Leg H H-570C

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: JUL -1 1997

In reply refer to: H-97-10 through -18

Honorable Ricardo Martinez
Administrator
National Highway Traffic Safety Administration
Washington, D.C. 20590

In severe frontal crashes, air bags clearly increase the chances of survival, particularly for unbelted adult drivers. The protection afforded by air bags, however, does not extend equally to all passenger vehicle occupants. Between 1993 and 1996, 38 children died because they were struck by an air bag in what would have otherwise been a survivable crash, and 23 adults were also killed by their air bags in crashes they should have survived. The increasing public concern about air bags and urgent questions regarding the effectiveness and the potential danger of these life-saving devices prompted the National Transportation Safety Board to convene a 4-day public forum in March 1997 to discuss concerns related to the role of air bags, to identify who is vulnerable to injuries, to examine the experience with air bags in other countries, and to address ways to increase seatbelt and child restraint use.[1] The National Highway Traffic Safety Administration (NHTSA) participated in the forum, along with representatives from Australia, Canada and Europe; the automobile industry; air bag suppliers; insurance, safety, and consumer groups; and family members involved in crashes where air bags deployed.

Several points became evident during the forum. The "one-size-fits-all" approach to air bag design is obsolete: air bags need to be designed to protect all people in a variety of crash situations. With regard to cars on the road today, children need to be in the back seat, and everyone needs to be buckled up and seated as far back as possible from the air bag. NHTSA needs to move quickly on a decision regarding air bag deactivation. NHTSA's databases of crash information preclude a proper evaluation of the effectiveness of air bags because the information is not comprehensive in one database and is insufficient in the other. Finally and perhaps most importantly, societal attitudes must change with regard to seatbelt use. The United States remains far behind other countries in seatbelt use, and the Nation pays a high price for it in terms of lives lost. Elected officials need to take responsibility for tough enforcement programs and to consider financial incentives (or penalties) if the Nation is to increase seatbelt use.

[1] National Transportation Safety Board. 1997. Proceedings of the National Transportation Safety Board public forum on air bags and child passenger safety; March 17-20, 1997; Washington, D.C. Report of Proceedings NTSB/RP-97/01; PB97-917001.

The Safety Board's concerns about motor vehicle occupant protection have led it to examine and recommend action on a wide range of safety issues throughout its 30-year history. Important changes have already occurred, including improved designs of seatbelts and child restraint systems, the required installation of lap/shoulder belts at all outboard seating positions, the mandated use of child restraint systems in all 50 States and seatbelts in 49 States, an increase in public education about the importance of restraint use, and increased child restraint and seatbelt use rates. Additional improvements, however, are still needed.

Certification of Air Bags

Research and crash investigations by the Safety Board and NHTSA have shown that children age 12 and younger, especially if unrestrained or in rear-facing infant seats, are at a high risk of air bag-induced injuries to the head and neck. Short-statured drivers and senior citizens may also be vulnerable to air bag-induced injuries. The forum representative from Transport Canada reported that Canadian crash tests using 5th percentile female dummies suggest that even properly belted individuals of small stature may be at significant risk of serious neck injury

Federal Motor Vehicle Safety Standard (FMVSS) 208 requires that passenger vehicle air bags be tested in a crash at 30 mph into a fixed barrier with an unrestrained 50th percentile male crash test dummy.[2] In its September 1996 study on child occupant protection, the Safety Board concluded that NHTSA's air bag performance certification testing does not adequately represent the range of actual crash environments because it does not consider belted child occupants and out-of-position occupants (belted and unbelted), the effects of pre-impact braking, or the seat track in the forward-most position.[3] The Board issued the following urgent safety recommendation to NHTSA:

> Immediately revise Federal Motor Vehicle Safety Standard 208, "Occupant Crash Protection," to establish performance requirements for passenger side air bags based on testing procedures that reflect actual accident environments, including pre-impact braking, out of position child occupants (belted and unbelted), properly positioned belted child occupants and with the seat track in the forward-most position. (H-96-18)

NHTSA responded to the Board's recommendations on May 16, 1997, stating that as of March 1997, automobile manufacturers were permitted to install depowered air bags in newly manufactured vehicles. The Board is currently evaluating NHTSA's response.

