team has pre-screened the notifications submitted.

Beginning in May 1998, NHTSA began reporting unconfirmed air bag related fatal injury counts in their monthly reports. This was done to avoid any distortions that might result from including only confirmed case counts, which typically lag approximately six months from initiation to confirmation. The primary reason for the lag time is medical record acquisition for injured occupants.

As of January 1, 2003, NHTSA's SCI program had a total of 242 cases (227 confirmed and 15 unconfirmed) where the deployment of the driver or passenger air bag resulted in a fatal injury to an occupant in a minor-to-moderate severity crash. One hundred and forty-one of the confirmed cases were children, of which 119 were children not in a RFCSS, and 22 were infants in rear facing child safety seats. There have been 76 adult driver and 10 adult front right passenger confirmed fatalities (Table 1).

**Table 1.**  
**Air bag-related fatality counts by occupant type and confirmation status.**

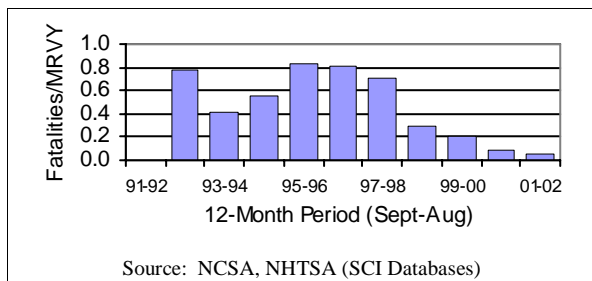
Occupant Type	Fatality Count		
	Conf.	Unconf.	Total
RFCSS	22	1	23
Children not in a RFCSS	119	6	125
Adult Drivers	76	7	83
Adult Passengers	10	1	11
Total	227	15	242

Source: NCSA, NHTSA (SCI Databases)

### CHILD AIR BAG-RELATED FATALITIES

In Table 1, 148 of 242 fatalities, or 61 percent, were children. These incidents were a cause of justified concern in the mid-1990s. Since then, the numbers relative to fleet size have decreased. Figure 1 presents the number of passenger air bag child fatalities normalized by the number of passenger air bags in the fleet over 12-month release periods. Each bar represents the number of children fatally injured by a deploying air bag during the given 12-month period divided by the number of passenger air bag-equipped vehicles in the fleet during that same interval. The denominator, denoted as million registered vehicle years (MRVY), is derived from R.L. Polk data on new registrations carried forward from each production year. It incorporates NHTSA

estimated vehicle attrition rates [Ref. 4] and assumes new vehicle release to be evenly spread through the introductory year. The fatalities are grouped into 12-month periods aligned with the vehicle production year - September 1 through August 31 - to facilitate the comparison with vehicle years. The denominator is not meant to represent exposure to deploying passenger air bags or even seating in front of passenger air bags (since such a denominator would not demonstrate the effect of moving children to the back seat); it is simply meant to descriptively compare fatalities to the number of air bags in the fleet, which has increased by about 15 million annually in recent production years.

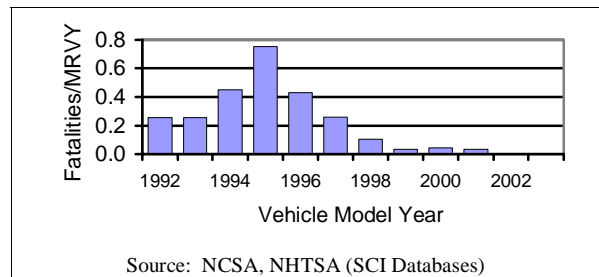


**Figure 1. Children fatally injured by a passenger air bag, normalized by MRVY; confirmed and unconfirmed as of September 1, 2002.**

Since incomplete years can be difficult to interpret, Figure 1 does not include the unfinished 12-month period beginning in September 2002. Four unconfirmed child fatalities added to the SCI's active investigations between September 1, 2002 and January 1, 2003 are not a component of Figure 2 or 3 although they are included in Table 1.

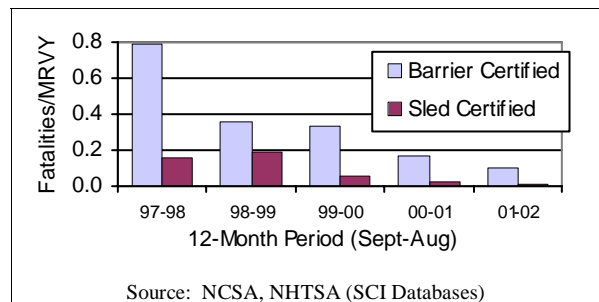
NHTSA and its partners (manufacturers, insurance companies and other organizations) have committed a high volume of public education resources in an effort to prevent air bag related injuries and fatalities, especially to children. One of the main messages put forth during the 1996 implementation of the educational campaigns has been that children are safer in the back seat. Figure 1 seems to indicate that the campaigns, likely bolstered by media attention, warning labels and word-of-mouth, have had a positive effect. However, in March of 1997 NHTSA issued a rulemaking action that allowed automobile manufacturers to expediently reduce the force at which their air bags deployed. A number of manufacturers began installing these air bags (referred to by NHTSA as "redesigned") in their 1998 model year vehicles. "Redesigned" air bags are those used in vehicles that have been certified to the unbelted 25 mph sled test option instead of the

