NATIONAL ASSOCIATION OF
STATE DIRECTORS OF
PUPIL TRANSPORTATION SERVICES

Passenger Crash Protection in School Buses

An Update

POSITION PAPER

INTRODUCTION: In July 1998, the National Association of State Directors of Pupil Transportation Services issued a Position Paper titled, "Passenger Crash Protection in Large School Buses." Since then, a number of significant actions have taken place. This updated Position Paper provides the latest information on passenger crash protection in all sizes of school buses.

Additionally, Dr. Phyllis Agran, one of the authors of a scientific paper quoted in the July 1998 Position Paper, notified the Association of her objection to the manner in which the paper was used in the Position Paper. Specifically, Dr. Agran noted that permission was not obtained from either her or the American Academy of Pediatrics, holder of the copyright. Furthermore, Dr. Agran noted that excerpts were taken out of context, edited, and presented in a misleading manner to support the State Directors Association's position against lap belts in large school buses. Dr. Agran has made it clear that in no way does the article, "Child Occupant Protection in Motor Vehicles," authored by her and her colleagues, suggest that children would be better protected from occupant injury in school buses if they were unrestrained, as is implied in the July 1998 Position Paper.

It was never the intention of the State Directors Association to violate any copyrights or misstate, take out of context, or misrepresent the information contained in Dr. Agran's scientific paper. The State Directors Association believes Dr. Agran's paper is an excellent work, and regrets any misunderstandings that may have resulted from the reference to her scientific paper in the July 1998 Position Paper.

The July 1998 version of this Position Paper should no longer be utilized.

Introduction

No one questions that school buses are the safest form of highway travel, or that today's school buses provide students with exceptional levels of safety. Despite these facts, the pupil transportation industry constantly is seeking ways to make a safe form of transportation even safer. In this quest, there are times when individuals and organizations will disagree over the potential benefits of certain safety features. This paper provides a discussion of the current status of passenger crash protection in school buses. It also provides comments from safety experts and safety researchers on the appropriateness of lap belts as a means of passenger crash protection for children. A Summary and Conclusions section is presented first, followed by detailed discussions of the wide range of topics and issues involved in the crash protection of children in school buses.

The State Directors Association believes it is important to define the terms that are used in the debate over the best means of providing crash protection to children in school buses. Unless terms that are consistent and unambiguous are used, there may be confusion. Unfortunately, the term "seat belt" means different things to different people.

Rather than using non-definitive terms such as "seat belt," precise terms should be used to define the "belt system" under discussion – it is either a "lap belt" or a "lap/shoulder belt." These terms are easily and completely understood by everyone.

Summary and Conclusions

School buses are the safest form of motor vehicle travel in the United States. While every serious injury or fatality to a student in a school bus is tragic, such instances are few in number each year. Nationwide, on average there are fewer than 10 school bus passenger fatalities each year out of approximately 10 billion student trips. In contrast, more than 800 school-aged children are killed in passenger cars or other private vehicles during normal school hours. It is likely that many of these children were on their way to or from school or school-related activity. In such instances, had these children been in a school bus, they would most likely be alive today.

Based on all of the real-world facts, "compartmentalization" in today's school buses is providing an extremely high level of crash protection for student passengers considering all the types of crashes involving school buses. There are no aggregate statistical data to suggest that a safety problem exists in large school buses that the installation of lap belts would solve. In fact, there is growing concern among safety professionals around the world over the use of lap belts as a form of passenger restraint for young or small children. In August 1998, at a public hearing held by the National Transportation Safety Board, five international experts in the field of motor vehicle occupant crash protection expressed their concern about the appropriateness of lap belts in providing crash protection to small children. The unanimous opinion was that lap belts were not a good means of providing crash protection to small children because small childrens' bone structure, particularly their hips, is still developing through grade school.

In addition, in November 1998, Mr. Jim Hall, Chairman of the National Transportation Safety Board, spoke to a national conference of school transportation professionals. In his remarks, Chairman Hall stated that, "I personally think it is our turn now to step up to the plate on the issue of lap/shoulder belts in school buses." He went on to state that while "we have to stop being indecisive on this issue," we should "commit to doing it, but let's do it right." Chairman Hall reiterated that "we have to make sure this is done on the basis of solid science. We don't want to simply bolt in lap belts at every seating position." Finally, Chairman Hall stated that "lap belts are probably not the most effective form of restraint for the millions of children transported on school buses."

A number of scientific papers that assess the effects of lap belts and lap/shoulder belts on children involved in real-world motor vehicle crashes have been conducted. While these studies appear to be based exclusively on children in passenger cars and other private vehicles, the conclusions of the studies raise important questions with respect to the appropriateness of lap belts in school buses. For example, the report, "Injuries to Children Restrained in 2- and 3-Point Belts," was presented at the 42nd Annual Proceedings of the Association for the Advancement of Automotive Medicine in October 1998. While the authors of the study did not draw any conclusions about the relative efficacy of lap belts versus lap/shoulder belts, they did point out that "Injury risks to children restrained in 2-point belts have been well described. 'Seat belt syndrome,' associated with the use of 2-point belts, includes contusion of the abdominal wall, fracture of the lumbar spine, and intra-abdominal injury."