[2] In addition to the certification test with an unrestrained 50th percentile male crash test dummy, manufacturers voluntarily test with a variety of crash dummy sizes and under various conditions with both restrained and unrestrained dummies.

[3] National Transportation Safety Board. 1996. The performance and use of child restraint systems, seatbelts, and air bags for children in passenger vehicles. Safety Study NTSB/SS-96/01. Washington, D.C.

Information obtained at the public forum highlighted the need for air bag certification testing that is representative of the actual crash environment on the driver's side in addition to the passenger side. For example, a woman who is 5 feet 2 inches tall testified about the air bag-induced injuries that she sustained when her 1990 model car struck a drainage culvert causing deployment of the air bag. She was wearing her seatbelt and the driver's seat was "in the last notch [most forward position] of the forward-and-backward tread." She sustained a broken neck, head and eye injuries, and was unconscious for "about 4½ weeks." As mentioned previously, 23 adults have been killed by the air bag in crashes they should have survived; many of these adults were unrestrained.

Several comments at the public forum dealt with the availability and suitability of crash test dummies. Dr. Harold Mertz, a General Motors researcher, stated that an effective 5th percentile female crash test dummy has been available for some time, and that 3- and 6-year-old child dummies have been developed and are being improved for more study. NHTSA stated in an April 18, 1997, letter to the Safety Board that a family of Hybrid III dummies had been developed and were being evaluated. According to NHTSA, the dummies were generally found suitable and useful for development and assessment of various types of restraint systems for research purposes but lacked response consistency and durability needed for standardization. NHTSA and the Society of Automotive Engineers (SAE) are working on these problems.[4]

A letter dated April 21, 1997, from the American Automobile Manufacturers Association (AAMA) to the Safety Board's public docket on the forum indicated that in the past, the adoption of a test dummy for use in crash testing often took several years; Dr. Mertz's testimony at the public forum also addressed the length of time that it took in the past to adopt new test dummies and to incorporate new injury criteria. NHTSA Administrator Ricardo Martinez testified at the forum that the agency plans to issue notices of proposed rulemaking to incorporate the 5th percentile female, 3-year-old, and 6-year-old Hybrid III dummies into the Code of Federal Regulations before the end of 1997. The Safety Board encourages NHTSA to work as quickly as possible to set the standards for these new dummies. The Safety Board believes that NHTSA should develop and implement a set of vehicle crash test standards that utilize the currently available 5th percentile female crash test dummy. The Board also believes that NHTSA should develop and implement a set of vehicle crash test standards using biologically representative child dummies and appropriate injury criteria.

Estimating the Effectiveness of Air Bags

The benefits of air bags can be examined from different aspects: their effectiveness in reducing the risk of fatal injuries, their effectiveness in reducing the severity of nonfatal injuries, and the performance of various air bag technologies. NHTSA uses data from its Fatality Analysis Reporting System (FARS) to estimate the reduction in fatality risk from air bags. According to analyses based on FARS data, air bags reduce the overall fatality risk by 11 percent for drivers in

[4] The Society of Automotive Engineers establishes voluntary standards, called recommended practices, that many automobile manufacturers adhere to in the design and development of automobiles.

passenger vehicles and by 13.5 percent for passengers over age 13. FARS data analyses also show that air bags increase fatality risk to children ages 0-12 and that air bags provide little protection for drivers over 70 years.[5] NHTSA uses the National Automotive Sampling System (NASS) to evaluate the effectiveness of air bags in reducing the likelihood of sustaining a moderate or greater injury. The NASS analysis found that air bags combined with the lap/shoulder belt provide the greatest injury protection. The injury reducing effectiveness of the air bag alone was not significantly better than being unrestrained.[6]

In performing these analyses, NHTSA used "air bag-equipped" as a surrogate for "air bag deployed" to estimate the effectiveness of air bags in reducing fatalities. These analyses did not determine whether or not the air bag actually deployed. Dr. Charles Kahane of NHTSA stated at the public forum that NHTSA was interested in determining the number of lives saved or the total percentage reduction in the fatality risk given that the vehicle was equipped with an air bag; the designation "air bag-equipped" was thus an adequate substitute for "air bag deployed" in these analyses. Dr. Kahane added that with FARS data, analysts could not rely on the variable that indicates whether or not an air bag deployed. Instead, he used the vehicle identification number (VIN) to determine whether or not a vehicle was equipped with an air bag and used this determination as the basis of the comparisons. Dr. Lindsay Griffin, a research scientist from the Texas Transportation Institute, supported Kahane's method.