unbelted 30 mph crash test option in Federal Motor Vehicle Safety Standard (FMVSS) No. 208. In crash tests, instrumented test dummies are placed in a production vehicle that is then crashed into a barrier. In sled tests, no crash takes place; the vehicle is placed on a sled-on-rails, and instrumented test dummies are placed in the vehicle. The sled and vehicle are accelerated very rapidly backward. As the vehicle moves backward, the dummies move forward inside the vehicle in much the same way that people would in a frontal crash. The air bags certified under the sled test, denoted here as "sled-certified" air bags, could be another factor in child fatality reduction. Figure 2, which charts the fatalities by vehicle model year (again normalized by MRVY), shows that child airbag fatalities have been less frequent in recent model year vehicles.



**Figure 2. Children fatally injured by a passenger air bag by vehicle model year, normalized by MRVY; confirmed & unconfirmed as of September 1, 2002.**

To separate the effect of public education from that of the rule change, the fatalities from Sept 1997 (the introduction of sled-certified air bags) onward are categorized by air bag type and charted separately over time in Figure 3. Vehicles with systems certified to the older barrier test are denoted as "barrier-certified." MRVY figures apply to vehicles by certification status.



**Figure 3. Children (0-12 yrs) fatally injured by a barrier-certified vs. a sled-certified passenger air bag, normalized by MRVY; confirmed and unconfirmed as of September 1, 2002.**

Figure 3 suggests that the effect of public education is positive, as seen in both barrier-certified and sled-certified vehicles as each category goes downward with time; and that the increased safety of sled-certified air bags to children in crashes of minor to moderate severity is also positive, in that the normalized count for the sled-certified bags is lower than that for barrier-certified bags within each 12-month period.

Concern has been expressed in the safety community and NHTSA that as used cars change hands, drivers who had been accustomed to vehicles without air bags – and therefore paid little attention to the safety campaigns - may be acquiring barrier-certified air bag vehicles. These drivers may also tend to be in lower income brackets than their new-car driving counterparts; if so, they may or may not differ in education, access to media, and/or skills with languages in which the safety messages are disseminated. Such factors could be confounding the apparent education and rule effects in Figure 3, and could also become an increasing problem in future years. SCI does not collect socio-economic information, but NHTSA will continue to monitor air bag fatalities for any upswing that could signal such trends.

It should be noted that NHTSA does not view sled-certified air bags as a permanent solution, since the sled test does not assure that the air bags are less injurious to the out-of-position (OOP) occupant, as there are no OOP tests in this rule. The Advanced Air Bag upgrade to FMVSS No. 208, which includes OOP tests, is discussed later in this paper.

In all child cases included in the SCI summaries, crash investigators have identified the passenger air bag and/or air bag cover flap as the source of the critical-to-fatal injuries. Little or no intrusion of the occupant compartment was reported, and the cases have speed changes less than 25 miles per hour. Given the crash severity levels involved in most of the cases investigated, one would not expect that these children would have sustained life threatening or fatal injuries in the absence of an air bag.

**Infant Injuries**

Of the 26 infant (0-1 year) fatalities, 10 were restrained in an appropriate infant seat, and the seat was secured by the safety belt in the front right seating position of a passenger air bag equipped vehicle. However, this is not considered properly restrained, since a RFCSS should never be placed in

the front seat of a vehicle equipped with a passenger air bag. (The only exception is for vehicles with no back seat and an air bag on/off switch in the off position.) In the remaining 16 cases, three were in or standing on the lap of the driver, four were in a RFCSS being held on the lap of the front right occupant and nine were either not properly secured in the RFCSS or the RFCSS was not secured with the vehicle’s safety belt.

**Injuries to Children NOT in a RFCSS**

Table 2 shows the restraint usage for the 114 confirmed children not in a RFCSS fatally injured by a deploying passenger air bag (it excludes the five children fatally injured by a deploying driver air bag). With the exception of six (including one unknown), the children were either unrestrained or improperly restrained by the available safety belt system, in or out of a forward facing child safety seat (FFCSS).

**Table 2.  
Restraint Usage for Confirmed Forward Facing Children Fatally Injured by a Passenger Air Bag**

On Lap of Passenger	21
FFCSS, Belts Not Used Properly	2
FFCSS, Belts Not Used	3
Unknown if Secured in FFCSS	1
Lap and Shoulder, no FFCSS	5
Shared Lap Belt	1
Used Lap Belt Only	13
No Restraint Used	64
Misused Belts (lap only or shoulder belt behind back)	4
<b>Total</b>	<b>114</b>

Source: NCSA, NHTSA (SCI Databases)

Table 2 shows five children restrained by lap and shoulder belts in the front seat. NHTSA recommends that all children 12 years of age and under be properly restrained in a rear seating position. For four of the five belted children the proper restraint for their physical dimensions would have been a child safety seat or a booster seat. The fifth child, who was over eighty pounds and thus not in the range recommended for safety seat, was leaning forward into the path of the deploying air bag after rebounding off of the seat due to a rear collision (there was no pre-impact braking).