The study concluded that, "Children restrained in 3-point belts exhibit a similar pattern of injury to those in 2-point belts, however 3-point belts appear to be protective for the lumbar spine." The authors of this study noted that while it included data on more real-world crashes than previous studies of the effects of 3-point lap/shoulder belts on children, it was still a relatively small study, and excluded belted children who were uninjured in motor vehicle crashes. The absence of data on children using lap or lap/shoulder belts who where uninjured makes it impossible to draw any conclusions about the absolute or relative effectiveness of lap or lap/shoulder belts on children.

The purpose of citing this study is not to suggest that the paper or the authors of the paper believe children are better off unrestrained in motor vehicles. Rather, studies such as this appear to indicate that all types of passenger crash protection devices may have unique consequences for children. The State Directors Association believes it is extremely important to understand the interaction of all types of passenger crash protection devices on the human body. Much is learned through epidemiological studies that are conducted by the medical community. If children or adults are needlessly injured in real-world crashes, such studies can assist in the identification of problems and the development of solutions to those problems.

The development of a better understanding of the types and causes of injuries occurring to passengers in school buses cannot be overstated. This information can only be gathered from medical records, either from the hospital or physician that treated the injured child. Without medical information on the type and severity of injury being suffered by school bus passengers in various types of crashes, it is not possible to properly evaluate the relative benefits of different forms of passenger crash protection in terms of preventing or inflicting injuries to children in school buses. Without data on how and when lap belts, or lap/shoulder belts, or
"compartmentalization" either reduce the risk of injury or cause an increased risk of injury to

children on school buses, it is inappropriate to suggest changes to current requirements for the crash protection of school bus passengers.

Some have suggested that differences in seat design (such as the seat cushion stiffness) between passenger cars and school buses reduce concerns about lap belt-induced injuries to small children. The State Directors Association believes it is only possible to determine the effect of seat designs on the relationship between lap belts and the skeletal development of children through scientific evaluation, including laboratory testing and evaluations of real-world crashes and medical records.

To that extent, in August 1998, the National Highway Traffic Safety Administration (NHTSA) announced an extensive 2-year research program to consider alternative methods for potentially improving Federal school bus passenger crash protection requirements. In announcing the program, NHTSA reiterated its belief that "compartmentalization" has proven to be an excellent form of school bus passenger crash protection, but believes it is important to develop the necessary data and science to review and evaluate objectively potential improvements in passenger crash protection for the next generation of school buses. The NHTSA research program is designed to determine whether it is technologically feasible and operationally practicable to upgrade the current Federal standards for passenger crash protection in school buses. The research approach is direct – develop data on existing school bus crashes to determine the causes of fatalities and serious injuries; use that data to evaluate existing and alternative passenger crash protection systems in a laboratory test environment; and consider the impact of various passenger crash protection systems on school bus capacity and emergency egress. Based on the results of this research program, the data and science necessary for making informed decisions about the safety of all children in school buses should be available.

Until such time that the research and crash test data support alternative crash protection systems, the State Directors Association continues to support the conclusions reached during the past 20 years by the National Academy of Sciences and the National Transportation Safety Board, and the position of the National Highway Traffic Safety Administration, that there is no supportable need for lap belts in large school buses. In addition, the State Directors Association believes that legislators and regulators, in carrying out their responsibility to establish public policy through laws and regulations, have an obligation to make decisions based on data and science, not emotion and supposition. To do otherwise could result in public policies that improperly use society's limited resources, and could result in additional injuries and fatalities to school bus passengers, rather than reducing or eliminating them.

The State Directors Association fully supports NHTSA's announced research program, and believes it is the appropriate mechanism for resolving the current debate about the appropriateness of lap belts in school buses, and to establish the foundation for potential improvements to school bus safety. The State Directors Association has provided suggestions to NHTSA on the scope and content of the research program, and will, to the extent permitted, stay involved in the research program and its results. The State Directors Association has already requested that NHTSA expand the scope of its research program to include all sizes of school buses, based on its concerns about the appropriateness of lap belts as a form of crash protection for young children.

The State Directors Association believes that all interested parties should take an active interest in the NHTSA research program, so as to insure that the program addresses the appropriate issues, and that NHTSA is aware of all existing data relative to pertinent issues involved in passenger crash protection in school buses. Over the years, many studies of school bus transportation have noted that there is a need for more and better data upon which to draw conclusions and make decisions. The NHTSA research program should be structured to collect and analyze the data needed to make informed public policy decisions about passenger crash protection in school buses. Without complete data, there are no bases to support changes to existing school bus safety requirements.

The State Directors Association believes it is inappropriate to consider legislation, at any level, to require lap belts in school buses while the Federal government is conducting research that is designed to develop the next generation of passenger crash protection systems in school buses. Without attempting to pre-judge the outcome of NHTSA's research program, it does not appear that the agency would conclude that lap belts, a 30-year-old technology, were the most effective form of passenger crash protection for school buses for the next century. Rather, with the advancements that have been made in lap/shoulder belt systems and energy absorbing materials and construction techniques, it would appear that NHTSA would propose changes to school bus passenger crash protection utilizing the latest technologies.