The Safety Board understands that using "air bag-equipped" as a surrogate for "air bag-deployed" is an acceptable method for studies designed to assess the overall benefits of air bags in passenger vehicles. However, with the advent of new air bag technology such as depowered air bags, cutoff switches, tag sensors, or other methods of deactivation, this crude method is not sufficient to measure the effectiveness of air bags. Assessments of the effectiveness of the various new air bag technologies will require a case-by-case collection of details regarding the installation and performance of the air bag and related systems such as cutoff switches, tag sensors, and other air bag technologies.

Timely evaluation of these new air bag technologies is essential. However, both Dr. Susan Ferguson, Vice President for Research at the Insurance Institute for Highway Safety, and Dr. John Graham, Director of the Harvard Center for Risk Analysis, stated in their testimony, at the public forum that because of the quantity of data needed for a statistical analysis, such an analysis of the new air bag technologies will not be possible with the data collection techniques currently in place. Thus, analysis of the effectiveness of depowered air bags, cutoff switches, tag sensors, and other new air bag technologies will need to be based on comprehensive crash investigations. These data need to be collected in an expeditious manner.

---

[5] National Highway Traffic Safety Administration. 1996. Fatality reduction by air bags. NHTSA Tech. Rep. DOT HS 808 470. Washington, D.C. August.

[6] National Highway Traffic Safety Administration. 1996. Effectiveness of occupant protection systems and their use. Third Report to Congress. Washington, D.C. December.

In its April 1997 letter to the Safety Board's public docket on the forum, the AAMA indicated that it has met with NHTSA to discuss establishing a process by which to evaluate the benefits of new air bag technologies:

> Within 12 months of full implementation of depowered air bags, the safety effects of this new restraint system design can be quantified. To this end AAMA's members will identify and advise NHTSA of each product introduced with depowered air bags. During this period of time, all FARS cases with a depowered system should get a "special in-depth" investigation. . . These data are essential to determine the actual safety benefit assignable to depowering and to better understand where further improvements may be needed.

The Safety Board agrees with the AAMA that a plan needs to be developed to evaluate the benefits of new air bag technologies and that this analysis should involve in-depth crash investigations. The Safety Board believes that NHTSA and the automobile industry should develop and implement a comprehensive crash investigation program to evaluate the effectiveness of air bags. This program should provide for long- and short-term evaluation of variations in air bag designs, advanced air bag technologies, and various methods to deactivate air bags.

Collecting Data on Injuries From Air Bags

Over 60 million passenger vehicles currently on the road are equipped with air bags, and more than 1 million air bags have deployed; however, information is limited on the results of most of these deployments. Testimony at the forum from Dr. Charles Kahane indicated that NHTSA estimates of the number of individuals saved by air bags are based on statistical analyses of the FARS database and not on data that reflect detailed investigations of individual cases.

FARS is a census of fatal traffic crashes within the 50 States, the District of Columbia, and Puerto Rico. Because FARS data are limited to crashes involving fatalities, the data cannot be generalized to nonfatal crashes. The most common crash in the United States leading to death is a single-vehicle crash, as General Motors researcher Dr. Leonard Evans noted at the forum. The preponderance of single-vehicle crashes in FARS is not representative of multivehicle crashes. Similarly, fatal crashes are usually more severe than injury-only crashes, thus crashes in FARS tend to be more severe than other crashes. NASS contains detailed data on a representative, random sample of about 5,000 police-reported traffic crashes, fatal and nonfatal, involving passenger vehicles towed from the scene because of damage resulting from the crash. A sufficiently large sample size is important when estimating air bag effectiveness, particularly when evaluating the effects on subgroups based on weight, height, and age.

Injury information in FARS is limited to injury severity, whether or not persons were taken to the hospital, and the date and time of death. Injury data are documented in detail in the NASS database, but the limited sample size makes it difficult to draw conclusions about the injuries resulting from air bags.