Ninety-five of the 114 fatalities involved pre-impact braking causing the child to move forward into close proximity of the stored air bag. Occupant contact with the instrument panel prior to deployment has

been confirmed for some cases by the identification of tissue, fluid, and/or clothing transfers on the air bag cover flap and/or instrument panel. Air bag injury general kinematics (for all age groups) are discussed in Chidester and Roston, 17<sup>th</sup> ESV [Ref. 3].

### AIR BAG-RELATED ADULT FATALITIES

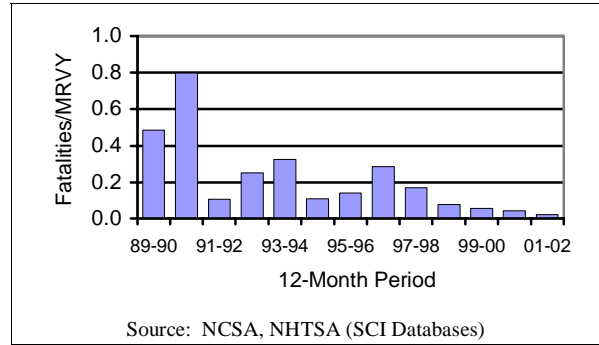
As of January 1, 2003, SCI teams had investigated a total of 94 cases (86 confirmed and 8 unconfirmed) in which the deployment of a driver or passenger air bag resulted in a fatal injury to an adult occupant in a crash of minor to moderate severity (Table 3).

**Table 3.**  
**Adults Fatally Injured by an Air Bag**  
**By Crash Year and Occupant Type**  
**Confirmed (C) and Unconfirmed (U)**  
**As of January 1, 2003**

Year	Adult Drivers		Adult Passengers		Totals	
	C	U	C	U	C	U
1990	1				1	
1991	4				4	
1992	3				3	
1993	4				4	
1994	8				8	
1995	5	1			5	1
1996	7		2		9	
1997	18		4		22	
1998	14		2		16	
1999	3				3	
2000	7	1	2		9	1
2001	2				2	
2002	0	5		1		6
Total	76	7	10	1	86	8

Source: NCSA, NHTSA (SCI Databases)

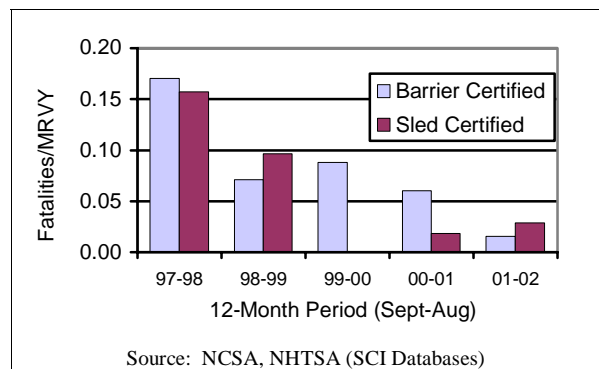
Figure 4 displays the data over 12-month production periods for adults fatally injured by a deploying driver air bag. As with the child data shown previously, the counts have been normalized by dividing the fatality count by the number of driver air bag-equipped vehicle-years in the fleet during that 12-month period. As before, the normalizing does not represent exposure to a deploying air bag, but simply compares fatality counts to numbers of air bags. Also as before, the incomplete year consisting of September through December 2002 is not included; thus two unconfirmed adult driver cases that were added to SCI's active investigations during those months are not depicted in Figures 4 or 5.



**Figure 4. Adults fatally injured by a driver air bag, normalized by MRVY; confirmed and unconfirmed as of September 1, 2002.**

Another principle imparted by the safety campaigns implemented in 1996 has been that drivers should keep at least 10 inches between their breastbone and the steering column. This message has been particularly stressed for women of small stature, who have been among those most at risk for air bag injuries. These efforts and the introduction of sled-certified air bags (as covered earlier) may have had positive effects on fatalities, which can be seen declining in Figure 4. To separate the effects, Figure 5 shows the normalized driver fatalities categorized by type of air bag certification over the years 1997 to 2002, where the MRVY includes only vehicles with the air bag type denoted.

In Figure 5, the education effect appears to be stronger than the redesign effect; fatalities in both categories decline over time but within several 12-month periods, sled-certified bags are close to pre-1998 bags in their normalized counts. Recall that in the similar chart for child fatalities presented earlier, the sled-test rule effect was noticeable within each



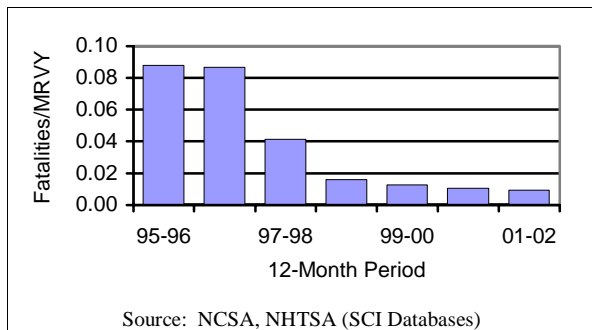
**Figure 5. Adults fatally injured by barrier-certified vs. sled-certified driver air bags, normalized by MRVY; confirmed and unconfirmed as of September 1, 2002.**

year. This may suggest that the benefits of the sled test are greater for child front seat passengers than for adult drivers.