While the NHTSA research program is underway, the State Directors Association believes that the pupil transportation industry, parents, state and local legislators, and all other interested parties should join forces in an effort to reduce the deaths and serious injuries to children that, either by choice or circumstance, travel to and from school and school-related activities in private vehicles, in vans that do not conform to Federal safety standards for school buses, in transit vehicles, or who walk or ride bicycles. While there are no exact numbers available, it is clear that hundreds of children are needlessly killed each year as they travel to or from school or a school-related activity in some manner other than a school bus. It is likely that the number of serious injuries to such children is equally high. The State Directors Association believes the most prudent course of action for the next two years is to address the safety issues of children not in school buses. In addition, the safety of children as pedestrians in the school bus loading zone must continue to be addressed. When the Federal government has completed its research, then the focus should return to the best means of providing passenger crash protection to children on school buses.

As a final note, the pupil transportation industry is made up of thousands of people who have the safety of children as their highest priority. Most are parents, also. Whenever there are devices or procedures which have the potential to make pupil transportation even safer, the State Directors Association is at the forefront of the debate. If a device or procedure proves to be beneficial based on all available data and information, the State Directors Association stands ready to provide its support to legislators and regulators.

Background and Related Information

The issue of whether to require “seat belts” in large school buses [those with a gross vehicle weight rating over 10,000 pounds] is a topic that has been studied thoroughly and debated for many years. An important, but often overlooked fact in the debate, is the difference between lap belts and lap/shoulder belts. Until recently, no one has advocated the installation of lap/shoulder belts in large school buses. During the last year, school transportation organizations have expressed their support for studies to determine the engineering feasibility and operational practicability of installing and using lap/shoulder belts for passengers of all ages and in all sizes of school buses. In addition, it is critical to develop an understanding of the interaction of lap/shoulder belts on children of all ages and sizes from a medical perspective.

In general, advocates for lap belts in school buses point to the potential benefits of lap belts in terms of reduced injuries and fatalities in certain types of school bus crashes -- typically side impact and rollover crashes. They also refer to improvements in pupil behavior as the result of lap belt usage. Finally, advocates point to the importance of consistency in teaching children to buckle-up in all types of motor vehicles -- if there are no lap belts in school buses, advocates believe there is an obvious break in the chain of consistency.

Life, however, is filled with numerous inconsistencies that young children and young adults must face. How they face or deal with those inconsistencies depends on how they are presented and explained by parents, highway safety officials, or educators. Children, even the very young, have tremendous capacity to reason and understand. For instance, children learn from infancy that adults are the rule makers, authority figures, and should be obeyed. All their contacts with adults (parents, grandparents, care givers, teachers) reinforce this teaching. However, children are also taught at an early age that some adults are not to be obeyed, such as strangers who offer gifts, auto rides, or attempt to touch children in unacceptable ways.

When appropriately presented, children and young adults can understand that a school bus and an automobile are very different in purpose, design, and construction. And, they can understand that although a lap belt or a lap/shoulder belt are important and appropriate for use while traveling in an automobile, light truck, or van, the passive occupant safety system in school buses, "compartmentalization," is equally appropriate.

Those opposed to the installation of lap belts in large school buses point to a wide variety of data and facts: (1) the safety record of school buses; (2) analyses of <u>all</u> types of real-world school bus crashes; (3) laboratory crash test data; and (4) the potential effects of lap belts on young children.
It is important to realize that lap belts only provide restraint around the hips of a seated individual. Lap/shoulder belts, on the other hand, provide restraint around the hips and across the upper torso of a seated individual.

The potential safety benefits of these two systems are very different. Lap belts, even when properly positioned and tightened, allow full upper torso movement. As a result, a person’s head could contact surrounding surfaces at higher impact velocities than if they were unbelted. Lap/shoulder belts restrain the upper torso and, thereby, reduce the likelihood of head contact with a surrounding surface.

It has been suggested that school buses that have wider seat spacing to accommodate the installation of child safety seats will reduce the potential for head contact for passengers utilizing lap belts. While the greater seat spacing would obviously reduce the likelihood of head impacts, not all school buses would be constructed with child safety seat anchorage systems and the resulting wider seat spacing. Additionally, even in school buses that were equipped with child safety seat anchorage systems and wider seat spacing, such anchorage systems and seat spacing would not necessarily be at every row of seats in the school bus.

Safety Record of School Buses

One of the major reasons for the outstanding safety record of school buses is the manner in which they are constructed. As is the case with all motor vehicles sold in the United States, school buses have to meet a stringent series of Federal motor vehicle safety standards designed to provide school bus passengers with high levels of safety should a crash occur. One of those Federal standards, "School Bus Passenger Seating and Crash Protection," establishes minimum occupant crash protection requirements for school buses built after April 1, 1977. For large school buses, the Federal standard requires occupant protection through a concept called "compartmentalization" -- strong, well-padded, well-anchored, high-backed, evenly-spaced seats.

In the late 1960's and early 1970's, research was conducted on how to best provide passenger crash protection to the various sizes of children that ride school buses. The research looked at alternative ways of reducing pupil injuries and fatalities in school buses as they existed at that time. School buses of that era typically had exposed metal seat frames and grab bars on the top of the seats, and the seats had little or no crash energy management or energy absorption capabilities.