Injury information is critical in evaluating the effectiveness of air bags. Several agencies, trauma centers, and hospitals have been examining injury data independently. The Centers for Disease Control and Prevention (CDC), an agency of the Department of Health and Human Services, has examined case reports of deaths to children in crashes involving an air bag deployment. Dr. Donald Huelke, an anatomist at the University of Michigan Transportation Research Institute, has reviewed over 500 cases of air bag deployments, but this figure represents less than one-tenth of 1 percent of the total number of deployments in the United States. Further, Dr. Jeffrey Augenstein, Director of the William Lehman Injury Research Center at the University of Miami, stated at the forum that when they do gather injury information related to air bags, the medical community at large, and emergency department staff in particular, do not generally have well-defined protocols for determining the sources of injuries sustained in passenger vehicle crashes.

Timely and reliable crash data and injury information are needed to evaluate the effectiveness of air bags. The Safety Board believes that NHTSA and the CDC should work together to develop data collection procedures and to establish a comprehensive database for recording all air bag-induced injuries identified by the medical community. This database should be able to link to the other available databases (for example, FARS and NASS) in order to obtain crash-specific information. Other air bag information is also vital for evaluating the effectiveness of air bags; for example, the type of air bag technology in the vehicle, and whether it was deactivated by a tag sensor or a mechanic. Consequently, NHTSA should revise its FARS and NASS databases to record specific information regarding the air bag equipment installed in the vehicle and its performance in the crash, such as the following: Did the air bag deploy, was it a depowered air bag, was there a cutoff switch, and was it on or off.

Collecting Uniform Crash Data

The Board recognizes that NHTSA relies on police accident reports for much of the data in the FARS and NASS databases, thus crash data need to be consistent within and between the States. Police accident reports, however, are not uniform and, as a result, data are inconsistent and interpretation of the data can be inaccurate. For example, a review of the 1995 State accident forms shows that only nine States have a separate data field for air bag information, several States incorporate air bag information into the restraint use or safety equipment field, and some States do not collect information on air bags. Additionally, the air bag information that is collected is usually limited, in most cases as to whether or not an air bag deployed and occasionally includes some information on belt use. Nor are the police accident reports adequate for collecting data on new air bag technologies. The Safety Board is aware that NHTSA is working with the Federal Highway Administration and the National Association of Governers' Highway Safety Representatives to develop guidelines for the collection of standardized data elements, including two data fields on air bags, which will provide for better comparisons and evaluations of traffic crashes. The Safety Board supports these efforts and believes this project provides an opportunity to collect additional uniform data to more reliably determine the effectiveness of air bags. The Board believes that NHTSA should revise and update the guidelines as the air bag technology changes. NHTSA should also provide these guidelines to the States. In turn, the

Board is asking the States, U.S. Territories, and the District of Columbia to incorporate the standardized data collection/data elements guidelines for traffic crashes into their police accident reports.

Seatbelt Use Surveys

According to NHTSA, the nationwide seatbelt use rate in the United States was 68 percent in 1996. NHTSA derived the nationwide rate from State surveys.[7] The belt use rate from each State's most recent survey was weighted by that State's proportion of the U.S. population, then all States were combined. The 1996 nationwide use rate was based on 40 State surveys conducted in 1996 and 10 conducted earlier. In addition to being used to calculate the nationwide belt use rate, the State surveys provide a means for monitoring increases (or decreases) in belt use in the individual States.

At the Safety Board's public forum, Dr. Ricardo Martinez, Administrator of NHTSA, and Mr. Brian O'Neill, President of the Insurance Institute for Highway Safety, indicated that both the content and the quality of the State surveys varies. NHTSA published guidelines in 1992 for developing State observational surveys of belt use but States currently are not required to follow them.[8] NHTSA reports that at least 29 States conduct probability-based observational surveys whereas the remaining States collect convenience-based samples. Wyoming is the only State that uses crash reports rather than observational data to estimate belt use and therefore its rate is not included in the calculation of the nationwide rate. Further, survey results are confounded by differences in the definition of the population to be observed. Most State surveys measure belt use of drivers and front-seat passengers but four States measure belt use of drivers only. All States observe belt use in passenger vehicles, 33 States include light trucks, and 24 States include vans. The variation in the State surveys reduces the reliability of the belt use rates.