It is worth noting again that the sled test does not test for OOP occupants. Prasad, et al, found several post-sled vehicles not passing OOP tests [Ref. 5].

### Adult Passengers

Adult passenger air bag-related fatalities have been comparatively rare; there are ten confirmed and one unconfirmed instances in SCI's air bag cases. The counts, normalized by MRVY, are displayed in Figure 6.

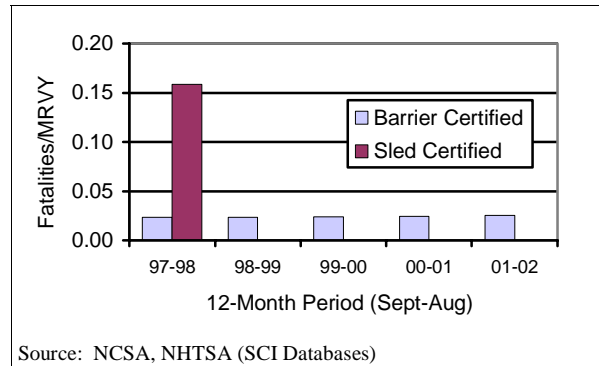


**Figure 6. Adults fatally injured by a passenger air bag, normalized by MRVY; confirmed and unconfirmed as of September 1, 2002.**

Figure 7 separates the counts into barrier-certified and sled-certified, normalizing for the appropriate type of bag. The comparatively high rate 1997-1998 year is pushed upward by the small denominator for sled-certified bags during their introductory year. Beyond that year, the normalized figure, while very small, has been largely unchanged, but has involved only pre-1998 air bags. The incomplete year starting in September 2002 is again omitted from Figures 6 and 7, but no adult passenger cases have been added during that time.

### DRIVERS AND ADULT PASSENGERS

The air bag injury patterns for drivers and adult passengers differ due to the location, size and shape of the air bags. The driver's air bag, because of its location in the steering wheel hub, is situated in close proximity to the occupant seating position. The front right passenger air bag is typically mounted in the instrument panel and is much larger in size to fill the space between the instrument panel and the right front passenger and, if present, a front center passenger.



**Figure 7. Adults fatally injured by a barrier-certified vs. a sled-certified passenger air bag, normalized by MRVY; confirmed and unconfirmed as of September 1, 2002.**

In all cases, the crash investigators have identified either the driver or passenger air bag and/or air bag cover flap as the source of the fatal injuries. Little to no intrusion of the occupant compartment was reported. Given the level of the crash severities involved, fatal injuries would not be expected without air bag deployment.

### Adult Driver Injuries

Table 4 shows adult drivers by height and restraint usage. Twenty-five of the drivers were restrained, properly or improperly, by the available safety belt system. In all but six of these cases the driver was 64" or less in height.

Driver air bag injury patterns are directly affected by the occupant's at-deployment positioning relative to the body region exposed to the deploying air bag. Fifty percent of the confirmed drivers suffered chest injuries while 43 percent sustained some combination of head, neck and spine injury. The remainder (seven percent) sustained a combination of head, neck, spine and chest injuries.

### Adult Passenger Injuries

The injury patterns for adult passengers are similar to those seen in the forward facing children. Passenger air bags are typically much larger than driver air bags to afford crash protection to the front right occupant. Some of these air bags inflate over an extremely large area in an effort to protect the front middle occupied positions.

Typically the front right passenger air bag requires more inflation volume, thereby creating a high

**Table 4.**  
**Adults Fatally Injured by a Driver Air Bag**  
**By Height and Restraint Usage**  
**As of January 1, 2003**

Height (Inches)	Restraint Usage		Totals
	Any Usage	None or Unknown	
47		1	1
56		2	2
58	2		2
59	1	2	3
60	1	2	3
61	1	3	4
62	5	8	13
63	3	3	6
64	5	9	14
65	2	3	5
66	1	6	7
67		4	4
68		2	2
69	1	1	2
70		1	1
71		2	2
72	2	2	3
Unk	2	2	3
Total	25	51	76

Source: NCSA, NHTSA (SCI Databases)

potential for injury when an occupant is in close proximity to the air bag deployment path.

Six out of the ten confirmed adult passenger air bag fatalities were unbelted, and one of the belted passengers was misusing the belt with the shoulder belt under the arm. All ten sustained injuries to the head, neck and/or spine. Most were placed out-of-position into the deployment path by a number of factors including pre-impact braking, multiple closely spaced near deployment events, running off the road or long crash pulses which also result in late deployments. The three belted passengers were all women less than 64 inches in height and over sixty years of age (two were over 90).

**PHYSICAL CHARACTERISTICS OF OCCUPANTS FATALLY INJURED BY A DEPLOYING AIR BAG**

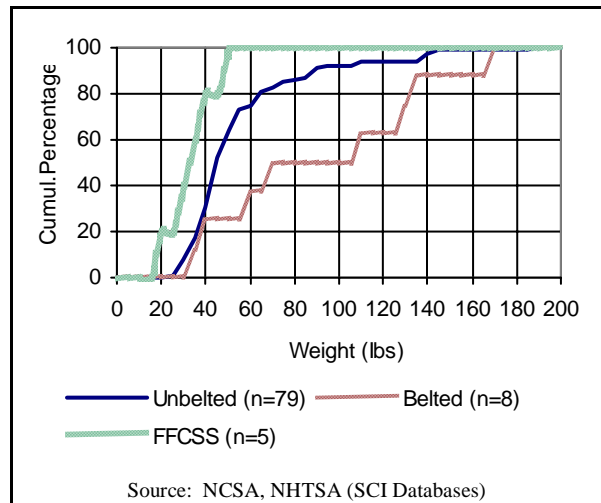
Cumulative percentages - proportions of observations less than or equal to a given value - can provide descriptive summary information on quantitative characteristics. This section displays cumulative percentages of certain physical characteristics of

confirmed occupants fatally injured by a deploying air bag, in order to help describe occupants who may be at highest risk of such injury. Since likelihood of injury can depend on restraint usage in combination with other factors, most of the charts presented differentiate between belted and unbelted occupants. Infants in a RFCSS are not included.

Percentages are based only on cases where the characteristic in question was recorded. The numbers of belted and unbelted occupants, as well as totals, may not match across charts because not all characteristics were known or recorded for all occupants.

**Right Front Passengers**

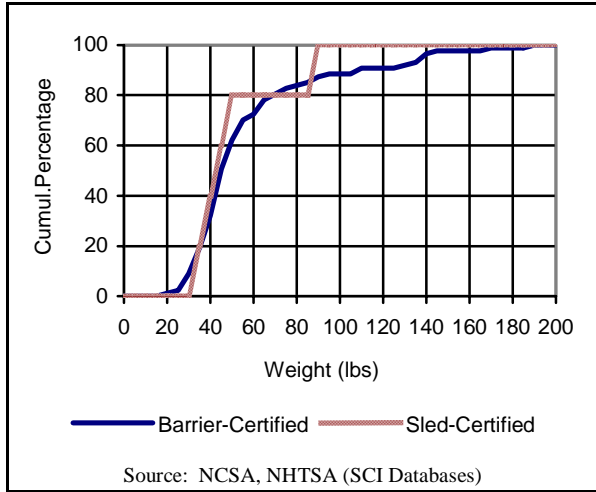
Figure 8 shows the weights of occupants, child and adult, fatally injured by a deploying air bag, by restraint usage. About 90 percent of the unbelted occupants weighed 90 pounds or less. .



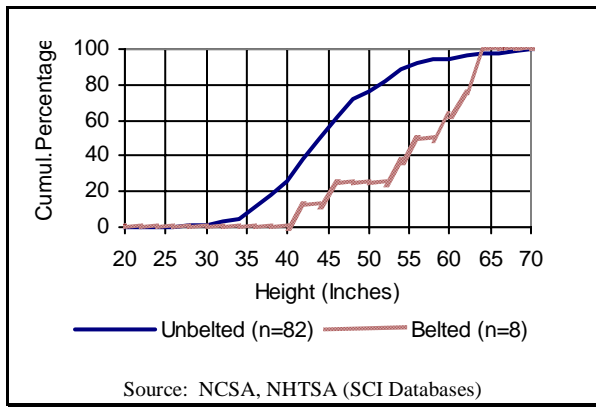
**Figure 8. Cumulative percentage, occupant weight in confirmed passenger air bag-related fatalities.**

Figure 9 shows right front passenger weights for any belt usage by sled-certified vs. barrier-certified air bags. The patterns for each style are quite similar, and both show about 80 percent weighing 80 pounds or less. Figure 10 displays right front passenger heights by belted status; about 90 percent of unbelted passengers were 54 inches in height or less. In Figure 11, which shows age by belted status, 92 percent of fatally injured unbelted passengers were 10 years of age or less. (Figure 11 includes all right front passengers, whether child or adult)

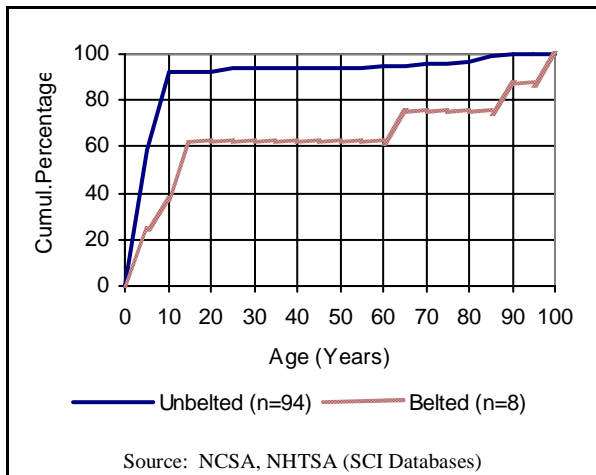




**Figure 9. Cumulative percentage, occupant weight in passenger air bag-related fatalities by test status.**



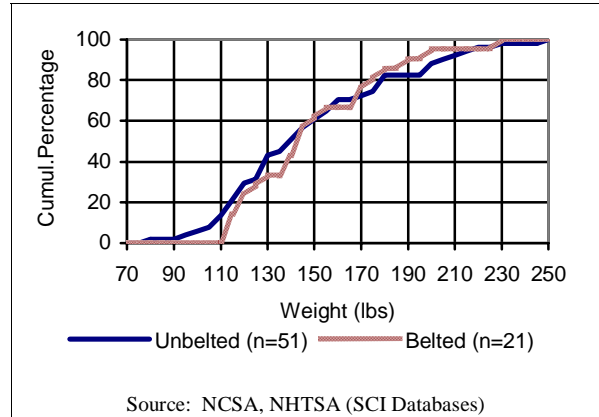
**Figure 10. Cumulative percentage, occupant height in confirmed passenger air bag-related fatalities.**



**Figure 11. Cumulative percentage, occupant age in confirmed passenger air bag-related fatalities.**

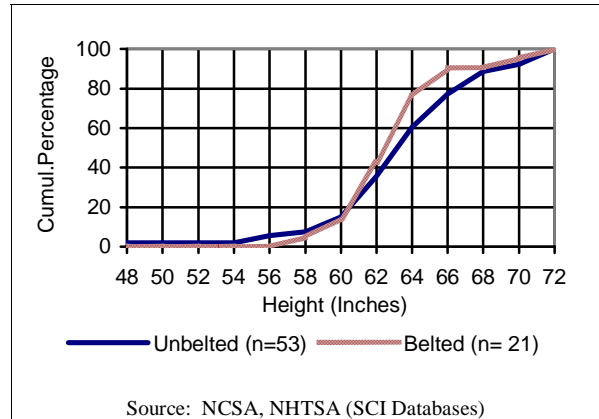
## Drivers

Figure 12 shows fatally injured driver weights by belted status. About 60 percent, whether belted or not, were 150 pounds or less. The weight patterns for unbelted drivers and belted drivers are quite similar.



**Figure 12. Cumulative percentages of driver weights in confirmed driver air bag-related fatalities.**

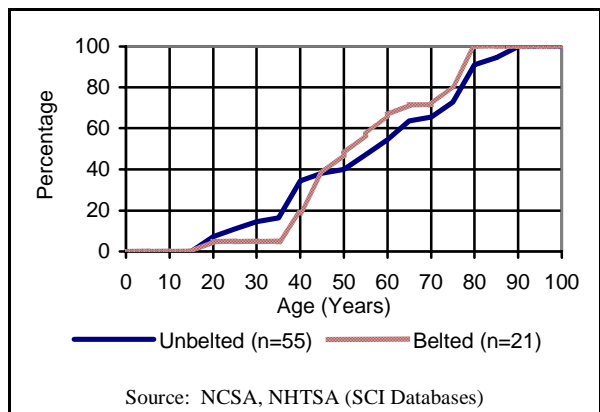
Figure 13 displays the heights of fatally injured drivers by belted status. It indicates that about 80 percent of belted drivers and 60 percent of unbelted drivers were no more than 64 inches in height.



**Figure 13. Cumulative percentages of driver heights in confirmed driver air bag-related fatalities.**

Figure 14 displays ages of fatally injured drivers by belted status. Only about 10 to 15 percent of belted or unbelted drivers were under 30 years of age, whereas about 55 percent to 60 percent were over 50 years old.





**Figure 14. Cumulative percentages of driver ages in confirmed driver air bag-related fatalities.**

The SCI program will continue to track these characteristics and update the findings if more cases are confirmed.

### SCI SPECIAL AIR BAG INVESTIGATIONS

Certain categories of air bag cases are of particular interest to the engineering and safety communities, and the SCI program has initiated special studies to investigate such cases. These categories include sled-certified or “redesigned” air bags, systems with advanced features that have not been certified to the advanced standard, and systems that have been certified to the advanced standard. In addition, SCI collects data on cases involving air bag on-off switches when a switch-equipped vehicle is involved in a crash of minor to moderate severity where an air bag-related fatality or life threatening injury has been confirmed. Since published cases in these various studies are available to the public, this section outlines the criteria for these studies and briefly discusses the numbers of cases in each category.

#### Redesigned Air Bags

As mentioned previously, NHTSA in March of 1997 issued a rulemaking action that allowed automobile manufacturers to reduce the force at which their air bags deployed. As explained earlier, these “redesigned” bags are certified to a sled test and are thus more accurately referred to as “sled-certified” air bags. Most of the manufacturers began introducing sled-certified air bags into their fleets beginning with 1998 model year vehicles. In order to determine how changes in the air bag affected occupants in real world crashes the NCSA initiated the Redesigned Air Bag Special Study (RABSS) in October 1997 to

collect data on crashes involving these sled-certified air bags.

The criteria have been refined through the years [Ref. 3], but the objective of this study has been and still is to collect data on crashes of high interest (children, out of position occupants, high damage severity, and multiple injured occupants) involving vehicles equipped with a sled-certified air bag system in which the air bag has deployed.

As of January 1, 2003, the RABSS had a total of 683 cases. Of these, 49 were still under active investigation, 38 were undergoing an agency review process and 271 are available to the public on the SCI web site. Also included in the reporting system for sled-certified air bags are 325 cases listed as PARTNERS cases. The manufacturers, insurance companies and other organizations provide these cases, which are also made available at the SCI web site.

#### Systems with Advanced Occupant Protection Features

As mentioned earlier, NHTSA in May 2000 issued an interim final rule for FMVSS No. 208. It amends the occupant crash protection standard to require that future air bags be designed to create less risk of serious air bag-induced injuries than current air bags, particularly for small women and young children; and provide improved frontal crash protection for all occupants, by means that include advanced air bag technology. It adds a wide variety of new requirements, test procedures, and injury criteria, using an assortment of new dummies. It replaces the sled test with a rigid barrier crash test for assessing the protection of unbelted occupants.

The phase-in of the new FMVSS 208 certification starts with the 2004 model year, but a few manufacturers began introducing systems with advanced features into their fleets during the 2000 model year. The NCSA initiated the Advanced Occupant Protection Special Study (AOPSS) in September 1999 to collect data on crashes involving model year 2000 or later vehicles equipped with advanced occupant protection features. For this study, advanced occupant protection may include one or more of the following: safety belt sensors, weight sensors, seat position sensors, multi-stage inflators, systems that may provide automatic air bag suppression, rollover sensors and event data recorders.

Due to the small number of vehicles currently available with an advanced occupant protection system the case selection criteria has been very general; cases are accepted with or without air bag deployment. The minimum criteria for AOPSS case selection are:

- $\geq$  2000 model year vehicle equipped with an advanced occupant protection system;
- The crash configuration must be an impact where the advanced restraint system is designed to protect the occupants and the vehicle is towed due to damage;
- Back plane impacts and rollovers are excluded.

As of January 1, 2003 the AOPSS program has a total of 78 cases: 23 active, 34 available to the public, and 23 under agency review. Most are frontal impact cases (Table 9). The Agency is sharing the AOPSS field data with the automobile manufacturers; this collaborative effort combines the talents of crash investigators, engineers, and designers, which enable all interested parties to perform case-by-case evaluation of the real world performance of these advanced technologies.

**Table 9.**  
**Number of AOPS Cases by Impact Plane**  
**As of January 1, 2003**

Impact Plane	Number of Cases
Front	64
Right	5
Left	4
Side and Front	1
Undercarriage	1
To Be Determined	3
<b>Total</b>	<b>78</b>

Source: NCSA, NHTSA (SCI Databases)

### Vehicles Certified to the Advanced Standard

In the 2003 model year, a small number of vehicle models became the first to be certified by the crash tests of the FMVSS Standard No. 208 Advanced Air Bag Final Rule. By doing this, manufacturers received credit towards required phase-in percentages in advance of the standard's effective date. In September 2002, the NCSA initiated an effort to collect data on crashes involving these "Advanced 208 Compliant" vehicles. At the outset of this new data collection effort the number of eligible vehicles on the roads was comparatively quite small, so any crash where an involved vehicle was certified to the new standard was considered for the study. As of January 17, 2003, SCI had four Advanced 208 Compliant cases. SCI expects to refine the selection

criteria for Advanced 208 Compliant cases as the phase-in of the advanced 208 standard progresses through future model years and the number of eligible cases grows.

SCI also collects data on side air bag and rollover curtain cases. As of January 1, 2003, the SCI teams had researched 83 such cases. Neither side air bags nor rollover curtains are required by the FMVSS No. 208.

### Air Bag On-Off Switches

In January 1998, NHTSA allowed vehicle dealers and repair shops to install on-off switches that allow driver and passenger air bags in passenger cars and light trucks to be activated and deactivated. Many vehicles, such as sports cars and pickup trucks that either have no rear seating space or a small rear seating space are equipped with passenger on-off switches as a standard feature. SCI does not have a special study for vehicles with on-off switches, but the program does collect data on such cases when a qualifying vehicle is involved in a crash of minor to moderate severity where an air bag related fatality or life-threatening injury has been confirmed.

Vehicle owners without switches can receive authorization from NHTSA to have their vehicles equipped with switches if they fall into any of the following groups:

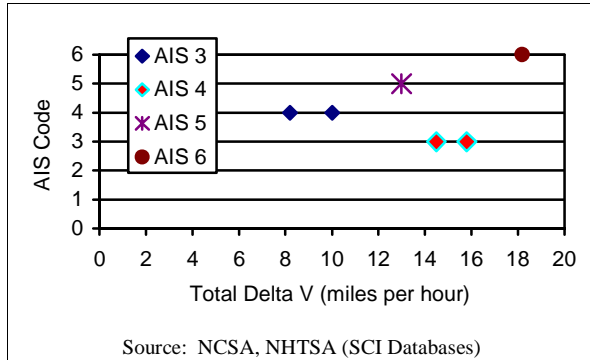
- People who must transport infants riding in rear-facing infant seats in the front passenger seat.
- People who must transport children ages 1 to 12 in the front passenger seat.
- Drivers who cannot change their customary driving position and keep 10 inches between the center of the steering wheel and the center of the breastbone.
- People whose doctors say that, due to a medical condition, the air bag poses a special risk that outweighs the risk of hitting their head, neck, or chest in a crash if the air bag is turned off.

Recommendations from a 1997 national conference of physicians that considered all medical conditions commonly cited as possible justification for turning off air bags can be obtained at:

<http://www.nhtsa.dot.gov/airbags/air%20bag%20conf%20rpt.html>.

SCI has six confirmed cases in which the case vehicle's passenger air bag was equipped with an on-off switch when there was an air bag-related fatality

or life-threatening injury. Figure 15 presents data for occupants injured in crashes with a passenger air bag on-off switch where the case occupant sustained either an air bag-related fatality or serious injury. As of January 1, 2003, none of these cases are available on the SCI Website, as they are either still being investigated or are under agency review. In each of the cases a pickup truck was the case vehicle. With



**Figure 15. Injury severity by total delta V for air bag-related fatalities and serious injuries in SCI crashes involving on-off switches.**

the exception of one case in which a 10-month-old child was seated on the lap of the driver and fatally injured by the driver air bag, the cases involved children in the right front passenger seat who were either fatally or seriously injured by the passenger air bag. The case occupant was fatally injured in all but one of these cases. An original equipment manufacturer on-off switch that was in the “on” position (air bag activated) was present in five of the six cases. The type of switch that was used and the switch position, for the case vehicle in the other case is unknown because the case vehicle was not available for inspection.

A query of the NASS Crashworthiness Data System found no suitable comparison cases where a switch was in the “off” position in a frontal crash. SCI will continue to pursue NASS cases for the purpose of comparison.

## CONCLUSIONS

NHTSA and its partners, (manufacturers, insurance companies and other organizations) have committed a high volume of public education resources in an effort to prevent air bag related injuries and fatalities, especially to children. This effort appears to be having a positive effect on reducing air bag related fatality cases, particularly in children.

NHTSA’s rulemaking changes beginning in March of 1997 also appear to have had a positive effect on reducing air bag-related fatalities, particularly in children.

NHTSA’s SCI data collection efforts will target FMVSS No. 208 Advanced Air Bag compliant vehicles as they become part of the fleet. The first FMVSS No. 208 Advanced Air Bag compliant models became available in model year 2003.

## DATA AVAILABILITY

Since 2001, summary tables have been published quarterly on the NHTSA’s Internet web site at the following web address:

<http://www-nrd.nhtsa.dot.gov/departments/nrd-30/ncsa/SCI.html>

The SCI online data access page is located at:

<http://www-nass.nhtsa.dot.gov/BIN/logon.exe/airmislogon>

within the NCSA website

[http://www-nrd.nhtsa.dot.gov/departments/nrd-30/ncsa/.](http://www-nrd.nhtsa.dot.gov/departments/nrd-30/ncsa/)

The interface (Figure 16) is a data filter that offers users a wide array of choices when querying the SCI



**Figure 16. NHTSA World Wide Web Query Interface for SCI cases.**

database. For specific case access, the most efficient method of retrieval is to use the **SINGLE CASE SELECTION** by entering the Case Number (upper-case may be required) and clicking Get Case. For a wider selection of cases, the user can use the pull down filters under the **MULTIPLE CASE SELECTION BASED ON FILTER CRITERIA**

section. Users can choose to see cases by entering parameters from one or more selection criteria areas:

**CASE TYPE** – This selection is based on the type of case such as: Child Safety Seat, School Bus, Side Air Bag, etc. Using this selection criteria and no other will return the most cases for the selected type.

**VEHICLE** - Provides a selection method for limiting the output case list based on vehicle model and year make. Year make can either be a range or a single year. The parameters in the section can be used independently of the other selection criteria areas.

**CRASH** – A multi-filter selection area that allows the output case list to be more specific based on year, state, month and/or mortality. The parameters in the section can be used independently of the other selection criteria areas.

**OCCUPANT** - A multi-filter selection area that allows the output case list to be more specific based on where the occupant was located in the vehicle (role) and some physical characteristics (sex, age, and height). These parameters can be used independently of the other selection criteria areas.

As a general rule for using data filters, the fewer parameters used will mean a greater return of qualifying data, in this instance more cases. Additionally, the use of more than a few parameters can mean that the query becomes too granular and the results could be less data (cases) than expected. The best practice is to perform several practice retrievals using a variety of parameters until the right blend of parameters provides the desired results.

Complete reports can also be obtained at the address below. The reports contain images and accordingly there is a cost associated with reproduction of the crash report.

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