Some of the research suggested that improvements in seat structure and energy absorbing padding, along with the installation of lap belts, were needed to improve the safety of children in school buses. However, there were other data and factors that had to be considered in establishing the Federal standards governing school bus construction. One of the most relevant dealt with concerns about whether lap belts would be used. No type of restraint device provides a benefit unless the vehicle occupant actively connects the belts.

In the mid 1970's when the Federal school bus standards where being developed, only a small percentage of occupants in all types of vehicles used the available belt system. This fact suggested that the usage rate of lap belts in large school buses would be equally low. No state or jurisdiction had mandatory belt use laws, as currently exist. As a result, the Federal government looked to a "passive" means of providing passenger crash protection in school buses. A "passive" crash protection requires no action by the vehicle occupant to attain the benefits of the system. For example, air bags, motorized lap/shoulder belt systems, and interior padding require no action by the vehicle occupant to obtain the benefits of the system.

The inherent benefits of a "passive" crash protection system versus an "active" crash protection system are important. First, the benefits of a "passive" system are always there, and require no action by the vehicle occupant. Second, "passive" crash protection systems, particularly those that utilize energy-absorbing structures and padding, provide protection to different sizes of occupants and in various seating positions. The "compartmentalization" concept for passenger crash protection in school buses is a passive crash protection system.

It must be recognized that the research conducted in the 1960's and 1970's was done on school buses that did not meet the safety requirements of modern school buses, those manufactured since April 1, 1977. Thus, it would be inappropriate to consider the results of those tests with respect to the potential effectiveness of lap belts in school buses that meet current Federal safety standards. The crash performance and interior design features of school buses built prior to April 1, 1977, are not comparable to school buses built after that date.

The effectiveness of "compartmentalization" has been confirmed in independent studies by the National Transportation Safety Board and the National Academy of Sciences.

National Transportation Safety Board (Safety Board)

In 1987, the Safety Board completed detailed analyses of 43 serious accidents involving large school buses to evaluate the effectiveness of "compartmentalization."[1] These crashes included frontal and side impacts, and included a large number of rollover crashes. A Safety Board team of accident investigators reconstructed each crash, evaluated the motion of the occupants, and identified the cause(s) of the injuries/fatalities. For each crash, an evaluation was made of whether the use of lap belts would have made a difference in the injury levels of the school bus occupants.

From a public policy perspective, the Safety Board's conclusions are extremely important.

1. School bus occupant deaths and the serious or worse injuries sustained by survivors were, for the most part, attributable to the occupants' seating position being in direct line with the crash forces. It is unlikely that the availability of any type of restraint would have improved their injury outcome.
2. Lap belt use probably would have made no change in the total number of school bus passengers who died in the crashes investigated ... possibly one more death would have resulted.
3. Lap belt use probably would have made no change in the number of surviving school bus passengers with severe or worse injuries.
4. At best, lap belt use probably would have reduced somewhat the injuries of less than 8 of the 24 surviving school bus passengers with serious injuries. At worst, seat belts might have increased the injury to almost as many passengers with serious injuries as it improved.
5. Lap belt use probably would have worsened the outcome for one-fifth [20%] of the 58 school bus passengers with moderate injuries.

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[1] "Crashworthiness of Large Poststandard Schoolbuses," National Transportation Safety Board, Report Number NTSB/SS-87/01, March 18, 1987. This study was designed to evaluate the effectiveness of the Federal requirements for "compartmentalization" under FMVSS No. 222. As such, it only compared the post-1977 school buses with pre-1977 school buses that were built to Federal requirements. Since there were no Federal requirements for lap belts on either pre-1977 school buses or post-1977 large school buses, it would have been inappropriate to include any crashes involving school buses equipped with lap-belts in this study.

These real-world data clearly show that while lap belts may offer a safety benefit in some instances, in most crashes the installation and use of lap belts would not have changed the injury outcome of the crash. Equally important is the fact that in a significant number of crashes the use of lap belts would have worsened the injury levels. In fact, it appears that in one instance the use of lap belts would have killed a child that would have otherwise survived. When all crashes are considered, it appears from the data that there are no overall benefits of lap belts in large school buses.

Since the Safety Board's study was completed in 1987, there have been a number of school bus crashes that have resulted in fatalities and serious injuries. While each of these crashes and the consequences are tragic, it is important to study such crashes to identify areas for potential safety improvements. Three of the most tragic crashes occurred in Carrollton, Kentucky; Alton, Texas; and Fox River Grove, Illinois.

In Carrollton, 27 occupants of a former school bus died due to fire and smoke inhalation. In Alton, 21 students drowned in a bus that rolled on its side and was totally submerged in water. And, in Fox River Grove, 7 students were killed when their bus was struck by a speeding train. Each of these crashes required immediate, quick action by passengers under extreme conditions, in order to survive. In Carrollton, a gasoline-fed fire spread rapidly through the bus, and provided very little time for evacuation of the crowded bus. In the Alton crash, the Safety Board's investigation report notes that there "was inadequate time for 81 desperate students to escape through the available window openings and rear emergency door. ... Escape was further complicated by dark murky water which obscured vision. ... The 21 students who perished did not have enough time to escape from the bus." In Fox River Grove, the students sitting in the back of the bus saw the train approaching and had only fractions of a second to move from the back of the bus to the front.

In each of these crashes, unlatching lap belts would have required additional time under panic conditions. In Carrollton, the passengers, many of whom were sleeping, were first stunned by a head-on crash with a pickup truck at a speed of over 100 miles per hour, and then had to cope with fire and dense smoke in an effort to escape the burning bus. No one died from trauma-induced injuries. In Alton, the bus was struck by a tractor-trailer, then plunged from a cliff into water, and the students had to escape in murky water while the bus was on its side. Any passengers on the right side of the bus would have been hanging from their seats by the lap belts. Again, no one died as a result of trauma-induced injuries. In Fox River Grove, all of the students in the back of the bus had only milliseconds to get out of their seats and run forward prior to the collision.

There is little doubt that the installation and use of lap belts in these crashes would have resulted in additional fatalities and serious injuries. This fact must be considered in any debate over the potential benefits of lap belts in school buses. Unfortunately, these crashes often are ignored by those who advocate the installation of lap belts in school buses. Instead, advocates for lap belts in school buses tend to base their arguments on selected crashes. For example, a 1996 rollover
crash of a school bus in Flagstaff, Arizona, which resulted in five students being ejected from the

bus, one of whom suffered serious permanent injuries. Of the 26 other students in the school bus, one also suffered serious permanent injuries. Like all fatalities and injuries to children, these injuries are tragic and everyone wishes they had never happened. However, in making public policy decisions, it is imperative to consider all information on a subject, not just data from selected crashes.

As stated earlier, there have been school bus crashes where lap belts may have offered a safety benefit. However, there are other crashes where the installation and use of lap belts would have resulted in more injuries and fatalities. When the entire range of school bus crashes are considered, the State Directors Association does not believe there is a compelling body of data to support the installation of lap belts in large school buses.

National Academy of Sciences

In 1989, the National Academy of Sciences completed a study at the direction of the United States Congress on "the principal causes of fatalities and injuries to school children riding in school buses and of the use of seat [lap] belts in school buses and other measures that may improve the safety of school bus transportation." The Academy was directed to "determine those safety measures that are most effective in protecting the safety of school children while boarding, leaving, and riding in school buses." In its conclusions, the Academy noted that "the overall potential benefits of requiring safety [lap] belts on large school buses are insufficient to justify a Federal requirement for mandatory installation. Funds used to purchase and maintain seat [lap] belts might be better spent on other school bus safety programs and devices that could save more lives and reduce more injuries." The Academy pointed out that since children are at greater risk of being killed in the school bus loading zone (i.e., while boarding or leaving the bus) than as a passenger in the school bus, "a larger share of the school bus safety effort should be directed to improving the safety of school bus loading zones."[2]

One of the often cited conclusions from the Academy's study is that "seat (lap) belts, when properly used on post-1977 ... school buses, may reduce the likelihood of death or injury to passengers involved in school bus crashes by up to 20 percent." That estimate was based on a 1986 study of rear seat occupants in passenger cars, only a small minority of which were of school age. It should be noted that at the time the 1986 study was conducted, there were relatively limited amounts of real-world data on the effectiveness of lap belts in the rear seats of passenger cars. Based on the differences in the body sizes of school bus and passenger car occupants, and the importance of proper position and adjustment of lap belts, it is not clear that the "up to 20 percent" effectiveness estimate was accurate with respect to school buses.

Since the mid 1980's, additional and significant real-world data have been obtained on the effectiveness of lap belts for rear seat occupants in passenger cars, primarily since belt usage in motor vehicles has increased dramatically in that time frame. Based on real-world crash data through 1996, NHTSA currently estimates that lap belts in school buses at best would be 5 percent effective in reducing school bus passenger fatalities.

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[2] It should be noted that while improvements have been made in school bus loading zone safety since the National Academy of Sciences' 1989 report, the greatest safety risk to pupils riding school buses is still as a pedestrian in the school bus loading zone. When all pupil transportation modes are considered, the greatest safety risk to students is as a pedestrian walking to or from school or as a passenger in a private motor vehicle transporting the student to or from school.

Considering those crashes where lap belts would likely exacerbate injuries, NHTSA estimates that lap belts would have no overall effectiveness in school buses. In its conclusions, NHTSA noted that the greatest benefit of lap belts to rear seat occupants of passenger cars was in terms of preventing ejection from the car, typically in rollover crashes. Since fatalities and serious injuries due to ejection from a school bus are relatively rare events, the effectiveness rate of lap belts in passenger cars is not directly applicable to school buses. These NHTSA conclusions were provided at an August 1998 Public Hearing held by the National Transportation Safety Board on Bus Crashworthiness and Occupant Survivability.

Lap Belt Concerns

In addition to the NHTSA comments at the August 1998 Public Hearing, an international panel of experts in the field of motor vehicle occupant crash protection testified about their views and opinions on how best to provide passenger crash protection to children in school buses. Five researchers, representing Australia, Canada, Europe, and the United States were asked about the appropriateness of lap belts in providing crash protection to small children. The unanimous opinion was that lap belts were not a good means of providing crash protection to small children because small childrens' bone structure, particularly their hips, is still developing through grade school.

One of the researchers discussed a passenger car crash where "...two children have become paraplegics in the rear of one vehicle that was struck head-on, because they were wearing lap belts, and they suffered severe injuries to their spine." Another researcher commented that, "The lap belts involve, in my mind, an unsatisfactory compromise." A third stated. "...as regard children, I would never ever recommend using lap belts." A comment by one of the researchers appears to accurately reflect the views of all of the international researchers – "So I think there is a lot to be considered before we wave our arms and say, 'Lap belts are the answer'."

In addition to the potential for a lap belt to cause internal injuries to small children, lap-belted school bus passengers also risk more severe head and neck injuries in crashes. Unlike passenger cars where there may be a significant amount of space between the rear seat and the front seat, in school buses the seat spacing has been significantly reduced by design. In 1985, Transport Canada issued a report on a series of crash tests it conducted to examine the outcome of lap-belted test dummies in simulated frontal crashes. These tests indicated that lap-belted test dummies in school buses received more severe head and neck injuries than unbelted test dummies in severe frontal crashes. At the time, several individuals questioned the test procedures and results of the Transport Canada study. However, no additional testing was done. In a 1997 series of crash (sled) tests conducted by NHTSA, the same results were found – lap-belted test dummies in school bus seats received higher head injury measures than unbelted test dummies. These 1997 tests appear to confirm the earlier study by Transport Canada.

In a November 2, 1998, speech before the annual conference of the National Association for Pupil Transportation, Jim Hall, Chairman of the National Transportation Safety Board spoke about school bus passenger crash protection. In his comments, Chairman Hall stated that, "I personally think its our turn now to step up to the plate on the issue of lap/shoulder belts in school buses." [Emphasis added.] Chairman Hall also stated that, "It is time for the school pupil transportation network of this country to call on the manufacturers and regulators to make this happen, rather than waiting for it to happen."

While these comments may be interpreted that Chairman Hall personally believes lap/shoulder belts should be installed in school buses right away, such a position is not supported by other statements he made. Specifically, Chairman Hall stated that while "we have to stop being indecisive on this issue," we should "commit to doing it, but let's do it right." Chairman Hall reiterated that "we have to make sure this is done on the basis of solid science. We don't want to simply bolt in lap belts at every seating position." Finally, Chairman Hall stated that "lap belts are probably not the most effective form of restraint for the millions of children transported on school buses."

While lap/shoulder belts in school buses may be one of the most logical technologies to evaluate, there is a significant amount of research to conduct before drawing conclusions about the efficacy of lap/shoulder belts in school buses. For example, the necessary science on how to design and install lap shoulder belt systems in school buses, such that they would be effective in reducing injuries and fatalities to all sizes of pupil passengers, has recently been initiated by several companies. The importance of developing the necessary data and science to determine the proper location of the shoulder belt anchorage point, so that it allows the shoulder belt to be in the proper location across the chest of every size child, can not be overlooked. There is considerable evidence that improper shoulder belt positioning is a significant safety problem in other types of motor vehicles. If we rush to install lap/shoulder belts in school buses without developing the necessary data and science, we may very well establish policies that result in a negative effect on the safety of children in school buses.

Additional Comments on Lap and Lap/Shoulder Belts

At the 1998 Annual Conference of the Association for the Advancement of Automotive Medicine, several presentations were made concerning injuries to children in motor vehicle crashes. In each case, it appears that the crashes investigated were confined exclusively to passenger vehicles. No school buses were included.

One of the papers[3] compared injuries to children restrained in lap belts and lap/shoulder belts. The authors studied the injuries to 98 children 15 years old or younger, half of which had been restrained in 2-point lap belts and the other half restrained in 3-point lap/shoulder belts. Seventy two percent of the children in the study were between the ages of 5 and 9 years -- the ages of children who typically ride school buses. The paper noted that, "Injury risks to children restrained in 2-point belts have been well described. 'Seat belt syndrome,' associated with the use of 2-point belts, includes contusion of the abdominal wall, fracture of the lumbar spine, and intra-abdominal injury."

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[3] "Injuries to Children Restrained in 2- and 3-Point Belts," Catherine S. Gotschall, Allison I. Better, Dorothy Bulas, and Martin R. Eichelberger of the Children's National Medical Center, and Frances Bents and Mike Warner of Dynamic Sciences, Inc., October 1998. 42nd Annual Proceedings of the Association for the Advancement of Automotive Medicine. This paper includes an extensive list of references which undoubtedly provide excellent information on crash protection for children.

The study concluded that, "Children restrained in 3-point belts exhibit a similar pattern of injury to those in 2-point belts, however 3-point belts appear to be protective for the lumbar spine." The authors of this study noted that while it included data on more real-world crashes than previous studies of the effects of 3-point lap/shoulder belts on children, it was still a relatively small study, and excluded belted children who were uninjured in motor vehicle crashes.

The absence of data on children using lap or lap/shoulder belts who where uninjured makes it impossible to draw any conclusions about the absolute or relative effectiveness of lap or lap/shoulder belts on children. The authors did not believe it was possible "to meaningfully compare the relative efficacy of the two restraint systems."

The purpose of citing this study is not to suggest that the paper or the authors of the paper believe children are better off unrestrained in motor vehicles. Rather, studies such as this appear to indicate that all types of passenger crash protection devices may have unique consequences for children. The State Directors Association believes it is extremely important to understand the interaction of all types of passenger crash protection devices on the human body. Much is learned through epidemiological studies that are conducted by the medical community. If children or adults are needlessly being injured in real-world crashes, such studies can assist in the identification of problems and the development of solutions to those problems.

While this study and others appear to be based exclusively on children in passenger cars and other private vehicles, the conclusions point out legitimate issues that must be fully understood with respect to the appropriateness of lap belts or lap/shoulder belts in school buses. Some have postulated that differences between school bus seats and passenger car seats are significant and that these differences reduce concerns about belt-induced injuries to small children. Others question whether there is scientific evidence that demonstrates the effects of seat designs on the relationship between lap and lap/shoulder belts and a child's skeletal development. This is the type of information that is expected to be developed during NHTSA's school bus passenger crash protection research program, which is discussed later in this paper.

Types of School Bus Crashes

Nationwide, the National Safety Council estimates that approximately 30,000 crashes occur each year in which a school bus is involved. Less than 7,000 of these crashes involve "injuries" to school bus occupants.[4] Most of these injury-involved crashes are minor in nature, however, serious school bus crashes do occur. When a serious crash occurs, the school bus passengers are mostly uninjured or receive minor to moderate injuries.[5] These serious crashes involve frontal, angular, side, rear, and rollover crashes.

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[4] The National Safety Council recently determined that the data it collects from individual states are inconsistent and unreliable indicators of actual injuries to school bus occupants. Accordingly, school bus occupant injury data will not be estimated by the National Safety Council in the future.

[5] According to mid-1980's state crash data reviewed by the National Academy of Sciences, only 5 percent of school bus passenger injuries are incapacitating (e.g., severe lacerations, broken limbs, head/chest injuries). A 1997 study of state crash data by NHTSA showed only 4 percent of school bus passenger injuries were serious, severe, or critical.

Unfortunately, there are crashes that result in serious injuries or fatalities to school bus passengers. Most of these crashes are very severe, and as reported by the National Transportation Safety Board in its 1987 report: "schoolbus occupant deaths and the serious or worse injuries ... were, for the most part, attributable to the occupant's seating position being in direct line with the crash forces. It is unlikely that the availability of any type of restraint [emphasis added] would have improved their injury outcome."

With respect to minor and moderate injuries, as discussed earlier, the Safety Board's study found that lap belt use would have worsened the injury levels for 20 percent of the students receiving moderate injuries. It was not possible to judge the effect of lap belt use on those passengers that only received minor injuries.

Obviously, there are some school bus crashes where lap belts may have reduced or eliminated injuries and/or fatalities. As was done in the National Transportation Safety Board's 1987 study, it is possible to assess what injuries may have been mitigated because of lap belts. However, it is much more difficult to suggest what injuries may have occurred as the result of the use of a lap belt, and whether those injuries would have been more severe than the injuries that were mitigated.

In order to evaluate objectively the potential safety benefit of any device, all aspects of the device must be studied and understood. It is not legitimate to consider isolated or anecdotal information and ignore a larger body of information and knowledge. Similarly, it is not legitimate to rely on hypothetical, theoretical, and/or laboratory information when real-world information exists.

Other Organizations

There is unanimity among a wide range of national organizations[6] that are charged with establishing national motor vehicle and highway safety policy that "compartmentalization" is effective in school buses and that lap belts should not be required in school buses. However, as with any controversial issue, there are organizations that believe there should be lap belts in school buses. These include a number of medical associations and state-level organizations. These organizations express their support for lap belts in school buses, but generally publish little or no data or detailed analyses to explain and justify their position, or do not consider all of the real-world data discussed above.

In the best interest of the safety and health of children, it would be beneficial if organizations that take a position on safety matters dealing with pupil transportation provided a detailed discussion and rationale for their position. This should include all of the facts, statistics, and analyses upon which the position is based, and should include a detailed discussion of why opposing views are incorrect or inappropriate.

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[6] These organizations include the National Highway Traffic Safety Administration, the National Transportation Safety Board, the National Safety Council, the National Academy of Sciences and others.

Some organizations and individuals have mis-characterized the conclusions from the 1989 National Academy of Sciences' report discussed earlier. In that report, the Academy concluded "seat (lap) belts, when properly used on post-1977, Type I school buses, may reduce the likelihood of death or injury to passengers involved in school bus crashes by up to 20 percent." [Emphasis added]

According to a March 27, 1998, Florida Senate Staff Analysis and Economic Impact Statement, the Florida PTA utilized the National Academy of Sciences' report to assert "that seat belts[7] on school buses would improve safety by 20 percent." [Emphasis added] Similarly, a citizens' group in Minnesota, People Advocating Seatbelt Safety, also claimed that "50% usage would reduce deaths and injuries by 20%." [Emphasis added]

There is a significant difference between the National Academy of Sciences' conclusion that says "may" and "by up to" and Florida PTA's and Minnesota's claim of "would." This is particularly important since the data used by the National Academy of Sciences were based on adults in the back seat of passenger automobiles, not children in school buses, as discussed earlier. Also, the 1989 data used by the National Academy of Sciences are outdated. The most recent real-world data indicate that at best lap belts would be 5 percent effective in reducing fatalities, but most likely would have no overall effectiveness.

Lap Belt Requirements in New York and New Jersey

Currently, there are two states that require the installation of lap belts in large school buses. New York has required the installation in all new school buses purchased after June 30, 1987. However, New York does not have a law requiring students to use the lap belts. Such requirements are left up to the individual school districts. Recent information provided by New York indicates that only 26 (4 percent) of New York's 709 public school districts have adopted policies which require all students to wear the available lap belts. Those school districts report an estimated 88 percent of elementary, 71 percent of middle, and 47 percent of high school students wear the available lap belts.

New Jersey passed a law in 1992 requiring the installation and use of lap belts in all new large school buses. While there is no official data on lap belt usage, New Jersey estimates that 75 percent of students wear the available lap belts, and that elementary-aged children use them more than high school-aged children.

The National Transportation Safety Board attempted to conduct a study of the effectiveness of lap belts in school buses in New York and New Jersey several years ago, however, the study has not generated any useable information since (thankfully) there have not been any serious crashes of school buses equipped with lap belts. As a result, there is no body of real-world data involving all types of serious school bus crashes that support the position that lap belts provide additional levels of crash safety in the aggregate over the safety provided by "compartmentalization."

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[7] The term "seat belt" on school buses as used by the Florida PTA is interpreted to mean lap belts, since that was the type of belt system considered by the National Academy of Sciences in its study.

Potential Changes to School Bus Passenger Crash Protection

In August 1998, NHTSA announced an extensive 2-year research program to consider improvements to school bus passenger crash protection requirements. In announcing the program, NHTSA reiterated its belief that "compartmentalization" has proven to be an excellent form of child crash protection, but believes it is important to develop the necessary data and science to develop the next generation of passenger crash protection in school buses. The NHTSA research program is designed to determine whether it is technologically feasible and operationally practicable to upgrade the current Federal standards for passenger crash protection in school buses. The research approach is direct – develop data on existing school bus crashes to determine the causes of fatalities and serious injuries; use that data to evaluate existing and alternative passenger crash protection systems in a laboratory test environment; and consider the impact of various passenger crash protection systems on school bus capacity and emergency egress. Based on the results of this research program, the data and science necessary for making informed decisions about the safety of all children in school buses will be available.

The State Directors Association fully supports the NHTSA research program, and notes that it contains much of the content and logic suggested by the Association in July 1998. The State Directors Association has requested that NHTSA expand the scope of its research program to include all sizes of school buses, based on the Association's concerns about the appropriateness of lap belts as a form of crash protection for young children. The State Directors Association maintains its belief that the two most logical options to consider in any research program on the subject of passenger crash protection in school buses are: (1) lap/shoulder belts for all designated seating positions; and (2) upgrades to "compartmentalization."

Lap/Shoulder Belts

As stated earlier, there is unanimity within the motor vehicle safety community that lap/shoulder belts offer superior levels of occupant crash protection over lap belts only. At the current time, there is little, if any, information available on the technological feasibility, operational practicability, potential benefits, and other potential positive and negative concerns associated with the installation of lap/shoulder belts in school buses. The State Directors Association believes it is important to develop as much information as possible on lap/shoulder belts in school buses in the course of the NHTSA research program. This includes assessing engineering issues associated with installing lap/shoulder belts in school buses, given the Federal requirements for "compartmentalization," and whether some of the Federal requirements would have to be eliminated or modified. It also includes an understanding of the potential injury risks to small children from lap/shoulder belts. As discussed earlier, the medical community regularly conducts epidemiological studies of motor vehicle crashes involving children, and such studies may provide important insight into the relative safety of various forms of passenger crash protection in school buses.

The development of a better understanding of the types and causes of injuries occurring to passengers in school buses can not be overstated. This information can only be gathered from medical records, either from the hospital or physician that treated the injured child. Without medical information on the type and severity of injury being suffered by school bus passengers in various types of crashes, it is not possible to properly evaluate the relative benefits of different forms of passenger crash protection in terms of preventing or inflicting injuries to children in school buses. Without data on how and when lap belts, or lap/shoulder belts, or "compartmentalization" either reduce the risk of injury or cause an increased risk of injury to children on school buses, it is inappropriate to suggest changes to current requirements for the crash protection of school bus passengers.

Since it is unrealistic to expect all school bus passengers would wear the lap/shoulder belts, and wear them correctly, it is important to identify potential safety issues to the unrestrained school bus passengers, who may not have the benefits of "compartmentalization" if lap/shoulder belts were installed at all designated seating positions. The State Directors Association does not believe the safety of those children, who either can not or do not want to utilize an available lap/shoulder belt, should be compromised.

Upgraded Compartmentalization

Unlike lap/shoulder belt systems which require school bus passengers to buckle up, "compartmentalization" is a passive passenger protection system. It may be possible to make school buses even safer through improvements in energy-absorbing materials and the use of energy absorbing construction at seating locations.

The Summary and Conclusions section appears at the beginning of this paper.

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