Dr. Martinez pointed out that NHTSA also conducts its own surveys to estimate belt use rates but because of the expense, the surveys are not done every year. The National Occupant Protection Use Survey (NOPUS) was conducted by NHTSA in late 1994 and again in the fall of 1996. NOPUS comprises three different studies: the moving traffic study provides information on overall shoulder belt use; the controlled intersection study provides information about shoulder belt use by vehicle type, characteristics of the belt users, and child restraint use; and the shopping center study provides information on rear seatbelt use and shoulder belt misuse.

[7] National Highway Traffic Safety Administration. 1997. Observed safety belt use in 1996. Research Note. Washington, D.C.

[8] Federal Register, Vol. 57, No. 125, dated June 29, 1992, page 28899

The NOPUS provides a probability-based sample of national belt usage rates that permit comparisons to be made between the 1994 and 1996 surveys.[9] Overall belt use increased from 58 percent in 1994 to 61.3 percent in 1996. The NOPUS estimate of 61.3-percent belt use rate is 7 percentage points lower than the 68-percent belt use rate derived from the State surveys.

NHTSA has not released the results of the 1996 NOPUS controlled intersection study; the 1994 results show that the overall estimated restraint use rate for children less than 5 years of age is 66 percent. For infants, the estimated restraint use rate was 88 percent; child restraints were used for all the restrained infants who were observed. For toddlers, the estimated restraint use rate was 61 percent; they were observed to be restrained either by child restraint systems or seatbelts. NHTSA cautions that reliable estimates of child restraint use are difficult to obtain because only 8 percent of the population is younger than age 5 and a limited number of observation sites were used for the NOPUS study.

Comparisons between State survey use rates and the NOPUS belt use rates are difficult to make because of differences in vehicle and occupant coverage. Additionally, comparisons between the State usage rates are also difficult to make because of deviations in the individual State surveys.

Consistent and reliable data are needed on seatbelt and child restraint use to enable comparisons between States, to monitor individual States' progress, and to calculate meaningful nationwide use rates. Further, the data should be collected on a representative sample. Therefore, the Safety Board believes that NHTSA should develop, in conjunction with the States, uniform measurement procedures and tools for the States to use when conducting surveys on seatbelt and child restraint use. NHTSA should also revise its 1992 guidelines to ensure that a probability-based design is used to select a representative sample of the population. NHTSA should then provide this information to the States. In turn, the Safety Board has asked the States, U.S. Territories, and the District of Columbia to replace their current data collection systems (State surveys, crash data) with the uniform measurement procedures, tools, and sampling design plan to be developed and provided by NHTSA for obtaining seatbelt and child restraint use rates. NHTSA should continue to collect nationally sampled data on seatbelt use and child restraint use to supplement and enhance the State surveys.

New Car Assessment Program

NHTSA developed the New Car Assessment Program (NCAP) test procedure in 1979 to help consumers determine the overall safety of a vehicle. The NCAP crash test procedure is conducted at 35 miles per hour with belted dummies; NHTSA's air bag certification crash tests are conducted at 30 mph with unbelted dummies. The NCAP program is intended to encourage automobile manufacturers to strive for high speed crash safety performance that exceeds the

[9] In Canada, usage rate surveys are conducted at 240 sites selected to be nationally representative, and the surveys are repeated annually. In Australia, the observational data are centrally coordinated, funded on a regular basis, and statistically based.

baseline requirements for vehicle certification. The vehicle is graded by a multiple star system based on the level of injury indicated by the instrumented dummies. This multiple star index is intended to guide consumers as to the relative level of safety performance for a given vehicle involved in a high speed frontal crash. More stars indicate better performance in a high speed frontal crash.

In March 1997, NHTSA modified the unbelted air bag certification test requirement of FMVSS 208 to allow auto manufacturers to install lower energy or less aggressive air bags. As a result, many consumers will want to know if the vehicle they plan to purchase has a depowered air bag and the extent to which it reduces their risk from air bag injury. However, several automobile manufacturers stated during the public forum that the desire to achieve a superior rating of safety in the NCAP high speed test may well be contributing to the continued use of high energy air bags.

High speed crash safety is certainly desirable. However, the NCAP goal should not compromise performance in actual crash environments or be counterproductive for certain subsets of the population, such as short-statured females or children. Alternative or complementary tests should be considered. For example, a low speed (15 to 20 mph) offset barrier crash would represent a range of common crashes and take into account vehicle characteristics such as deployment threshold, late firing of an air bag, and aggressiveness of the air bag. The Safety Board believes that NHTSA should evaluate, through public comment, the NCAP test procedures to determine (a) if the crash test procedures are counterproductive to development of air bag technology that is safe for all occupants, and (b) if the NCAP program provides consumers with the safety information they need to purchase a vehicle. If necessary, NHTSA should develop new methods for providing meaningful information to consumers on vehicle safety in high speed and other types of crashes. This process should attempt to provide information on vehicle safety in a broader spectrum of vehicle crashes as opposed to just high speed frontal crashes.

Electronic Recording of Crash Data

Since the early days of vehicle safety standards, government and industry have desired better data on the actual forces and acceleration levels in actual crash situations. In the early 1970s, NHTSA sponsored research to develop and install crash recorders in vehicles in actual field service. These electro-mechanical devices, crude by today's solid-state technology, were installed in a limited number of fleet vehicles. Solid-state electronic accelerometers and data recording and readout devices have advanced substantially since the first NHTSA research in this area. Indeed, such devices serve as the basis for many of the air bag sensor systems in use today and provide crash data readout parameters of value to NHTSA and industry researchers.

The availability of accurate physical data that describe the forces and accelerations experienced in highway crashes is even more important today than it was in the 1970s. Assessments of the effectiveness of air bags and other restraint systems in relation to measured crash pulses depend on instrumentation systems that can record these data. On-board recording systems are technologically feasible and could be installed in passenger vehicles in much the same

way that flight data recorders are used to capture relevant data from commercial airliners. Thus, the Safety Board believes that the domestic and international automobile manufacturers, in conjunction with NHTSA, should develop and implement a plan to gather better information on crash pulses and other crash parameters in actual crashes, utilizing current or augmented crash sensing and recording devices

Therefore, the National Transportation Safety Board recommends that the National Highway Traffic Safety Administration:

Develop and implement a set of crash test standards that utilize the currently available 5th percentile female crash test dummy. (H-97-10)

Develop and implement a set of vehicle crash test standards using biologically representative child dummies and appropriate injury criteria. (H-97-11)

Develop and implement, in conjunction with the automobile industry, a comprehensive crash investigation program to evaluate the effectiveness of air bags. This program should provide for long- and short-term evaluation of variations in air bag designs, advanced air bag technologies, and various methods to deactivate air bags. (H-97-12)

Develop, in conjunction with the Center for Disease Control and Prevention, data collection procedures and establish a database for recording all air bag-induced injuries identified by the medical community. (H-97-13)

Revise the Fatality Analysis Reporting System and the National Automotive Sampling System to record specific information regarding the air bag equipment installed in the vehicle and its performance in the crash, such as the following: Did the air bag deploy, was it a depowered air bag, was there a cutoff switch, and was it on or off. (H-97-14)

Develop guidelines for the collection of standardized data elements, including data fields for air bags, which will provide for better comparisons and evaluations of traffic crashes. Revise and update the guidelines as necessary as the air bag technology changes. Provide these guidelines to the States. (H-97-15)

Develop, in conjunction with the States, uniform measurement procedures and tools for the States to use when conducting surveys on seatbelt and child restraint use, and revise the 1992 guidelines to ensure that a probability-based design is used to select a representative sample of the population. Provide this information to the States. (H-97-16)

Evaluate, through public comment, the New Car Assessment Program (NCAP) test procedures to determine (a) if the crash test procedures are counterproductive to development of air bag technology that is safe for all occupants, and (b) if the NCAP program provides consumers with the safety information they need to purchase a vehicle. If necessary, develop new methods for providing meaningful information to consumers on vehicle safety in high speed and other types of crashes. (H-97-17)

Develop and implement, in conjunction with the domestic and international automobile manufacturers, a plan to gather better information on crash pulses and other crash parameters in actual crashes, utilizing current or augmented crash sensing and recording devices. (H-97-18)

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman