SCHOOL BUS

SAFETY BELT STUDY

FINAL REPORT

Submitted to the

NEW JERSEY

DEPARTMENT OF LAW AND PUBLIC SAFETY

Office of Highway Traffic Safety

December 1989

NEW JERSEY INSTITUTE OF TECHNOLOGY

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By the

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Research Team:

Athanassios K. Bladikas
Muhammad Shahid Iqbal
Md. Firoz Kabir
Suebsak Nanthavanij

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EXECUTIVE SUMMARY

Introduction

Safety belts have been standard equipment in passenger automobiles for quite some time, and they have proven to be effective life-saving and injury-preventing devices. However, not all school buses are required to be equipped with seat belts. The debate on whether or not safety belts should be required on school buses is rather lively, and both sides make strong arguments in support of their points of view. Because of the convincing arguments made on both sides, the State Legislature decided to investigate the issue further, and directed the Office of Highway Traffic Safety in the Department of Law and Public Safety to conduct or cause to be conducted a study on the safety of the use of lap seat belts in all Type I and Type II school vehicles. The New Jersey Institute of Technology Center for Transportation Studies and Research, which as part of its mission is dedicated to service the research needs of state and local government, conducted this study for the Office of Highway Traffic Safety.

The U.S. Department of Transportation specifies safety standards for school buses. Thirty of the fifty Federal Motor Vehicle Safety Standards (FMVSS) apply to buses, including school buses. FMVSS 222 - School Bus Seating and Crash Protection, establishes occupant protection requirements for school bus passenger seats and restraining barriers. Its purpose is to reduce occupant fatalities and injury severity from school bus occupant impacts against structures within the vehicle during crashes and sudden driving maneuvers. The standard applies to all school buses and provides passenger protection through the "compartmentalization" of the vehicle. This standard also specifies the required deflection criteria, head and knee impact requirements, and establishes criteria for cushioning sufficiently the head and leg impact zones. The seat back height is required to be 20 inches above the Seating Reference Point (SRP). The maximum spacing between the rear surface of the front seat and the SRP of the immediate back seat is specified to be 24 inches.

The National Highway Traffic Safety Administration (NHTSA) has declared school buses to be "the safest form of surface transportation". This statement is correct and can be substantiated by the national fatality and fatality rate figures. School buses, having a fatality rate of only 0.5 per million vehicle miles traveled, are about four times as safe as passenger cars that have an overall rate of 1.9 fatalities per million vehicle miles, and are almost 100 times safer than motorcycles. If a similar comparison were to be made for the State of New Jersey, one would have to say that school buses are infinitely more safe than automobiles, since there has been no fatality of a school bus passenger over the last decade in this State. Obviously, the safety record of school buses is unquestionably very strong. However, this should not imply that safety improvements are not possible, since accidents involving school buses do happen, and children continue to get killed and injured, although in relatively small numbers.

The time and funds allocated to this study did not permit the conduct of original and capital intensive research such as crash testing, or lengthy comparative accident studies. By necessity, secondary sources were primarily used. Final recommendations are made on the basis of investigations that covered four main bodies of knowledge or information sources. These sources were bus and sled crash tests that were conducted for U.S. safety agencies and manufacturers and the Canadian Government, systematic school bus accident investigations and available statistics on school bus accidents, operating experiences of school districts that have their buses equipped with seat belts, and finally, professional and interest group views that were found in the literature or were solicited by the study team.

Review of Bus and Sled Crash Tests

Evidence on the desirability of using seat belts on school buses that can be derived from the actual crash testing of vehicles is rather limited. Bus crash testing started with two series of tests that were conducted at the University of California at Los Angeles (UCLA) in 1967 and 1972. Transport Canada conducted bus crash tests in 1984, and the latest testing was done in 1985 in this country, and it actually involved one Thomas Built school bus. The only known sled crash test was conducted by NHTSA in 1976.

The first series of crash tests at UCLA recommended the use of seat belts in combination with padded high-back safety seats. The second series of crash tests concluded that belted passengers were subjected to higher head impact forces than their unbelted counterparts, but no serious injuries were predicted for the belted passengers. Both series of tests confirmed that seat belts would provide additional protection to passengers in side impact and rollover accidents.

The Transport Canada crash tests and the NHTSA sled tests reported higher Head Injury Criterion (HIC) values (a measure of how the head decelerates during impact) for belted passengers. But, the results of those two tests are not consistent in terms of their prediction of potential injuries because of the presence of seat belts. Whereas the HIC values of the NHTSA sled tests did not even reach half the maximum acceptable limit of 1,000, the HIC values measured by the Transport Canada crash tests exceeded 2,000 for Type II buses, but were still well below 1,000 for Type I buses. This should not be surprizing, since the Canadian buses were crashed at roughly double the speed of the NHTSA sleds. There has been a considerable amount of criticism of the high speeds, as well as the instrumentation and test dummies used in the Transport Canada tests. Researchers also argued that a maximum acceptable HIC value of much higher than 1,000 might be applicable for children. Experts' reviews of the Canadian tests noted that the results should be viewed with caution.

The side impact crash test conducted by Thomas Built Buses Inc. was criticized for the inappropriate positioning of belted and unbelted passengers. Thus, the validity of this crash test is also questionable.

On the basis of the conclusions and reviews of the bus and sled crash test results, the authors of this report have determined that seat belts may not be beneficial in frontal impacts, but in side impacts and rollover accidents they would provide significant additional protection to school bus passengers. Therefore, the decision to require the installation of seat belts on all school buses should consider both the increase of injury potential in frontal impacts and the reduction of injuries in side impact and rollover accidents.

Review of Accident Investigations

Fortunately, the number of school bus accidents, and particularly accidents involving fatalities and serious injuries are very small. While this is a comforting fact, it poses a serious problem when one wishes to perform comparative studies in order to evaluate the effectiveness of a safety device. The next best alternative to a statistical analysis, is to investigate the accidents that did happen, and on the basis of expert judgement, determine what impact the presence of seat belts would have had on fatalities or injuries. Only accident investigations which covered a significant sample of accidents are considered in this chapter. The research team heard and saw in print a number of individual accident accounts that took place in the past within the state of New Jersey. They ranged from the Pemberton bus driver who thanked God for the absence of seat belts on the bus she was driving when it caught fire, to the Newark Police Chief who also thanked God but for the presence of seat belts on a bus that overturned after being struck on its side by a police car. However, these accounts are anecdotal, and since they do not represent a systematic and unbiased investigative effort, they were not used in the decision making process.

A National Transportation Safety Board (NTSB) investigation of 43 accidents involving large school buses determined that seat belts could have provided additional protection to passengers that suffered serious and above level injuries. There were 15 passengers who were partially or fully ejected from the buses. Only 4 of them sustained minor to moderate injuries and 11 suffered serious to critical injuries. These injury outcomes are an indication of the extreme severity associated with ejection, and ejection is certainly an event which can be prevented by seat belts. Overall, due to the severity of the accidents included in the Safety Board's investigation, the findings only pertain to what might happen to belted passengers during the worst possible school bus accident cases. But, even for these cases, the results are not against seat belts. Belts would have been neutral for fatalities, severe injuries and minor injuries, would have reduced serious injuries, and increased moderate injuries. The trade-off is between the reduction of serious injuries and the increase of moderate injuries and it should be considered as being overall beneficial.

A very large sample of accidents was investigated by the Texas Transportation Institute. This study concluded that 10 out of 19 fatalities could have been prevented by seat belts. Although this number excludes 6 fatalities that were contested by critics, it still implies an approximate effectiveness rate of 50 percent. An assessment of seat belt effectiveness for injuries could not be made by the Texas accident investigations due to lack of sufficient data. However, the determination of fatality and incapacitating injury frequency by accident type is of particular importance. About 63 percent of the incapacitating injuries are caused by side impacts and rollover accidents, 28 percent are the result of front impact accidents, and rear impacts cause an insignificantly small number of injuries. Since these proportions are based on a very large sample of data, they can provide insights that can be used to determine the effectiveness of seat belts.

School Bus Accident Statistics

According to a Transportation Research Board (TRB) study, school bus transportation is responsible annually for the deaths of 10 school bus passengers and 38 student pedestrians. In addition, 19,000 school bus related injuries occur annually, of which 50 percent (9,500) involve school bus passengers, 5 percent (950) pedestrians, 10 percent (1,900) school bus drivers, and 35 percent (6,650) other motorists. The vast majority of the 950 pedestrian injuries, (808 or 85 percent) are students. Overall, the severity of injuries sustained by the 9,500 injured school bus passengers is relatively moderate. Only 5 percent (475) of the students sustain incapacitating injuries, nonincapacitating injuries are 25 percent (2,375) of the total, and possible injuries are the overwhelming majority (70 percent or 6,650). The injuries sustained by the 808 student pedestrians are typically more severe than the injuries sustained by school bus passengers. The proportions and numbers of incapacitating, nonincapacitating, and possible injuries for student pedestrians are 20 percent (162), 30 percent (242), and 50 percent (404) respectively. Not only is the frequency of incapacitating injuries for pedestrians four times as great as it is for passengers (20 versus 5 percent), but as the TRB study noted "the incapacitating injurers sustained by pedestrians appear to be more severe than the incapacitating injuries sustained by school bus passengers". An additional fact very worth noting is that 35 percent (283) of all students injured as pedestrians are struck by their own school buses.

New Jersey was in 1987 the fifth safest state (after North Dakota, Wyoming, Kansas and Nebraska) in terms of accidents per million vehicle-miles with a rate of 4.3, while the national average rate was 10.0. In terms of pupil injuries per million vehicle-miles, New Jersey was below the national average (1.4 versus 1.9), but 17 states had lower rates. In terms of pupil injuries per 1,000 transported pupils, New Jersey had a rate of 0.3 which is identical with the national average.

In the state of New Jersey 13,234 school buses (8,306 Type I and 4,928 Type II) travel 124.4 million vehicle miles in a typical year, transporting 626,701 students daily for school sponsored activities. The New Jersey Department of Transportation and the New Jersey Department of Eduction are two sources of school bus accident data for this State. The overall numbers involving injury accidents reported by both Departments are comparable. However, property damage only accidents are grossly under-reported to the Department of Education (106 versus 826 in the DOT reports). Approximately 60 percent of the State's school bus fleet is operated by contractors (7,946 out of the 13,234 vehicles). However, according to DOE reports, district operated vehicles were involved in 256 accidents and contractor operated vehicles in only 98 accidents. The implication of this is that contractors generate 27.7 percent of the accidents, while they operate 60 percent of the vehicles. Unless contractors are able to operate their vehicles quite a few times more safely than school districts, this discrepancy is unjustifiable. Obviously, contractors tend not to report to the Department of Education many of their property damage accidents.

Since there has not been a school bus student passenger fatality in this State for quite some time, no average annual passenger fatalities can be estimated from New Jersey accident data. However, if the State was equally unlucky as the rest of the nation, and had the same average fatality rate per million vehicle-miles, then there should be approximately 0.33 school bus passenger fatalities and 1.25 student pedestrian fatalities per year. These numbers are demonstrative of the "tricks" that the laws of rare events and statistics can play. In the 1986-87 school year there were 2 student pedestrian fatalities in New Jersey (a boy on a bicycle was also killed), and the State more than satisfied its ghastly quota of the pedestrian fatality rate. However, 1 student passenger should be killed in New Jersey every 3 years (0.33 per year), but none has been killed in the last decade. This simply means that we have been lucky in this State lately. No one can predict for how long this streak of luck can continue. Twenty more years may pass without a single school bus passenger fatality, and then a horrible accident may occur that will kill 12 students inside a bus and bring us in line with the national average.

When the total sample of rare incidents is small, one may develop a false sense of security by not observing a class of those incidents at all, and the New Jersey school bus passenger fatality rate just mentioned is a good example. When the sample is small, one may also falsely determine the relative distribution or proportions of incidents. In the case of accidents for example, if the sample is small, the relative importance of an injury class or a collision mode may be overestimated or underestimated. To avoid problems of this type, and to obtain classifications that conform to national practice, New Jersey accident data were used to simply obtain overall figures. National factors were then used to determine future State expectations of accidents by category. Using New Jersey Department of Transportation Data for 1983 to 1986, it was determined that in an average year 1,022 school bus related accidents occur in the state causing injuries to 720 persons. These 720 injuries, if distributed according to the national averages, will consist of 360 (50 percent) school bus passengers, 36 (5 percent) pedestrians, 72 (10 percent) school bus drivers, and 252 (35 percent) others (motorists, bicyclists, etc.). Of the 36 pedestrians injured, 30 (85%) should be student pedestrians. Therefore, the total number of pupil injuries should be 390, of which 360 will be injured as school bus passengers and 30 as pedestrians. The focus of this study is school bus passenger injuries, and using national factors to allocate them among the three basis injury types, it was determined that 18 incapacitating, 90 nonincapacitating and 252 possible injuries should be expected to occur during an average year in the State of New Jersey.

Review of Injury Outcomes and Frequency of Injuries

On the basis of the available reports on injury criteria, passengers' physical injury locations and bus interior contact points, it can be determined that approximately 50 to 70 percent of all school bus passenger fatalities occur during frontal impact and rollover accidents. The rollover accidents (involving both collision and non collision) are of particular importance, since they are causing approximately 40 to 50 percent of all fatalities. Passenger ejection is mostly a phenomenon associated with rollovers, and it is generally accompanied by a high probability of passenger fatality or severe injury, and as such, it has to be emphasized.

The New York State accident data suggest that 70 percent of all incapacitating and non incapacitating injuries occur on the head, face, eyes and legs. More than 40 percent of the pupils that suffer incapacitating injuries die, 25 percent sustain concussions, and another 25 percent suffer fractured or dislocated bones. The NTSB analysis of rather severe accidents identified that side walls, window frames, crushed roofs, and stanchions (modesty panels) as the major contact points in the bus interior causing more than 75 percent of all serious to critical injuries.

The Texas accident investigations indicate that side impacts cause injuries most frequently, followed by frontal impacts and rollovers. The frequency of injuries caused by rear impacts is very low. The general applicability of this distribution is reasonable, if one also considers the evidence on the distribution of injured body parts and injury-causing contact points in the interior of the bus. Rollover injuries can be caused by both collision and non-collision accidents. Even a small number of rollover accidents may cause a substantial number of injuries, because of the high severity associated with this type of accidents. On the basis of the Texas study, which is the most comprehensive, and the remaining literature that has been already discussed, the authors of this report determined that the distribution presented in Table A can be used as a reasonable approximation of incapacitating and nonincapacitating injuries by accident type that can be expected to be occurring in the future. The distribution of possible injuries by accident type was not considered, because these injuries are very minor (about 80 percent as just complaint of pain) and insignificant.

Accident Type	Percent of School Bus Passenger Injuries		
	Incapacitating	Non-incapacitating	Possible
Front End	29	35	No infere-nce on % figures is made
Side Impact	38	30	
Rollover	26	20	
Rear End	2	10	
Unknown (presumably non collision)	5	5	
Total	100	100	

Table A: Anticipated Future Distribution of School Bus Passenger Injuries by Accident Mode.

Review of Operating Experiences

There are three known surveys that investigated the operating experiences of districts, which in the absence of federal requirements, decided to equip their Type I school buses with seat belts. The major objective of these studies was to collect factual information (e.g., use rates), and substantiate arguments about a variety of issues associated with school bus seat belts that do not have a direct impact on the device's safety effectiveness (e.g., carryover effect). Two of the studies - performed by NHTSA and TRB - were national in scope, while the third collected data in the State of New York for two consecutive years, subsequent to that state's requirement that Type I school buses should be equipped with lap belts.

The use rate is the most important factor of a seat belt implementation program. The available literature and the information obtained by the authors of this report from New Jersey school districts indicates that a satisfactory use rate can be achieved, provided that the use is mandated and the program is implemented properly. The NHTSA study observed 80 to 100 percent use rates among elementary school children and 50 percent or less among high school students. TRB concluded that a 50 percent overall use rate can be expected, and a higher rate might be achieved with a rigorous enforcement policy. The authors of this report consider that with proper enforcement an overall use rate of 50 to 75 percent can be achieved within the first 5 years of implementation, and a rate of 75 percent and above can be maintained on and after the 10th year of implementation.

The operating experience demonstrates conclusively that seat belts improve student discipline in the bus, drivers are distracted less, and as a result accidents may be reduced by 1.5 to 5 percent. Overall injuries could be reduced by a similar proportion. Although this is an item that merits consideration, it is not included in the determination of seat belt effectiveness, because of the conservative nature of the estimates.

Because of the limited operating experience that we have to date with seat belts, there is no clear evidence in the literature to support any clear carryover effect. However, habit formation does develop over a longer period of time. If a carryover effect really exists, it is sufficient by itself to justify the installation of seat belts on school buses. However, because no conclusive evidence was found in the reviewed literature, it was not considered in the derivation of seat belt effectiveness.

There is evidence from the operating experience of belt-equipped school buses in New York State that seat belts may cause as many minor injuries as other collision or non accident causes. However, if seat belts are proven to be effective in reducing fatalities and incapacitating or non-incapacitating injuries, any minor injuries that may be caused by belts due to their misuse are of minor importance, and insufficient to invalidate the seat belts' overall effectiveness. Furthermore, the minor injuries contributed by seat belts can be reduced by effective administrative policies, which are essential in order to achieve any benefit from a school bus seat belt program. The New York State survey also reported vandalism and multiple problems such as broken buckles, cut belts etc., whereas such problems have not been reported as a major factor in the districts studied by NHTSA. Therefore, these problems may be reduced substantially with a better disciplinary policy.

It is apparent from the studies that were summarized above, that school districts that have mandated and are enforcing the use of seat belts have better experiences with their seat belt programs. On the other hand, where seat belt use is optional or enforcement is not strict, the success of the program has been offset by low use rates, misuse of the belts, and other problems. The fact that the majority of school districts (including those of New York State) reported a usage rate of less than 25 percent, is not enough to dismiss as generally impossible to achieve the experience from some school districts like

West Orange, NJ and Skokie, IL that report 95 to 100 percent use rates. Rigorous enforcement policies, educational programs, administrative support, driver co-operation, transportation directors' support, and parental safety awareness are all necessary to reap the benefits from the installation of seat belts on school buses.

Professional and Interest Group Opinions and Associated Issues

Some districts are concerned with the liability issues that the installation of seat belts in school buses may create. Although there has not been a single court case involving liability associated with seat belts in a belt-equipped bus, a number of law suits have arisen out of the non-existence of belts in buses, with the settlements being generally in favor of the plaintiffs. The following two quotations are indicative of legal opinions on the subject:

> "... a school board's failure to install seat belts may give rise to substantial liability, and actually installing seat belts and adopting a program to insure their use would go a long way toward avoiding not only injuries but liability. A school district would not have to guarantee that every seat belt is used, only adopt a reasonable program to encourage their use."

> "....if the court allows the jury to decide the amount of care that should be taken, a case could just as well he based on the question of whether seat belts should have been installed when they were not, as on the failure to insist on proper use if they were installed.... it would not be in the district's best interest for the jury to perceive that safety equipment was omitted because the school district felt that the policy would lessen liability or costs." (NCSBSB, Third Edition, 1986).

Obviously, liability should not be a major consideration in deciding whether or not to have seat belts in school buses.

Expert medical opinions can be found that are in favor of and against seat belts as a restraining device. Although most of the experts acknowledge the safety benefits of seat belts for adults in motor vehicles, some are concerned that the same may not be true for young children. The National Coalition for Seat Belts on School Buses summarized in its 1986 report the resolutions or statements of the following medical associations that are supportive of seat belts on school buses:

The American Medical Association
The American Academy of Pediatrics
The American College of Preventive Medicine
The Society for Adolescent Medicine
The American Association of Oral and Maxillofacial Surgery

The California Highway Patrol sponsored study sought the opinions of school bus manufacturers. They felt that in frontal impacts lap belts would not be beneficial. In rollover accidents lap belts would help reduce injuries by protecting the passengers from being struck from the side and roof of the bus. In rear impacts lap belts would not be beneficial and in some instances the belt could increase the accident severity. The responses were mixed for side impacts to assess an overall opinion. Some felt that belts would not make any difference as far as head and neck injuries are concerned. Some also pointed out that the refitting of belts is undesirable because the floor strength of an old bus would not be sufficient to withstand the belt load, and that several new FMVSS chapters would be needed if lap belts are installed. The current seat frames would require additional strengthening, which in turn would require additional seat back padding to conform with the standards. The increased rigidity of the seat may counter the deflection criteria of the seats required by the current standard. One manufacturer pointed out that if belted students ride with unbelted students, a double loading could result when an unbelted student hits the rear of the seat in front that contains a belted student. Such an impact could cause seat anchor failure and produce more severe injuries.

The opinions of school district transportation coordinators throughout the state were solicited through a mail-back questionnaire. The overall response rate was 34 percent. The majority of school districts (75 percent) do not favor legislation that will mandate the installation of seat belts on Type I school buses, 11 percent favor such legislation and 14 percent are undecided or did not express any opinion. Responding on why their Type I buses are not equipped with seat belts, four major reasons came up with a response rate greater than 50 percent (multiple responses were allowed):

1. Belts are not required by law (80%),
2. Belts may cause more injuries than they will prevent (63%),
3. Belts may be used as weapons (60%), and
4. Belts may not improve safety (53%).

Forty percent of the responding districts expressed concern about liability. The cost of the belts does not appear to be much of a concern.

No matter how beneficial a measure may be, before it becomes a requirement that everyone should abide by, its cost should also be considered, since we live in a world of limited resources. The cost of equipping all New Jersey school buses with seat belts is estimated to be about $1.084 million annually.

Adult monitors on school buses can be of substantial help in improving school bus passenger and student pedestrian safety. They can assist children at loading and off-loading zones to cross the street (when necessary). A considerable number of student pedestrian fatalities and injuries can be prevented if adult monitors are present. They can maintain discipline by ensuring that the children are seated and do not stand on the seats, roam the aisles, keep their head or hand outside the windows, fall out of the door, or fight. Monitors, if not injured themselves, can expedite the evacuation process, and if buses are equipped with belts, they can ensure that belts are worn and buckled up properly. There is no doubt that monitors can substantially improve school bus safety. The only argument against having monitors is their high cost. If monitors were to be used in all school buses in New Jersey, the cost would be $64.3 million per year. Although monitors can help implement a seat belt program, they are not required for its success.

Review of Alternative Restraint Systems

There is sufficient evidence (UCLA tests) to demonstrate that armrests, lap bars, and air bags either do not have the potential of improving school bus passenger safety, or require further development in order to be cost effective. Multipoint restraint systems are not a solution either, because of the submarining effect they cause, and the inherent operational difficulties associated with their cumbersome use. Contoured padded seats and less aggressive deformable seats do not offer a better alternative to the unaltered (presently in use) seat, as the Transport Canada sled tests proved. The lap-shoulder belt, although dismissed by the UCLA tests, it performed reasonably well in the Canadian sled tests by producing more acceptable HIC values in the Transport Canada sled tests. However, the chest acceleration rate values did not fall below the acceptable threshold level. Moreover, this restraint system has been judged to cause more injuries to unrestrained passengers, because of the stiffer seats that the system requires.

On the basis of the Canadian experience, it appears that rearward facing seats on school buses can contribute to further safety improvements. The Transport Canada sled test results established that rearward facing seats generate HIC and chest acceleration values that are not only well below the threshold limits, but also well below the values generated by any other forward facing seat, with or without seat belts. The operating experience of three school buses with rearward facing seats in Canada did not suggest any significant problems regarding the adaptability and acceptability of this seating system. However, further research is necessary, if rearward facing seats, with or without belts, are to become standard school bus equipment. With the present state of knowledge, rearward facing seats should not be considered as a feasible alternative to the forward facing seating system. Further experimentation with rearward facing seats is certainly worthwhile and it should be encouraged.

Seat Belt Effectiveness

The lack of sufficient data, makes the accurate estimation of a school bus seat belt effectiveness very difficult. However, to derive a quantitative measure of any possible benefit or harm that the installation of seat belts in school buses may generate, such an estimate is necessary. The Transportation Research Board committee that investigated the subject, assumed an overall seat belt effectiveness that ranged between zero and 20%, without providing any justification for this choice. Using this effectiveness range, and further assuming a 50% usage rate, TRB estimated that seat belts will save each year nationally up to 1 fatality, up to 48 incapacitating injuries, up to 238 non-incapacitating injuries and up to 665 possible injuries. Given these statistics, and a $43 million total cost of equipping all Type I school buses with seat belts, the TRB committee concluded that seat belts on school buses would not be cost-effective.

Instead of estimating an overall effectiveness range, seat belt effectiveness is considered to be variable in this study, and depending on the impact modes that a school bus may experience in an accident, as well as the severity level that the school bus occupants may sustain. A major advantage of a variable rate of effectiveness is that the obtained estimates are much more accurate. Furthermore, seat belts may improve safety under a given set of circumstances, but they may reduce it, if those circumstances are altered. Variable rates of effectiveness have an additional major advantage, since they are capable of incorporating into the analysis these trade-offs. The accident statistics that are available from previous studies were used to estimate the overall effectiveness of seat belts for each accident category as follows:

Seat belts do not appear to be effective in frontal impacts. Furthermore, the effectiveness of the device may be negative in a number of accidents of this type.

Seat belts can provide substantial additional protection, and they will be highly effective in side impact accidents.

Seat belts can provide substantial additional protection, and they will be highly effective in rollover accidents.

Seat belts will not provide meaningful additional protection in rear impact accidents, but they will not increase the injury potential either. Their effectiveness is, therefore, neutral for this type of accidents.

On the basis of the review of all available research on the subjects of seat belt behavior and accident causes on school buses, seat belt effectiveness factors were developed for fatalities and injury accidents by type.

The effectiveness of seat belts in preventing fatalities was determined rather conservatively to be in the range of 25 to 35 percent.

The effectiveness of seat belts in preventing injuries varies according to accident and collision type, and it was determined to be as indicated in Table B.

Accident Type	Injury Type		
	Incapacitating	Non-incapacitating	Possible
Front End (with no rollover)	-20 to 5	-10 to 10	*
Side (with no rollover)	40 to 70	40 to 70	*
Rollover	40 to 70	40 to 70	*
Rear End (with no rollover)	-5 to 5	0 to 20	*
Others (non-collision, non-rollover)	40 to 70	40 to 70	*

* No inference on effectiveness is made

Table B: Seat Belt Effectiveness by Accident and Injury Type.

The derivation of the quantitative impact that seat belt installation in all school buses will have in the State of New Jersey was performed by a six step process using facts obtained from the literature and this study team's own determination of parameters. Ranges are provided for most parameters, so that a sensitivity analysis can be performed.

Fatalities That Can be Prevented by Seat Belts

Table C determines the number of school bus passenger fatalities that may be prevented by seat belts during an average year in the State of New Jersey. If the mid-range of the estimate is used, and a 75 percent seat belt use rate is assumed, 0.074 fatalities per year will be saved. This is equivalent to saving one life every 13 years. Under the most pessimistic assumption (lowest end of effectiveness and a 50 percent use rate) 0.049 fatalities per year will be saved, or one life every 20 years. Ideally (highest effectiveness and 100 percent use rate), 0.099 lives per year will be saved, or equivalently one life every 10 years.

Total no. of fatalities	Belt usage	Belt effectiveness	No. of fatalities that may be prevented or reduced by seat belts.	
			Total	Mid range
0.33	50%	25-35%	0.041-0.058	0.049
0.33	75%	25-35%	0.062-0.086	0.074
0.33	100%	25-35%	0.082-0.099	0.099

Table C: Future Fatalities to Be Prevented by Seat Belts in New Jersey

Injuries That Can be Prevented by Seat Belts

Table D determines the number of school bus passenger injuries that may be prevented or reduced by seat belts in an average year in the State of New Jersey. Using the mid range of the estimates and a 75 percent use rate, about 5 incapacitating and 21 non-incapacitating injuries should be prevented annually. Under ideal conditions 9 incapacitating and 40 non-incapacitating injuries should be prevented. Under the worst case scenario, the incapacitating and non-incapacitating injuries prevented will be approximately 2 and 8 respectively. The effectiveness of seat belts is not determined in this study for the 250 possible (C level) injuries that take place during an average year in the state. Overall, there should not be any significant difference in the number of possible injuries with or without belts. However, by the 10th year of implementation when the seat belt program is fully operational, and provided that use is rigorously enforced, even a considerable number of possible injuries may also be prevented.

In summary, if seat belts are installed in all school buses operating in this State, fatalities and injuries will be reduced. The overall number will be small, but approximately 22 percent of the fatalities, 27 percent of the incapacitating injuries and 23 percent of the nonincapacitating injuries will be prevented. These reduction rates will materialize provided that the seat belt use rate is about 75 percent, and this is a very realistic assumption under an appropriate attitudinal and enforcement climate.

Belt usage	No. of injuries that may be prevented or reduced by seat belts				
	Incapacitating		Non-incapacitating		Possible
	Total	Mid range	Total	Mid range	
50%	1.95-4.49	3.22	8.32-19.80	14.06	No
75%	2.93-6.73	4.83	12.48-29.70	21.09	estimate
100%	3.91-8.97	6.44	16.65-39.60	28.12	is made

Table D: Future Injuries to Be Prevented by Seat Belts in New Jersey

Conclusions and Recommendations

School buses are without any doubt the safest mode of transportation. Furthermore, a greater proportion of school bus pupil fatalities occurs outside rather than inside the vehicle. However accidents do happen and pupils continue to get injured or killed in the interior of the bus. Requiring the installation of seats belts in all school buses will improve the vehicle's overall safety performance, as it was calculated in detail in the previous chapter. The benefits from the installation of seat belts will not be very significant, because the fatality and injury base that seat belts can affect is very small. In addition, the estimation of factors that were used in the derivation of seat belt effectiveness was rather conservative. An argument can even be made that justifies seat belts in terms of their cost effectiveness. Seat belts will cost the taxpayers of this State about $1 million per year. In return, approximately 0.074 fatalities, 5 incapacitating injuries, and 21 nonincapacitating injuries will be prevented per year. Without placing a dollar value on the life of a child, or the cost of medical care until recovery (or for life in some instances), and given the conservative nature of the estimates, the money appears to be well spent. It has been estimated that many environmental and occupational safety and health regulations cost between $7 million and $132 million per life saved. Seat belts on school buses will be at or below the lower end of this range.

Since seat belts were found to be effective, it is recommended that both Type I and Type II school buses should be required to be equipped with seat belts in the State of New Jersey.

It is obvious that seat belts can be effective only when they are used. Therefore, it is further recommended that seat belt use for all occupants (students, monitors, drivers, teachers, parents) is also mandated in all buses that are equipped with seat belts. Simply installing seat belts without mandating their use will be a waste or resources. Furthermore, problems with double loading of seats may arise.

Because of technical problems, the retrofitting of existing school buses with seat belts is undesirable. Seat belts should be introduced into the State's school bus fleet gradually as the fleet is renewed. It is recommended that seat belts should be required on Type I school buses purchased after the effective date of the Bill that will establish that requirement. The requirement of seat belt use on Type II vehicles and the seat-belt equipped vehicles already in service should be effective immediately. The seat belts required should be of the lap belt type.

Seat belts are safety devices and their use should be treated with the seriousness they deserve. Their use should be strictly enforced, just like the use of protective equipment in sports events that students participate. Parents, principals, teachers, transportation coordinators, mechanics, and drivers have to cooperate if seat belts are to be effective.

The installation and use of seat belts, will obviously not eliminate fatalities and injuries completely, although a small step will be taken in the right direction. The progress of research on rearward facing seats should be followed closely. The concept has the potential of improving further the safety of school buses, and when conclusive results are available supporting its use, New Jersey should adopt it also. New Jersey has provided in the past a leadership role in highway safety (e.g., the Jersey barrier). It can do the same again by conducting evaluation experiments with buses equipped with rearward facing seats, similar to those conducted in Canada. The cost will be relatively small, but the potential benefits could be very substantial. They may provide the next substantial step towards improving school bus safety, and generate benefits similar to those achieved by the 1977 standards.

The fatalities and injuries occurring outside the bus are tragic and unjustifiable, and measures should be taken to reduce them. Monitors will be effective, but they are very costly. Mechanical gates, electronic sensors, video monitors, STOP arms, and better driver training are all alternatives for monitors but much less effective. This problem deserves more attention and study than seat belts. When the seat belt issue is settled, both proponents and opponents of seat belts should concentrate their efforts in improving safety on the outside of school buses. The authors of this report found that all groups are genuinely interested and concerned with school bus safety, no matter what their stand on seat belts was. When these groups of energetic individuals join their forces, the only possible outcome can be better protection for our children which are our society's most precious resource.

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CHAPTER 1

INTRODUCTION

BACKGROUND

Safety belts have been standard equipment in passenger automobiles for quite some time. The capability of safety belts to completely eliminate or at least reduce the severity of injuries to humans when accidents occur, has been recognized to the point where their use has become mandatory. New Jersey, like other states, started in 1983 with the implementation of a child restraint law requiring all children up to five years old to be restrained with safety belts or secured in child seats when traveling in passenger automobiles. In 1985 this requirement was extended to the general population with the enactment of a mandatory safety belt law that mandated the use of safety belts by all drivers and front seat automobile passengers.

Although safety belts have proven to be effective life-saving and injury-preventing devices, the requirements for their use are inconsistent. Their use is not only not required, but sometimes it is also impossible, since entire classes of vehicles (e.g., trucks and most school buses) are still not equipped with them. The debate on whether or not safety belts should be required on school buses is rather lively, and both sides make strong arguments in support of their points of view.

Proponents of safety belts on school buses note the track record of the device in improving automobile safety, and point at the inconsistency of the current practice. Parents and children alike are wondering why they should buckle up when they are in the family car, while children cannot even do the same even if they want to in their school bus. The proponents' argument is that installing and requiring the use of safety belts in school buses will make the vehicles safer, and more importantly, it will reinforce the habit of buckling up that children acquire as preschoolers when they ride with their parents, and they will continue using their safety belts as adults.

Opponents of the measure express doubts about the capability of safety belts to improve school bus safety. They argue that school buses, because of their size, visibility and careful operation are safer than cars and do not need safety belts. Besides, the argument continues, belts may increase the probability of injury in some accidents and can become a hazard rather than a safety device in accidents involving fire, rollovers or submersion under water. Finally, some are critical of the device's cost effectiveness, arguing that in our world of limited resources, funds spent on safety belts could be put in better use elsewhere.

PURPOSE AND SCOPE

New York State is the only state that currently requires its Type I school buses (Gross Vehicle Weight greater than 10,000 pounds) to be equipped with seat belts, and there are a number of school districts throughout the country that do the same. Seat belt proponents introduced legislation that would have required Type I school buses to be equipped with seat belts in the State of New Jersey. However, because of the convincing arguments made on both sides, the State Legislature decided to investigate the issue further, and commissioned a study with a bill introduced by Senator Rand on February 29, 1988 and approved on November 9, 1988 (see Appendix A for the Bill's full text). For this purpose it has directed the Office of Highway Traffic Safety in the Department of Law and Public Safety to conduct or cause to be conducted a study on the safety of the use of lap seat belts in all Type I and Type II school vehicles.

The New Jersey Institute of Technology Center for Transportation Studies and Research, which as part of its mission is dedicated to service the research needs of state and local government, conducted this study for the Office of Highway Traffic Safety as mandated by the State Legislature.

The scope of this research effort was to gather pertinent information from the results of previously conducted crash tests and statistics on the number and severity of injuries resulting from school bus accidents and assess the effectiveness of seat belts in enhancing the safety of school bus passengers. Such information was collected from the current literature, federal agencies, state and public agencies, and school bus manufacturers. In addition, full consideration was given to all issues and arguments made by both proponents and opponents of safety belts, and an attempt was made to validate or disprove arguments on the basis of empirical or statistical evidence that was gathered during the investigation of current practices in the state or through the review of the literature on the subject.

This report is a detailed account of that study. It presents facts and views, and conclusions and recommendations on seat belt installation in school buses, as well as other issues pertaining to school bus safety.

SCHOOL BUS SAFETY

The National Highway Traffic Safety Administration (NHTSA) has declared school buses to be "the safest form of surface transportation" [1]. This statement is correct and can be very well documented by simply glancing at the national fatality and fatality rate figures of Table 1 which is reproduced from a recent Transportation Research Board study on school bus safety [2]. School buses, having a fatality rate of only 0.5 per million vehicle miles traveled, are about four times as safe as passenger cars that have an overall rate of 1.9 fatalities per million vehicle miles, and are almost 100 times safer than motorcycles. No matter how or where the school bus is compared with other modes of transportation, it is always the safest. A Canadian study concluded that "a student is 8 times more liable to be injured while travelling to or from school in a vehicle other than a school bus" [3], a California study found that "school buses without seat belts are 16.2 times more safe than automobiles" [4], and if a similar comparison were to be made for the State of New Jersey, one would have to say that school buses are infinitely more safe than automobiles, since there has been no fatality of a school bus passenger over the last decade in this State. Obviously, the safety record of school buses is unquestionably very strong. However, this should not imply that safety improvements are not possible, since accidents involving school buses do happen, and children continue to get killed and injured, although in relatively small numbers.

Vehicle Type	Occupant Fatalities[a]	Estimated Vehicle Miles Traveled (Millions)	Occupant Fatalities per Hundred Million Vehicle Miles Traveled
Motorcycles	4,551	9,397[b]	48.4
Passenger Cars	24,922	1,301,214[b]	1.9
School Buses	17[d]	3,808[c]	0.5

a *Fatal Accident Reporting System 1986.* NHTSA, U.S. Department of Transportation.
b *Highway Statistics 1987.* U.S. Department of Transportation.
c School buses operated at public expense traveled 3,301 million vehicle miles in 1986 (*School Bus Fleet*, 38). This number was factored upward on the basis of enrollment to include private school transportation.
d Five-year average based on 1982-1986 data.

Table 1: Occupant Fatalities and Fatality Rates by Vehicle Type.

Since school bus safety is at relatively high levels already, the incremental benefit to be derived from any additional efforts would be by necessity rather small as indicated in Figure 1, where idealized safety levels are plotted against efforts to improve safety. As safety levels are approaching the plateau of the curve, the safety improvement (S_2 - S_1) becomes relatively small when compared with the efforts (EC_2 - EC_1) associated with achieving that improvement. The impact from requiring Type I school buses to be equipped with seat belts will, therefore, be rather small, irrespective of whether it is going to be beneficial or detrimental to overall school bus safety.

CURRENT STATUS OF SCHOOL BUS SAFETY STANDARDS

A number of Federal Motor Vehicle Safety Standards (FMVSS) are currently applicable to school buses. The last time these standards were revised was on April 1, 1977 and cover a wide range of safety aspects as follows:

1. FMVSS 105 - Hydraulic Break Systems
2. FMVSS 111 - Rearview Mirrors
3. FMVSS 217 - Bus Window Retention and Release
4. FMVSS 220 - School Bus Rollover Protection
5. FMVSS 221 - School Bus Body Joint Strength

6. FMVSS 222 - School Bus Passenger Seating and Crash Protection

7. FMVSS 301 - Fuel System Integrity

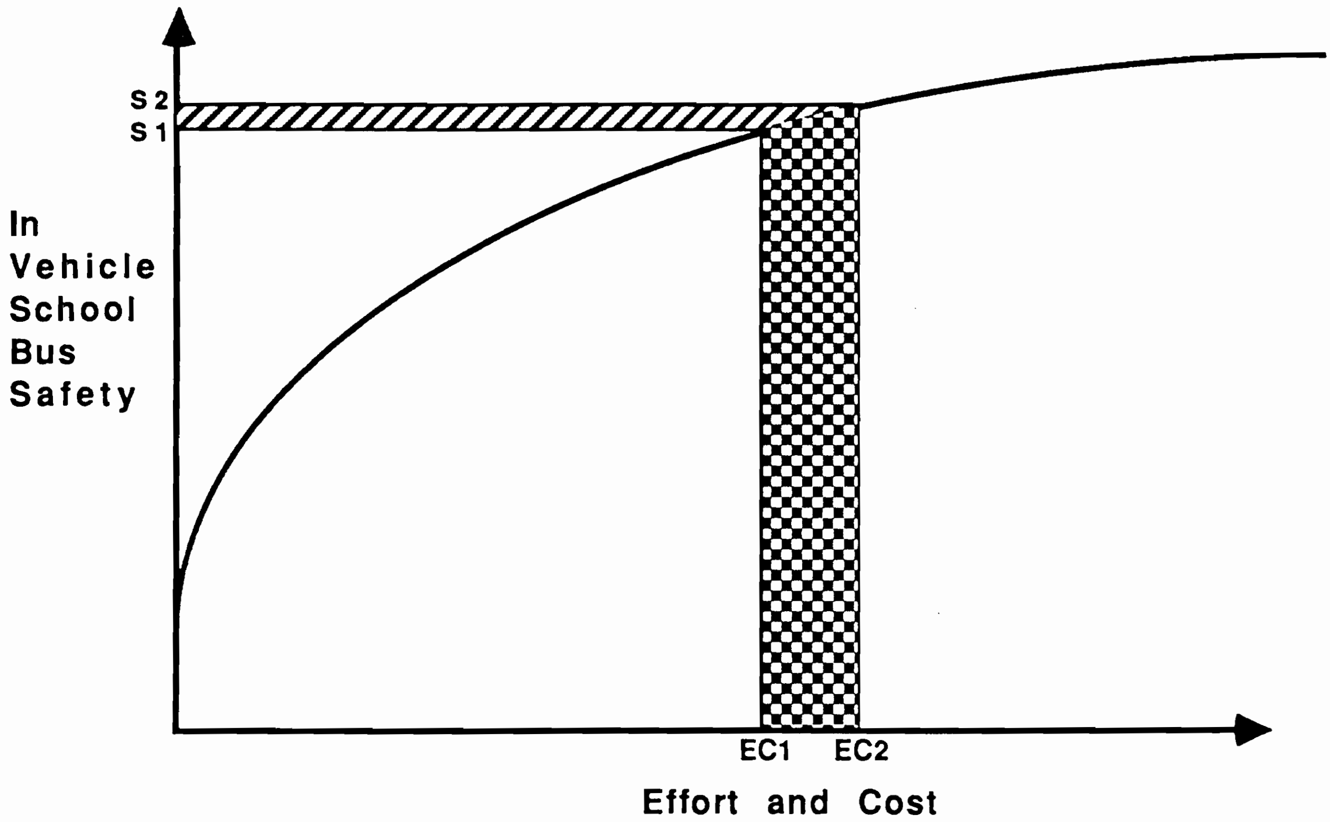

Figure 1: Conceptual Representation of School Bus Safety

Although each of the FMVSS standards covers an important safety aspect, FMVSS 222 is the one that is of particular concern for the purpose of this study, since it specifies standards for seats and occupant restraints. This standard requires that all school buses manufactured after April 1, 1977 have forward facing, padded, and high back seats which should not be spaced too far apart. These requirements are known collectively as "compartmentalization" because they tend to form compartments that can contain the student in the case of an impact in the direction of the bus's movement. Type II school buses are also required to be equipped with lap belts while Type I buses are not.

The above are minimum safety standards, and local governments or school districts may, if they so desire, improve on them. For example, standees are prohibited on school buses in New Jersey, but this is not the case in the State of New York, although New York State requires seat belts on Type I buses. According to New Jersey State requirements, no pre-1977 school buses should be operating in New Jersey after June 1987, and the maximum capacity for a Type I bus in this State is 54 passengers, while elsewhere it could be up to 66 passengers. Individual school districts may also specify additional safety equipment when they order school buses such as stop arms, escape hatches, safety belts, etc.

STUDY APPROACH

The time and funds allocated to this study did not permit the conduct of original and capital intensive research such as crash testing, or lengthy comparative accident studies. By necessity, secondary sources were primarily used. Final recommendations are made on the basis of investigations that covered four main bodies of knowledge or information sources. Bus and sled crash tests that were conducted for U.S. safety agencies and manufacturers and the Canadian Government were the first body of knowledge that provided insights in seat belt effectiveness on school buses and they are discussed in Chapter 2. Systematic school bus accident investigations and available statistics on school bus accidents are presented in Chapters 3 and 4. This information can be useful in determining the accident circumstances under which seat belts may improve or worsen injuries to school bus occupants. Operating experiences of school districts that have their buses equipped with seat belts were the third, and a rather significant source of information, and they are presented in Chapter 5. They are used to confirm or disprove some arguments made by both proponents and opponents of seat belts, and they also serve the purpose of drawing some conclusions on issues that are associated with seat bets, but have no direct bearing on their safety effectiveness such as implementation difficulties, the carry-over effect, cost, liability, etc. Finally, professional and interest group views that were found in the literature or were solicited by the study team were given serious consideration and are presented in Chapter 6. Opinions of physicians, emergency medical services and police personnel, bus manufacturers, contractors, and parents were considered, and a survey of all New Jersey school district transportation coordinators was conducted as well.

Lap-type seat belts are not the only restraining system that can be installed in a school bus, and Chapter 7 is devoted to a discussion of alternative restrains and seating systems. On the basis of the information that the crash tests, accident investigations and accident statistics provided, a determination of the effectiveness of seat belts for the State of New Jersey was made on the basis of a six step process, and the results are presented in Chapter 8. The final Chapter 9 is devoted to recommendations on lap belts, as well as other safety improvements covering in-vehicle as well as general school bus safety.

CHAPTER 2

BUS AND SLED CRASH TESTS

Evidence on the desirability of using seat belts on school buses that can be derived from the actual crash testing of vehicles is rather limited. Over the past twenty years there have been only five tests that replicated a small sub-set of the total possible accidents that can occur in real situations on the road. Four of these tests are discussed in this chapter. The fifth, whose purpose was to evaluate alternative seat and restraining systems is presented in Chapter 7. Bus crash testing started with two series of tests that were conducted at the University of California at Los Angeles (UCLA) in 1967 and 1972. Transport Canada (the Canadian equivalent of our U.S. Department of Transportation) conducted bus crash tests in 1984, and the latest testing was done in 1985 in this country, and it actually involved one Thomas Built school bus. The only known sled crash test was conducted by the National Highway Traffic Safety Administration (NHTSA) in 1976. The purpose of this chapter is to give a brief account of all four tests, including a brief description of the tests, the conclusions drawn by the teams that conducted them, and the criticisms of the testing methods and results that appeared in the literature. Finally, a synthesis of all aspects of this body of knowledge is made in order to draw conclusions on whether or not seat belts should be required on school buses.

UCLA CRASH TESTS

Researchers at UCLA conducted two series of crash tests involving a variety of school bus collision modes. The purpose of the tests was to provide specific and practical recommendations and solutions to agencies responsible for school bus safety. The study had a variety of objectives. It was intended to evaluate a number of school bus seat types as well as passenger restraint systems and answer questions about their proper design, construction and installation.

Series I Tests - 1967

The 1967 collision experiments at UCLA duplicated three types of collisions, a head-on, a rear-end, and a right-angle collision. Although the same type school bus was struck in all three cases, the types of vehicles used to strike the school bus were different, and the passenger restraint types, seat types, and passenger sizes studied were numerous [5].

Experimental Features

For the head-on collision experiment, a 1965 GMC-Superior school bus (weighing 17,500 lbs.) travelling at 30 mph was struck squarely head-on by a 1944 Mack-Superior school bus (weighing 7,500 lbs.) travelling at the same speed. To simulate a rear-end collision, the same type (1965 GMC model) school bus, while stationary, was squarely impacted in the rear by a 1960 plymouth 4-door sedan (weighing 4,400 lbs.) travelling at 60 mph. In the third experiment, a 1966 chevrolet 4-door sedan of 4,500 lbs. travelling at 60 mph struck head-on the side at the rear wheel position of the same type (1965 GMC model) school bus while at a stationary position.

The restraint types tested in the experiment were:

i) no restraint
ii) lap belt only
iii) lap belt and diagonal shoulder strap
iv) air bag
v) restraint bar.

A variety of different seats (11 types) were tested in the experiments. They ranged from the conventional standard seats used in school buses at the time, to other variations such as seats with high backs, seats with hand rails or armrests, inflated air bag seats, united airlines siesta seats, etc. To simulate passenger type variations, anthropometric[1] dummies corresponding to ages of 3-, 6-, 13-year olds, and adult were used in the school bus.

The instrumentation involved a large number of transducers and specialized photographic systems strategically positioned, and other provisions were made for scientific observations. The categories of data recorded included a wide range of interacting factors. The experimental study collected data on the kinematics of passengers, forces sustained by passengers, loadings on restraint systems, relative injury exposure for passengers in different seating arrangements under the same collision circumstances, vehicle collision dynamics, and vehicle structural performance.

Test Findings and Conclusions

The UCLA researchers pointed out that for the head-on collision test, the seat back height ahead of the passenger was the primary consideration because it generally was the object initially contacted by both the unrestrained and partially restrained passengers. For the rear-end collision test, the seat back height was the principal variable governing the occurrence of whiplash injury. Side impact collisions usually force passengers into direct contact with compartment structures or side window glass. Therefore, for the side-impact experiment, the presence or absence of restraint systems and arm rests represented the most important consideration. These observations are certainly in conformity with conventional wisdom. One has also to keep in mind, that these tests were conducted before the current standards on seat back height became effective. The standard school bus seat at the time had a low back with a metal rail along the entire length of the back's top.

On the basis of data collected during the 1967 crash tests, the conclusions drawn by the UCLA team pertaining to lap seat belts on school buses were the following:

---

[1] The word anthropomorphic used later in this chapter is a synonym to anthropometric. Both words mean "resembling the human body". They are both used here because studies that have been reviewed prefer one over the other.

The greatest single contribution to school bus collision safety is a high strength and high-back (28 in.) safety seat. High back seats (28 in. or more) greatly contribute to the compartmentalization of passengers, thereby reducing the chances of injuries sustained by passengers being hurled against one another, regardless of their size. Next in importance is the use of a three point belt, a lap belt or other form of effective restraint. Seat belts are recommended for use with safety seats.

Lap type safety belts would provide substantial additional protection to school bus passengers in high-back seats that have efficient padding on the rear panel of its back rests.

Lap belts should not be used for low seat back units because their use substantially increases the highly adverse forces to the spinal column resulting from whiplash and they virtually assure severe head or neck impacts with low backrests ahead.

In the absence of armrests, the lap belt does provide some hip restraint against sideward movement, thereby reducing forces that a displaced passenger may apply to a companion seated beside him during a side impact collision.

In summary, the first UCLA series of tests concluded that a high seat back (28 in.) is the most important safety feature that can be added to school buses, and seat belts would provide substantial additional safety when used with high-back padded seats. But, seat belts should not be used in combination with low-back seats. However, these recommendations should be carefully analyzed together with the results of the Series II UCLA experiments, which provided additional information.

Series II Tests - 1972

The second series of experiments at UCLA simulated two types of full scale collisions, a head-on and a right-angle, both involving the same type of school bus [6].

Experimental Features

For the head-on collision a 1969 Superior school bus (60 passenger) travelling at 30 mph was struck squarely head-on by a 1962 International 2-ton dump truck which was also travelling at 30 mph. For the second test involving a side impact collision, the same type school bus, while stationary, was impacted at its side by a 1967 Ford 4-door sedan travelling at 60 mph.

The school bus seat types, restraints, passengers simulated by anthropometric dummies, and data collection techniques were similar to those of the Series I experiments.

Test Findings and Conclusions

On the basis of data collected from the Series II crash tests, the major conclusion drawn by the UCLA team pertaining to lap seat belts on school buses was:

Seat belts are not recommended for school buses having conventional seats with hard surface, weakly structured frames, lack of side-force restraint (padded armrests at the aisle) and grossly inadequate backrest height.

In other words, the Series II experiments confirmed the findings of the Series I experiments to the extent that the safety performance of lap belts is unacceptable in conventional school buses (i.e., pre-1977 standard school buses). However, to analyze the overall safety performance of lap belts, the following additional findings of the Series II experiments are of significance:

The average size school child (13-years old) would sustain smaller head impact forces (44 g versus 67 g) if left unbelted than if lap-belted, provided that he was protected by a 28-inch high energy absorbing, UCLA-design seat back.

For side impact exposure, the UCLA padded armrest side restraint appeared to provide passenger protection as effectively as full use of lap belt restraints.

For buses provided with safety seats having a performance profile comparable to the UCLA design, seat belts will contribute significantly to improved safety, especially during severe upset collision exposures, provided that extrication procedures can be perfected to allow the rapid evacuation of a fully loaded, overturned bus, (i.e., removing 40 to 60 children hanging upside down suspended by their seat-belts). However, when safety seats are used, the researchers regarded further restraint measures, such as the installation of safety belts, of minor importance, because of the special protection afforded to school buses by their size and visibility.

The UCLA collision researchers have always advocated strongly the continuous use of lap-type safety belts in passenger vehicles on all occasions. However, they modified their views when school buses are concerned, because school bus seats are designed differently and are positioned close together making the use of lap belts highly inadvisable unless seat structures are designed, installed and spaced in a manner compatible with the use of lap belts.

In summary, the UCLA researches concluded after both Series of tests that taking into consideration the factor of special protection provided to the school bus by its size and visibility, the addition of seat-belts would be of minor importance when safety seats (28-in. high padded seat back) are used. Furthermore, if school buses are equipped with safety seats, the most likely contribution to safety that seat belts will provide during three of the most commonly occurring accidents will be as follows:

Head-on Collisions: Seat belts will not provide a significant safety enhancement. They will rather expose the passengers to a higher head acceleration level (67 g).

Side Impact Collisions: Seat belts, if fully used, will provide equal passenger protection as armrests.

Rollover Upset Collisions: Seat belts will be of substantial assistance, provided that appropriate evacuation procedures exist.

TRANSPORT CANADA CRASH TESTS

Transport Canada conducted crash tests on three school buses in 1984 [3]. The purpose of the Transport Canada testing program was to determine the reaction of the belted and unbelted test-dummies in small and large school buses during frontal barrier collisions. The tests were intended to assess the effect that seat belts would have on school bus passengers, and to determine whether or not school bus standards provide the anticipated level of occupant protection. One has to keep in mind that in the time that elapsed between the UCLA tests and the Transport Canada tests, standards that became effective in the USA adopted the use of the safety seat recommended by the UCLA tests. In addition, Type II buses were also required to be equipped with seat belts.

Experimental Features

Bus types: Three different buses were used for the Transport Canada tests. Two of the buses consisted of a mid-sized 22-passenger Thomas Minotour, and a small 20-passenger Camp Wagon van conversion. The GVWRs[1] of these two buses were 10,000 lbs. or less and they are equivalent to Type II buses. The third bus was a Type I bus, a 66-passenger, 1984 Blue Bird with a GVWR of 25,000 lbs.

Collision type: Each of the buses was subjected to a barrier frontal collision at 48 km/h (approximately 30 mph). The resulted impact forces were comparable to those resulting from a head-on-collision between the school bus and a car travelling at highway speed.

Anthropometric dummies: Each of the buses contained six 5th percentile[2] female dummies representing large elementary school students. In addition two anthropometric dummies representing 6-year olds were used in the Type I bus only.

Seat spacing and instrumentation: There were 11 rows of seats in the bus. The 1st, 6th and 11th rows were used for the test. The seat spacing was 21 inches (maximum seat spacing allowed in Canada) for row 1, 27 inches (a spacing that would counter the compartmentalization concept for passive passenger protection) for row 6, and 24 inches for row 11 (the current standard in the USA). All six 5th percentile

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[1] Actual Gross Vehicle Weight (GVW) is the sum of the chassis weight, plus the body weight, plus the driver's weight, plus the total weight of seated pupils. Actual GVW shall not exceed the chassis manufacturer's Gross Vehicle Weight Rating (GVWR) for the chassis [33].

[2] If the entire population is placed in ascending order in terms of size, a 5th percentile dummy will represent a person of such a size that 5% of the population is smaller than it and 95% bigger.

dummies were instrumented to record forces on the head and chest, and three of these were also instrumented with femur load cells.

Three dummies were lap belted and the remaining three were left unbelted. The dummies were placed in pairs, with each seat occupied by one restrained and one unrestrained dummy for each seat spacing arrangement. The two dummies representing 6-year olds that were used in the Type I bus only, were not instrumented or restrained. High speed cameras recorded the motion of dummies during collisions.

Head injury criteria (HIC)[1] and chest acceleration rates[2] were measured for the instrumented dummies. An HIC value of 1,000 and a chest acceleration rate of 60 g were used as threshold values above which serious injury or death could be assumed to occur. Femur loads in excess of 2,250 lb. are unacceptable in U.S. and Canadian standards.

Test Findings and Conclusions

A Summary of the Transport Canada test results is presented in Table 2. Four basic observations can easily be made from the data of this Table.

1. Belted dummies experienced higher head and generally lower chest accelerations than did the unbelted ones.
2. In both small buses (Thomas Minotour and Camp Wagon) the lap belted dummies experienced HIC values in excess of 1,000, whereas the unrestrained dummies experienced HIC values less than 1,000.
3. In the large (Blue Bird) bus all dummies (lap belted or unbelted) experienced HIC values much less than 1,000. But, the lap belted ones experienced HIC values approximately three times greater than those for the unrestrained ones. According to the study authors these differences can be attributed to "the fact that the restrained dummies' heads struck the seat backs in a manner

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1 HIC is a measure of the forces the head experiences during a crash. It does not measure injury to the neck or facial laceration. The higher the HIC score, the greater the likelihood of serious or fatal injuries. The Federal government requires that cars equipped with automatic restraints not exceed a HIC of 1,000 in 30 mph crash tests. However, individuals have a wide range of tolerance to injury. Consequently, although there are relationships between dummy test results and actual injuries, there is no single cutoff point for serious injury or death. Higher scores simply indicate a higher potential risk and lower scores indicate a lower potential risk [11].

2 Chest deceleration is a measure of the amount of force the belted dummy's chest experiences during the crash impact. Higher chest deceleration scores indicate that it is more likely that occupants will sustain serious internal injuries. The score is given in gravitational units (g). Cars equipped with automatic restraints must not exceed 60 g in the 30 mph compliance tests [11].

that did not permit efficient energy absorption by those seat backs. Sharp peaks in head acceleration traces indicate that the dummy heads compressed the seat back padding to such a degree that they 'bottomed out' on the steel structure underlying the padding in the seat back".

4. In all cases (lap belted or unrestrained) except one, the chest accelerations were less than the life threatening maximum of 60 g. The single exception exceeded the criterion by by only 0.4 g. For the Blue Bird (large) and Thomas (small) buses the unbelted dummies experienced higher chest acceleration than did the comparable belted dummies.

Dummy No.	Location In Bus	Seat Spacing (in)	Belted(B) Unbelted(U)	HIC	Chest Accel. (g)	Vehicle Data
1	Front LH	21	U	*	60.4	Large School Bus
2	Front RH	21	B	649	40.8	(more than 10,000 GVWR)
3	Center LH	27 1/8	B	629	28.1	66-Passeng. Blue Bird
4	Center RH	27 1/8	U	220	34.2	Veh. Wt. 17,923 lbs
5	Rear LH	24	U	205	48.2	Veh. Velocity 30.5 mph
6	Rear RH	24	B	731	25.0	Veh. Decel. 15 g
1	Front LH	21	B	2,505	40.1	Small School Bus
2	Front RH	21	U	893	47.9	(less than 10,000 GVWR)
3	Center LH	26 1/2	B	1,144	38.6	22-Pas. Thomas Minotour
4	Center RH	26 1/2	U	741	59.8	Veh. Wt. 8,875 lbs
5	Rear LH	24	B	1,173	42.4	Veh. Velocity 29.42 mph
6	Rear RH	24	U	494	44.9	Veh. Decel. 19.5 g
1	Front LH	21 1/8	B	2,016	32.5	School Van Conversion
2	Front RH	20 1/2	U	369	21.1	(less than 10,000 GVWR)
3	Center LH	26 1/2	B	2,195	32.2	20-Passeng. Campwagon
4	Center RH	27	U	946	42.0	Veh. Wt. 6,724 lbs
5	Rear LH	24 1/2	B	1,711	37.5	Veh. Velocity 29.44 mph
6	Rear RH	24 1/2	U	607	24.4	Veh. Decel. 49 g

* Data not valid due to technical problems.

Table 2: Summary of Transport Canada Frontal Crash Tests.

Femur loads are not shown in Table 2, but measurements on three dummies (one belted and two unbelted) were below the limit of 2,500 lbs.

Belted dummies experienced more severe neck extensions than did the unbelted ones due to the angle at which they struck the seat ahead of them. The neck extension of several belted dummies was judged to be life threatening.

The major conclusions of the Transport Canada tests pertaining to seat belt restraints and compartmentalization in frontal collisions are as follows:

> *The passive occupant protection of the seating system (known as compartmentalization), required by Federal regulations since 1980 (1977 in the U.S.A.) functions as intended during frontal impacts and provides excellent protection for occupants.*
>
> *The use of lap belts in any of the three tested sizes of recent model school buses may result in more severe head and neck injuries for a belted occupant than for an unbelted one, in a severe frontal collision.*

Criticisms of the Canadian Tests

University of Michigan and Rochester researchers, NHTSA, and professional groups criticized the validity of the Transport Canada tests on a variety of grounds.

The University of Michigan critics [7] concentrated on the following four aspects of the Transport Canada tests:

1. There are some questions "as to whether or not a HIC value of 1,000 is a conclusive measure of serious head injury, particularly for children". Although higher HIC values were measured on the belted dummies, the highest value of 731 recorded on the Type I bus is much less than the 1,000 limit.

2. The restrained dummy heads contacted the padded seat back (which could have been better padded) resulting in higher HIC values. But, the unrestrained dummies hit the top of the seat backs with their neck, and there were no load cells or accelerators mounted on the necks to measure the resulting load. Thus, no reliable injury prediction could be made.

3. There is no biomechanical justification to the Canadian tests' inference that the "neck extension of several restrained dummies was judged to be life threatening". Humans bend differently from dummies[1] with stiff neck and rigid torso as used in the Canadian tests, and do not tend to suffer "life threatening" neck injuries in the situations that the tests attempted to model.

4. The large Blue Bird bus was occupied by six 5th percentile female dummies, representing 14-year old junior high school students, and two six-year old size dummies (unrestrained and uninstrumented). Thus, the conclusion of the test, if valid, is limited in real wold applications. Smaller dummies representing younger children should have been used also. One of the 6-year old dummies should have been restrained for comparison purposes.

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[1] The Anthropometric Test Devices (dummies) used in the Canadian tests were dimensioned in accordance with CMVSS 100 and conform to FMVSS part 572 specifications in the USA.

University of Rochester Professor John D. States [8] in another criticism disagreed with the Transport Canada findings on the following two grounds:

1. The dummies used in the Canadian tests do not accurately model the flexibility of human spines. The additional stiffness of dummy spine prevented load sharing contact of the chest, head and upper extremities with the seat in front. This contact would have reduced the head acceleration and HIC values for the belted dummies.

2. The HIC value of 1,000 is not applicable to children. Considering the results of experimental studies on arterial vessel walls in the brain of children, and the flexible and elastic characteristics of children skulls, the HIC value for children is greater than 1,500 and possibly 2,000.

Dr. Yeager of the National Coalition for Seat Belts on School Buses [9] criticized the selection of the 5th percentile (representing a 14-year old) female dummy because of its height, which during impact targets the head on the seat back where padding narrowly covers the metal bar, thus causing higher HIC values. Furthermore, he questioned the use of a type 572 dummy because of its stiffness that produces excessive HIC readings.

Explaining its position on seat belts on school buses, the National Highway Traffic Safety Administration (NHTSA) made the following observation on the Transport Canada tests:

> "It should be recognized that "compartmentalization" countermeasures were specifically designed to protect the occupant in frontal barrier tests, similar to those conducted by the Canadians. The low head injury readings for the unbelted dummies is indicative that compartmentalization performs as well in production buses as it did in the research tests which perfected the concept." [1]

In the same report, however, NHTSA pointed out some of the limitations of the Transport Canada tests by stating:

> "In examining the Canadian tests, several factors must be considered. A 30 mph barrier crash force for a large bus is an unlikely occurrence. For example, a head on crash between a large bus and a full-size car, both travelling at 55 mph would be less severe to bus occupants than the 30 mph barrier test. Also, only one size dummy was used which typically represents a junior high school student. The geometry for younger children would be significantly different with likely different results. Taken together, the results of the Canadian tests should be viewed with caution."

THOMAS BUILT BUSES CRASH TESTS - 1985

Of the three tests conducted by Thomas Built Buses, Inc. only one (a right side impact) can be used for the purpose of comparison of both lap belted and unrestrained dummies. The other two tests (a head-on crash and a left side impact crash) either did not involve instrumented dummies or data were partially lost [10].

Experimental Features

The right side impact test involved a 16-passenger 1985 Thomas Minotour Bus (GWVR less than 10,000 lbs.). This vehicle, being a Type II school bus, is currently required to be equipped with lap belts. The bus was impacted from its right side by a barrier of 4,000 lbs. moving at 30.8 mph. There was a total of eight dummies in the vehicle. Six were instrumented 50th percentile dummies (two lap belted, and four unrestrained), the seventh was an uninstrumented 5th percentile dummy (lap belted), and the eighth an uninstrumented 5th percentile dummy (lap belted).

Test Findings and Conclusions

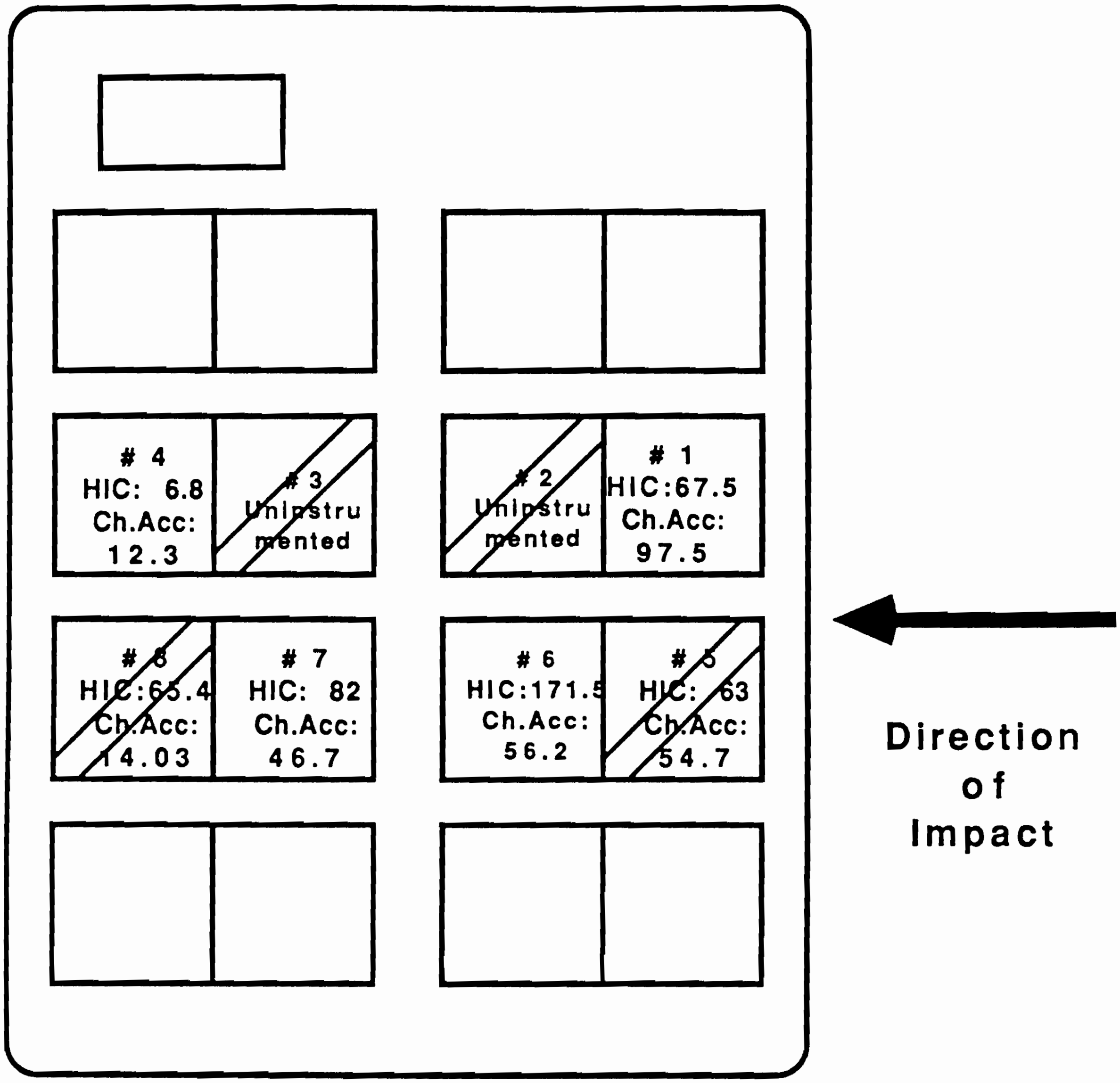
Of the six dummies that were instrumented, the two lap belted, and three of the four unrestrained dummies sustained non life threatening HIC (less than 1,000) and chest acceleration (less than 60 g) values. The remaining unrestrained dummy suffered a HIC of 67.5 and a chest acceleration of 97.5 g considered to be life threatening. Figure 2 contains a pictorial representation of the test.

On the basis of the obtained results, Thomas Built Buses, Inc. concluded:

"Compartmentalization works as it was designed to work in frontal or side impacts. These tests also indicate that in the case of side impact, there seems to be very little significant difference between the belted and unbelted dummies in these test conditions relating to head and chest injuries".

The National Transportation Safety Board (NTSB) reviewing the Thomas crash tests noted that "... the Thomas Built Buses crash tests provide an indication of what can be expected from a 30 mph side impact involving a school bus transporting both lap belted and unrestrained passengers. Since a belted dummy was seated next to an unbelted dummy during the test, the test results do not necessarily provide an indication of head or chest injuries to be expected if a small school bus transporting all lap belted passengers is involved in a side impact, nor for that matter, what to expect if all passengers are unrestrained". [11]

In a critique of Thomas Bus side impact crash tests, the National Coalition for Seat Belts on School Buses argued that "The unbelted dummies remained in the "compartment" because during the side collision they were thrown into the belted dummies. The belted dummies acted like padded side arms and helped keep the unbelted dummies in their seating area. Unfortunately, school buses don't have padded side arms to contain children during side collisions." [9] This statement refers to dummies in positions #4 and #6 on the bus (see Figure 2), which were thrown on their belted neighbors in positions #3 and #5.



Key to dummies used:

Position 1:	50% instrumented unrestrained
Position 2:	6-year-old restrained by lap belt (uninstrumented)
Position 3:	5% belted (uninstrumented)
Position 4:	50% instrumented unrestrained
Position 5:	50% instrumented restrained by lap belt
Position 6:	50% instrumented unrestrained
Position 7:	50% instrumented unrestrained
Position 8:	50% instrumented restrained by lap belt

Figure 2: Thomas Built Crash Test Details

NHTSA SLED TESTS - 1978

The second best alternative to performing crash tests utilizing the entire vehicle, is the performance of crash tests utilizing only a group of seats mounted on a sled. Sled tests are conducted by fixing school bus passenger seats with specific spacing and restraint systems on an electro-mechanical movable sled mounted on a track. Anthropomorphic dummies (restrained and unrestrained) are placed on the seats which are fixed with respect to the sled. The sled is then rapidly accelerated or decelerated on the track, and the resulting forces exerted on various body parts of the dummies are measured. Obviously, lateral impacts cannot be model with sled testing since the vehicle body is not present and observations of dummies hitting the side walls or other interior features cannot be made.

Experimental Features

The NHTSA sled tests were conducted to determine the response of dummies in simulated frontal collisions with and without lap belts. Five tests (test nos. 37, 38, 39, 40, 41, NHTSA) are considered here as each of these tests involved both belted and unbelted school bus passenger dummies, thus providing an opportunity to compare the performance of both belted and unbelted school bus occupants. In these tests, standard school bus seats were subjected to simulated frontal collisions at 15 mph (for tests 37, 38, 39 and 40), and 20 mph (for test no. 41). In each of these tests, the responses of four 50th percentile, male anthropomorphic dummies (two lap belted, two unrestrained) were compared. The school bus seat spacing remained constant at 20 inches. The front seat was empty, the center seat held two lap belted dummies, and the two dummies at the back seat were unrestrained [12].

Test Findings and Conclusions

The test data for all five NHTSA sled crashes are summarized in Table 3. On the basis of the measurements obtained during the sled tests on the 50th percentile dummies, the following major observations were made by the NHTSA researchers:

> *The use of lap belts do not reduce peak head accelerations but in fact, in most cases, actually cause an increase in peak accelerations. This may be probably due to the fact that the head contact point is moving higher up on the dummy head with the use of lap belts. It may also be due to the redirection of the head impact into the stiff axis of the seat back structure.*

> *The effect of seat belts on head acceleration and torso response appear to be insignificant. However, on the basis of knee response evaluations, the use of lap belts has a slight to moderate influence on decreasing femur loads.*

> *HIC and chest acceleration values for both belted and unbelted dummies were within acceptable limits (HIC less than 1,000, chest acceleration less than 60 g).*

> *Passenger containment increases with increasing seat back height, and there are no significant additional benefits that can be obtained by using lap belts. However, during rebound, the use of lap belts seems to*

have a positive influence on containment.

All seats (with belted or unbelted dummies) appeared to satisfy the established injury criteria for femur loads (i.e., less than or equal to 1,700 lbs. for an impact speed of 20 mph.).

Test No.	Sled Speed (mph)	Seat Spacing (Inches)	Dummy No *	Lap Belt	HIC	Chest Accel. (g)
37	14.9	20	1	Yes	181	21
			2	Yes	155	23
			3	No	77	18
			4	No	116	16
38	14.8	20	1	Yes	226	18
			2	Yes	156	16
			3	No	259	25
			4	No	233	24
39	14.9	20	1	Yes	175	27
			2	Yes	155	30
			3	No	107	17
			4	No	87	13
40	14.8	20	1	Yes	321	21
			2	Yes	499	25
			3	No	128	15
			4	No	183	19
41	19.8	20	1	Yes	447	51
			2	Yes	465	30
			3	No	201	29
			4	No	184	31

* Dummy 1: Left Position, Center Seat
Dummy 2: Right Position, Center Seat
Dummy 3: Left Position, Back Seat
Dummy 4: Right Position, Back Seat

Table 3: Summary of NHTSA Sled Test Results.

In effect the NHTSA study results suggest that for frontal collisions, lap belts do not appear to have a significant effect on the response characteristics of a 50th percentile adult dummy and as a consequence, they cannot make significant contributions to increased occupant safety. The use of lap belts increased peak head accelerations for most of the belted dummies, seemed to have a positive influence on containment during rebound, and a slight to moderate influence on decreasing femur loads.

NHTSA researchers also reported that they were unable to evaluate the potential for serious neck and spine injuries on the unbelted dummies. Film documentation of the sled tests revealed that there may be other potentially harmful body loadings that were not covered by the instrumentation of the tests. One such case involves unbelted dummies impacting the seat back on their throat. It was also observed that an unbelted child dummy having stiff knee padding was stopped abruptly allowing the torso to rotate until the head made contact with the seat back. Then a violent whipping was set in the dummy's spine as it attempted to "beam" the inertial loads of the torso to the knee and head contact points. It is not known if this "whipping action" is unique to the dummy structure or it represents evidence of a real serious injury problem. There are no existing injury criteria to cover these potential injury modes, noted the NHTSA researchers.

REVIEW OF BUS AND SLED CRASH TESTS

The series I crash tests at UCLA recommended the use of seat belts in combination with padded high-back safety seats. The series II crash tests concluded that belted passengers were subjected to higher head impact forces than their unbelted counterparts, but no serious injuries were predicted for the belted passengers. Both series I and series II tests confirmed that seat belts would provide additional protection to passengers in side impact and rollover accidents. However, considering the special protection afforded to school buses by their visibility and size, the addition of seat belts would be of minor importance. The fact is that even with the additional benefit of their greater visibility and size, school buses do get involved in accidents in all impact modes. Therefore, the evidence derived from the UCLA crash tests that seat belts are beneficial in side impacts and rollovers is important in terms of the overall school bus passenger safety improvement.

The Transport Canada crash tests and the NHTSA sled tests reported higher HIC values for belted passengers. But, the results of those two tests are not consistent in terms of their prediction of potential injuries because of the presence of seat belts. Whereas the HIC values of the NHTSA sled tests did not even reach half the maximum acceptable limit of 1,000, the HIC values measured by the Transport Canada crash tests exceeded 2,000 for Type II buses, but were still well below 1,000 for Type I buses. This should not be surprising, since the Canadian buses were crashed at roughly double the speed of the NHTSA sleds. There has been a considerable amount of criticism of the high speeds, as well as the instrumentation and test dummies used in the Transport Canada tests. Researchers also argued that a maximum acceptable HIC value of much higher than 1,000 might be applicable for children. Experts' reviews of the Canadian tests noted that the results should be viewed with caution.

The side impact crash test conducted by Thomas Built Buses Inc. was criticized for the inappropriate positioning of belted and unbelted passengers. Thus, the validity of this crash test is also questionable.

On the basis of the conclusions and reviews of the bus and sled crash test results, the authors of this report have determined that seat belts may not be beneficial in frontal impacts, but in side impacts and rollover accidents they would provide significant additional protection to school bus passengers. Therefore, the decision to require the installation of seat belts on all school buses should consider both the increase of injury potential in frontal impacts and the reduction of injuries in side impact and rollover accidents. This trade-off will be quantified in Chapter 8 of this report.

CHAPTER 3

SCHOOL BUS ACCIDENT INVESTIGATIONS

INTRODUCTION

Fortunately, the number of school bus accidents, and particularly accidents involving fatalities and serious injuries are very small. While this is a comforting fact, it poses a serious problem when one wishes to perform comparative studies in order to evaluate the effectiveness of a safety device. To determine statistically from past accident experiences whether seat belts (or any other safety feature), will improve safety, one needs a number of accidents that occurred under very similar circumstances and involved buses some of which were equipped with seat belts and some were not. Then, a determination of the device's effectiveness can be made by comparing fatalities, and the number and severity of injuries that occurred in the two groups of buses. This methodology cannot be used to determine the effectiveness of seat belts. First of all, Type II school buses are required to be equipped with seat belts, while the Type I are not. Therefore, no comparative studies can be done for the same class of vehicles. Although there are some Type I buses that are equipped with seat belts, their number and accident involvement is so small, that a comparative analysis is not possible.

The next best alternative to a statistical analysis, is to investigate the accidents that did happen, and on the basis of expert judgement, determine what impact the presence of seat belts would have had on fatalities or injuries. Only accident investigations which covered a significant sample of accidents are considered in this chapter. The research team heard and saw in print a number of individual accident accounts that took place in the past within the state of New Jersey. They ranged from the Pemberton bus driver who thanked God for the absence of seat belts on the bus she was driving when it caught fire, to the Newark Police Chief who also thanked God but for the presence of seat belts on a bus that overturned after being struck on its side by a police car. Other accounts included:

a) A Type I school bus was hit by a truck. An observer felt that compartmentalization was enough since no children were injured. Actually the children helped the injured driver (who was not belted) off the bus.

b) A car traveling at a very high speed (50-60 mph) scraped the front bumper of a Type II bus in East Windsor resulting in the injury of a student who "sprained muscle from seat belt" according to the report filed with the Department of Education.

c) A Type I bus broadsided a Type II bus in Camden. Of the 20 belted children in the Type II bus, only one was injured (suffered a split lip), and so was the monitor who was unbelted. Of the 12 unbelted students in the Type I bus, eight went to the hospital and six had to be carried off on back bards with neck and head injuries.

d) A bus in Newark was hit by a snow plow and crashed into a building. All students were belted and none were injured.

e) Seat belts were helpful in the latest serious accident in the state (April 1989 in Montclair)

All of the above accounts are rather anecdotal. They are quoted here just because they represent information collected during the course of the study. However, they were not used in the decision making process that led to the final recommendations because they do not represent a systematic and unbiased investigative effort.

Only two systematic studies of school bus accident investigations have been performed in the past for the purpose of evaluating the effectiveness of lap belts. One was conducted by the National Transportation Safety Board (NTSB) and the other by the Texas Transportation Institute of the Texas A & M University System. The remainder of this chapter presents and discusses the findings of these two studies, after a brief summary of the injury scales used to classify accidents.

INJURY SCALES

There is a number of ways that one can classify accidents according to their severity. The school bus accident literature uses primarily two injury scales to code school bus occupant injuries. The American National Standards Institute (ANSI) injury scale is the most commonly used. The Abbreviated Injury Scale (AIS) is the second standard classification scheme. The basics of both injury scales are briefly presented here in order to familiarize the reader with their classifications that will be mentioned frequently in subsequent sections.

ANSI Injury Scale

The ANSI scale classifies non-fatal injuries in the following three levels [2]:

Level A (Incapacitating Injury) The injury causes disabilities to such a degree that the person injured is not able to walk, to drive, or continue with any activities which was capable of performing before the injury occurred. Level A injuries include severe lacerations, broken or distorted limbs, skull or chest injuries, abdominal injuries, being unconscious at or when taken from the accident scene, and being unable to leave accident scene without assistance. Momentary unconsciousness is excluded.

Level B (Non Incapacitating Evident Injury) Injuries of a nonincapacitating nature are evident to observers at the scene of the accident where the injury occurred. Level B injuries include lump on head, abrasions, bruises, minor lacerations and others. Limping is excluded (the injury cannot be seen).

Level C (Possible Injury) Any injury reported or claimed that is not a fatal injury, incapacitating injury, or nonincapacitating evident injury. Level C injuries include momentary unconsciousness, claim of injuries not evident, limping, complain of pain, nausea, and hysteria.

There may be some variations in coding these injuries in different states. Furthermore, it is not known how accurately police officers apply this scale when reporting the severity of injuries after an accident. The detailed New York State data on injuries in Table 10 can provide a better understanding on the types and severity of injuries coded in the ANSI injury scale. The Texas accident investigations used this injury scale also.

Abbreviated Injury Scale (AIS)

Motor vehicle occupant injuries may be coded in the Abbreviated Injury Scale (AIS). The AIS codes used by the Transportation Safety Board's investigations of school bus accidents are as follows: [11]

ALI Code	Description	Example
1	Minor	Bruises, abrasions, superficial lacerations (less than 2 inches on face or 4 inches on body provided they do not extend into subcutaneous tissue), fractured finger, sprained wrist, fractured nose.
2	Moderate	Deep laceration, mild concussion, head injury with amnesia about accident and no neurological damage, fractured clavicle ("collar bone"), sprained knee, fractured foot, fractured ulna in arm.
3	Serious	Fractured femur, dislocated hip, brain swelling, contused bladder, fractured pelvis, crushed forearm, hand amputation, head injury with prior unconsciousness and neurologic deficit.
4	Severe	Ruptured spleen, amputation of leg above knee, brain hematoma less than 100 cc.
5.	Critical	Pulmonary artery laceration, complete spinal cord lesion (quadriplegia or paraplegia), ruptured liver, unconsciousness more than 24 hours or penetrating skull injury, brain hematoma more than 100 cc.
6.	Maximum (Virtually, unsurvivable)	Torso transection, massive skull crush, spinal cord crush with total transection C-3 or above, crushed brain stem.
7.	Injured, unknown severity	Insufficient information is available. Or outcome rather than injury is described (i.e., arm trauma, closed head injury, kidney injury).
8.	Unknown if injured	Medical report states "redness over eye", "suspicion of _______" or no information is available.

NTSB STUDY - 1987

The National Transportation Safety Board investigated the crash performance of large post standard school buses (manufactured after April, 1977 with GVWR greater than 10,000 lbs) [11]. The investigation concentrated on 43 accidents involving 44 school buses (two buses collided with each other in one of the accidents). The study focussed primarily on events during crashes for evaluating how well the standards worked, how the occupants sustained injuries, if any, and how serious the injuries were. The study attempted to analyze also what difference lap belts would have made in the final outcome. Namely, whether the number and severity of injuries would have increased or decreased, if lap belts were present. It is this final aspect of the NTSB study that is of interest at this point, and the sections that follow are devoted to it.

Study Features

A school bus accident was included in the NTSB study if it met the first and at least one of the remaining three criteria listed below:

1. The vehicle was a Type I school bus manufactured after April 1, 1977, and was occupied by school age children, and

2. The school bus was involved in a moderate speed collision that disabled the bus (occupant injuries need not have resulted), or

3. The school bus overturned, or

4. One or more of the school bus occupants was seriously injured or killed in the accident (the accident could be of any type)

Of the 44 buses studied by the NTSB, half (22) were involved in rollover accidents, but only 8 of them were pure non-collision rollovers (14 were involved in a collision prior to rolling over). Of the remaining 22 buses that were involved in non-rollover collisions, 16 were impacted from the front or rear, three were involved in side impact accidents, and three in multiple impact type collisions. There were a total of 1,166 school bus passengers and 44 drivers occupying the buses studied. There were 13 passenger fatalities and 588 injuries. The injury status of 15 passengers was not known, and 563 did not sustain any injuries. Four of the 44 buses included occupant restraints in the form of lap belts, loop belts (not considered a safety device), and secured wheel chairs. Of the 1,166 passengers 1,119 were unrestrained and 47 restrained (40 by lap belts).

Lap Belt Effectiveness Analysis Results

NTSB analyzed the injuries to unrestrained passengers in order to estimate what the effect of lap belt use might have been. To perform the analysis NTSB tried to seek answers of the following questions for each of the 1,119 unrestrained passengers:

1. What injuries sustained by the unrestrained passengers would have been eliminated if they had been lap belted?

2. What injuries would have been sustained if the passengers had been lap belted and held in place?

The NTSB analysis of the potential impact of seat belts on fatalities and injuries of surviving passengers is summarized below:

Fatalities: Out of the 13 total school bus passenger fatalities, lap belt use would have probably:

prevented 2 deaths
made no difference for 10 deaths, and
the effect could not be determined for 1 death.

Furthermore, lap belt use would have caused death to three of the surviving passengers. Thus, the probable net effect is practically zero. The study stated that, if lap belts were present, possibly an additional passenger death would have occurred.

Injuries: The injuries sustained by the school bus occupants were classified according to the Abbreviated Injury Scale (AIS). The injury levels sustained by the 1,106 surviving passengers were as follows:

Severe to maximum injuries (AIS 4 or above):	4 passengers
Serious injuries (AIS 3):	24 passengers
Moderate injuries (AIS 2):	58 passengers
Minor or no injuries (AIS 1):	1,020 passengers

The NTSB study dealt individually with each one of the above injury categories and reached some conclusions which are summarized in Table 4. For some injury categories best and worst estimates were provided, while for other categories only a single estimate was made.

For AIS 4 and above injuries: Out of the 4 passengers injured at this level, lap belt use probably would have reduced injuries to an AIS 3 or below for 1 passenger, worsened the outcome for 1 passenger, and made no difference for 2 passengers. In effect, lap belt use probably would not have changed the total number of surviving school bus passengers with severe or worse injuries.

For AIS 3 injuries: NTSB estimated that at best the net effect from the presence of lap belts would have been to reduce the accident severity for 7 passengers in this category (8 reductions and 1 increase). At worst, the net effect would have been to reduce the accident severity for 2 passengers (8 reductions and 6 increases).

For AIS 2 injuries: Of the 58 passengers in this category, lap belt use probably would have worsened the injury severity for one-fifth (12) of the passengers. At best, the injury severity could have been reduced for 9 passengers with a net effect of increasing the injury severity for 3 individuals. At worst there would be no severity reductions with a net effect of increasing the accident severity for 12 passengers. The Board could not determine the effect that lap belt use would have on the majority of passengers in this category.

For AIS 1 or no injuries: No conclusions were reached for the remaining (1,020) unrestrained passengers who sustained minor or no injuries. The data were insufficient to make judgements for this category, and the report stated that the "...

Board did estimate in some individual cases the effect that lap belt use could have made. Overall, it is not prepared to make the same injury outcome determinations as done for the higher level injuries. It is unlikely that seat belt use would have reduced minor injuries."

		Probable Effect of Lap Belt Use (Number. of Passengers)				
Injury Severity	Total Injuries	Severity Reduced	Severity Increased	No Effect	Effect Unknown	Net Effect
AIS ≥ 4	4	1	1	2	0	None
AIS 3	24	8	1	12	3	At best, reduced severity for 7 passengers
		8	6	7	3	At worst, reduced severity for 2 passengers
AIS 2	58	9	12	0	37	At best, increased severity for 3 passengers
		0	12	0	46	At worst, increased severity for 12 passengers
AIS ≤ 1	1,020				1,020	Unlikely to reduce minor injuries
TOTAL	1,106	18	14	14	1,062	At best, reduced severity for 4 passengers
	1,106	9	19	9	1,069	At worst, increased severity to 10 passengers

Table 4: Lap Belt Effectiveness on Surviving Unrestrained Passengers (NTSB Study).

Ejected passengers: There were 15 passengers, among the 1,119 unrestrained, that were totally or partially ejected from the buses. Six of the ejected passengers died. Two sustained critical injuries, 5 severe injuries, 2 serious injuries, 2 moderate injuries, and 4 minor injuries. Discussing the fatalities, NTSB investigators concluded that it was not known "...if they died as a result of injuries sustained outside the bus, during ejection, or as a result of injuries sustained within the bus before ejection. It is not correct to assume automatically that all injuries sustained by ejected passengers occurred as a result of ejection and thus, had they been restrained, injury outcomes would have improved".

In an overview of the injury outcomes, the NTSB study noted that 90 percent of the 1,119 unrestrained school bus passengers in the study sustained no injuries or only minor (AIS 1) injuries, 5 percent received moderate (AIS 2) injuries, only 4 percent sustained higher than moderate level (AIS 3-6) injuries, and the outcome for 1 percent was not known. Therefore, the school bus passengers fared very well in the accidents investigated, even though they were selected in a way that slanted the sample toward the more serious accidents. This observation, however, simply reiterates the fact that school buses are indeed very safe vehicles overall.

Restrained Passengers in the NTSB Study

The NTSB study sample included four buses carrying restrained passengers. Of the 47 restrained occupants of these buses, 40 were lap belted. The NTSB experts felt that they did not have sufficient data to ascertain whether lap belts had a positive or negative impact on the injury severity of these passengers and they refrained from drawing any conclusions on the effectiveness of lap belts on the basis of the belted passengers' injury experience.

Study Conclusions

On the basis of all the evidence gathered from the 43 accidents it investigated, NTSB summed up its findings in the following two broad conclusions:

> *"The Board does not recommend that Federal safety standards be amended to require that all new large school buses be equipped with lap belts for passengers."*

> *"The Federal safety standards, providing for "compartmentalization", worked well in Safety Board investigated crashes to protect school bus passengers from injury in all types of accidents."*

TEXAS SCHOOL BUS ACCIDENT INVESTIGATIONS - 1986

The Texas Transportation Institute investigated school bus accident data obtained from police reports in the State of Texas for the ten-year period between 1975 and 1984 [13]. During this period there were 12,669 accidents involving school buses in the state. Of these, only 7 percent (887 accidents) were injury or fatality accidents. There were 19 fatal injuries, 160 incapacitating injuries (A level; not able to walk, drive, etc.), 1,648 non-incapacitating injuries (B level, bump on head, abrasions, minor lacerations, etc.), and 2,359 possible injuries (limping, complaint of plain)

The 19 fatalities occurred in 13 accidents and were classified as follows:

Fell out of the open door	1
Leaning head out of windows	3
Ejected	3
Passenger head struck the bus roof	2
Thrown around within the bus (in rollover)	8
Severe collision impact at the passenger seating position	1
Wheel chair turn over (non crash event)	1

The Texas team analyzed the police report of each accident, and made a determination on whether seat belts would have prevented each of the above fatalities. Their conclusions were:

> Seat belts would have eliminated the fatal injuries for the student who fell out of the bus and was run over by the school bus itself, and for the three students who were leaning their heads out of windows. However, appropriate

disciplinary measures, which were not always followed, would have eliminated these fatal injuries also.

Two of the three ejected passengers would have been saved by seat belts. The ability of a seat belt to prevent injuries to the third passenger was not clear, because the impact took place right at the passenger's location.

Seat belts would have prevented injuries for the two passengers who were injured because their head struck the roof of the bus and for the 8 passengers who were injured as they were thrown around inside the bus in rollovers.

One passenger was severely injured due to a severe collision impact near the passenger's seating position, and the benefit of a seat belt could not be determined. The passenger who died because his wheel chair turned over was not involved in any crash event, and the accident report had no indication that the bus was specially equipped to carry handicapped children.

In summary, the Texas researchers concluded that seat belts would have saved 12 lives, would have saved four additional ones which could also have been saved if the students were properly disciplined, and no conclusion could be reached for three additional deaths. This assessment was partially questioned by Kyser who expressed concerns about the findings for two accidents that produced 6 fatal injuries [2]. On the basis of his personal on-site inspection in the case of one accident, and from his personal conclusions based on physical evidence and discussions with the accident investigators in the other case, he inferred that there was no evidence which could lead one to state that lap belts would have prevented death for the 6 passengers in these two accidents. The Texas researchers acknowledged in a memorandum that the police officers' information and narratives were marginal at best in their ability to determine seat belt effectiveness in passenger fatalities, and that detailed information of the type collected by Kyser and others could contribute to a better estimate of seat belt effectiveness. However, even if the six disputed fatalities were not prevented by seat belts, there were still six fatalities that seat belts could have prevented, and four more for which seat belts could have provided equal protection as proper discipline

Another aspect which was not considered in the Texas study was an assessment of any possible fatal injuries that might have occurred to the less severely injured passengers had they been wearing seat belts. The Texas researchers found that the information on the police accident reports was not sufficient to make such an estimate. The NTSB investigation of 43 accidents that was discussed earlier, concluded that seat belts might have prevented two fatalities but there might have been fatal injuries to three other and less seriously injured passengers had they been belted. The NTSB study pointed out also that in rollover collisions, the fatalities and serious injuries were caused primarily due to the force of impact, and not as much by the dynamics of the rollover. It was not clear from the Texas study to what degree the collision impact or the dynamics of rollovers contributed to the deaths of the eight passengers who were thrown around inside the bus. If the impact was responsible for the fatality, then seat belts probably might not have helped. If both the impact and rollover dynamics contributed to fatalities, then it was most likely that the severity of the fatal injuries might have been reduced by seat belts in the majority of the accidents, just as the Texas study inferred.

In the cases of incapacitating, non-incapacitating, and possible injuries, the effectiveness of seat belts could not be determined by the Texas study. Summarizing their investigation, the researchers observed that the school bus is an extremely safe mode of transportation, since only 19 fatal injuries and 160 incapacitating injuries were sustained in over 12,600 school bus accidents in a 10-year period. Their major conclusions were that:

> *The data available do not provide conclusive evidence that lap belts are needed in large school buses.*
>
> *With the limited funds available, lap belts in school buses are not safety cost effective.*
>
> *Improved vehicle maintenance, bus driver training and rider training may have a greater potential in reducing the frequency and severity of accidents over time.*

REVIEW OF ACCIDENT INVESTIGATIONS

The NTSB investigation of 43 accidents involving large school buses determined that seat belts could have provided additional protection to passengers that suffered AIS-3 and above level injuries. A large number of undetermined cases in the AIS-2 injury category precludes one from drawing any definitive conclusion on the effectiveness of seat belts for these moderately injured passengers. It is reasonable to conclude that the benefit or harm that could be contributed by seat belts would have been rather marginal. The fact that the sample of accidents analyzed in the NTSB study are slanted towards severe crashes, essentially reduces the chances that any protective device could have made much of a difference. There were 11 serious to critical injuries and only 4 minor to moderate injuries associated with the 15 passengers who were partially or fully ejected from the buses. These injury outcomes are an indication of the extreme severity associated with ejection, and ejection is certainly an event which can be prevented by seat belts.

Frontal and rear end impacts were the most common collision modes investigated by the NTSB study. Although side impacts cause a substantial proportion of school bus accidents (about 30 percent), there were just three such accidents in the sample of 43. While side impacts were under-represented, rollovers were over-represented in the NTSB sample. Of the 43 cases, 22 were rollovers, contributed either by collision (14) or non-collision (8) incidents, while such accidents contribute to no more than 25 percent of the total. Seat belts are deemed to improve safety in both side impact and rollover accidents. The disproportionately large number of rollover accidents may have balanced the disproportionately small number of side impacts included in the sample and, therefore, the overall anticipated benefits can be considered representative of the results that could have been obtained, if the sample was more representative of actual accident frequencies. Overall, due to the severity of the accidents included in the Safety Board's investigation, the findings only pertain to what might happen to belted passengers during the worst possible school bus accident cases. But, even for these cases, the results are not against seat belts. Belts would have been neutral for fatalities, severe injuries and minor injuries, would have reduced serious injuries, and increased moderate injuries. The trade-off is between the reduction of serious injuries and the increase of moderate injuries and it should be considered as being overall beneficial.

The very large sample of accidents investigated by the Texas Transportation Institute study makes it more significant in terms of its ability to evaluate the overall effectiveness of seat belts in school buses. The Texas study inferred that 10 out of 19 fatalities could have been prevented by seat belts. Although this number excludes the 6 contested fatalities, it implies an approximate effectiveness rate of 50 percent. An assessment of seat belt effectiveness for injuries could not be made by the Texas accident investigations due to lack of sufficient data. However, the determination of fatality and incapacitating injury frequency by accident type shown in Table 5 is of particular importance. It is evident that 63 percent of the incapacitating injuries are caused by side impacts and rollover accidents, 28 percent are the result of front impact accidents, and rear impacts cause an insignificantly small number of injuries. Since these proportions are based on a very large sample of data, they can provide insights that can be used for the seat belt effectiveness methodology developed in Chapter 8.

	Number and Percent of Injuries		
Accident Type	Fatal	Incapacitating	Total
Rear End	0(0%)	3(2%)	3(2%)
Front End	4(21%)	46(29%)	50(28%)
Side (non-rollover)	8(21%)	61(38%)	69(38%)
Rollover	4(21%)	41(26%)	45(25%)
Unknown	3(16%)	9(5%)	12(7%)
Total	19(100%)	160(100%)	179(100%)

Table 5: Injury Frequency by Accident Type in Texas.

CHAPTER 4

SCHOOL BUS ACCIDENT DATA ANALYSIS

NATIONAL EXPOSURE

According to the Transportation Research Board study, [2] the nation's school buses travel approximately 3.8 billion vehicle-miles during an average year. School bus transportation is responsible annually for the deaths of 10 school bus passengers and 38 student pedestrians. In addition, 19,000 school bus related injuries occur annually, of which 50 percent (9,500) involve school bus passengers, 5 percent (950) pedestrians, 10 percent (1,900) school bus drivers, and 35 percent (6,650) other motorists. The vast majority of the 950 pedestrian injuries, (808 or 85 percent) are students.

Overall, the severity of injuries sustained by the 9,500 injured school bus passengers is relatively moderate. Only 5 percent (475) of the students sustain incapacitating (A level) injuries, nonincapacitating (B level) injuries are 25 percent (2,375) of the total, and possible injuries (C level) are the overwhelming majority (70 percent or 6,650). The injuries sustained by the 808 student pedestrians are typically more severe than the injuries sustained by school bus passengers. The proportions and numbers of incapacitating, nonincapacitating, and possible injuries for student pedestrians are 20 percent (162), 30 percent (242), and 50 percent (404) respectively. Not only is the frequency of incapacitating injuries for pedestrians four times as great as it is for passengers (20 versus 5 percent), but as the TRB study noted "the incapacitating injurers sustained by pedestrians appear to be more severe than the incapacitating injuries sustained by school bus passengers". An additional fact very worth noting is that 35 percent (283) of all students injured as pedestrians are struck by their own school buses, while the remaining 65 percent (525) are injured when struck by other vehicles.

Table 6 contains a summary of national school bus accident stratistics by strate as reported in the latest available (1987) edition of *Accident Facts*. Fatalities and fatality rates are not included because they are very small. New Jersey was the fifth safest state (after North Dakota, Wyoming, Kansas and Nebraska) in terms of Accidents per million vehicle-miles with a rate of 4.3, while the national average rate was 10.0. In terms of pupil injuries per million vehicle-miles, New Jersey was below the national average (1.4 versus 1.9), but 17 states had lower rates. In terms of pupil injuries per 1,000 transported pupils, New Jersey had a rate of 0.3 which is identical with the national average.

STATE EXPOSURE

In the state of New Jersey 13,234 school buses (8,306 Type I and 4,928 Type II) travel 124.4 million vehicle miles in a typical year, transporting 626,701 students daily for school sponsored activities [34].

ACCIDENT FACTS EDITION 1987

STATE	VEHICLES	ANNUAL BUS MILAGE (000)	PUPIL TRANSP. DAILY	TOTAL BUS ACC.	PUPILS INJURED	ACCI./ MILLION VEH.-MILE	PUPIL INJ./ MILLION VEH.-MILE	PUPIL INJ./ 1000 TRANSP. PUPIL
1 _ALABAMA	7,048	54,077	435,000	286	39	5.3	0.7	0.1
2 _ALASKA	650	7,200	42,000	76	-	10.6	-	-
3 _ARIZONA	-	32,108	-	-	-	-	-	-
4 _ARKANSAS	4,233	40,649	266,452	204	-	5.0	-	-
5 _CALIFORNIA	15,088	261,603	908,698	2,137	380	8.2	1.5	0.4
6 _COLORADO	5,179	41,282	226,219	308	54	7.5	1.3	0.2
7 _CONNECTICUT	-	-	-	-	-	-	-	-
8 _DELAWARE	1,274	15,632	81,557	112	57	7.2	3.6	0.7
9 _DIST. OF COL.	151	1,800	7,000	62	4	34.4	2.2	0.6
10 _FLORIDA	8,620	139,353	748,901	1,107	511	7.9	3.7	0.7
11 _GEORGIA	10,028	84,336	818,884	956	82	11.3	1.0	0.1
12 _HAWAII	769	11,342	39,607	11	3	-	0.3	-
13 _IDAHO	2,001	18,989	122,000	108	6	5.7	0.3	0.0
14 _ILLINOES	-	180,784	-	-	-	-	-	-
15 _INDIANA	10,522	59,529	648,074	-	84	-	1.4	0.1
16 _IOWA	6,821	63,087	246,897	571	59	9.1	0.9	0.2
17 _KANSAS	5,144	41,358	164,411	151	-	3.7	-	-
18 _KENTUCKY	6,744	72,422	446,563	999	195	13.8	2.7	0.4
19 _LOUISIANA	7,429	64,156	580,966	683	59	10.6	0.9	0.1
20 _MAINE	2,399	27,235	165,654	140	8	5.1	0.3	0.0
21 _MARYLAND	4,975	75,843	441,787	1,112	43	14.7	0.6	0.1
22 _MASSACHUSETTS	-	58,699	-	-	-	-	-	-
23 _MICHIGAN	13,840	107,683	965,000	-	-	-	-	-
24 _MINNESOTA	10,500	93,138	325,855	662	-	7.1	-	-
25 _MISSISSIPPI	5,100	42,159	358,266	317	50	7.5	1.2	0.1
26 _MISSOURI	8,955	96,909	448,035	583	185	6.0	1.9	0.4
27 _MONTANA	1,321	16,678	60,106	73	15	4.4	0.9	0.2
28 _NEBRASKA	3,422	30,585	56,379	126	-	4.1	-	-
29 _NEVADA	919	11,278	57,782	210	50	18.6	4.4	0.9
30 _NEW HAMPSHIRE	1,942	11,873	99,206	129	24	10.9	2.0	0.2
31 _NEW JERSEY	12,628	128,037	630,143	548	177	4.3	1.4	0.3
32 _NEW MAXICO	2,056	28,127	132,543	187	35	6.6	1.2	0.3
33 _NEW YORK	-	166,778	-	-	-	-	-	-
34 _NORTH CAROLINA	13,002	111,945	705,254	1,102	487	9.8	4.4	0.7
35 _NORTH DAKOTA	1,877	25,805	47,249	6	0	0.2	0.0	0.0
36 _OHIO	-	157,526	-	-	-	-	-	-
37 _OKLAHOMA	6,407	50,637	299,956	355	98	7.0	1.9	0.3
38 _OREGON	4,556	40,854	233,828	358	10	8.8	0.2	0.0
39 _PENNSYLVANIA	19,814	239,846	1,345,002	-	109	-	0.5	0.1
40 _RHODE ISLAND	-	-	-	-	-	-	-	-
41 _SOUTH CAROLINA	5,988	61,789	443,650	864	336	14.0	5.4	0.8
42 _SOUTH DAKOTA	1,279	-	45,108	84	3	-	-	0.1
43 _TENNESSEE	6,373	66,144	553,483	846	326	12.8	4.9	0.6
44 _TEXAS	24,500	181,000	1,000,000	1,696	345	9.4	1.9	0.3
45 _UTAH	-	16,482	-	-	-	-	-	-
46 _VERMONT	-	-	-	-	-	-	-	-
47 _VIRGINIA	9,312	80,759	725,856	811	117	10.0	1.4	0.2
48 _WASHINGTON	-	63,367	-	-	-	-	-	-

STATE	VEHICLES	ANNUAL BUS MILAGE (000)	PUPIL TRANSP. DAILY	TOTAL BUS ACC.	PUPILS INJURED	ACCI./ MILLION VEH.-MILE	PUPIL INJ./ MILLION VEH.-MILE	PUPIL INJ./ 1000 TRANSP. PUPIL
49 _WEST VIRGINIA	2,994	37,372	283,183	641	3	17.2	0.1	0.0
50 _WISCONSIN	6,829	75,445	462,033	911	212	12.1	2.8	0.5
51 _WYOMING	1,560	13,680	43,539	41	0	3.0	0.0	0.0
US TOTAL	350,000	3,700,000	21,700,000	37,000	6,900	10.0	1.9	0.3

Table 6: National School Bus Accident Statistics By State

The New Jersey Department of Transportation and the New Jersey Department of Eduction are two sources of school bus accident data for this State. Table 7 contains school bus accident statistics that were summarized from Department of Transportation reports for the latest available calendar year (1986), and Table 8 contains a summary of Department of Education reported accidents for the 1986-1987 school year. Although the time periods covered in the two tables are not identical, it is obvious that the overall numbers involving injury accidents reported by both Departments are comparable. However, property damage only accidents are grossly under-reported to the Department of Education (106 versus 826 in the DOT reports). Approximately 60 percent of the State's school bus fleet is operated by contractors (7,946 out of the 13,234 vehicles). However, looking at the total accidents by ownership type in Table 8, one sees that district operated vehicles were involved in 256 accidents and contractor operated vehicles in only 98 accidents. The implication of this is that contractors generate 27.7 percent of the accidents, while they operate 60 percent of the vehicles. Unless contractors are able to operate their vehicles quite a few times more safely than school districts, this discrepancy is unjustifiable. Obviously, contractors tend not to report to the Department of Education many of their property damage accidents. Additional data on national and New Jersey school bus accident statistics can be found in Appendix B.

Since there has not been a school bus student passenger fatality in this State for quite some time, no average annual passenger fatalities can be estimated from New Jersey accident data. However, if the State was equally unlucky as the rest of the nation, and had the same average fatality rate per million vehicle-miles, then there should be approximately 0.33 school bus passenger fatalities and 1.25 student pedestrian fatalities per year. These numbers are demonstrative of the "tricks" that the laws of rare events and statistics can play. In the 1986-87 school year there were 2 student pedestrian fatalities in New Jersey (a boy on a bicycle was also killed), and the State more than satisfied its ghastly quota of the pedestrian fatality rate. However, 1 student passenger should be killed in New Jersey every 3 years (0.33 per year), but none has been killed in the last decade. This simply means that we have been lucky in this State lately. No one can predict for how long this streak of luck can continue. Twenty more years may pass without a single school bus passenger fatality, and then a horrible accident may occur that will kill 12 students inside a bus and bring us in line with the national average.

When the total sample of rare incidents is small, one may develop a false sense of security by not observing a class of those incidents at all, and the New Jersey school bus passenger fatality rate just mentioned is a good example. When the sample is small, one may also falsely determine the relative distribution or proportions of incidents. In the case of accidents for example, if the sample is small, the relative importance of an injury class or a collision mode may be overestimated or underestimated. To avoid problems of this type, and to obtain classifications that conform to national practice, New Jersey accident data were used to simply obtain overall figures. National factors were then used to determine future State expectations of accidents by category. Using New Jersey Department of Transportation Data for 1983 to 1986, it was determined that in an average year 1,022 school bus related accidents occur in the state causing injuries to 720 persons. These 720 injuries, if distributed according to the national averages, will consist of 360 (50 percent) school bus passengers, 36 (5 percent) pedestrians, 72 (10 percent) school bus drivers, and 252 (35 percent) others (motorists, bicyclists, etc). Of the 36 pedestrians injured, 30 (85%) should be student pedestrians. Therefore, the total number of pupil injuries should be 390, of which 360 will be injured as school bus passengers and 30 as pedestrians. Using national factors for incapacitating,

SUMMARY OF MOTOR VEHICLE TRAFFIC ACCIDENTS

FROM 01/01/86 - 12/31/86
TYPE OF VEH.: SCHOOL BUS

COUNTY	# FAT-AITY	# INJ-URY	# OF ACCI. INVOLVING INJURY #: 1	2	3	4	5 & ABOVE	# OF ACCIDENTS: PAT.	INJ.	PDO	TOTAL	COLLISION TYPE(INJ. & FATAL ACCI.): SD	AN	HO	SPV	SFO	LT	PED	PC	OT
1-ATLANTIC	-	26	2	2	2	1	1	-	8	24	32	2	2	-	-	2	1	1	-	-
2-BERGEN	-	49	25	6	4	-	-	-	35	102	137	14	14	2	2	2	-	-	1	-
3-BURLINGTON	1	18	6	4	-	1	-	1	11	41	53	6	2	3	-	-	-	-	1	-
4-CAMDEN	-	31	10	2	1	-	2	-	15	48	63	8	3	1	-	2	-	-	1	-
5-CAPE MAY	-	2	2	-	-	-	-	-	2	8	10	-	1	-	-	1	-	-	-	-
6-CUMBERLAND	-	13	7	3	-	-	-	-	10	16	26	3	5	-	-	-	1	-	-	-
7-ESSEX	1	126	18	10	5	1	2	1	40	70	111	16	13	1	3	2	3	1	-	2
8-GLOUCESTER	-	16	7	2	-	-	1	-	10	30	40	3	4	1	-	1	-	1	-	-
9-HUDSON	-	25	16	-	3	-	-	-	19	47	66	3	5	-	2	-	-	5	1	3
10-HUNTERDON	-	18	3	1	-	-	1	-	4	14	18	2	1	-	-	1	-	1	-	-
11-MERCER	1	41	10	6	2	2	1	1	21	38	60	3	14	-	-	1	-	1	1	-
12-MIDDLE SEX	-	99	18	6	3	2	5	-	29	88	117	12	12	3	2	2	2	-	-	1
13-MONMOUTH	-	52	16	6	3	2	1	-	27	70	97	8	8	5	1	1	1	1	1	1
14-MORRIS	-	42	14	3	2	-	2	-	20	56	76	11	6	2	-	-	1	-	-	1
15-OCEAN	-	41	5	6	3	-	3	-	17	37	54	5	9	-	-	1	1	-	1	-
16-PASSAIC	-	40	9	5	2	-	2	-	18	37	55	3	4	3	3	-	1	3	-	1
17-SALEM	-	5	1	2	-	-	-	-	3	5	8	1	-	2	-	-	-	-	-	-
18-SOMERSET	-	28	8	2	-	-	2	-	12	20	32	1	5	4	-	2	-	-	-	-
19-SUSSEX	-	23	2	2	-	1	2	-	7	24	31	1	3	2	-	-	-	-	-	1
20-UNION	-	39	11	5	1	-	2	-	19	45	64	2	7	2	2	3	1	1	-	1
21-WARREN	-	16	3	-	2	-	1	-	6	6	12	2	-	2	-	2	-	-	-	-
TOTAL	3	750	193	73	33	10	28	3	333	826	1162	106	118	33	15	23	12	15	7	11

LEGEND :-

SD — SAME DIRECTION
AN — ANGLE
HO — HEAD ON
SPV — STRUCK PARKED VEHICLE
SFO — STRUCK FIXED OBJECT
LT — LEFT TURN FROM OPPOSITE DIRECTION
PED — PEDESTRIAN
PC — PEDAL CYCLE
OT — OTHER

Table 7: Summary of New Jersey School Bus Accident Statistics as Reported by NJDOT.

SCHOOL BUS ACCIDENT REPORT
DIVISION OF FINANCE
BUREAU OF PUPIL TRANSPORTATION
NEW JERSEY STATE DEPARTMENT OF EDUCATION
1986-87

REPORTABLE DAMAGE AND INJURY INCOLVING

COUNTY	TOTAL # OF ACCICENTS	PROPERTY DAMAGE ONLY	PUPIL INJURY IN EXCESS OF $15	MINOR PUPIL INJURY UNDER $15	BUS DRIVER	MOTORIST/ PEDESTRIAN	FATAL	TYPE OF OWNERSHIP DIST.	CONT.	S.V.	COLLISION WITH ONE/MORE VEHICLES	RR TRAIN	BICYCLE	FIXED OBJEC	RUN OFF ROAD	ON BOARD ACCIDENT	OTHER	ASSOCIATION BEFORE ENT. BUS	AFTER LEV. BUS
1-ATLANTIC	15	9	10	6	4	7	2	10	5	2	12	-	-	2	1	-	-	-	-
2-BERGEN	17	5	12	6	3	4	-	3	14	9	15	-	-	-	-	1	1	-	-
3-BURLINGTON	29	12	17	6	3	9	-	27	2	8	27	-	-	1	-	-	1	-	-
4-CAMDEN	30	4	8	2	6	7	-	23	7	5	29	-	-	1	-	-	-	-	-
5-CAPE MAY	4	2	-	-	1	-	-	2	2	-	2	-	-	2	-	-	-	-	-
6-CUMBERLAND	7	-	1	-	3	1	-	6	1	1	5	-	-	1	-	-	1	-	-
7-ESSEX	3	3	2	1	1	-	-	1	2	3	3	-	-	-	-	-	-	-	-
8-GLOUCESTER	25	8	30	9	5	7	-	19	6	4	23	-	-	2	-	-	-	-	-
9-HUDSON	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10-HUNTERDON	13	8	-	-	1	1	-	10	3	1	11	-	-	2	-	-	-	-	-
11-MERCER	21	5	3	4	1	2	-	14	7	2	16	-	-	3	-	1	1	-	-
12-MIDDLE SEX	24	4	15	18	4	5	2	15	9	13	20	-	-	-	1	-	3	-	-
13-MONMOUTH	39	7	16	11	9	7	2	35	4	12	35	-	1	1	1	-	1	-	1
14-MORRIS	31	8	3	12	5	7	1	20	9	13	25	-	-	5	-	1	-	-	-
15-OCEAN	45	13	20	20	6	10	1	43	2	13	39	-	-	3	2	-	1	-	1
16-PASSAIC	8	-	3	4	-	1	-	4	4	2	8	-	-	-	-	-	-	-	-
17-SALEM	8	1	6	-	1	1	-	5	3	1	7	-	-	-	-	1	-	-	-
18-SOMERSET	16	8	3	2	1	1	-	11	5	8	14	-	-	1	-	-	1	-	1
19-SUSSEX	6	3	-	-	-	-	-	3	3	3	5	-	-	1	-	-	-	-	-
20-UNION	9	2	8	5	2	2	-	4	5	3	7	-	-	1	1	-	-	-	-
21-WARREN	6	4	4	6	-	1	-	1	5	3	4	-	-	2	-	-	-	-	-
T O T A L	356	106	161	112	56	73	*8	256	98	106	307	-	1	28	6	4	10	-	3

*FATALITIES - 2 PUPILS
5 DRIVERS OF OTHER VEHICLES
1 BOY ON BICYCLE

Table 8: Summary of New Jersey School Bus Accident Statistics as Reported by NJDOE.

nonincapacitating and possible injuries, the total passenger and pedestrian injuries can be allocated to each injury type as indicated in Table 9. The focus of this study is school bus passenger injuries.

Injury Type	School Bus Passenger Injuries		Student-Pedestrian Injuries	
	National Exposure (%)	State Exposure No. (%)	National Exposure (%)	State Exposure No.(%)
Incapacitating	5%	18(5%)	20%	6(20%)
Nonincapacitating	25%	90(25%)	30%	9(30%)
Possible	70%	252(70%)	50%	15(50%)
Total	100%	360(100%)	100%	30(100%)

Table 9: Estimated Future Annual School Bus Injuries in New Jersey

In summary, it was determined that during an average future year there are going to be approximately 0.33 school bus passenger fatalities in the State. As far as annual injuries to school bus passengers are concerned, 18 will sustain incapacitating injuries, 90 will sustained nonincapacitating injuries and 252 will sustain possible injuries. This information will be used in Chapter 8 to determine the overall effectiveness of seat belts on school buses.

INJURY CRITERIA IN SCHOOL BUS ACCIDENTS

The distribution of injuries by type is not sufficient to assess the effectiveness of a safety measure. Substantially more information is needed such as the physical location of injuries on the body, the major causes of injuries, the most probable injury-causing contact points inside the school bus, and the frequency of each injury type by accident mode. The available literature that can provide this type of information is relatively limited, but studies do exist that can provide the required insights.

Physical Location and Type of Injuries Sustained

The most commonly injured body parts of school bus occupants are the head, face, and legs. A study of 12 bus accidents (school bus, chartered bus and cross county bus) revealed that "over one third of injuries were to the head and neck, principally the face. They consist of lacerations, contusions and fractures." [14] Although these observations were based on investigations of pre-1977 buses when the overwhelming cause of school bus passenger accidents was the seat, more recent studies by NTSB (1987) and TRB (1989) have also concluded that the head and facial region are the major location of injuries, even in the school buses currently on the road.

On the basis of its investigations of 43 post-1977 school bus accidents, the NTSB study [11] reported that the head, skull or face was the body region most frequently injured in the 189 injuries of AIS 2 and above level, and the frequency increased with injury severity. Forty three percent of the serious to critical or above (higher than AIS 3) level injuries were to this region of the body. The upper leg was the next most common body part to be injured, with nearly one-third of all AIS 3 injuries being fractured femurs.

The TRB study [2] reviewed police reported injuries sustained by school bus passengers in New York State accidents between 1980 and 1986. There were 170 incapacitating (A level), 971 non-incapacitating (B level), and 2,619 possible (C level) injuries. The study revealed that approximately one-third of each type of injuries sustained were head injuries. Fifty eight percent of A level injuries and 64 percent of B level injuries were head and face injuries. Approximately 10 percent each of the A, B and C level injuries were at the hip/upper leg and knee/lower leg/foot areas. Considering the fact that 78 percent of all C level injuries were just "complaint of pain", it is justifiable to concentrate on the A and B level injuries which are more serious. Table 10 is reproduced from the TRB study and contains the full details of how injuries were distributed according to their location, outcome, and status of the victim.

On the basis of accident statistics collected from 6 states (California, Kansas, Maryland, Michigan, New York and North Carolina) the TRB study estimated that the national injury distribution would be 5 percent incapacitating (A level), 25 percent non-incapacitating (B level) and 70 percent possible (C level) injuries.

Major Injury Causes and Probable Contact Points in the Bus

It is very difficult to determine exactly how injuries were caused, and when the accident is very serious, even a detailed investigation may not produce the desired information because the victims are found after the accident in a location different from that they were occupying during the accident, and some victims are not able to give an account of what transpired. A study of pre-1977 buses noted that severe injuries were caused for three reasons [14]:

> "The individuals seated in the immediate proximity to the deformed structure are exposed to envelopment by the structure and panels"
>
> "Other individuals seated in the vicinity of the collision location are subjected to potentially injurious deceleration forces."
>
> "Those individuals who are located close enough to the impact area experience sufficient deceleration to catapult them from their seats and they move in relation to the impact area. Since the interior panels for these types of impacts often separate, injuries of a lacerative or slicing nature are produced."

	Injury Severity (%)		
	A Level (incapacitating) (N=170)	B Level (nonincapacitating) (N=971)	C Level (possible) (N=2,619)
Location of Most Severe Physical Complaint			
Head	33.4	31.7	27.9
Face	10.0	32.7	6.1
Eye	14.1	1.4	0.0
Neck	5.9	1.1	12.6
Chest	2.4	2.0	3.2
Back	1.8	1.1	9.3
Shoulder/upper arm	4.1	3.1	5.9
Elbow/lower arm/hand	7.1	8.7	4.8
Abdomen/pelvis	4.7	0.5	2.7
Hip/upper leg	5.9	2.9	2.7
Knee/lower leg/foot	6.5	12.8	10.0
Entire body	1.8	0.4	5.9
Unspecified	2.3	1.6	8.9
	100.0	100.0	100.0
Most Severe Physical Complaint			
Amputation	0.6	0.0	0.0
Concussion	27.0	0.0	0.0
Internal	9.4	0.0	0.0
Minor bleeding	6.5	30.9	0.0
Severe bleeding	14.7	0.0	0.4
Minor burn	0.6	0.6	0.0
Moderate burn	0.0	0.0	0.0
Severe burn	0.0	0.0	0.0
Fracture/dislocation	24.7	0.0	0.0
Contusion/bruise	0.6	53.0	0.0
Abrasion	0.6	15.5	0.0
Complaint of pain	12.9	0.0	77.7
Non visible	2.4	0.0	16.9
Unspecified	0.0	0.0	5.4
	100.0	100.0	100.0
Victims' Physical and Emotional Status			
Unconscious	4.7	0.0	0.0
Semiconscious	11.8	0.0	0.0
Incoherent	2.9	0.0	0.0
Shock	3.5	1.1	1.3
Conscious	77.1	98.9	98.7
	100.0	100.0	100.0

Table 10: Injury Distribution by Body Location, Outcome, and Victim Status. (NY State Data as Reported by TRB SR222).

The NTSB investigation of 43 school bus accidents concluded that:

Contact with the side wall was most often specified.

Contact with the seat back caused very few moderate and above injuries.

Contact with other school bus passengers (i..e., being thrown on top of each other during rollovers) caused only minor injuries with just one exception.

The NTSB investigators found that intrusion played a major role in injury causation, inflicting from 45 to 66 percent of all AIS 3 and above level injuries. "Intrusion here includes both injuries resulting from contact with side walls, roofs, etc., damaged by intrusion, and injuries resulting from transmission of forces released during the intrusion event. All of the moderate and above injuries traceable to roof contact, were injuries caused by contact with a crushed roof. When unrestrained passengers were known to have contacted an intact roof (during rollover) only minor injuries were caused. Some of the injuries caused by contacting a side wall involved contact with a crushed side wall. The addition of padding on the side wall could conceivably reduce the number of injuries caused by contact with the side wall." Table 11 presents the probable contact points that are responsible for injuries on school buses.

It is evident from Table 11 that for a large number of injuries the probable contact point could not be ascertained. Nevertheless, the study identified the side walls, side window or window frames, and roof as the most probable contact points that are causing the larger proportions of moderate and above level injuries (AIS 2-6). If the injuries caused by unknown contact points are distributed according to the proportion of injuries of known contact points, then it might be said that side walls, window/window frames, and crashed roof cause approximately 50 percent of AIS 2-6 (moderate and above) injuries and 75% of AIS 3-6 (serious and above) injuries. The seat (seat legs, seat back) caused very few injuries in these post-1977 buses, while with pre-77 buses, "the overwhelming cause of injury in a school bus collision was the seat" [33].

It is obvious that a large number of injuries have been eliminated due to the high back and padded seats of the post-1977 standard buses. However, possibilities of improving the side walls, windows and roof should be given serious consideration, since they have been identified as probable contact points causing the majority of moderate, serious and above level injuries. As the NTSB study pointed out, the addition of padding should be given consideration for further safety improvements of school buses.

Accident Types and Injury Outcome

Accidents in school buses may be broadly classified into non-collision type and collision type. A collision type accident generally involves one or more of the three impact modes -- frontal, side or rear end. Both collision and non-collision accidents may also cause a bus to roll over. Thus, rollover accidents can be classified into non-collision and collision (involving frontal, side or rear end impact) types.

Probable Contact	Moderate and above injuries (AIS 2-6) No. of Injuries	%	Serious and above injuries (AIS 3-6, excludes moderate injuries) No. of Injuries	%
Side wall (includes intrusion)	14	7	9	21
Side window or window frame	13	7	5	12
Roof (crash only)	8	4	6	14
Stanchion or modesty panel	6	3	3	7
Overhead Luggage racks	6	3	0	0
Seat legs	6	3	1	2
Seat backs	2	1	1	2
Other(*)	16	9	1	2
Unknown	118	62	16	38
	189		42	

(*) No injury serious and above was known to be caused by contact with the bus floor. Only one moderate injury was known to be caused by contact with another bus occupant.

Table 11: Probable Injury-Causing Contact Point on School Buses (NTSB).

Frequency of Accident Types

No reliable national or state data are available on the proportion of different types of accidents involving school buses. The NTSB study [11] quoted a NHTSA study which, based on newspaper reports of school bus accidents over a 5-year period (July 1968 to June 1973), found that 34.2 percent of all accidents involved front or rear impacts, 14.2 percent side impacts, and 8.4 percent rollovers (with or without impact). However, for 41.3 percent of the accidents, either the type was unknown or it involved a pedestrian or non-collision. The study had its limitations. The large number of unspecified accidents was one of them, and secondly, only serious accidents tend to receive media attention. A larger database (police reports of Canadian school bus accidents in 1981), suggests that approximately 55 percent of all accidents involving school buses result from head-on type collisions.

The Texas study that investigated school bus accidents over a 10-year period reported a proportion of different accident types involving fatality and incapacitating injuries as indicated in Table 12.

Accident Type	Number and Percent of Accidents	
	Fatal	Incapacitating
Front end	4 (31%)	20 (28%)
Side	4 (31%)	28 (40%)
Back end	0 (0%)	2 (3%)
Rollover	2 (15%)	13 (18%)
Unknown	3 (23%)	8 (11%)
Total	13 (100%)	71 (100%)

Table 12: Frequency of Fatal and Incapacitating Injury Accidents by Type (Texas Data 1975 - 1984).

The Transportation Research Board committee analyzed for its report FARS (Fatal Accident Reporting System) data from 1982 to 1986. Passenger fatalities were distributed by accident type as indicated in Table 13. The 26 fatal accidents included in the table were responsible for 60 passenger fatalities. Nine of the 26 accidents involved rollovers and caused 25(42%) of the 60 total fatalities. The large proportion of front impact accidents (54%), must have including front impact rollovers, and must have also caused a significant proportion of the total fatalities.

The distribution of school bus accidents by impact or collision mode cannot be ascertained very accurately from the available studies, since their results are not very close with each other. Nevertheless, one can easily recognize the fact that more than half of the fatalities are caused by rollover and front impact accidents. In the final analysis, however, it is the distribution of fatalities and injuries by accident type that are more important than the frequency of accident types themselves.

Frequency of Fatalities and Injuries by Accident Type

It was observed in the preceding discussion of TRB's analysis, that rollover and front impact accidents cause the majority of fatalities. This observation can also be made easily from the evidence that NHTSA collected [1] utilizing FARS data that contained 34 school bus passenger fatalities (3 were ejections). The results of that study are summarized in Table 14.

Point of Initial Impact	Number of accidents involving fatality (FARS 1982-1986, TRB) Initial Impact(*)	Principal Impact(**)
Front	14 (54.0%)	11 (42.0%)
Side (Right or Left)	5 (19.0%)	5 (19.0%)
Rear	3 (11.5%)	2 (8.0%)
Under Carriage	0	1 (4.0%)
Top	0	3 (11.5%)
Non Collision	3 (11.5%)	3 (11.5%)
Unknown	1 (4.0%)	1 (4.0%)
Total	26 (100%)	26 (100%)

* Initial point of impact produces the first property damage or personal injury.
** Principal point of impact produces the greatest property damage or personal injury.

Table 13: Frequency of School Bus Fatal Accidents by Initial Impact Mode. (FARS 1982-86, TRB).

Impact direction	Percent of Passenger Fatalities No rollover	Rollover	Total
Collision:			
Front	20.6	35.3	55.9
Side	14.7	0	14.7
Rear	0	0	0
Under Carriage	2.9	0	2.9
Non collision			
Rollover	--	14.7	14.7
No rollover	11.8	--	11.8
Other, unknown	0	0	0
Total	50.0	50.0	100

Table 14: Frequency of School Bus Passenger Fatalities by Impact Mode. (FARS 1981-1983, NHTSA,1985).

Point of Initial Impact	Number of accidents involving fatality (FARS 1982-1986, TRB)	
	Initial Impact(*)	Principal Impact(**)
Front	14 (54.0%)	11 (42.0%)
Side (Right or Left)	5 (19.0%)	5 (19.0%)
Rear	3 (11.5%)	2 (8.0%)
Under Carriage	0	1 (4.0%)
Top	0	3 (11.5%)
Non Collision	3 (11.5%)	3 (11.5%)
Unknown	1 (4.0%)	1 (4.0%)
Total	26 (100%)	26 (100%)

* Initial point of impact produces the first property damage or personal injury.
** Principal point of impact produces the greatest property damage or personal injury.

Table 13: Frequency of School Bus Fatal Accidents by Initial Impact Mode. (FARS 1982-86, TRB).

Impact direction	Percent of Passenger Fatalities		
	No rollover	Rollover	Total
Collision:			
Front	20.6	35.3	55.9
Side	14.7	0	14.7
Rear	0	0	0
Under Carriage	2.9	0	2.9
Non collision			
Rollover	--	14.7	14.7
No rollover	11.8	--	11.8
Other, unknown	0	0	0
Total	50.0	50.0	100

Table 14: Frequency of School Bus Passenger Fatalities by Impact Mode. (FARS 1981-1983, NHTSA,1985).

The Texas accident investigation revealed that the 19 school bus passenger fatalities and 160 incapacitating injuries were distributed by accident type as shown in Table 15. The Texas data confirm that a large number of fatalities and incapacitating injuries are caused by rollover accidents. This study, because of its large sample size and long time period that it covered, may be considered to be a true representation of the school bus accident experience. Therefore, the reported results can offer substantial assistance in determining the distribution of fatalities and injuries by accident mode.

Accident Type	Number and Percent of School Bus Passenger Fatalities and Incapacitating Injuries	
	Fatal	Incapacitating
Front End	4 (21%)	46 (29%)
Side (not rollover)	8 (42%)	61 (38%)
Rear End	0 (0%)	3 (2%)
Rollover	4 (21%)	41 (26%)
Unknown	3 (16%)	9 (5%)
Total	19 (100%)	160 (100%)

Table 15: Fatal and Incapacitating Injuries to school bus passengers (Texas Experience, 1975-1984)

REVIEW OF INJURY OUTCOMES AND FREQUENCY OF INJURIES

On the basis of the available reports on injury criteria, passengers' physical injury locations and bus interior contact points, it can be determined that approximately 50 to 70 percent of all school bus passenger fatalities occur during frontal impact and rollover accidents. The rollover accidents (involving both collision and non collision) are of particular importance, since they are causing approximately 40 to 50 percent of all fatalities. Passenger ejection is mostly a phenomenon associated with rollovers, and it is generally accompanied by a high probability of passenger fatality or severe injury, and as such, it has to be emphasized. Although an exact school bus passenger fatality distribution by accident mode could not be clearly ascertained from the available literature, the authors of this report determined that the distribution presented in Table 16 can be used as a reasonable approximation of the accident types by impact mode that can be expected to be occurring in the future.

The New York State accident data suggest that 70 percent of all incapacitating and non incapacitating injuries occur on the head, face, eyes and legs. More than 40 percent of the pupils that suffer incapacitating injuries die, 25 percent sustain concussions, and another 25 percent suffer fractured or dislocated bones. The NTSB analysis of rather severe accidents identified that side walls, window frames, crushed roofs, and stanchions (modesty panels) as the major contact points in the bus interior causing more than 50 percent of all moderate to critical (AIS 2-AIS 6) injuries. These bus elements become even more predominant (75 percent) in their contribution to serious and above level (AIS 3-AIS 6) injuries.

Accident Type	Percent of School Bus Passenger Fatalities
Rollover (including both collision & non collision)	50
Front End (no rollover)	20
Side (no rollover)	20
Rear End (no rollover)	5
Other (passenger suddenly falling out of bus, keeping head out and struck, etc.)	5
Total	100

Table 16: Anticipated Future Distribution of School Bus Passenger Fatalities by Accident Mode.

The Texas accident investigations indicate that side impacts cause injuries most frequently, followed by frontal impacts and rollovers. The frequency of injuries caused by rear impacts is very low. The general applicability of this distribution is reasonable, if one also considers the evidence on the distribution of injured body parts and injury-causing contact points in the interior of the bus. Rollover injuries can be caused by both collision and non-collision accidents. Even a small number of rollover accidents may cause a substantial number of injuries, because of the high severity associated with this type of accidents. On the basis of the Texas study, which is the most comprehensive, and the remaining literature that has been already discussed, the authors of this report determined that the distribution presented in Table 17 can be used as a reasonable approximation of incapacitating and nonincapacitating injuries by accident type that can be expected to be occurring in the future.

The distribution of possible injuries by accident type was not considered, because, according to New York State data, 78 percent of all possible injuries are just complaint of pain, another 17 percent are "none visible", and the remaining 5 percent are unspecified. In addition, in 99 percent of possible injury cases the victim remains conscious, and in only 1 percent of the cases the victim is in shock. Therefore, possible school bus occupant injuries are by their nature of minor importance. Emphasis should be placed first on how to prevent or reduce occupant fatalities and incapacitating injuries, and second on non-incapacitating injuries. It should be expected that possible injuries would automatically be reduced also, if effective devices can be provided or measures taken that protect school bus passengers from fatal, incapacitating and non-incapacitating injuries.

Accident Type	Percent of School Bus Passenger Injuries		
	Incapacitating	Non-incapacitating	Possible
Front End	29	35	No infere-nce on % figures is made
Side Impact	38	30	
Rollover	26	20	
Rear End	2	10	
Unknown (presumably non collision)	5	5	
Total	100	100	

Table 17: Anticipated Future Distribution of School Bus Passenger Injuries by Accident Mode.

CHAPTER 5

OPERATING EXPERIENCE WITH SEAT BELTS ON SCHOOL BUSES

Both proponents and opponents of seat belts, in order to substantiate their views, present rather elaborate scenarios on what might or might not take place when seat belts are going to be installed on Type I school buses. While well thought out and argued hypotheses may be quite convincing, the best way of ascertaining possible behavior under a given set of circumstances, is through observations of what actually is happening in situations where those circumstances are already present.

SOURCES OF INFORMATION

There are three known surveys that investigated the operating experiences of districts, which in the absence of federal requirements, decided to equip their Type I school buses with seat belts. The major objective of these studies was to collect factual information (e.g., use rates), and substantiate arguments about a variety of issues associated with school bus seat belts that do not have a direct impact on the device's safety effectiveness (e.g., carryover effect). Two of the studies - performed by NHTSA and TRB - were national in scope, while the third collected data in the State of New York for two consecutive years, subsequent to that state's requirement that Type I school buses should be equipped with lap belts.

NHTSA Study - 1985

NHTSA surveyed in April 1985 nine school districts, which at the time, operated 85% (125) of the 143 large school buses equipped with seat belts in the United States. The school districts included were Glencoe, Wilmette, and Skokie districts # 68 and # 72, in Illinois; West Orange and West Windsor in New Jersey; Ardsley, Comerwogue and Greenburgh in New York; and Hartland in Vermont [15]. The operating experience of belt equipped buses in these districts varied from six to twenty months at the time of the study. The sites included both rural and suburban communities with middle class population. All nine school districts represented in the study were credited with above average academic ratings in their States, had no major discipline problems such as school vandalism or high dropouts, and had comprehensive operating budgets and funding for bus belt programs. Mandatory car belt laws were in effect or were awaiting implementation in the States which included 8 of the 9 districts. Parents in the communities of the districts were reported to be safety conscious with self reported safety belt usage rates of 80 to 100 percent, whereas the national self reported average rate was about 35 percent and the nationally observed rate was about 19 percent at the time of the study. Each site had some kind of educational program for students on school bus seat belt mechanics and policy. School administrators, transportation directors (though initially opposed), drivers and parents were reported to be supportive of the school belt program.

The study was performed through one day visits to each of the school districts, field investigations, and informal discussions with school officials, transportation coordinators, bus drivers, parents, and students. The study's objective was to answer the following set of three questions:

What are the seat belt use rates and what factors are associated with higher use rates?

Is there a carryover effect?

What is the impact of bus belt use on student behavior?

New York Association of Pupil Transportation Survey - 1988 and 1989.

The New York State Legislative Commission on Critical Transportation Choices recommended in 1986 that safety belts should be standard equipment on every school bus operated in that state and manufactured on or after July 1, 1987. That recommendation become NY State law, but although the buses are equipped with belts, the state does not mandate their use which is left up to individual districts. The Commission justified partially its recommendation on the operating experiences of two school districts which were operating seat belt equipped buses for a considerable period of time. The Commission noted that two school districts - Ardsley and Greenburgh Central 7 - claimed 80 percent usage of seat belts either with or without monitors. Furthermore, Greenburgh's large school buses had no monitors, and Ardley's eleven buses equipped with seat belts had monitors. Nevertheless, each district reported the same usage rate [16].

It is evident that the Legislative Commission's recommendation was based on real world experiences of high belt usage rates in two districts. However, when seat belt installation became mandatory in New York State and more school districts mandated the use of seat belts, the usage rates reported by the majority of the districts was not impressive as it is evident from two surveys conducted by the New York State Pupil Transportation Association surveys in 1988 and 1989 [28]. The major topics that the surveys addressed included seat belt use rates, seat belt related problems that the districts experienced, injuries resulting from seat belt use as well as other causes, the operating costs associated with seat belts, and bus down time for belt repairs. The surveys were reported to have responses from 502 and 476 districts in 1988 and 1989 respectively, representing a 65 percent response rate.

Transportation Research Board Survey - 1989.

This survey was part of the comprehensive Transportation Research Board study on "Improving School Bus Safety", which has been already mentioned [2]. The survey posed questions that were similar to those of the NHTSA study. It was conducted in the Fall of 1987 and was addressed to 24 school districts in different states that operated lap belt equipped Type I school buses. The number of responding districts was 16.

The contents of the above three reports and other relevant studies are used to discuss in subsequent sections the following issues:

a) Seat belt use on school bus.
b) The carryover effect.
c) Impact of seat belts on student behavior.
d) Program benefits and problems.

SEAT BELT USE RATES

The NHTSA study reported that the elementary school student usage rate was 80 to 100 percent, while among high school students the reported usage rate was 50 percent or less. Most of the habitual belt users were predominantly those who had previously worn belts in family cars. Many students who lacked initiative, needed to be reminded by drivers or monitors to buckle up. Younger students were more likely to buckle themselves because they were told to do so by an adult (driver, monitor, teacher or parents). The older students, who did not use seat belts in the school buses, considered bus belts to be limiting their personal choice of freedom, creating discomfort and inconvenience, and that belts were rather appropriate for younger children, and not for themselves.

The NHTSA researchers observed the following patterns associated with school bus seat belt use:

Some school districts achieved high usage rates fairly early through "hands-on" bus belt training and early on-board monitoring, whereas in other districts, where educational and training programs were rather limited, belt usage rates increased slowly.

Multi-year increases in belt use were reported in three school districts which were early starters of the bus belt program. The outcome was credited to their multi-year seat belt education programs, and continued entry into the system of elementary school children who were already accustomed to the use of child safety seats and other preschool occupant restraints. However, for the same trend to occur in other districts, it might require classroom reinforcement, and several years' time of seat belt presence in order to acquire the habit of use.

Some school officials expressed optimism that "growing public support for belt use and state mandatory belt laws for cars would make future bus belt usage more socially acceptable to students and drivers." However, administrators and drivers expressed doubt that even with these elements in place, high belt usage rates could be achieved among older students, because drivers would most likely be reluctant to enforce belt laws with this group, and monitors would not usually be assigned to ride with older students.

The site visits of NHTSA researchers revealed that sanctions were rarely invoked for student non use of school bus seat belts. It was found that discipline problems on the bus rather than noncompliance with safety belt policies was most likely to trigger sanctions.

NHTSA investigators observed that the nine school districts studied were unique with respect to their self-initiated school bus belt programs. They were middle class socially and academically, had adequate funding, were involved in various bus safety efforts before they installed belts, had innovative transportation coordinators, committed school officials, and supportive, belt wearing parents. These may not be the characteristics of most U.S. school districts. The researchers, therefore, concluded:

> *"Achieving or surpassing the student belt use rates reported in this study would not be reasonably expected in districts where these traits were not present to affect all aspects of program development and implementation."*

The New York State survey found in 1989 that 85.3 percent of the responding districts had 20-passenger or larger school buses equipped with seat belts in service. The proportion of districts that had similarly equipped vehicles in 1988 was 58.7 percent. Although the availability of seat belts increased considerably between the two years, districts were very slow in mandating their use. The proportion of districts that mandated the use of seat belts increased slightly from 8.4 percent (42 out of 502) in 1988 to 10.59 percent (52 out of 476) in 1989. The reported seat belt use rates from the districts that did mandate their use were as follows:

Reported student belt use rate	No. of districts (%)	
	1988	1989
1__25%	27(64%)	34(65.45%)
26__50%	4(9.5%)	7(13.5%)
51__75%	5(11.9%)	4(7.6%)
76__100%	6(14.3%)	7(13.5%)
	42(100%)	52(100%)

It is apparent that approximately 65% of the districts that mandated seat belt use reported a use rate that was less than 25% percent.

The Transportation Research Board survey discovered a wide variation of use rates among the responding districts as the following findings indicate:

Fairfax county, Virginia operated 293 Type I school buses equipped with seat belts transporting 25,248 students. Seat belt use was optional and the reported usage rate was less than 20%

Skokie (Fairview), Illinois district # 72, was transporting 555 students in belt-equipped buses. Each bus had a monitor on board. Seat belt use was 100%

West Orange, New Jersey operated 26 type I belt-equipped buses transporting 2,000 school children. Seat belt use was reported to be 95%.

On the basis of their own survey and other available studies, the TRB committee concluded that "If all type I school buses were equipped with seat belts, roughly one half of all passengers would use them. However, considerable variability exists in seat belt use rates among school districts with some reporting rates as low as 20 percent (Fairfax County, Virginia) and others reporting rates approaching 100 percent (Skokie, Illinois). If seat belts had been routinely available in school buses, and if seat belt use had been rigorously enforced, higher usage rates might have resulted."

CARRYOVER EFFECT

On the issue of whether the use of seat belts in school buses has a habit forming effect on students that carries over to their behavior to make them use seat belts in private automobiles, the NHTSA study concluded on the basis of the experiences of 9 school districts that "Evidence of 'carryover effects' was inconclusive. On the one hand, some informants said students who had previously used car belts increased their frequency of car belt use after riding belted buses and students who rode these buses were more likely than other students to prompt other car passengers to buckle up. On the other hand parent car rules and attitudes, mandatory car belt use laws, and classroom education programs appeared to play more dominant roles in students' car belt use than bus-belt carryover effects."

The NHTSA researchers emphasized that a habit formation of bus belt use by students must be demonstrated for any carryover effect to occur. The experiences of the researchers in the nine study sites were that occasional or supervised bus belt use did not lead to clear demonstrations of habitual behavior. The study pointed out, that it is possible that formation of bus belt use habits might take several years and require classroom reinforcement and education. Therefore, carryover effects would not be clearly perceived in the short term.

Long term carryover effects were not easy to prove, the NHTSA researchers explained, even if high seat belt use on school buses were to somehow be achieved, because, as states would enact mandatory car belt laws, an increasing number of students would be wearing car belts regardless of provisions for bus belts, leaving a greatly reduced student 'hold-out' population to be influenced. In addition, higher school bus seat belt use rates must reflect new habit formation (rather than reflect imposed behavior), if carryover is to occur.

IMPACT OF SEAT BELTS ON STUDENT BEHAVIOR

On the issue of whether seat belts on school buses have an impact on student behavior, the NHTSA researchers observed that "Improved student conduct on the bus appears to be one of the major benefits of a belted school bus program. Students riding with belt equipped and non-equipped buses reported this effect."

Administrators, transportation directors and drivers reported improved student behavior on the buses equipped with belts. The site experience of the NHTSA investigators revealed that students were seated and there was little or no standing or roaming in aisles. Instances of putting hands or heads out of windows were few, and fewer fights or rowdy behavior were observed. The drivers were less distracted and required to speak to the students less frequently. Even in the district with the lowest reported seat belt use rate, the drivers reported that the belt program had a significant effect on improving student behavior. A similar view was reiterated by the Fairfax County district considered by the TRB study. Although the use rate was reported to be only 20% and vigorous objections to installing seat belts on Type I school buses were raised, it was acknowledged that seat belts can improve student-conduct on school buses.

On the basis of available research and its own survey, the TRB committee concluded that the use of seat belts in school buses might improve student behavior and reduce driver distractions somewhat.

Not many research papers are available on whether disruptive student behavior causes school bus accidents. A 1980 study of accidents in three North Carolina Counties estimated that the true number of accidents due to drivers' distraction would probably lie somewhere between 1.5 and 5 percent [17]. Another study did not quantify the relationship, but it concluded that "Perhaps in the final analysis the exact number of accidents precipitated by disruptions is secondary, the tragic facts are that drivers are distracted by behavior and needless accidents do occur,...." [18].

PROGRAM PERCEPTION, BENEFITS AND PROBLEMS

The NHTSA researchers observed the following during their visits to the nine districts that had self-initiated seat belt programs:

School administrators perceived that seat belts increased student safety and improved student conduct.

The transportation directors, although initially opposed to a trial bus belt program subsequently supported installation of seat belts on school buses.

Drivers in most sites, and parents uniformly supported the program.

Students generally favored the program, younger students reported positive feelings while the older students voiced most objections to be belted.

The Transportation Research Board survey found that most of the 16 districts that responded were pleased with their seat belt programs and few were not.

Evidence of overall program benefits could not be clearly ascertained from the results of the New York Pupil Transportation Association survey, since it was not designed to look for such benefits.

Addressing problems that may be associated with seat belt programs, NHTSA researchers made the following observations:

> Belt related vandalism and mischief did not occur in most of the districts. The few reported instances of vandalism and mischief were limited to removal of buckles from straps and stuffing belts within the seat cushions.
>
> Some students fail to tighten the belts and wear them in a proper manner.
>
> Each belt has to be adjusted on each trip because of the varied size of students transported by the buses. Retractable belts that tighten automatically were ordered by at least one district.

The New York State Legislative Commission on Critical Transportation Choices offered the following suggestion about seat belt adjustments:

> "The question of how many lap belts to install for a standard 39-inch seat depends on whether large or small children are being transported. The user makes the decision when ordering by specifying the number of belts per seat. Consideration should be given to ordering belts with retractors as the feature encourages proper fit of the lap belt. Alternatively, providing bus monitors would assure correct belt positioning."

Although retracting seat belts would tighten any slack of the belt when worn, either separate buses would be required to transport younger and older students or, some or all buses of a district would be required to have some of their 39-inch seats fitted with 2 and some with 3 seat belts to accommodate both young (small) and older (large) students. The operating problems and cost of such an arrangement are considerable.

The TRB survey found that in Fairfax county, Virginia seat belt use as a weapon was a minor problem, but vandalism of belts and theft of belt buckles had been major problems. As mentioned earlier, most of the 16 responding districts in the TRB survey were pleased with their bus belt program. No major problems were reported by other districts.

The 1989 New York Pupil Transportation Association survey uncovered a number of problems associated with seat belts:

Of the 406 districts operating belt-equipped buses, 69 districts reported that seat belts caused 204 injuries. The cited causes were belts used as weapon, tripping, and metal splinters.

Of the total 476 responding districts, 71 districts reported 170 injuries that did not involve seat belts. The cited injury causes were fighting/horse play, bumps from the road, and tripping.

Of the 406 responding districts operating belt-equipped buses 34.5% (140/406) reported multiple problems with seat belts. The problems as cited were cut belt, buckle removed, broken buckle, improper adjustment, and belts tied together.

The survey report concluded that while school bus transportation remained one of the safest modes of transport, the apparent rising incident of seat belt related injuries must be addressed, and that additional monitoring and training in proper belt use by the students might be required.

In an earlier study, South West Institute researchers, investigated the operating experience of a Houston school district that installed seat belts on pre-1977 buses. The Houston Independent school district had 246 buses equipped with seat belts, and was transporting daily 21,000 students. The district attempted a massive safety program during the 1973 school year, which included an intensive seat belt use campaign. The district did not experience bus accidents where seat belts would have made a material difference to those that were reported as injured. The investigation concluded that the positive benefits from seat belts had been minimal, and it was not recommend that seat belts should continue to be purchased and installed [4]

REVIEW OF OPERATING EXPERIENCES

The use rate is the most important factor of a seat belt implementation program. The available literature and the information obtained by the authors of this report from New Jersey school districts indicates that a satisfactory use rate can be achieved, provided that the use is mandated and the program is implemented properly. The NHTSA study observed 80 to 100 percent use rates among elementary school children and 50 percent or less among high school students. TRB concluded that a 50 percent overall use rate can be expected, and a higher rate might be achieved with a rigorous enforcement policy. The authors of this report consider that with proper enforcement an overall use rate of 50 to 75 percent can be achieved within the first 5 years of implementation, and a rate of 75 percent and above can be maintained on and after the 10th year of implementation. This increasing use is based on the fact that with the passage of time, the habit formation will proliferate through the ranks of the student body as the younger children who have been observed to use seat belts at very high rates grow older and influence the overall use rate.

The operating experience demonstrates conclusively that seat belts improve student discipline in the bus, drivers are distracted less, and as a result accidents may be reduced by 1.5 to 5 percent. Overall injuries could be reduced by a similar proportion. Although this is an item that merits consideration, it is not included in the determination of seat belt effectiveness, because of the conservative nature of all factors derived for the purpose of effectiveness calculations.

Because of the limited operating experience that we have to date with seat belts, there is no clear evidence in the literature to support any clear carryover effect. However, habit formation does develop over a longer period of time. Therefore, 5 to 10 years after the implementation of a mandatory school bus seat belt use law a carryover effect can be obtained, provided that it is not countered by school personnel and parental attitudes. If a carryover effect really exists, it is sufficient by itself to justify the installation of seat belts on school buses. However, because no conclusive evidence was found in the reviewed literature, it was not considered in the derivation of seat belt effectiveness.

There is evidence from the operating experience of belt-equipped school buses in New York State that seat belts may cause as many minor injuries as other collision or non accident causes. However, if seat belts are proven to be effective in reducing fatalities and incapacitating or non-incapacitating injuries, any minor injuries that may be caused by belts due to their misuse are of minor importance, and insufficient to invalidate the seat belts' overall effectiveness. Furthermore, the minor injuries contributed by seat belts can be reduced by effective administrative policies, which are essential in order to achieve any benefit from a school bus seat belt program. The New York State survey also reported vandalism and multiple problems such as broken buckles, cut belts etc., whereas such problems have not been reported as a major factor in the districts studied by NHTSA. Therefore, these problems may be reduced substantially with a better disciplinary policy.

It is apparent from the studies that were summarized above, that school districts that have mandated and are enforcing the use of seat belts have better experiences with their seat belt programs. On the other hand, where seat belt use is optional or enforcement is not strict, the success of the program has been offset by low use rates, misuse of the belts, and other problems. The fact that the majority of school districts (including those of New York State) reported a usage rate of less than 25 percent, is not enough to dismiss as generally impossible to achieve the experience from some school districts like West Orange, NJ and Skokie, IL that report 95 to 100 percent use rates. Rigorous enforcement policies, educational programs, administrative support, driver co-operation, transportation directors' support, and parental safety awareness are all necessary to reap the benefits from the installation of seat belts on school buses. The primary purpose of seat belts on school buses is to protect passengers in accidents. The limited operating experience to date, essentially provides no basis for determining the benefits of seat belts in terms of reducing injuries or fatalities. However, it can be used to determine a future use rate, which in turn can be used to determine the overall effectiveness of seat belts.

CHAPTER 6

PROFESSIONAL AND INTEREST GROUP OPINIONS AND ASSOCIATED ISSUES

Expert opinion should be given special consideration, particularly when the issue is as hotly debated as the one under consideration here. In these situations, statements can be made by proponents or opponents which may be perfectly logical to a lay person, but may not be justifiable if one had the knowledge of the expert to make a critical evaluation. The purpose of this chapter is to present the views of the experts on the subject of seat belts on school buses. Experts here are considered to be persons or organizations who because of their professional training or work experience have an intimate knowledge of school bus safety and as such can predict not only the effectiveness of seat belts in preventing accidents, but can also offer their considered opinion on associated issues that are not directly related to safety. Before the opinions of experts are presented, the standards that govern school bus safety are presented briefly, because most of the discussions are centered about the issue of whether existing safety measures are adequate.

EFFECTIVENESS OF FEDERAL MOTOR VEHICLE SAFETY STANDARDS

The U.S. Department of Transportation specifies safety standards for school buses. Thirty of the fifty Federal Motor Vehicle Safety Standards (FMVSS) apply to buses, including school buses. Three of these standards are of particular importance to the present study. They became effective in April 1977, and apply to school buses only.

FMVSS 220 - School Bus Rollover Protection This standard establishes performance requirements for school buses during rollovers. The purpose of the standard is to insure that the school bus body structure can withstand forces encountered during rollovers, thus reducing the number of fatalities and injuries that may be contributed from failures of the school bus body structure. This standard applies to all school buses.

FMVSS 221 - School Bus Body Joint Strength This standard establishes requirements for the strength of school bus body panels. Its purpose is to reduce fatalities and injuries resulting from the structural collapse of school bus bodies during crashes. The standard applies to large school buses over 10,000 lbs.

FMVSS 222 - School Bus Seating and Crash Protection The standard establishes occupant protection requirements for school bus passenger seats and restraining barriers. Its purpose is to reduce occupant fatalities and injury severity from school bus occupant impacts against structures within the vehicle during crashes and sudden driving maneuvers. The standard applies to all school buses and provides passenger protection through the "compartmentalization" of the vehicle. This standard also specifies the required deflection criteria, head and knee impact requirements, and establishes criteria for cushioning sufficiently the head and leg impact zones. The seat back height is required to be 20 inches above the Seating Reference Point (SRP). The maximum spacing between the rear surface of the front seat and the SRP of the immediate back seat is specified to be 24 inches (in the horizontal plane).

Prior to the specification of seat back height and seat spacing standards, NHTSA conducted sled tests that included seat back heights of 20, 22 and 24 inches and seat spacings of 20, 22 and 24 inches. While adopting a seat back height of 20 inches above the SRP, NHTSA does not dispute the argument that a properly constructed higher seat can provide even more protection, but the 20-inch seat adopted by the agency provides reasonable protection [2]. UCLA researchers who conducted the 1967 crash tests, recommended seats that are 28 inches high (approximately 24 inches above the SRP). Currently, two states (New York and Illinois) require 24-inch high seats (4 inches above the Federal standard). The TRB study found that these states have no operational problems with the higher seat backs, and recommended that the minimum seat back height should be raised from 20 inches to 24 inches form the SRP [2].

Effectiveness of FMVSS

The changes incorporated by Federal standards in post-1977 school buses improved safety significantly. FMVSS 222 requires closely spaced seats with high padded seat backs intended to contain or compartmentalize the passenger in the event of a crash and thereby providing passive protection to school bus occupants. NHTSA reviewed the effectiveness of FMVSS 222 in 1980 and concluded that seat belts are probably effective in reducing 69 percent of the injuries in the vast majority of school bus accidents which usually involved minor damage to the bus, and at most few passenger injuries at minor or moderate injury levels. In addition, the seats probably reduced 29 percent of the injuries in few violent school bus accidents that produced fatalities. In the relatively rare cases of very violent accidents involving rollovers, crashes with trains etc., where the passengers are thrown into contact with broken glass, walls, roof, and other interior objects, or are ejected from the bus, the standard had only limited success. [19]

The TRB study concluded from its reviewed of the available literature on the effectiveness of Federal standards that "the three school bus safety standards issued in 1977 (FMVSS 220, 221 and 222) have been highly effective in reducing school bus passenger injuries." [2]

Federal Standards and Seat Belt Use

Federal standards do not require seat belts in large (GVWR over 10,000 lbs) school buses. But, the small school buses (GVWR less than 10,000 lbs) are required to be equipped with seat (lap) belts. FMVSS 209 (Seat Belt Assemblies), and FMVSS 210 (Seat Belt Assembly Anchorage) provide the requirements and specifications for seat belt installation. NHTSA says that seat belts are necessary and effective for occupant protection in small buses, because of their similarity to passenger cars. For large school buses, NHTSA said: "In view of the effectiveness of current safety standards and excellent safety record of school buses generally, we do not believe that a federal requirement for safety belts in large school buses is warranted". The National Transportation Safety Board reviewed this matter in 1983, and found that "current NHTSA standards appear to be effective in eliminating or substantially reducing the majority of school bus passenger injuries." [1]

In summary, the Federal standards governing school buses, and particularly those incorporated in post-1977 buses, improved school bus passenger safety significantly. The available research results suggest that increasing the seat back height to 24 inches from 20 inches above the SRP may provide additional protection.

Installation of Seat Belts in New Buses

Although Federal regulations do not require the installation of seat belts in Type I buses, NHTSA, emphasizes that the Federal standards specify the minimum safety requirements applicable to school buses, and "Nothing prohibits a state or local jurisdiction from purchasing buses equipped with seat belts." [1]

Regarding the capability of large post-1977 large bus seats to withstand belt loads, Diane K. Steed of NHTSA stated that seats in the Superior and Thomas manufactured buses passed the required tests of seat integrity and seat anchorage to withstand the belt load. However, there is no requirement that these buses do so, because seat belts are not required to be installed in them. [9]

Booz Allen and Hamilton Inc. conducted a study of seat belts in school buses for the California Highway Patrol [20]. Bus manufacturers were reported in this study as supporting the view that current seat frames would require additional strengthening, if lap belts were to be installed. Answering a similar inquiry, Joseph Levin, chief counsel of NHTSA said:

> "Manufacturers who indicate that seats or floors of larger buses are not strong enough to install the seat belts probably misunderstood the belt requirements for large buses. Seat belts can be installed for passenger seats without complying with any existing seat belt requirements. The National Highway Traffic Safety Administration suggests that states adopt the belt load requirements previously proposed for standard No. 222. School bus seats currently in production should be sufficiently strong to withstand the former proposed belt load requirements[1]."[9]

The installation of safety belts in passenger cars and small buses conforms to the requirements of FMVSS 208 (Occupant Crash Protection), FMVSS 209 (Safety Belts) and FMVSS 210 (Safety Belt Anchorages). However, since FMVSS 222 does not require seat belts in large buses, the purchasers have no explicit guidelines concerning their installation. NHTSA noted that most manufactures who install belts and anchorages at the request of purchasers, voluntarily comply with these standards, although they are not required to do so [1].

The Booz Allen and Hamilton study pointed out that the manufacturers stressed the need for seat belt installation standards for large buses, since without standards they could be held responsible for lap belt failures even if the installation had been engineered to the highest standards possible. The National Coalition for Seat Belts on School Buses suggested the following guidelines for the installation of seat belts: [9]

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1 NHTSA considered the possibility of installing seat belts in all school buses in 1973. However, in 1977 when FMVSS 222 was issued, lap belts for passenger seats in large buses were not required.

"Young children find it easier to fasten belts on the front center of the abdomen. Also, larger children find it difficult to buckle a belt at the side hip position when three to a seat. Therefore, NCSSB recommends that the short end be 16" and the long end be 29" from where the seat back meets the cushion. This permits an easier center abdomen fastening of the seat belt. The aisle positions must have the short 16" end to avoid a tripping hazard. The belts should be attached to the posterior seat frame under the seat cushion and not to the walls of the bus or the leg of the seat. The color of the webbing for the middle seating position when there are three belts per seat, should differ from the color of the webbing of the two outside set of belts. The buckles should be light-weight and only one end of the belt should be adjustable, not both ends. Similar buckles should be attached at the aisle positions so the belt can't be attached across the aisle."

The bus and sled crash tests indicated that in frontal collisions the belted dummies experienced higher HIC values than the unbelted ones. The New York State Legislative Commission whose recommendations were the basis for requiring Type I buses to be equipped with seat belts in that State, also recommended that improved padding on seat backs and metal cross bars should be required on all school buses equipped with seat belts. The purpose of this last recommendation was to reduce the severity of the head impact during front end collisions. But, the Transport Canada sled test results [22] showed no improvement of HIC values even with increased padding on the seat backs.

In summary, it is apparent from NHTSA's position, that although seat belts are not required by Federal standards for post-1977 large buses, the buses manufactured in conformance with FMVSS 222 should be capable to withstand the belt load, and any local jurisdiction is at liberty to make its own decision to equip the large buses with seat belts. However, when this liberty is exercised by a school district, there exist no Federal standard on how to install the belts on large buses, and manufactures are concerned about liability in the event of lap belt failure.

Retrofitting School Buses with Seat Belts

Since the state or any local jurisdiction is permitted to equip the school buses with seat belts, it is possible that seat belts may be added to new as well as old buses. NHTSA has pointed out that several major companies that manufacture large school buses (Amtram, Blue Bird, Carpenter, Crown, Superior, Thomas and Wayne) did not advise to retrofit a school bus (either pre-1977 or post-1977 construction) with lap belts nor did they recommend that their dealers do so. The Insurance Institute for Highway Safety (IIHS) referring to NHTSA and Wayne corporation remarks reported that school districts that retrofit their school buses with lap belts should be very careful about installation, and "under no circumstances should belts be added to buses that were manufactured before 1977. The old bus seats have an exposed rail. Because of the dynamics of a crash, lap belts would actually increase the force with which an occupant's head would strike the rail." [21]. NHTSA said that industry officials cited several problems that prevent the successful retrofitting of pre-1977 buses. They include seats that might not have padded covering, and seat construction that might not be strong enough resulting in a collapse from the loads generated by lap belts.

Regarding post-1977 buses, NHTSA reported that none of the manufacturers was willing to retrofit them with lap belts, because after a few years of use the bus floors deteriorate and are less capable of withstand the forces that belted passengers may place on them in the event of crashes. All systems, and particularly the floor, must be of the same strength and condition as that of a new bus, if retrofitting is to take place. NHTSA recommended that school districts wanting to retrofit post-1977 school buses with belts should first make sure that the belts meet FMVSS 209 (safety belts). Furthermore, if the manufacturer sold buses that had a lap belt option, school districts should check to see how they were installed and, if possible, follow the manufacturer's installation method [1]. The National Coalition for Seat Belts on School Buses (NCSSB) stated that the coalition has no position on the issue, and was unable to make any blanket statement on retrofitting. However, NCSSB suggested that each bus must be individually examined for possible retrofitting.

In summary, it is evident that pre-1977 school buses should not be retrofitted with seat belts. If any school district wishes to retrofit post-1977 school bus with belts, the bus should be carefully examined with regard to seat frame, floor strength and condition, and in the absence of any specific guidelines, NHTSA recommendations for retrofitting should be followed.

Liability Issue Associated with Seat Belts

Some districts are concerned with the liability issues that the installation of seat belts in school buses may create. The major liability questions that may arise, compiled by Thomas Bus Inc. [23], are who would be liable if:

A child is not wearing the seat belt and is injured in a bus accident.

A child is not wearing the seat belt properly (belt too loose or tight) and is injured during an accident.

A child is injured by tripping over a belt or is hit by a belt.

A child is not wearing the belt because it does not operate properly (vandalized earlier in the day), and is injured in an accident.

There have been no cases to date involving the above mentioned questions in school districts that are operating belt-equipped buses throughout the nation. The survey of 81 school districts in Texas did not find liability to be an issue of critical importance at the time of the survey. However, several administrators reported that the liability issue would become a problem, if safety belts were mandated [13].

The National Coalition for Seat Belts on School Buses presented some viewpoints on the issue. In a letter, dated July 1985, and addressed to this organization, a Texas law firm argued:

> "Of all the red herring resorted to, to avoid putting seat belts in school buses, the liability aspect has got to be the most fraudulent. I would recommend your contacting a local plaintiff's attorney to give a talk to the school board to explain how a school board's failure to install seat belts may give rise to substantial liability, and actually installing seat belts and adopting a program to insure their use would go a long way toward avoiding not only

injuries but liability. A school district would not have to guarantee that every seat belt is used, only adopt a reasonable program to encourage their use."

Similar views were also expressed by another letter, dated February 1986, to the Denver Board of Education by a Denver law firm which argued:

> "....if the court allows the jury to decide the amount of care that should be taken, a case could just as well be based on the question of whether seat belts should have been installed when they were not, as on the failure to insist on proper use if they were installed.... it would not be in the district's best interest for the jury to perceive that safety equipment was omitted because the school district felt that the policy would lessen liability or costs." (NCSBSB, Third Edition, 1986).

Although court cases involving liability issues associated with seat belts in a belt-equipped bus are not available, Carol Fast (of the NCSBSB) in her testimony to a Nassau County (New York) public hearing (December 1984) reported that two law suits had arisen in the county out of the non-existence of belts in buses. A child was killed in one case and in the other the child was paralyzed. Arthur Yeager (Physicians for Automotive Safety) provided the following information on cases that arose from the failure to install seat belts:

> Jose Jesus Aguire vs. Dario Hinjosa, et al Corpus Christi, TX. Child was decapitated by a pole as he stuck his head out of a window as the bus started to pull away from the curb. It was argued that if seat belts had been provided and he was belted he could not have put his head out of the window. The bus manufacturer and bus distributor contributed about 40% of the over half million dollar settlement.
>
> Terry vs. Northern Kentucky Transit Cincinnati, Ohio. When bus stopped suddenly, the teacher in the front right seat was thrown over the modesty panel into the stairwell and suffered injury. Settlement was against the bus operator for about $50,000.00.
>
> Leon Lewis, et al vs. Galveston Independent School District Alvin TX. About 43 passengers were injured and one died as a bus which was struck by a car crashed through a guardrail and fell 30 feet onto its side. Passengers were hurt as they were thrown violently from right to left as the bus fell on its side. There was little deformation of the vehicle and injuries were attributed to the lack of passenger containment in their space leading to contact with seats, seat legs and sidewall. Many were seriously injured with long hospital stays and permanent injury. Case is awaiting trial.
>
> IMO Karen Mc Bride Philadelphia PA $2.5 million solar settlement for permanent severe brain damage from being thrown from seat into sidewall when bus skidded into a guardrail and tree.
>
> Ralph G. Lee vs. Board of Education of Howard county et al Columbia, MD. Brain injury as a result of concussion as bus rolled on its side after collision with a car. Case was settled but the level is unknown.

Canadian researchers expressed the following views regarding the liability aspect of mandatory child restraint system laws for passenger automobiles:

"...where parents fail to take appropriate measures to ensure that their children are adequately placed in a restraint assembly, and these children suffer injuries directly caused by such failure, an action will lie against their parents for negligence. Where a parent with a young child improperly places the child in a system or does not put the child in one at all and is involved in a collision, even though the collision may be entirely the fault of someone else, the defendant will have available the seat belt defense to the extent that the injuries suffered by the child may be directly attributed to the improper use or the failure to use the child restraint system. That amount that is offset against the global award may be claimed by the child against his or her parent. Here the standard of the reasonable parent will likely be determined by the manufacturer's standards for the use of the child-restraint system set out in one type of legislation and by legislation that mandates the use of such a system." [24]

If seat belts are installed in school buses, the school district may be found to have responsibilities similar to those of the parent in the above child-restraint law case. Although a district may be sued whether seat belts are present in a school bus or not, the available evidence indicates that the absence of belts increases the probability of substantiating negligence.

The authors of the report are of the opinion that liability should not be a major consideration in deciding whether to have seat belts in school buses or not. The primary consideration should be the safety effectiveness of the device.

EXPERT VIEWS

Medical Views

Expert medical opinions can be found that are in favor of and against seat belts as a restraining device. Although most of the experts acknowledge the safety benefits of seat belts for adults in motor vehicles, some are concerned that the same may not be true for young children.

Several expert medical views were collected by Ed Mehler for his testimony before the Sub-committee on Commerce and Finance, on Bill HR-4187 (School Bus Safety Act of 1973) and were reproduced in the 1986 report of the National Coalition of Seat Belts on School Buses [9]. They are summarized below:

Dr. Donald Harrington, an orthopedic surgeon said that any injury to the hip or back caused by wearing a seat belt occurs only in high trauma (severe impact accidents) and that any injury occurring in this manner would be minor compared to the extensive injuries that would have occurred if a belt had not been used. He is reported to have said that there is no question about seat belts providing greater safety for school children in buses.

Dr. Haller of Johns Hopkins Hospital said: "it is unlikely that there would be internal injuries due to use of seat belts. Especially not in children or slender adults.

If the impact of an accident is severe enough for a seat belt to cause injury then that passenger would be dead without one."

A similar opinion was expressed by Dr. Frank Sin, an orthopedic surgeon. He said: "any injury sustained by passengers due to seat belts would, in nearly all cases, be far less severe than the resulting injuries caused by no seat belts being used."

On the other hand, there are views expressing concerns about injuries that may occur from seat belts. A Maryland Department of Education (1974) study quoted Dr. Noer, an orthopedic surgeon saying: "If the seat belt is permitted to ride up above the iliac crest, there is nothing from a skeletal standpoint to prevent lesions produced by seat belts, including crashed kidneys, ruptured bladders, and damage to the pregnant uterus. If the seat belt is worn properly as a lap belt, it hooks between the thigh bones and the interior - superior iliac spine of the pelvis. These are broad strong bony projections hanging slightly downward, that completely prohibit such injuries which can occur only when the seat belt is worn too loose and thus patient slides out from under it, or else worn too high. But in a child, these bony prominances are too rounded. The thigh is relatively larger and the pelvis itself smaller. Therefore it is almost impossible to apply a seat belt to a youngster in such a way that with a decelarative force, the child's weight will not be thrown directly upon the viscera."

The Maryland study however noted that Dr. Noer was very much in favor of appropriate restraint devices. In Ed Mehler's testimony, Dr. Noer was quoted as having said that other safety improvements such as adequate strength of bus bodies, better anchorage of belts and a better seat design such as the one recommended by UCLA, and escape hatches should be made first. Furthermore, the seats should be turned around. Under these conditions he would recommend seat belts in all school buses.

Dr. Verone Robert of the University of Michigan has been quoted in a 1972 paper by David Soul (a former NHTSA highway safety specialist) to have said that children are not miniature adults, they are built differently and the adult lap belt is not acceptable for the child. However Ed Mehler referring to his conversation with Dr. Robert said in his testimony that Dr. Robert's statements were made for toddlers, not for school children, and according to Dr. Robert seat belts would be of tremendous value in saving lives and preventing injuries in the event of a school bus accident.

Thomas Built Buses, Inc. compiled several medical experts' opinions. The sources and views are: [23]

In *Surgery, Gynecology and Obstetrics* (September 1970) a medical expert reported that

1) lap type seat belts prevent more injuries than they cause, principally because they prevent the victim from being thrown out of the automobile, or being harried with it.

2) lap type seat belts redirect the decelerating forces from the head and chest to the lower parts of the abdomen.

3) when the belt is worn improperly, renal contusions and ruptures of the liver, pancreas and spleen have occurred.

Dr. Charles L. White (*Annals of Surgery*, April 1968) said that the physical laws of colliding bodies suggest that forcible impact between abdominal wall and seat belts may tear and rupture the hollow viscera.

The views of medical experts are of great importance because they are the ones who treat injured school children after accidents. However, the views summarized so far were expressed before the implementation of current Federal safety standards, whose contribution to increased safety has been acknowledged by all. The experts that were already quoted, may not express the same opinions for post-1977 buses. Recent medical opinions from individual medical experts are not available in the literature. However, the present position of a number of medical associations is very clear. The National Coalition for Seat Belts on School Buses summarized in its 1986 report the following resolutions or statements of medical associations:

> The American Medical Association resolved (June 1984) to "support legislative action to promote availability of effective seat belts in all school buses in the United States."
>
> The American Academy of Pediatrics supports the position that: "Seat belts should be required on all newly manufactured school buses, regardless of their size and the number of pupils transported." (October, 1984)
>
> The American College of Preventive Medicine supports the "immediate installation of seat belts in new school buses as immediate preventive action to protect the health of children." (June, 1984)
>
> The Society for Adolescent Medicine position statement (May 1985) stated that the Society "whose primary concern is the health and welfare of youth strongly supports the use of seat belts when riding in school buses."
>
> The American Association of Oral and Maxillofacial Surgery resolved that "by its board of Trustees, Committees and Fellowship, endorse, advocate and counsel the use of seat belts, safety restraints, or combinations thereof in all motor vehicles with compartments for the carriage of passengers, including school buses; to patients and the public in general."

In summary, although individual opinions may differ, the associations of medical professionals endorse the installation of seat belts on school buses. Therefore, the majority of medical experts favor seat belts on school buses.

Manufacturers Views

The California Highway Patrol sponsored study [20] sought the opinions of school bus manufacturers, and they expressed the following views:

In frontal impacts lap belts would not be beneficial.

In rear impacts lap belts would not be beneficial and in some instances the belt could increase the accident severity.

The responses were mixed for side impacts to assess an overall opinion. Some felt that belts would not make any difference as far as head and neck injuries are concerned.

In rollover accidents lap belts would help reduce injuries by protecting the passengers from being struck from the side and roof of the bus.

Two problems associated with FMVSS compliance were pointed out.

(a) The refitting of belts is undesirable because the floor strength of an old bus would not be sufficient to withstand the belt load.

(b) Several new FMVSS chapters would be needed if lap belts are installed. The current seat frames would require additional strengthening, which in turn would require additional seat back padding to conform with the standards. The increased rigidity of the seat may counter the deflection criteria of the seats required by the current standard.

Four additional points were made associated with implementation

(a) Seat belt installation standards in automobiles would not apply to school buses. Therefore, an anchoring system has to be designed. Without standards, product liability is of concern. Seat spacing and seat frame strength standards would have to be changed due to the higher HIC values associated with belted students.

(b) One manufacturer pointed out that if belted students ride with unbelted students, a double loading could result when an unbelted student hits the rear of the seat in front that contains a belted student. Such an impact could cause seat anchor failure and produce more severe injuries.

(c) Several pointed out that seating capacity would be reduced, if only two belts were required to be installed in the current 3-seat bench. This would have an adverse effect on the school districts since additional buses and funds would be required.

(d) Installation is feasible because an engineering solution can be developed, However, it will be costly.

Morris Adams of Thomas Built Buses Inc. during an interview with *School Bus Fleet* [25] expressed the following views:

The requirement of belts in automobiles should not be equated with the need to install belts on school buses too. ...School buses are built in such a way that they can absorb greater impact forces. School bus joints have strength standards that no other vehicles made in the United States have to meet. ...Upon impact, school bus passengers are not thrown on the dashboard or wind shields. School bus passengers are not seated near the door, and there is no possibility of a school child thrown out of the bus unless the roof got torn off the bus. ...School buses travel at low speed in a friendly environment on a regular schedule and are easily visible by their color. ...Compartmentalization and padding of the seats provide adequate safety to school bus passengers. However, if belts are added on school buses, some "performance standards" must be formulated.

The school bus manufacturers' view that their vehicles are already safe cannot be disputed. However, while seat belts may increase injuries in some cases, they may also reduce injuries in some other cases (e.g., rollovers). Lack of installation guidelines and "performance standards" for seat belts on Type I buses are legitimate reasons for concern, considering the litigious nature of our society. The concerns expressed about seat frame and bus floor strength requirements were addressed in the preceding section on installation of belts on new buses.

Survey of New Jersey Transportation Coordinators

The opinions of school district transportation coordinators throughout the state were solicited through a mail-back questionnaire. The New Jersey Department of Education provided a list which contained 217 different individuals. The overall response rate was 34 percent.

The most important findings of the survey were:

a) The majority of school districts (75 percent) do not favor legislation that will mandate the installation of seat belts on Type I school buses, 11 percent favor such legislation and 14 percent are undecided or did not express any opinion.

b) If seat belts are mandated by the State, then 55 percent of the districts favor lap-shoulder belts, 31 percent prefer lap belts, and 14 percent did not express any opinion.

c) Responding on why their Type I buses are not equipped with seat belts, four major reasons came up with a response rate greater than 50 percent (multiple responses were allowed):

1. Belts are not required by law (80%),
2. Belts may cause more injuries than they will prevent (63%),
3. Belts may be used as weapons (60%), and
4. Belts may not improve safety (53%).

Forty percent of the responding districts expressed concern about liability. The cost of the belts does not appear to be much of a concern.

Most respondents wrote lengthy comments. The following appeared with relatively high frequency:

The school bus is already a safe mode of transportation and seat belts are not needed.

It is difficult to attain satisfactory usage rates.

Seat belts may be a hazard in emergency evacuation situations such as when the bus rolls over or catches fire.

Adult monitors or attendants may be required to enforce and supervise the use of belts.

Several studies and the Transport Canada tests have shown that seat belts are not recommended for school buses.

Seat belts would be a maintenance problem.

Seat belts may be misused.

Attention should be focussed on ingress and egress zones.

Driver training and increased vehicle maintenance would give better results.

More details about this survey are presented in Appendix C.

IMPLEMENTATION COST

No matter how beneficial a measure may be, before it becomes a requirement that everyone should abide by, its cost should also be considered, since we live in a world of limited resources. The cost of equipping all New Jersey school buses with seat belts is estimated in this section, as well as the cost of providing monitors in all school buses.

Cost of Seat Belts

The total number of school buses in New Jersey is currently 13,234. Of that 8,306 (63%) are Type I and 4,928 are Type II buses. The Type II buses are required to be equipped with seat belts by law, and only the additional cost required for installation of seat belts in Type I buses should be considered. Approximately 50 Type I buses are already equipped with seat belts and are currently in operation in different school districts. Therefore, the cost of seat belt installation on 8,256 buses needs to be estimated.

It is estimated that the cost of installing seat belts in a Type I school bus is $1,000.00. The annual maintenance cost is approximately $35.00 per bus. Seat belts can remain in service for 15 years after installation, and have no salvage value. A five percent interest rate is assumed.

On the basis of above estimates, if all school buses are required to be equipped with seat belts, the additional cost in the State of New Jersey will be $1.084 million annually as the following computations indicate:

$$TC = \left(IC \frac{i(1+i)^n}{(1+i)^n - 1} + MC \right) N$$

where: TC = Total additional annual cost for belts on all school buses
IC = Installation Cost = $1,000 per bus
i = Discount rate = 5%
n = Service life of belts = 15 years
MC = Annual Maintenance Cost = $35 per bus
N = Number of buses to be equipped = 8,256

Hence, TC = (1000 X 0.09634 + 35) X 8526 = $1,084,343

The feasibility of improving school bus safety by installing seat belts is determined in this study independently of the decision on whether monitors should be used also. However, because monitors are the most effective safety measure, they are briefly considered in the next section.

Use and Cost of Monitors on School Buses

Adult monitors on school buses can be of substantial help in improving school bus passenger and student pedestrian safety. Their contribution and assistance can be useful in a variety of areas:

> They can assist children at loading and off-loading zones to cross the street (when necessary). A considerable number of student pedestrian fatalities and injuries can be prevented if adult monitors are present.
>
> They can maintain discipline by ensuring that the children are seated and do not stand on the seats, roam the aisles, keep their head or hand outside the windows, fall out of the door, or fight.
>
> Monitors, if not injured themselves, can expedite the evacuation process.
>
> If buses are equipped with belts, they can ensure that belts are worn and buckled up properly.

There is no doubt that monitors can substantially improve school bus safety. The only argument against having monitors is their high cost. The TRB study considered monitors to be 25 to 75 percent effective (the highest effectiveness rate of any other safety measure) in preventing or reducing all school bus passenger and student pedestrian fatalities and injuries. If each of the 13,234 school buses in New Jersey is provided with an adult monitor, the cost would be $64.3 million per year (assuming $4,860.00 per monitor, hired at the rate of $5.40/hr., working 5 hr./day, 180 days/year [2]).

A California law requires that students in grades K through 8 must be escorted by the driver when crossing the road during off-loading. There are operating problems associated with this requirement, since longer delays are caused to other traffic at bus stops, and leaving children unattended on a parked bus creates the potential for mishaps. However, California reports few problems with the practice. The TRB study attempted to use 1982-1986 FARS data to evaluate the effectiveness of this law. Although no definitive proof could be obtained, the California law appeared to be having a beneficial, and perhaps substantial effect in improving safety.

Monitors should be and are used in school buses transporting handicapped children. The decision to use monitors on all school buses should be made individually by each school district that is better able to determine if it can afford the cost associated with them The California law that requires the driver to escort children at off-loading zones should be studied further for possible implementation in New Jersey.

CHAPTER 7

ALTERNATIVE SEAT AND RESTRAINING SYSTEMS

The high back, padded seats currently used in US school bus fleets are obviously not the only, and possibly, not even the ideal seats. Lap belts, which are the main objective of this report's focus, are also not the only passenger restraining system that can possibly be installed in school buses. The purpose of this chapter is to present a review of what has appeared so far in the literature on the safety effectiveness of various school bus seats and seating arrangements, as well as alternative restraining systems. Most of the evidence on the safety effectiveness of alternative seats and restraints stems from the UCLA tests that were already discussed, [5] and a set of Transport Canada sled crash tests that were specifically performed three years ago with that purpose in mind.

UCLA TESTS - 1967

The discussion on the UCLA tests in Chapter 2 concentrated only on the evidence those tests provided on the effectiveness of lap belts. However, the UCLA crashes tested a variety of alternative restraining systems as well, including armrests, restraint bars, air bags, and lap-shoulder belts.

Armrests

If armrests are added to the existing seats, every school bus passenger seating position can become really "compartmentalized". The existing high back seats provide passenger separation in the vehicle's direction of travel, and arm rests could add some separation in the direction perpendicular to the vehicle. The UCLA investigators concluded from the crash tests that seats having strong but well padded armrests provide important lateral constraint. In addition, the seats become more comfortable due to their additional body support. However, these seats are a little difficult to enter, sit down in, or exit. If armrests are provided for every passenger, they contribute significantly to safety improvements during side impacts by preventing the bus passengers from being ejected from their seats laterally to strike passengers across the aisle, and by preventing larger passengers from crushing against a smaller passenger who may be seated in his path. The UCLA team suggested that "as a minimum requirement, each school bus seat should have an armrest on the aisle side".

Although armrests provide significant lateral restraint, they also have significant operational disadvantages, as the study realized. In addition, they do not provide substantial protection in rollovers. Furthermore, they reduce the seating capacity of the bus, if they are provided for all passengers. If only one armrest per seat is provided at the aisle side, the passengers seating at the aisle seats run the risk of suffering additional or more serious injuries during side impacts. Therefore, armrests are not a desirable restraining device.

Restraint Bars

This restraint consists of a swing type bar anchored at the seat back and positioned in front of the passengers next to their laps. Restraint bars may provide some protection in frontal impacts, but they are of little value in side impacts. The UCLA researchers described them as an impractical solution due to their injury producing potential and considering the advantages of seat anchored lap belts.

The TRB study [2] reported that at least two companies have recently undertaken the development of a lap bar restraint system similar to that tested by the UCLA experiments as an alternative to lap belts. The TRB committee reviewed the lap bar restraint system test results and identified the following potential problems:

> The instability and poor positioning of the bar could result in intrusion injuries to the upper abdomen, fractures of the lower spine, or crushing injuries to the upper legs, whereas a belt worn across the lower pelvis will remain in that position and passively follow the direction of body movement.
>
> One bar restraining two or three passengers of different sizes complicates the optimum positioning of the bar relative to the pelvis.
>
> Finally, there would be no lateral restraint to the passengers in a side or oblique impact.

On the basis of the available evidence, restraint bars do not appear to provide any potential improvement to school bus passenger safety.

Air Bags

The air bag system tested by the UCLA team had several technical, operational, and maintenance problems associated with it. Furthermore, airbags are considerably costlier than other alternatives. Therefore, their use in school buses was not recommended.

Lap-Shoulder Belts

This belt is the standard restraining system in the front seats of passenger automobiles, and it has been credited with the saving of many lives. Unfortunately, it cannot be as effective in school buses. If the cross-chest portion of the belt has an anchor point at the rear and substantially above shoulder level, then the belt passes across the throat in a manner which produces sufficient forces of lacerative nature to cause neck as well as back injury during side and head-on collision. The asymmetrical restraining of this device causes the upper torso to rotate from behind the belt. Therefore, to prevent injuries from the cross-chest portion of the device, the upper anchor point has to be located at shoulder level. However, considering the wide variation of heights in common school bus passengers, anchor points would have to be provided over a wide range in order to accommodate the varying sizes of the passengers. This would require a rigid structure at shoulder level that could cause injuries to all but the shortest child. The UCLA study concluded that the potential gain from the use of cross-chest belts for school bus passengers is too questionable to warrant further consideration, and the restraint is not recommended for use in school buses.

TRANSPORT CANADA SLED TESTS - 1986

The original Transport Canada school bus crash test results indicated that the lap belted dummies pivoted about the lap belt and struck their head very severely on the seat back in front. These dummies compressed the seat padding to such a degree that they "bottomed out" on the seat structure underlying the seat back. The belted dummies suffered higher Head Injury Criteria (HIC) values. The results of these 1984 crash tests led the Canadian researchers to investigate further the entire seating system, in order to ascertain under what circumstances seat belts should be installed in school buses. To achieve this, Transport Canada conducted a series of sled tests in 1986, experimenting with various seating concepts each of which incorporated a restraint system [22].

Test Features

This Transport Canada study attempted the evaluation of the following five different alternative types of seating systems:

a) **Contoured padded seat back with lap belt:** This system included additional padding on the top and the rear of the seat back to cushion any head impact.

b) **Less aggressive seat back and lap belt:** This was a deformable seating system to allow greater seat back deflection when struck from the rear.

c) **Rearward facing seat with lap belt:** The passenger seats faced towards the rear of the bus for this alternative. The seat back was increased in height and reinforced.

d) **Lap-shoulder belt:** The seat frame structure was considerably reinforced and a lap-shoulder belt was used for this alternative.

e) **Multi-point restraint system:** This system incorporated a harness type restraint consisting of a lap and two shoulder straps. The seat structure was considerably reinforced.

An unaltered standard bus seat with lap belts was tested, in addition to the above five seating systems, for base line comparison purposes.

Systems a), b) and c) incorporated lap belts with emergency locking retractors. System d) used automotive type lap and shoulder belts, and system e) and the unaltered seat were equipped with manually operated belts.

The seat spacing for each test was approximately 26 inches (660 cm.) from the rear surface of the front seat back to the front surface of the rear seat back. This corresponds to approximately 21 inches (533 mm) from the rear seating reference point (SRP) to the back surface of the front seat back.

For each test, two 5th percentile adult female anthropomorphic test devices (ATD) were placed on two seats, and one of the seats was located in front of the other. The rear seat dummy was instrumented to record head and chest acceleration, femur and seat belt loads. The front seat dummy was not instrumented and was used for loading purposes only.

Each of the seating systems, including the unaltered seat, were tested by mounting them on sleds for two collision modes. The first simulated a head on impact and the second an oblique impact (30 degree from head on). The peak acceleration and the maximum velocity applied were 30 g and 30 mph respectively for both impact modes.

Test Findings and Conclusions

The HIC and chest acceleration values measured during the tests are summarized in Table 18. All seating systems were evaluated on the basis of threshold values of 1,000 for the HIC, and 60 g for chest acceleration. A brief summary of the conclusions drawn about each system is provided below:

Seat Series	Head-on Impact		Oblique Impact	
	HIC	Peak Chest Accel. (g)	HIC	Peak Chest Accel. (g)
Unaltered	1,116.6	58.9	1,181.4	79.8
Contoured Padded	1,082.0	71.6*	1,154.9	68.2
Less Aggressive	1,079.8	48.6	1,423.8	65.0
Rearward Facing	275.9	35.1	309.2	35.4
Three-Point Belt	634.6	60.3	917.6	72.2*
Multi-Point Belt	558.8	65.3*	834.5	68.7*

* Value exceeded 60 g for more than 3 milliseconds, which is not acceptable by U.S. and Canadian standards.

Table 18: HIC and Chest Acceleration Values in Transport Canada Sled Tests.

Contoured Padded Seat With Lap Belt

Additional padding was used to increase the thickness of the seat back in order to reduce the severity of any head impact. However, the HIC values experienced by the dummies in this seating system for both impact modes tested, showed no improvement over the standard unaltered seat with lap belt. The chest accelerations also exceeded the threshold value of 60 g. Although the test film data showed that the contoured padded seats with lap belts reduced the neck extension substantially, they were not able to do the same with the HIC and chest acceleration values.

Less Aggressive Deformable Seat With Lap Belt

This seat was designed to allow the top portion of the seat back structure to deform upon impact, and thereby absorb sufficient energy to reduce the head acceleration substantially. The test results of this seat suggested that the peak head acceleration was significantly lower and the chest acceleration was somewhat lower than that of the unaltered seat. However, the HIC value was essentially the same as that produced when impacting the unaltered seat.

> *On the basis of the sled test results of the two improved forward facing seats (contoured padded seat and less aggressive seat) with lap belts, Transport Canada concluded that these seats were not effective in reducing the HIC values to acceptable levels.*

Rearward Facing Seat With Lap Belt

This seating system produced the best results of all configurations tested. The resulting HIC value for the head-on and oblique impact modes were 275.6 and 309.2 respectively, whereas the HIC values for the unaltered seat were 1,116.6 and 1,181.4 for the same impact modes. This seating arrangement was also capable of reducing the chest acceleration values substantially in comparison to the values that the unaltered seat produced (from 58.9 g to 35.1 g for the head-on collision, and from 79.8 g to 35.4 g for the oblique impact).

> *Transport Canada concluded that the rearward facing seat was effective in reducing all injuries to acceptable levels, and it recommended that the rear facing seat should be the subject of further investigation and testing.*

Three-Point Restraint System (Lap-Shoulder Belt)

The seat incorporated a lap belt and a shoulder belt. The sled test results indicated that restraining the upper torso by the shoulder belt of this three point system reduced the HIC value to acceptable levels, but it did not improve the resultant chest acceleration. It was evident from the sled test results that further research would be necessary to reduce chest accelerations to acceptable levels in three point systems. Transport Canada further emphasized that if three point lap shoulder belts were to be used with school bus seats, it was imperative that belts would have to be worn at all times. Otherwise any injuries to unrestrained occupants striking the seat back would be more severe than they would have been with an existing seat, because of the increased seat rigidity required for the mounting of a lap shoulder belt system.

> *Transport Canada observed that "three point seat belt systems have the potential to improve occupant protection, but further design work would be necessary by the bus manufacturers to reduce chest loading and to determine if it would be necessary to strengthen the floor construction."*

Multi-Point Restraint System

This seat system consisted of a lap belt and two shoulder straps. The sled test results showed that the HIC values for both head-on and oblique impact modes were within acceptable limits. However the chest acceleration values exceeded 60 g for more than three milliseconds. The other major concern of the system was that it permitted submarining of the test ATD.

Transport Canada concluded: "The multi-point system should not be considered further since problems were encountered with submarining. The system was judged to be cumbersome and difficult to put on and adjust properly."

Reward Facing Seats With Lap Belts

The Transport Canada sled test results demonstrated that high-backed, reward facing seats with lap belts provide a substantial potential for increasing occupant protection during frontal and near collisions. Since a rearward facing seat is a rather novel concept, Transport Canada undertook a demonstration project to evaluate the seats under normal operating conditions [26, 27].

Demonstration Project Features

The normal forward facing seating arrangement of three school buses were replaced by passenger seats that faced towards the rear of the bus. Three seat belts with emergency locking retractors were installed in every 39 inch seat. Seat height for the demonstration buses was increased by approximately 10 inches over that of standard seats in order to provide adequate head restraint for the seat occupants. Seat spacing was marginally closer than what normally exists on a regular bus. The three demonstration school buses were put into operation on regular school bus routes during the 1987 - 1988 school year. The bus routes combined both urban and rural settings, included highland and lowland areas, and a variety of Canadian road conditions.

The demonstration project was evaluated through data and information obtained from a variety of sources, including surveys, questionnaires, and personal visits by the project researchers. The evaluation procedure relied on the following five sources:

1. Students in kindergarten through grade 5 (under 11 years of age) who rode the demonstration bus took home questionnaires to be completed by their parents. The questionnaire provided an opportunity for both students and parents to express their opinions about the demonstration bus. The response rate was 50 percent.

2. Students in grades 6 and higher (11 to 18 years of age) who rode the demonstration bus were given the opportunity to comment through self-completed questionnaires. The response rate was 51 percent.

3. Sixteen school bus drivers who had the opportunity to drive the demonstration buses were interviewed either by telephone or in person.

4. Research staff took school bus rides in order to observe student and driver reactions.

5. Transportation supervisors, students, drivers, and other people involved with the project were interviewed after the project was completed.

Demonstration Project Findings and Conclusions

A problem with the rearward facing seats was passenger discomfort. Parent respondents to the questionnaire indicated that the school bus made their children feel sick at rates that were four times as great for the buses equipped with rearward facing seats (20.7 percent for the demonstration buses versus 5.2 percent for the regular buses). However, only 8.2 percent of the parents whose children were using the demonstration buses reported that feeling sick was a problem. Of the student respondents (11 to 18 years of age) 43.4 percent reported feeling sick on the demonstration bus, compared to 6.0 percent reporting the same while using regular buses. But, 20% of the demonstration bus group reported that feeling sick was a problem. The researchers observed that although there were some complaints of feeling ill, in most cases the students overcome the problem in a few days, and they seemed to be very adaptable to the new concept.

Other problems that were cited by the student respondents (11 to 18 years of age) with relatively high frequency were uncomfortable seats (9%), insufficient space between seats (8%), and too high seats (6%). These problems were also confirmed when the research staff personally visited the sites and had discussions with the students. The demonstration bus seats were marginally closer than the standard regular bus seats but the perceptual effect of the increased seat height by 25 cm (10 inches) seemed to give a feeling of decreased seat space. Furthermore, the installation of three seat belts in every 39-inch seat were uncomfortable for older or larger students. The researchers noted that modifications in seat spacing and seat belt positions could lead to positive reactions from older students and possibly increase their belt use.

All sixteen drivers mentioned that due to the very high seat backs, they had some visibility problems when trying to observe traffic at the right side of the bus. Student discipline on the demonstration buses was normal. The drivers reported that students' motion sickness was not a big problem, and they did not receive any complaints from their passengers. The study concluded that the school bus drivers generally coped very well with the demonstration buses, although they preferred the usual forward facing seats which allowed them to supervise the students better.

There were two isolated instances where the demonstration bus was totally unacceptable to students. In one case a group of 25 students (grades 10 to 12) riding the demonstration bus complained of lack of leg room, uncomfortable seats, and dislike of rearward facing seats. The driver in this bus also had a great dislike for rearward facing seats. As a result the demonstration bus was replaced by a regular bus on that route. After talking to students and the driver, the researchers concluded that although the students had some complaints, they would have ridden the bus, had it not been for the driver's attitude who refused to listen to any more complaints and disliked the bus himself. In the other incident, a student simply did not like the demonstration bus and exhibited violent behavior. He was then accommodated in a regular bus.

The belt usage rate for elementary school children was not known from the questionnaire sent to the parents of these children. The self-completed questionnaires of the older students revealed that 42.1 percent of them used belts in more than 6 of the last 10 trips taken. The drivers reported that belt use rates for elementary school children was in the 90 to 100 percent range, and for the junior and high school children the rate was about 40 to 75 percent, except for one district

(Surrey, B.C.) where the usage was close to zero. But, the students of Surrey, B.C. reported seat belt use in cars with a mean of 9.4 times in the last 10 trips taken by them. The researchers stated that the same students' nonuse of seat belts in the demonstration bus indicated that "positive attitudes and high usage rates of seat belts in cars do not predict belt use on school buses". The older or larger students complained that the installation of three belts per 39-inch seat was uncomfortable. It was also pointed out that drivers' attitude towards seat belts and enforcement of their use were important factors affecting belt usage rates. The majority of the drivers indicated that seat belts were not necessary for safety purposes. Similar findings of high belt usage for younger students and the significant decline of belt usage for older students were also reported by the field visitors of this project.

There was no instance of a belt used as a weapon. There were three instances of belts being knotted deliberately to prevent their proper functioning. The researchers recommended belts with emergency locking retractors.

The self-completed questionnaires of the students revealed that they perceived the safety level of the demonstration bus to be higher (mean rating of 4.1 on a 5 point scale) than that of the regular school bus (mean rating of 2.9 on the 5 point scale). However, 17-year olds were less convinced than younger children about the safety benefits of the demonstration. Parents who had the opportunity to examine the bus, liked the concept of rearward facing seats with seat belts. They felt that this arrangement would provide more protection in a head-on collision.

Summarizing the discussion on the evaluation data on the operational experience of the demonstration buses the Canadian researchers concluded:

> *"...the rear facing seat with seat belt configuration was generally accepted by elementary and intermediate level students. With some modification as suggested by the students themselves, the seating arrangement could be made more acceptable to high school students. However, this would not guarantee an increase in seat belt usage by senior students who seem to be aware that school buses were already comparatively safe vehicles".*

A recommendation was also made that the Canadian Motor Vehicle Safety Standards on school buses should be modified to allow rearward facing seats. However, before any such modification is made, the seat back height and seat spacing should be carefully reviewed. Furthermore, benefits that could be derived from rear facing seats without seat belts should be investigated.

REVIEW OF ALTERNATIVE RESTRAINT SYSTEMS

There is sufficient evidence (UCLA tests) to demonstrate that armrests, lap bars, and air bags either do not have the potential of improving school bus passenger safety, or require further development in order to be cost effective. Multipoint restraint systems are not a solution either, because of the submarining effect they cause, and the inherent operational difficulties associated with their cumbersome use. Contoured padded seats and less aggressive deformable seats do not offer a better alternative to the unaltered (presently in use) seat, as the Transport Canada sled tests proved. The lap-shoulder belt, although dismissed by the UCLA tests, it performed reasonably well in the Canadian sled tests, which also proved that rearward facing seats appear to have a very substantial potential in improving school bus safety. Therefore, these two devices merit some additional consideration.

Lap-Shoulder Belt (Three-Point Restraint System)

The three-point system appeared to produce more acceptable HIC values in the Transport Canada sled tests. However, the chest acceleration rate values did not fall below the acceptable threshold level. Moreover, this restraint system has been judged to cause more injuries to unrestrained passengers, because of the stiffer seats that the system requires. Taking into consideration this fact, a NTSB study [9] noted that one or more of the following changes might be necessary before lap-shoulder belts can be installed in large school buses:

Federal standards setting performance requirements for school bus seats may have to be amended to allow stiffer seats, thus reducing the benefits of "compartmentalization".

The shoulder portion of lap/shoulder belts must be attached to a point other than the frame of the school bus seat, so that excessive loadings would not occur (but no other location seems obvious).

A Federal standard for lap/shoulder belt anchorages applying to school buses would have to be developed.

It is evident from all currently available research that the lap-shoulder belt (three-point restraint system), in its present state of development, does not provide a viable alternative solution to the lap belt.

Rearward Facing Seating System

On the basis of the Canadian experience, it appears that rearward facing seats on school buses can contribute to further safety improvements. The Transport Canada sled test results established that rearward facing seats generate HIC and chest acceleration values that are not only well below the threshold limits, but also well below the values generated by any other forward facing seat, with or without seat belts. The operating experience of three school buses with rearward facing seats in Canada did not suggest any significant problems regarding the adaptability and acceptability of this seating system. However, further research is necessary, if rearward facing seats, with or without belts, are to become standard school bus equipment. With the present state of knowledge, rearward facing seats should not be considered as a feasible alternative to the forward facing seating system. Further experimentation with rearward facing seats is certainly worthwhile and it should be encouraged.

CHAPTER 8

SEAT BELT EFFECTIVENESS

The lack of sufficient data, that has been mentioned repeatedly in previous chapters, makes the estimate of a school bus seat belt effectiveness very difficult. However, to derive a quantitative measure of any possible benefit or harm that the installation of seat belts in school buses may generate, such an estimate is necessary. The Transportation Research Board committee that investigated the subject, assumed an overall seat belt effectiveness that ranged between zero and 20%, without providing any justification for this choice. Using this effectiveness range, and further assuming a 50% usage rate, TRB estimated that seat belts will save each year nationally up to 1 fatality, up to 48 incapacitating injuries, up to 238 non-incapacitating injuries and up to 665 possible injuries. Given these statistics, and a $43 million total cost of equipping all Type I school buses with seat belts, the TRB committee concluded that seat belts on school buses would not be cost-effective.

Instead of estimating an overall effectiveness range, seat belt effectiveness is considered to be variable in this study, and depending on the impact modes that a school bus may experience in an accident, as well as the severity level that the school bus occupants may sustain. A major advantage of a variable rate of effectiveness is that the obtained estimates are much more accurate. Furthermore, seat belts may improve safety under a given set of circumstances, but they may reduce it, if those circumstances are altered. Variable rates of effectiveness have an additional major advantage, since they are capable of incorporating into the analysis these trade-offs. The purpose of this chapter is to present the methodology used to derive variable seat belt effectiveness rates and generate these rates on the basis of the available evidence presented in previous chapters.

SEAT BELT EFFECTIVENESS BY IMPACT MODE

School bus occupant fatalities and injuries are caused by accidents involving either impacts (front end, side, or rear end), or rollovers. Rollovers may or may not be preceded by an impact. There is also a small number of accidents where no impacts or rollovers are involved. For example, a school bus may run off the road and eventually stop without colliding or rolling over, but its occupants may be injured from the uncontrolled motion of the bus. The accident statistics that are available from previous studies and which were presented in Chapter 4 can be used to estimate the effectiveness of seat belts for each accident category.

Frontal Impacts

The bus and sled crash tests that were conducted in this country and in Canada, revealed that in frontal impacts belted school bus passengers experienced higher HIC values than unbelted passengers. There is a considerable amount of variation among the results that the various tests produced. Although the UCLA tests measured higher head accelerations for a belted dummy, no serious or harmful injuries were considered to result from the restraint. The NHTSA sled test results showed higher HIC values in most of the belted dummies, but all the values were within the acceptable threshold value of 1,000. The NHTSA sled tests also revealed that some harmful loadings occur on the throat and spine of the unbelted dummies. The Transport Canada tests predicted severe head injuries for belted passengers, although the highest HIC value experienced by an unbelted dummy in the Type I bus was 731. Transport Canada's second series of tests showed HIC value of higher than 1,000 for the belted dummy in the current bus seating system, but in this case no unbelted dummy was tested in the same sled test, making any comparison impossible. Transport Canada's crash tests were also criticized by researchers on several grounds.

Most of the experimental studies investigated direct frontal impacts. The possibility of an unrestrained aisle seat occupant being thrown in the middle of the bus during an angular impact, and the chances of getting injured by contacting seat legs, stanchions, etc. was ignored. Any possible benefit from using seat belts in these cases was not discussed. It is reasonable to expect that in angular frontal impacts, "compartmentalization" will not contain those seated at aisle seats, and seat belts can provide them with additional protection.

It is evident that although there exists a considerable amount of controversy over the validity of the crash tests' injury predictions and conclusions, the experimental studies suggest that seat belts may not provide additional benefit to the school bus occupants, and may even expose them to additional injuries. The "compartmentalization" effect generated by FMVSS 222 compliance has been judged to provide adequate protection to school bus occupants in frontal impacts.

> ***Overall, seat belts do not appear to be effective in frontal impacts. Furthermore, the effectiveness of the device may be negative in a number of accidents of this type.***

Side Impacts

The experimental evidence on this type of impact in rather limited. The Thomas Built crash tests were criticized for the inappropriate seating positions of belted and unbelted dummies. The UCLA crash test researchers concluded that additional protection could be afforded to school bus occupants by seat belts in a side impact collision. A UCLA Trauma Research Group researcher who investigated school and other bus accidents said that in side impacts "The occupant may be catapulted from his seat to strike the edge of the seat across the aisle, or the opposite side interior, or the floor. Injuries incurred include bruising, abrasions, lacerations and simple fractures of the lower extremities to deeper lacerations and more complex fractures of head/face. Injury frequency data is not available, but the clinical in-depth studies indicate that these injury patterns are most common for low speed collisions."[14] These observation were based on pre-1977 buses, but the body mechanics of passengers in side impacts would not change significantly, if post-1977 buses are involved.

The NTSB study of 43 large school bus accidents concluded that a lap belt would not provide upper torso restraint to the passenger. Hence passengers would remain free to strike one another when seated together, and also to strike windows when seated at the window seat. However, the NTSB study noted that the belted passengers would not be thrown into the next row of seats or into the aisle.

It is evident from the limited number of available studies that during side impact accidents seat belts can provide substantial additional protection to school bus occupants. A belted passenger seated at the window seat may suffer some injuries even if he/she is belted. However, a seat belt can prevent further injuries by not allowing the passenger to be thrown out of the seat. The current closely spaced, high back seats contain passengers in frontal or rear impact accidents but provide practically no containment during side impact.

Overall, seat belts can provide substantial additional protection, and they will be highly effective in side impact accidents.

Rollover Accidents

The UCLA crash test investigators said that additional protection would be provided to school bus occupants in upset collisions, provided that the extrication process is perfected. NTSB's study of crashworthiness of large post-standard buses identified that in a collision rollover, it is the primary impact and not the rollover motion, that was the primary cause of casualties. However, in a non-collision rollover, the rollover dynamics was the major cause of injuries. Discussing the motion of lap belted passengers in rollover accidents, NTSB said that the passengers seated away from the side on which the bus would come to rest would gain additional protection for not sustaining the ground impact. But, the passengers seated on the other side, would not be protected, as they would be able to contact the windows and side walls.

The Texas accident investigations identified eight fatalities that might have been caused to passengers who were thrown around within the bus in rollover accidents. A UCLA researcher noted that "when a rollover occurs, the injury patterns reflect those found as a result of lack of restraint within a seat, as well as full and partial ejection through collision openings and through windows or window openings." There is sufficient proof to establish that an ejected passenger sustains more severe injuries. Even in the NTSB study, which argued that seat belts were not needed in school buses, 15 passengers were ejected, of which nine received serious or critical injuries, four sustained moderate injuries, and two minor injuries. Although the windows of school buses are partitioned and ejection is difficult, passengers have been ejected partially or fully in real world school bus accidents and suffered fatalities or serious level injuries. The moment a passenger is ejected, the possibilities of suffering further injuries are increasing substantially. The UCLA researcher found that "...an ejected (non-restrained or non-contained) bus occupant has a potential exposure to critical on fatal injuries of greater than 80 percent (i.e., he has a four in five chance of critical or fatal injuries)." Ejections, commonly a phenomenon which occurs in rollovers, demand special consideration due to the extreme severity of the injuries associated with them.

Seat belt opponents have been expressing concerns that in rollover accidents the belted passengers may suffer additional injuries as they are hanging up-side-down from their seats. The proponents of seat belts argue that the belted passengers would be better off hanging from their seats rather than being thrown around inside the bus contacting every possible hazardous point and sustaining injuries. Expert medical opinion appears to concur with the proponents. Medical professional associations favor seat belts in school buses and are not concerned with injuries to belted passengers dangling from their seats. The recent United Airlines' Flight 232 accident in Sioux City, Iowa provides evidence that supports the arguments of the proponents. Although aircraft should not be compared with buses, passengers hanging by their seat belts up-side-down in the sections of the airliner that did not fail structurally, walked away from the crash site uninjured, even though the plane tumbled several times at a very high speed.

Overall, seat belts can provide substantial additional protection, and they will be highly effective in rollover accidents.

Rear Impacts

In rear impact collisions seat back height constitutes the major factor of protection, because the occupants' primary contact is with the seat back. NHTSA's sled tests suggested that the major consideration in determining seat back height should be the whiplash of the head over the top of the seat back in rear impacts. The authors of this report support the TRB study recommendation to increase the seat back height to 24 inches (the current federal standard is 20 inches) above the Seating Reference Point (SRP) in order to provide additional protection in rear impacts. Seat belts may add some protection in containing the passengers in angular rear impacts, but no significant benefit should be expected.

Overall, seat belts will not provide meaningful additional protection in rear impact accidents, but they will not increase the injury potential either. Their effectiveness is, therefore, neutral for this type of accidents.

DETERMINATION OF SEAT BELT EFFECTIVENESS FACTORS

On the basis of the review of all available research on the subjects of seat belt behavior and accident causes on school buses, seat belt effectiveness factors were developed for fatalities and injury accidents by type.

Fatalities

The available research suggests that fatalities are primarily caused at the proximity of the point of impact. In severe impacts, intrusion may occur, and in rollovers, partial or full ejection may take place. Passengers sustaining fatal injuries in cases of severe intrusion and crashing of the roof at their seating location will not benefit from seat belts. But, a severely injured passenger in rollovers, side impacts or prior to ejections may sustain fatal injuries due to being thrown around within the bus or out of the bus. NTSB's and UCLA's studies [5, 6] proved that ejection is dangerous and it does happen, though rarely, in school bus accidents. The Texas study also proved that over 50 percent of the fatalities caused by rollovers and impacts could have been prevented by seat belts. The Texas study also indicated that seat belts are a substitute for discipline, saving an additional 25 percent of the total fatalities. Seat belts can prevent some fatalities in rollovers, ejections, side impacts, and also in lack of discipline related mishaps. Seat belts on the other hand, may in frontal impacts convert some severe or critical injuries to fatal injuries as it was inferred by the NTSB study.

The effectiveness of seat belts in preventing fatalities was determined rather conservatively to be in the range of 25 to 35 percent.

Injuries

To determine seat belt effectiveness in preventing or reducing occupant injuries, incapacitating (A level) injuries were of major concern because of their potential to inflict permanent disabilities (e.g., loss of sight, inability to walk, etc.). The experimental studies predicted higher HIC values for belted passengers in frontal impacts. It is recognized that the "compartmentalization" afforded to passengers by the current seating system provides adequate protection, and seat belts may cause additional injuries. In angular frontal impacts seat belts can provide some protection to the aisle seat passengers. The effectiveness of seat belts in preventing incapacitating injuries in frontal collisions was determined to be in the range of -20 to 5 percent. In side impacts and rollovers, except where intrusion is the major cause of injuries, belts can provide substantial protection, as it was demonstrated in the previous section. The effectiveness of seat belts in preventing incapacitating injuries in side impacts and rollovers was determined to be in the range of 40 to 70 percent. In rear impacts seat belts would be of minor importance. Considering the facts that in direct rear impacts a passenger may suffer higher HIC values during the rebound, and that in angular rear impacts a passenger seated at the aisle seat may be contained within the seat if belted, the effectiveness of seat belts in preventing incapacitating injuries in rear impacts was determined to be in the range of -5 to 5 percent.

Non-incapacitating (B level) injuries are caused by rather minor impact forces. TRB's analysis of New York State accidents (1980 - 1986) revealed that 53 percent of these injuries are contusions/bruises, 30 percent minor bleedings, and 16 percent abrasions. Containment of passengers within the seat can provide additional protection for these types of injuries. Therefore, seat belts are considered to be effective in all types of accidents to prevent non-capacitating injuries. However, the effectiveness of seat belts in preventing non-incapacitating injuries in frontal impacts was determined to be in the range of -10 to +20 percent with the understanding that some belted passengers sustaining non-incapacitating injuries in a front end collision involving substantial impact force may suffer additional head injuries because they are restrained. In rear impact generated non-incapacitating injuries there is no problem with the rebounding of a belted passenger. Therefore, the effectiveness of seat belts in preventing non-incapacitating injuries in rear impacts was determined to be in the range of 0 to 20 percent. For side impacts, rollovers, and other accidents seat belt effectiveness for non-incapacitating injuries was determined to be the same as it is for incapacitating injuries.

Regarding possible (C level) injuries, TRB's analysis of New York State data revealed that 78 percent of these injuries are mere complaint of pain, 17 percent are "none visible", and the remaining 5 percent are unspecified. These injuries are for all practical purposes insignificant and irrelevant in comparison with the other injuries discussed above. Seat belts may prevent some of these injuries, but they may also cause some of them either in accidents or because they were misused by the passengers. Determining the effectiveness of seat belts for these injuries is of no consequence. Therefore, no determination of seat belt effectiveness is made for possible injuries.

The effectiveness of seat belts in preventing injuries varies according to accident and collision type, and it was determined to be as indicated in Table 19.

Accident Type	Seat Belt Effectiveness		
	Incapacitating	**Non-incapacitating**	**Possible**
Front End (with no rollover)	-20 to 5	-10 to 10	*
Side (with no rollover)	40 to 70	40 to 70	*
Rollover	40 to 70	40 to 70	*
Rear End (with no rollover)	-5 to 5	0 to 20	*
Others (non-collision, non-rollover)	40 to 70	40 to 70	*

* No inference on effectiveness is made

Table 19: Seat Belt Effectiveness by Accident and Injury Type.

SEAT BELT ACCIDENT REDUCTION POTENTIAL IN NEW JERSEY

The derivation of the quantitative impact that seat belt installation in all school buses will have in the State of New Jersey was performed by a six step process using facts obtained from the literature and this study team's own determination of parameters. Ranges are provided for most parameters, so that a sensitivity analysis can be performed. The details associated with each step follow:

Step 1: Seat Belt Usage

The percent of students that are going to be using seat belts, if school buses are equipped with them, is a critical parameter. Obviously, a zero percent use rate will not have any differential impact on safety, while a 100 percent use rate will generate the maximum possible impact. As it was stated in Chapter 5, a 75 percent average seat belt usage rate can be expected. Usage rates of 50 percent and 100 percent are also used in the computations to represent respectively a most pessimistic and an ideal scenario.

Step 2: Accident Base

Before estimating fatality or injury reductions or increases, the number of expected fatalities and injuries on which seat belts will have an effect (accident base) has to be known. As it was demonstrated in Chapter 3, in the State of New Jersey 0.33 fatalities may occur in an average year. The estimated total school bus passenger injuries per year are 360, of which 18 are incapacitating injuries, 90 non-incapacitating injuries, and 252 possible injuries.

Step 3: Injury Frequency by Accident Mode

Since seat belts have a different effect depending on accident type, a distribution of accidents is needed to perform the calculations. On the basis of the Texas school bus accident experience, a distribution of injuries by accident type was produced and it is presented in Table 20. The incapacitating injury column of this table is a modification of Table 5 with the difference being that the unknown injuries of Table 5 were now distributed among the other accident types. The nonincapacitating injury percentages are estimated on the basis of the remaining literature.

Accident Type	Percent of school bus passenger injuries		
	Incapacitating	Non-incapacitating	Possible
Front End	29	35	no inference on distribution is made
Side	38	30	
Rollover	26	20	
Rear End	2	10	
Unknown (Presumably non-collision, non-rollover)	5	5	
Total	100	100	

Table 20: Expected School Bus Occupant Injury Distribution by Accident Type

Step 4: Seat Belt Effectiveness

The effectiveness of seat belts was discussed at length in this chapter. The factors used are:

For fatalities: 25 to 35 percent.

For injuries: Factors depend on injury type according to Table 19.

Step 5: Injury Distribution by Accident Mode

Since the effectiveness rates depend on accident type, the number of total accidents in the state has to be distributed among the various accident types also. The information provided in steps 2 and 3 can be used to generate an estimate of the number of school bus passenger fatalities, incapacitating, and non-incapacitating injuries that can be attributed to the various accident modes.

The number of fatalities per year is 0.33. Since it is a very small number, and only one overall range of effectiveness rates was determined, fatalities are not distributed among the various accident types. The number of injuries that can be expected to occur during an average year in the state are distributed by accident type as indicated in Table 21.

Accident Type	No. (percent) of Future Annual School Bus Passenger Injuries in New Jersey		
	Incapacitating	Non-incapacitating	Possible
Front End	5.22 (29%)	31.50 (35%)	Not distributed by accident type
Side	6.48 (38%)	27.00 (30%)	
Rollover	4.68 (26%)	18.00 (20%)	
Rear End	0.36 (2%)	9.00 (10%)	
Others (non-collision, non-rollover)	0.90 (5%)	4.50 (5%)	
Total	18 (100%)	90.00 (100%)	252 (100%)

Table 21: Estimated Number of Occupant Injuries by Accident Mode

Step 6: Determination of Seat Belt Accident Reduction Potential

The estimates of fatalities and injures that can be prevented or reduced by seat belts in the state of New Jersey during an average year are computed using the information provided by Steps 1, 4, and 5, and the following formulae:

Fatalities that may be prevented = Total no. of fatalities x Percent of belt use x Percent of belt effectiveness

Injuries that may be prevented = Total no. of injuries x Percent of belt use x percent of belt effectiveness

Fatalities That Can be Prevented by Seat Belts

Table 22 determines the number of school bus passenger fatalities that may be prevented by seat belts during an average year in the State of New Jersey. If the mid-range of the estimate is used, and a 75 percent seat belt use rate is assumed, 0.074 fatalities per year will be saved. This is equivalent to saving one life every 13 years. Under the most pessimistic assumption (lowest end of effectiveness and a 50 percent use rate) 0.049 fatalities per year will be saved, or one life every 20 years. Ideally (highest effectiveness and 100 percent use rate), 0.099 lives per year will be saved, or equivalently one life every 10 years.

Total no. of fatalities	Belt usage	Belt effectiveness	No. of fatalities that may be prevented or reduced by seat belts.	
			Total	Mid range
0.33	50%	25-35%	0.041-0.058	0.049
0.33	75%	25-35%	0.062-0.086	0.074
0.33	100%	25-35%	0.082-0.099	0.099

Table 22: Future Fatalities to Be Prevented by Seat Belts in New Jersey

Injuries That Can be Prevented by Seat Belts

Table 23 determines the number of school bus passenger injuries that may be prevented or reduced by seat belts in an average year in the State of New Jersey. Using the mid range of the estimates and a 75 percent use rate, about 5 incapacitating and 21 non-incapacitating injuries should be prevented annually. Under ideal conditions 9 incapacitating and 40 non-incapacitating injuries should be prevented. Under the worst case scenario, the incapacitating and non-incapacitating injuries prevented will be approximately 2 and 8 respectively. The effectiveness of seat belts is not determined in this study for the 250 possible (C level) injuries that take place during an average year in the state. Overall, there should not be any significant difference in the number of possible injuries with or without belts. However, by the 10th year of implementation when the seat belt program is fully operational, and provided that use is rigorously enforced, even a considerable number of possible injuries may also be prevented.

In summary, if seat belts are installed in all school buses operating in this State, fatalities and injuries will be reduced. The overall number will be small, but approximately 22 percent of the fatalities, 27 percent of the incapacitating injuries and 23 percent of the nonincapacitating injuries will be prevented. These reduction rates will materialize provided that the seat belt use rate is about 75 percent, and this is a very realistic assumption under an appropriate attitudinal and enforcement climate.

Belt usage	No. of injuries that may be prevented or reduced by seat belts				
	Incapacitating		Non-incapacitating		Possible
	Total	Mid range	Total	Mid range	
50%	1.95-4.49	3.22	8.32-19.80	14.06	No estimate is made
75%	2.93-6.73	4.83	12.48-29.70	21.09	
100%	3.91-8.97	6.44	16.65-39.60	28.12	

Table 23: Future Injuries to Be Prevented by Seat Belts in New Jersey

CHAPTER 9

CONCLUSIONS AND RECOMMENDATIONS

SUMMARY

School buses are without any doubt the safest mode of transportation. Furthermore, a greater proportion of school bus pupil fatalities occurs outside rather than inside the vehicle. However accidents do happen and pupils continue to get injured or killed in the interior of the bus. Requiring the installation of seats belts in all school buses will improve the vehicle's overall safety performance, as it was calculated in detail in the previous chapter. The benefits from the installation of seat belts will not be very significant, because the fatality and injury base that seat belts can affect is very small. In addition, the estimation of factors that were used in the derivation of seat belt effectiveness was rather conservative. An argument can even be made that justifies seat belts in terms of their cost effectiveness. Seat belts will cost the taxpayers of this State about $1 million per year. In return, approximately 0.074 fatalities, 5 incapacitating injuries, and 21 nonincapacitating injuries will be prevented per year. Without placing a dollar value on the life of a child, or the cost of medical care until recovery (or for life in some instances), and given the conservative nature of the estimates, the money appears to be well spent. It has been estimated that many environmental and occupational safety and health regulations cost between $7 million and $132 million per life saved [31]. Seat belts on school buses will be at or below the lower end of this range.

RECOMMENDATIONS ON SEAT BELTS

Since seat belts were found to be effective, it is recommended that both Type I and Type II school buses should be required to be equipped with seat belts in the State of New Jersey.

It is obvious that seat belts can be effective only when they are used. Therefore, it is further recommended that seat belt use for all occupants (students, monitors, drivers, teachers, parents) is also mandated in all buses that are equipped with seat belts. Simply installing seat belts without mandating their use will be a waste of resources.

Because of technical problems, the retrofitting of existing school buses with seat belts is undesirable. Seat belts should be introduced into the State's school bus fleet gradually as the fleet is renewed. It is recommended that seat belts should be required on Type I school buses purchased after the effective date of the Bill that will establish that requirement. The requirement of seat belt use on Type II vehicles and the seat-belt equipped vehicles already in service should be effective immediately

The seat belts required should be of the lap belt type. Although this type of belt may provide less protection than some alternative restraints, the technical and operational problems with these alternatives more than cancel out their additional benefits.

Since no stands exist that specify how seat belts should be installed in Type I vehicles, the specifications for anchoring them should be the same as those followed by the manufacturers when installing them in Type II buses. The National Coalition for Seat Belts on School Buses recommendations on belt color coding, matching buckles, etc that were quoted on page 59 should also be followed in order to make the use of seat belts easier and minimize their misuse.

Seat belts are safety devices and their use should be treated with the seriousness they deserve. Their use should be strictly enforced, just like the use of protective equipment in sports events that students participate.

Parents, principals, teachers, transportation coordinators, mechanics, and drivers have to cooperate if seat belts are to be effective. Parents should be informed and asked to remind their children to "buckle up" when they leave home in the morning. Principals should establish seat belt programs ranging from evacuation drills to insure that students can exit the bus in an orderly manner during an emergency, to policies on penalties to students that refuse to use their belts. Teachers can contribute by urging their classes before they are dismissed after the last period that they should "buckle-up" when they get on the bus. Transportation coordinators should educate their drivers and mechanics on the benefits of seat belt use. Mechanics should pay as much attention on seat belts as they pay on other safety features of the bus such as its brakes or mirrors. Drivers should be reminding their students to "buckle-up" often.

RECOMMENDATIONS ON SCHOOL BUS SAFETY

The installation and use of seat belts, will obviously not eliminate fatalities and injuries completely, although a small step will be taken in the right direction. The progress of research on rearward facing seats should be followed closely. The concept has the potential of improving further the safety of school buses, and when conclusive results are available supporting its use, New Jersey should adopt it also. New Jersey has provided in the past a leadership role in highway safety (e.g., the Jersey barrier). It can do the same again by conducting evaluation experiments with buses equipped with rearward facing seats, similar to those conducted in Canada. The cost will be relatively small, but the potential benefits could be very substantial. They may provide the next substantial step towards improving school bus safety, and generate benefits similar to those achieved by the 1977 standards.

The fatalities and injuries occurring outside the bus are tragic and unjustifiable, and measures should be taken to reduce them. Monitors will be effective, but they are very costly. Mechanical gates, electronic sensors, video monitors, STOP arms, and better driver training are all alternatives for monitors but much less effective. This problem deserves more attention and study than seat belts. When the seat belt issue is settled, both proponents and opponents of seat belts should concentrate their efforts in improving safety on the outside of school buses. The authors of this report found that all groups are genuinely interested and concerned with school bus safety, no matter what their stand on seat belts was. When these groups of energetic individuals join their forces, the only possible outcome can be better protection for our children which are our society's most precious resource.

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APPENDIX A

LEGISLATION

AUTHORIZING

THIS STUDY

A 2326

INTRODUCED FEBRUARY 29, 1988

By Senator RAND

APPROVED NOVEMBER 9, 1988

Chapter 152, 1988

AN ACT directing the Office of Highway Traffic Safety in the Department of Law and Public Safety to conduct a study on the safety of using seat belts in certain public school transportation vehicles, and making an appropriation.

BE IT ENACTED *by the Senate and General Assembly of the State of New Jersey:*

1. The Office of Highway Traffic Safety in the Department of Law and Public Safety shall conduct or cause to be conducted a study on the safety of the use of lap seat belts in all Type I and Type II school vehicles as defined pursuant to R.S. 39:1-1.

This study shall include:

a. A comprehensive review of crash testing research;

b. Commentary and supported opinion on the accuracy and reliability of the current body of research including, but not limited to, the 1984 Transport Canada crash testing study which was conducted by Arvin Calspan Industries of Buffalo, New York;

c. The efficacy of the United States Department of Transportaion's Highway Safety Manual volume 17, also known as "Standard 17"; and

d. Recommendations as to the required use of lap type seat belts for large Type I school buses and smaller Type II school vehicles.

2. Within nine months of the effective date of this act, the Office of Highway Traffic Safety in the Department of Law and Public Safety shall make a report of its findings and recommendations thereon to the Legislature, the United States Department of Transportation's National Highway Traffic Safety Administration, the National Transportation Safety Board and the National Safety Council.

3. Prior to the submission of the report pursuant to section 2 of this act, a preliminary report by the Office of Highway Traffic Safety in the Department of Law and Public Safety shall be reviewed by the Department of Transportation and the Department of Education. Commentary and supported opinion by the Department of Transportation and the Department of Education shall be included in the report submitted.

4. There is appropriated from the General Fund to the Department of Law and Public Safety $35,000.00 to effectuate the purposes of this act.

5. This act shall take effect immediately.

TRANSPORTATION
Motor Vehicles

Directs the Department of Law and Public Safety to study and report on whether use of seat belts in school vehicles is harmful or beneficial to passengers; appropriates $35,000.

APPENDIX B

SCHOOL BUS

ACCIDENT

STATISTICS

The purpose of this appendix is to present some additional school bus accident statistics. Its contents are as follows:

Pages 99 to 102: National school bus accident statistics by state for 1986 and 1985. Similar data for 1987 were presented in Table 6.

Pages 103 to 106: New Jersey school bus accident statistics as reported by the Department of Education for School Years 1986-87 and 1987-88. Page 103 is a repetition of Table 8.

Pages 107 to 108: New Jersey school bus accident statistics as reported by the Department of Transportation for calendar years 1986 and 1985 by County.

Pages 109 to 129: Detailed New Jersey school bus accident statistics by municipality for 1986 as reported by the Department of Transportation.

ACCIDENT FACTS EDITION 1986

STATE	VEHICLES	ANNUAL BUS MILAGE (000)	PUPIL TRANSP. DAILY	TOTAL BUS ACC.	PUPILS INJURED	ACCI./ MILLION VEH.-MILE	PUPIL INJ./ MILLION VEH.-MILE	PUPIL INJ./ 1000 TRANSP. PUPIL
1 _ALABAMA	7,048	54,000	403,881	312	88	5.8	1.6	0.2
2 _ALASKA	650	7,200	40,000	95	-	13.2	-	-
3 _ARIZONA	-	-	194,529	202	80	-	-	0.4
4 _ARKANSAS	4,233	37,600	265,916	230	46	6.1	1.2	0.2
5 _CALIFORNIA	15,088	274,634	882,541	1,737	592	6.3	2.2	0.7
6 _COLORADO	5,179	43,253	223,640	299	82	6.9	1.9	0.4
7 _CONNECTICUT	-	-	215,497	940	90	-	-	0.4
8 _DELAWARE	1,274	16,022	81,043	75	87	4.7	5.4	1.1
9 _DIST. OF COL.	151	2,000	2,475	65	0	32.5	0.0	0.0
10 _FLORIDA	8,620	138,980	744,185	938	311	6.7	2.2	0.4
11 _GEORGIA	10,028	90,250	814,822	991	249	11.0	2.8	0.3
12 _HAWAII	769	6,782	38,900	-	-	-	-	-
13 _IDAHO	2,001	19,918	122,000	135	19	6.8	1.0	0.2
14 _ILLINOIS	-	-	889,734	2,414	276	-	-	0.3
15 _INDIANA	10,522	58,436	647,801	856	107	14.6	1.8	0.2
16 _IOWA	6,821	62,526	248,368	500	81	8.0	1.3	0.3
17 _KANSAS	5,144	45,236	158,766	248	21	5.5	0.5	0.1
18 _KENTUCKY	6,744	76,645	453,207	914	175	11.9	2.3	0.4
19 _LOUISIANA	7,429	65,108	576,516	777	301	11.9	4.6	0.5
20 _MAINE	2,399	29,436	165,183	192	44	6.5	1.5	0.3
21 _MARYLAND	4,975	76,275	442,387	1,065	27	14.0	0.4	0.1
22 _MASSACHUSETTS	-	-	507,035	1,060	129	-	-	0.3
23 _MICHIGAN	13,840	114,245	964,293	30	1	0.3	0.0	0.0
24 _MINNESOTA	10,500	116,473	831,214	723	-	6.2	-	-
25 _MISSISSIPPI	5,100	39,747	359,435	382	59	9.6	1.5	0.2
26 _MISSOURI	8,922	98,534	451,090	632	174	6.4	1.8	0.4
27 _MONTANA	1,321	17,016	58,643	74	7	4.3	0.4	0.1
28 _NEBRASKA	3,422	30,527	56,151	123	30	4.0	1.0	0.5
29 _NEVADA	919	12,491	55,174	62	15	5.0	1.2	0.3
30 _NEW HAMPSHIRE	1,942	12,466	96,371	166	28	13.3	2.2	0.3
31 _NEW JERSEY	12,628	130,436	629,004	582	202	4.5	1.5	0.3
32 _NEW MEXICO	2,056	19,525	131,082	233	31	11.9	1.6	0.2
33 _NEW YORK	-		1,658,063	466	261	-	-	0.2
34 _NORTH CAROLINA	13,002	115,665	712,476	1,168	572	10.1	4.9	0.8
35 _NORTH DAKOTA	1,877	25,516	49,075	26	4	1.0	0.2	0.1
36 _OHIO	-	-	1,310,660	1,354	318	-	-	0.2
37 _OKLAHOMA	6,407	58,245	296,349	427	60	7.3	1.0	0.2
38 _OREGON	4,556	43,170	222,899	343	10	7.9	0.2	0.0
39 _PENNSYLVANIA	19,814	243,253	1,382,337	1,752	160	7.2	0.7	0.1
40 _RHODE ISLAND	-	-	-	-	-	-	-	-
41 _SOUTH CAROLINA	5,988	63,850	442,384	796	629	12.5	9.9	1.4
42 _SOUTH DAKOTA	1,279	8,555	46,318	75	29	-	3.4	0.6
43 _TENNESSEE	6,373	64,011	556,484	831	148	13.0	2.3	0.3
44 _TEXAS	24,500	182,000	1,000,000	1,228	557	6.7	3.1	0.6
45 _UTAH	-	-	116,189	102	2	-	-	0.0
46 _VERMONT	-	-	-	-	-	-	-	-
47 _VIRGINIA	9,312	83,031	725,333	686	163	8.3	2.0	0.2
48 _WASHINGTON	-	-	384,627	310	28	-	-	0.1

STATE	VEHICLES	ANNUAL BUS MILAGE (000)	PUPIL TRANSP. DAILY	TOTAL BUS ACC.	PUPILS INJURED	ACCI./ MILLION VEH.-MILE	PUPIL INJ./ MILLION VEH.-MILE	PUPIL INJ./ 1000 TRANSP. PUPIL
49 _WEST VIRGINIA	2,994	39,182	285,650	665	6	17.0	0.2	0.0
50 _WISCONSIN	6,829	73,508	464,548	866	140	11.8	1.9	0.3
51 _WYOMING	1,560	14,970	40,791	34	19	2.3	1.3	0.5
US TOTAL	350,000	3,400,000	21,600,000	28,000	23,000	8.2	6.8	1.1

ACCIDENT FACTS EDITION 1985

STATE	VEHICLES	ANNUAL BUS MILAGE (000)	PUPIL TRANSP. DAILY	TOTAL BUS ACC.	PUPILS INJURED	ACCI./ MILLION VEH.-MILE	PUPIL INJ./ MILLION VEH.-MILE	PUPIL INJ./ 1000 TRANSP. PUPIL
1 _ALABAMA		51,105	386,239	258	97	5.0	1.9	0.3
2 _ALASKA	600	7,200	39,000	124	-	17.2	-	-
3 _ARIZONA	3,316	35,245	199,986	199	72	5.6	2.0	0.4
4 _ARKANSAS	4,180	39,428	263,916	230	57	5.8	1.4	0.2
5 _CALIFORNIA	17,248	245,555	867,549	1,282	286	5.2	1.2	0.3
6 _COLORADO	-	-	-	207	-	-	-	-
7 _CONNECTICUT	4,686		243,000	788	37	-	-	0.2
8 _DELAWARE	1,252	15,632	81,043	91	7	5.8	0.4	0.1
9 _DIST. OF COL.	144	2,073	2,600	58	6	28.0	2.9	2.3
10 _FLORIDA	7,787	-	738,007	579	24	-	-	0.0
11 _GEORGIA	9,473	-	803,390	969	230	-	-	0.3
12 _HAWAII	735	7,374	38,048	36	10	4.9	1.4	0.3
13 _IDAHO	2,004	18,989	120,000	99	12	5.2	0.6	0.1
14 _ILLINOIS	15,791	180,000	894,748	2,485	275	13.8	1.5	0.3
15 _INDIANA	8,629	59,529	663,834		128	0.0	2.2	0.2
16 _IOWA	6,847	62,829	253,031	511	41	8.1	0.7	0.2
17 _KANSAS	-	-	-	-	-	-	-	-
18 _KENTUCKY	7,297	71,548	462,204	941	148	13.2	2.1	0.3
19 _LOUISIANA	7,511	65,837	583,959	711	77	10.8	1.2	0.1
20 _MAINE	2,280	26,680	167,004	148	3	5.5	0.1	0.0
21 _MARYLAND	4,880	71,940	444,222	1,032	21	14.3	0.3	0.0
22 _MASSACHUSETTS	7,279	66,613	512,259	1,020	143	15.3	2.1	0.3
23 _MICHIGAN	-	-	-	-	-	-	-	-
24 _MINNESOTA	9,923	90,170	700,000	675	185	7.5	2.1	0.3
25 _MISSISSIPPI	5,300	42,807	358,388	271	72	6.3	1.7	0.2
26 _MISSOURI	9,242	96,279	453,662	599	193	6.2	2.0	0.4
27 _MONTANA	1,320	17,827	63,108	55	4	3.1	0.2	0.1
28 _NEBRASKA	3,622	31,139	61,427	153	14	4.9	0.4	0.2
29 _NEVADA	874	11,278	55,174	62	15	5.5	1.3	0.3
30 _NEW HAMPSHIRE	1,827	10,793	94,482	190	59	17.6	5.5	0.6
31 _NEW JERSEY	12,600	120,000	628,412	573	206	4.8	1.7	0.3
32 _NEW MAXICO	2,021	23,330	130,691	161	14	6.9	0.6	0.1
33 _NEW YORK	-	-	1,977,000	621	181	-	-	0.1
34 _NORTH CAROLINA	12,825	110,511	725,732	1,246	613	11.3	5.5	0.8
35 _NORTH DAKOTA	1,891	25,484	48,281	39	7	1.5	0.3	0.1
36 _OHIO	14,374	153,207	1,319,505	1,665	225	10.9	1.5	0.2
37 _OKLAHOMA	6,395	58,609	295,694	377	212	6.4	3.6	0.7
38 _OREGON	3,822	39,611	226,650	330	13	8.3	0.3	0.1
39 _PENNSYLVANIA	19,521	230,112	1,545,995	2,011	142	8.7	0.6	0.1
40 _RHODE ISLAND	1,652	15,179	103,192	107	13	7.0	0.9	0.1
41 _SOUTH CAROLINA	5,942	59,857	438,117	834	387	13.9	6.5	0.9
42 _SOUTH DAKOTA	-	-	-	-	-	-	-	-
43 _TENNESSEE	6,364	68,703	569,900	657	113	9.6	1.6	0.2
44 _TEXAS	22,481		947,110	1,210	316	-	-	0.3
45 _UTAH	-	-	-	-	-	-	-	-
46 _VERMONT	-	-	-	-	-	-	-	-
47 _VIRGINIA	9,042	79,500	720,984	699	119	8.8	1.5	0.2
48 _WASHINGTON	6,005	61,043	376,727	248	50	4.1	0.8	0.1

STATE	VEHICLES	ANNUAL BUS MILAGE (000)	PUPIL TRANSP. DAILY	TOTAL BUS ACC.	PUPILS INJURED	ACCI./ MILLION VEH.-MILE	PUPIL INJ./ MILLION VEH.-MILE	PUPIL INJ./ 1000 TRANSP. PUPIL
49 _WEST VIRGINIA	2,941	37,338	292,061	690	29	18.5	0.8	0.1
50 _WISCONSIN	6,859	73,807	462,347	642		8.7	0.0	0.0
51 _WYOMING	1,289	13,074	41,322	52	3	4.0	0.2	0.1
US TOTAL	340,000	3,400,000	22,100,000	29,000	5,500	8.5	1.6	0.2

SCHOOL BUS ACCIDENT REPORT
DIVISION OF FINANCE
BUREAU OF PUPIL TRANSPORTATION
NEW JERSEY STATE DEPARTMENT OF EDUCATION
1986-87

REPORTABLE DAMAGE AND INJURY INCOLVING

COUNTY	TOTAL # OF ACCICENTS	PROPERTY DAMAGE ONLY	PUPIL INJURY IN EXCESS OF $15	MINOR PUPIL INJURY UNDER $15	BUS DRIVER	MOTORIST/ PEDESTRIAN	FATAL	TYPE OF OWNERSHIP: DIST.	CONT.	S.V.	COLLISION WITH: ONE/MORE VEHICLES	RR TRAIN	BICYCLE	FIXED OBJEC	RUN OFF ROAD	ON BOARD ACCIDENT	OTHER	ASSOCIATION: BEFORE ENT. BUS	AFTER LEV. BUS
1-ATLANTIC	15	9	10	6	4	7	2	10	5	2	12	-	-	2	1	-	-	-	-
2-BERGEN	17	5	12	6	3	4	-	3	14	9	15	-	-	-	-	1	1	-	-
3-BURLINGTON	29	12	17	6	3	9	-	27	2	8	27	-	-	1	-	-	1	-	-
4-CAMDEN	30	4	8	2	6	7	-	23	7	5	29	-	-	1	-	-	-	-	-
5-CAPE MAY	4	2	-	-	1	-	-	2	2	-	2	-	-	2	-	-	-	-	-
6-CUMBERLAND	7	-	1	-	3	1	-	6	1	1	5	-	-	1	-	-	1	-	-
7-ESSEX	3	3	2	1	1	-	-	1	2	3	3	-	-	-	-	-	-	-	-
8-GLOUCESTER	25	8	30	9	5	7	-	19	6	4	23	-	-	2	-	-	-	-	-
9-HUDSON	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10-HUNTERDON	13	8	-	-	1	1	-	10	3	1	11	-	-	2	-	-	-	-	-
11-MERCER	21	5	3	4	1	2	-	14	7	2	16	-	-	3	-	1	1	-	-
12-MIDDLESEX	24	4	15	18	4	5	2	15	9	13	20	-	-	-	1	-	3	-	-
13-MONMOUTH	39	7	16	11	9	7	2	35	4	12	35	-	1	1	1	-	1	-	1
14-MORRIS	31	8	3	12	5	7	1	20	9	13	25	-	-	5	-	1	-	-	-
15-OCEAN	45	13	20	20	6	10	1	43	2	13	39	-	-	3	2	-	1	-	1
16-PASSAIC	8	-	3	4	-	1	-	4	4	2	8	-	-	-	-	-	-	-	-
17-SALEM	8	1	6	-	1	1	-	5	3	1	7	-	-	-	-	1	-	-	-
18-SOMERSET	16	8	3	2	1	1	-	11	5	8	14	-	-	1	-	-	1	-	1
19-SUSSEX	6	3	-	-	-	-	-	3	3	3	5	-	-	1	-	-	-	-	-
20-UNION	9	2	8	5	2	2	-	4	5	3	7	-	-	1	1	-	-	-	-
21-WARREN	6	4	4	6	-	1	-	1	5	3	4	-	-	2	-	-	-	-	-
T O T A L	356	106	161	112	56	73	*8	256	98	106	307	-	1	28	6	4	10	-	3

*FATALITIES - 2 PUPILS
5 DRIVERS OF OTHER VEHICLES
1 BOY ON BICYCLE

SCHOOL BUS ACCIDENT REPORT
DIVISION OF FINANCE
BUREAU OF PUPIL TRANSPORTATION
NEW JERSEY STATE DEPARTMENT OF EDUCATION
1986-87

NON-REPORTABLE DAMAGE AND INJURY INCOLVING

COUNTY	TOTAL # OF ACCICENTS	PROPERTY DAMAGE ONLY	MINOR PUPIL INJURY UNDER $15	BUS DRIVER	MOTORIST/ PEDESTRIAN	TYPE OF OWNERSHIP: DIST.	CONT.	S.V.	COLLISION WITH: ONE/MORE VEHICLES	RR TRAIN	BICYCLE	FIXED OBJEC	RUN OFF ROAD	ON BOARD ACCIDENT	OTHER	ASSOCIATION: BEFORE ENT. BUS	AFTER LEV. BUS
1-ATLANTIC	13	3	-	-	-	10	3	3	10	-	-	3	-	-	-	-	-
2-BERGEN	10	3	-	-	-	5	5	5	10	-	-	-	-	-	-	-	-
3-BURLINGTON	45	7	-	-	-	39	6	13	36	-	-	8	1	-	-	-	-
4-CAMDEN	41	-	-	-	-	36	5	7	37	-	-	4	-	-	-	-	-
5-CAPE MAY	4	-	-	-	-	4	-	1	3	-	-	-	-	-	1	-	-
6-CUMBERLAND	8	-	-	-	-	8	-	1	7	-	-	1	-	-	-	-	-
7-ESSEX	5	-	-	-	-	3	2	4	3	-	-	1	-	-	1	-	1
8-GLOUCESTER	28	2	-	-	-	25	3	4	25	-	-	2	1	-	-	-	-
9-HUDSON	3	-	-	-	-	3	-	-	3	-	-	-	-	-	-	-	-
10-HUNTERDON	12	3	-	-	-	8	4	1	9	-	-	3	-	-	-	-	-
11-MERCER	32	3	2	-	1	16	16	8	25	-	1	6	-	-	-	-	-
12-MIDDLE SEX	36	1	-	-	-	29	7	14	31	-	-	5	-	-	-	-	-
13-MONMOUTH	36	1	-	-	-	32	4	11	31	-	-	5	-	-	-	-	-
14-MORRIS	38	7	-	-	-	32	6	7	30	-	-	5	2	-	1	-	-
15-OCEAN	46	3	-	-	-	46	-	5	37	-	-	9	-	-	-	-	1
16-PASSAIC	14	1	-	-	-	13	1	4	11	-	-	3	-	-	-	-	-
17-SALEM	8	1	-	-	-	8	-	2	7	-	-	1	-	-	-	-	-
18-SOMERSET	12	-	-	-	-	8	4	5	10	-	-	2	-	-	-	-	-
19-SUSSEX	5	1	-	-	-	2	3	-	5	-	-	-	-	-	-	-	-
20-UNION	20	4	-	-	-	17	3	6	15	-	-	5	-	-	-	-	-
21-WARREN	5	2	-	-	-	1	4	1	3	-	-	2	-	-	-	-	-
TOTAL	421	42	2	-	1	345	76	102	348	-	1	65	4	-	3	-	2

SCHOOL BUS ACCIDENT REPORT
DIVISION OF FINANCE
BUREAU OF PUPIL TRANSPORTATION
NEW JERSEY STATE DEPARTMENT OF EDUCATION
1987-88

NON-REPORTABLE DAMAGE AND INJURY INCOLVING

COUNTY	TOTAL # OF ACCICENTS	PROPERTY DAMAGE ONLY	MINOR PUPIL INJURY UNDER $15	BUS DRIVER	MOTORIST/ PEDESTRIAN	TYPE OF OWNERSHIP DIST.	CONT.	S.V.	COLLISION WITH ONE/MORE VEHICLES	RR TRAIN	BICYCLE	FIXED OBJEC	RUN OFF ROAD	ON BOARD ACCIDENT	OTHER	ASSOCIATION BEFORE ENT. BUS	AFTER LEV. BUS
1-ATLANTIC	15	3	-	-	-	15	-	-	5	-	-	-	-	-	-	-	-
2-BERGEN	10	1	-	-	-	5	7	3	9	-	-	-	-	1	-	-	-
3-BURLINGTON	10	1	-	-	-	5	3	3	10	11	-	-	-	-	-	-	-
4-CAMDEN	13	-	-	-	-	10	2	-	13	-	-	-	-	-	-	-	-
5-CAPE MAY	1	1	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-
6-CUMBERLAND	3	3	-	-	-	3	-	-	-	-	-	3	-	-	-	-	-
7-ESSEX	2	2	-	-	-	2	-	-	2	-	-	-	-	-	-	-	-
8-GLOUCESTER	7	6	-	-	-	8	-	-	7	-	-	1	-	-	-	-	-
9-HUDSON	3	3	-	-	-	3	-	-	2	-	-	1	-	-	-	-	-
10-HUNTERDON	17	2	2	-	-	9	8	7	18	-	-	2	-	-	-	-	-
11-MERCER	42	-	-	-	-	37	3	13	42	-	-	-	-	-	-	-	-
12-MIDDLE SEX	32	5	-	-	-	23	6	4	21	-	1	-	-	-	-	-	-
13-MONMOUTH	38	3	-	-	-	34	-	3	32	-	1	-	-	-	-	-	-
14-MORRIS	17	5	-	-	-	16	1	2	17	-	-	1	-	-	-	-	-
15-OCEAN	3	-	-	-	-	2	2	1	3	-	-	-	-	-	-	-	-
16-PASSAIC	2	-	-	-	-	2	-	2	2	-	-	-	-	-	-	-	-
17-SALEM	3	2	-	-	-	2	1	1	-	-	-	-	-	-	-	-	-
18-SOMERSET	5	5	-	-	-	2	1	1	-	-	-	-	-	-	-	-	-
19-SUSSEX	6	1	-	-	-	1	5	-	5	-	-	-	-	-	-	-	-
20-UNION	12	6	2	-	-	11	2	-	10	-	-	1	-	-	-	-	1
21-WARREN	10	1	-	-	-	6	1	1	8	-	-	-	-	-	-	-	-
TOTAL	251	50	4	-	-	197	42	41	207	11	2	9	-	1	-	-	1

SCHOOL BUS ACCIDENT REPORT
DIVISION OF FINANCE
BUREAU OF PUPIL TRANSPORTATION
NEW JERSEY STATE DEPARTMENT OF EDUCATION
1987-88

REPORTABLE DAMAGE AND INJURY INCOLVING

COUNTY	TOTAL # OF ACCICENTS	PROPERTY DAMAGE ONLY	MINOR PUPIL INJURY UNDER $15	BUS DRIVER	MOTORIST/ PEDESTRIAN	FATAL	TYPE OF OWNERSHIP			COLLISION WITH				RUN OFF ROAD	ON BOARD ACCIDENT	OTHER	ASSOCIATION	
							DIST.	CONT.	S.V.	ONE/MORE VEHICLES	RR TRAIN	BICYCLE	FIXED OBJEC				BEFORE ENT. BUS	AFTER LEV. BUS
1-ATLANTIC	15	12	1	3	8	1	14	1	1	-	-	-	-	-	-	-	-	-
2-BERGEN	4	1	1	-	-	-	3	1	1	-	-	-	-	-	-	-	-	-
3-BURLINGTON	18	13	5	4	4	-	12	5	6	-	-	-	-	-	-	-	-	-
4-CAMDEN	3	2	5	1	-	1	3	-	1	-	-	-	-	-	-	-	-	-
5-CAPE MAY	5	3	3	-	-	-	5	1	-	-	-	-	-	-	-	-	-	-
6-CUMBERLAND	1	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
7-ESSEX	15	2	3	-	-	-	14	-	6	-	-	-	-	-	-	-	-	-
8-GLOUCESTER	4	3	6	-	-	-	3	1	1	-	-	-	-	-	-	-	-	-
9-HUDSON	6	2	1	-	-	-	4	1	-	-	-	-	-	-	-	-	-	-
10-HUNTERDON	11	11	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-
11-MERCER	21	6	8	-	2	-	11	15	9	-	-	-	-	-	-	-	-	-
12-MIDDLE SEX	22	7	7	-	-	-	14	6	6	-	-	-	-	-	-	-	-	-
13-MONMOUTH	15	4	3	2	1	-	10	4	5	-	-	-	-	-	-	-	-	-
14-MORRIS	36	19	3	-	-	-	19	15	3	-	-	-	-	-	-	-	-	-
15-OCEAN	35	11	20	2	4	-	35	1	3	-	-	-	-	-	-	-	-	-
16-PASSAIC	8	3	17	2	2	-	4	4	3	-	-	-	-	-	-	-	-	-
17-SALEM	5	7	3	-	-	-	2	2	1	-	-	-	-	-	-	-	-	-
18-SOMERSET	20	15	10	3	1	1	13	9	9	-	-	-	-	-	-	-	-	-
19-SUSSEX	8	3	3	1	-	-	-	8	4	-	-	-	-	-	-	-	-	-
20-UNION	5	5	3	-	-	-	3	3	1	-	-	-	-	-	-	-	-	-
21-WARREN	3	3	1	-	-	-	1	3	1	-	-	-	-	-	-	-	-	-
T O T A L	260	133	103	18	22	*3	181	81	61	-	-	-	-	-	-	-	-	-

*FATALITIES - 2 PUPILS
1 PASSENGER OF OTHER VEHICLE

SUMMARY OF MOTOR VEHICLE TRAFFIC ACCIDENTS

FROM 01/01/86 - 12/31/86
TYPE OF VEH.: SCHOOL BUS

SR. NO.	COUNTY	NUMBER OF ACCIDENTS ALL	FATAL	INJURY	PROP. DAMAGE
1	ATLANTIC	32	0	8	24
2	BERGEN	142	0	37	105
3	BURLINGTON	57	1	14	42
4	CAMDEN	64	0	16	48
5	CAPE MAY	11	0	2	9
6	CUMBERLAND	28	0	12	16
7	ESSEX	116	1	43	72
8	GLOUCESTER	42	0	10	32
9	HUDSON	66	0	19	47
10	HUNTERDON	19	0	6	13
11	MERCER	62	1	22	39
12	MIDDLESEX	124	0	40	84
13	MONMOUTH	101	0	31	70
14	MORRIS	80	0	23	57
15	OCEAN	59	0	21	38
16	PASSAIC	58	0	20	38
17	SALEM	8	0	3	5
18	SOMERSET	35	0	13	22
19	SUSSEX	34	0	8	26
20	UNION	65	0	19	46
21	WARREN	13	0	7	6
		1216	3	374	839

Source: Bureau of accident records, New Jersey DOT
Report no. 15 - accidents by vehicle type
July 22,1988

SUMMARY OF MOTOR VEHICLE TRAFFIC ACCIDENTS

FROM 01/01/85 - 12/31/85
TYPE OF VEH.: SCHOOL BUS

SR. NO.	COUNTY	NUMBER OF ACCIDENTS			
		ALL	FATAL	INJURY	PROP. DAMAGE
1	ATLANTIC	32	0	13	19
2	BERGEN	156	0	51	105
3	BURLINGTON	49	0	20	29
4	CAMDEN	73	0	25	48
5	CAPE MAY	7	0	3	4
6	CUMBERLAND	28	0	9	19
7	ESSEX	106	1	34	71
8	GLOUCESTER	35	0	13	22
9	HUDSON	56	0	11	45
10	HUNTERDON	20	0	8	12
11	MERCER	55	0	19	36
12	MIDDLESEX	115	2	36	77
13	MONMOUTH	134	1	35	98
14	MORRIS	85	1	26	58
15	OCEAN	48	0	23	25
16	PASSAIC	52	0	21	31
17	SALEM	4	0	1	3
18	SOMERSET	42	0	16	26
19	SUSSEX	25	0	11	14
20	UNION	75	0	19	56
21	WARREN	9	0	2	7
		1206	5	396	805

Source: Bureau of accident records, New Jersey DOT
Report no. 15 - accidents by vehicle type
March 23,1987

SUMMARY OF MOTOR VEHICLE TRAFFIC ACCIDENTS

FROM 01/01/86 - 12/31/86
TYPE OF VEH.: SCHOOL BUS

COUNTY	CITY	# FAT-AITY	# INJ-URY	# OF ACCI. INVOLVING INJURY #: 1	2	3	4	5 & ABOVE	# OF ACCIDENTS: PAT.	INJ.	PDO	TOTAL	COLLISION TYPE(INJ. & FATAL ACCI.): SD	AN	HO	SPV	SFO	LT	PED	PC	OT
1-ATLANTIC	1-ABSECON	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	2-ATLANTIC	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	3-BUENA BORO	-	3	-	-	1	-	-	-	1	-	1	-	1	-	-	-	-	-	-	-
	4-BUNA VISTA TWP.	-	4	-	-	-	1	-	-	1	2	3	-	-	-	-	1	-	-	-	-
	5-EGG HARBOR TWP.	-	4	2	1	-	-	-	-	3	8	11	1	-	-	-	1	-	1	-	-
	6-FOLSOM BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	7-GALLOWAY TWP.	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
	8-HAMILTON TWP.	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
	9-LINDWOOD	-	2	-	1	-	-	-	-	1	-	1	-	1	-	-	-	-	-	-	-
	10-LONGPORT BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	11-NORTHFIELD	-	10	-	-	-	-	1 (10 #)	-	1	-	1	-	-	-	-	-	1	-	-	-
	12-PLEASANTVILLE	-	3	-	-	1	-	-	-	1	2	3	1	-	-	-	-	-	-	-	-
	13-VENTNOR	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
T O T A L		-	26	2	2	2	1	1	-	8	24	32	2	2	-	-	2	1	1	-	-

LEGEND :-

SD ___ SAME DIRECTION	SPV ___ STRUCK PARKED VEHICLE	PED ___ PEDESTRIAN
AN ___ ANGLE	SFO ___ STRUCK FIXED OBJECT	PC ___ PEDAL CYCLE
HO ___ HEAD ON	LT ___ LEFT TURN FROM OPPOSITE DIRECTION	OT ___ OTHER

COUNTY	CITY	# FAT-AITY	# INJ-URY	# OF ACCI. INVOLVING INJURY # 1	2	3	4	5 & ABOVE	# OF ACCIDENTS FAT.	INJ.	PDO	TOTAL	COLLISION TYPE(INJ. & FATAL ACCI.) SD	AN	HO	SPV	SPO	LT	PED	PC	OT
2-BERGEN	1-ALLENDALE BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	2-ALPINE BORO	-	1	1	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-
	3-BERGENFIELD BORO	-	2	-	1	-	-	-	-	1	1	2	-	1	-	-	-	-	-	-	-
	4-CLOSTER BORO	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
	5-CRESSKILL BORO	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
	5-DUMONT BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	7-ELMWOOD PARK BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	8-EAST RUTHERFORD BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	9-EMERSON BORO	-	1	1	-	-	-	-	-	1	1	2	-	-	1	-	-	-	-	-	-
	10-ENGLEWOOD	-	3	3	-	-	-	-	-	3	2	5	-	2	-	1	-	-	-	-	-
	11-ENGLEWOOD CLIFFS BORO	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	12-FAIR LAWN BORO	-	6	-	-	2	-	-	-	2	4	6	2	-	-	-	-	-	-	-	-
	13-FAIRVIEW BORO	-	2	-	1	-	-	-	-	1	2	3	-	1	-	-	-	-	-	-	-
	14-FORT LEE BORO	-	1	1	-	-	-	-	-	1	5	6	1	-	-	-	-	-	-	-	-
	15-FRANKLIN LAKES BORO	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
	16-GLEN ROCK BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	17-HACKENSACK	-	4	4	-	-	-	-	-	4	3	7	1	1	-	1	-	-	-	1	-
	18-HARRINGTON PARK BORO	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
	19-HASBROUCK HEIGHTS	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
	20-HAWORTH BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	21-HILLSDALE BORO	-	1	1	-	-	-	-	-	1	1	2	1	-	-	-	-	-	-	-	-
	22-LITTLE FERRY BORO	-	1	1	-	-	-	-	-	1	2	3	-	1	-	-	-	-	-	-	-
	23-LODI BORO	-	2	2	-	-	-	-	-	2	5	7	1	1	-	-	-	-	-	-	-
	24-LYNDHURST TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	25-MAHWAH TWP.	-	2	2	-	-	-	-	-	2	2	4	-	-	1	-	1	-	-	-	-
	26-MONTVALE BORO	-	-	-	-	-	-	-	-	-	4	4	-	-	-	-	-	-	-	-	-
	27-NEW MILFORD BORO	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	28-OAKLAND BORO	-	2	-	1	-	-	-	-	1	3	4	1	-	-	-	-	-	-	-	-
	29-ORADELL BORO	-	2	2	-	-	-	-	-	2	1	3	1	1	-	-	-	-	-	-	-
	30-PARAMUS BORO	-	10	3	2	1	-	-	-	6	13	19	3	2	-	-	-	-	-	-	-
	31-PARK RIDGE BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	32-RAMSEY BORO	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
	33-RIDGEFIELD BORO	-	1	1	-	-	-	-	-	1	2	3	-	1	-	-	-	-	-	-	-
	34-RIDGEFIELD PARK VILL.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	35-RIDGEWOOD VILLAGE	-	1	1	-	-	-	-	-	1	2	3	-	1	-	-	-	-	-	-	-
	36-RIVER EDGE BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	37-RUTHERFORD BORO	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	38-SADDLE BROOK TWP.	-	2	-	1	-	-	-	-	1	-	1	-	-	-	-	1	-	-	-	-
	39-SADDLE RIVER BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	40-TEANECK TWP.	-	4	1	-	1	-	-	-	2	8	10	2	-	-	-	-	-	-	-	-
	41-TENAFLY BORO	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	42-UPPER SADDLE RIVER	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	43-WALDWICK BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	44-WYCKOFF TWP.	-	1	1	-	-	-	-	-	1	2	3	-	2	-	-	-	-	-	-	-
TOTAL		-	49	25	6	4	-	-	-	35	102	137	14	14	2	2	2	-	-	1	-

COUNTY	CITY	# FAT-AITY	# INJ-URY	# OF ACCI. INVOLVING INJURY #: 1	2	3	4	5 & ABOVE	# OF ACCIDENTS: PAT.	INJ.	PDO	TOTAL	COLLISION TYPE(INJ. & FATAL ACCI.): SD	AN	HO	SPV	SFO	LT	PED	PC	OT
3-BURLINGTON	1-BURLINGTON	-	1	1	-	-	-	-	-	1	-	1	-	1	-	-	-	-	-	-	-
	2-BURLINGTON TOWN	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	3-CINNAMINSON TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	4-EVESHAM TWP.	1	3	1	1	-	-	-	1	2	10	13	1	-	1	-	-	-	-	1	-
	5-LUMBERTON TWP.	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	6-MANSFIELD TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	7-MAPLE SHADE TWP.	-	1	1	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-
	8-MEDFORD TWP.	-	-	-	-	-	-	-	-	-	6	6	-	-	-	-	-	-	-	-	-
	9-MOORES TOWN	-	1	1	-	-	-	-	-	1	1	2	1	-	-	-	-	-	-	-	-
	10-MOUNT HOLLY TWP.	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	11-MOUNT LAUREL TWP.	-	1	1	-	-	-	-	-	1	5	6	1	-	-	-	-	-	-	-	-
	12-PEMBERTON BORO	-	-	-	-	-	-	-	-	-	4	4	-	-	-	-	-	-	-	-	-
	13-RIVERSIDE TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	14-SHAMONG TWP.	-	1	1	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-
	15-SOUTH HAMPTON TWP.	-	6	-	1	-	1	-	-	2	-	2	-	-	2	-	-	-	-	-	-
	16-SPRINGFIELD TWP.	-	2	-	1	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-
	17-TABERNACLE TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	18-WEST AMPTON TWP.	-	2	-	1	-	-	-	-	1	1	2	-	1	-	-	-	-	-	-	-
	19-WILLINGBORO TWP.	-	-	-	-	-	-	-	-	-	4	4	-	-	-	-	-	-	-	-	-
TOTAL		1	18	6	4	-	1	-	1	11	41	53	6	2	3	-	-	-	-	1	-

LEGEND :-

SD — SAME DIRECTION
AN — ANGLE
HO — HEAD ON
SPV — STRUCK PARKED VEHICLE
SFO — STRUCK FIXED OBJECT
LT — LEFT TURN FROM OPPOSITE DIRECTION
PED — PEDESTRIAN
PC — PEDAL CYCLE
OT — OTHER

COUNTY	CITY	# FAT-AITY	# INJ-URY	# OF ACCI. INVOLVING INJURY # 1	2	3	4	5 & ABOVE	# OF ACCIDENTS FAT.	INJ.	PDO	TOTAL	COLLISION TYPE(INJ. & FATAL ACCI.) SD	AN	HO	SPV	SFO	LT	PED	PC	OT
4-CAMDEN	1-BARRINGTON BORO	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	2-BELLMAWR BORO	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	3-BERLIN TWP.	-	2	-	1	-	-	-	-	1	1	2	-	-	1	-	-	-	-	-	-
	4-CAMDEN	-	1	1	-	-	-	-	-	1	4	5	-	-	-	-	-	-	-	1	-
	5-CHERRY HILL TWP.	-	-	-	-	-	-	-	-	-	11	11	-	-	-	-	-	-	-	-	-
	6-CHESILHURST BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	7-COLLINGSWOOD BORO	-	4	1	-	1	-	-	-	2	-	2	2	-	-	-	-	-	-	-	-
	8-GIBBSBORO BORO	-	1	1	-	-	-	-	-	1	-	1	-	-	-	-	1	-	-	-	-
	9-GLOUCESTER	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	10-GLOUCESTER TWP.	-	1	1	-	-	-	-	-	1	6	7	1	-	-	-	-	-	-	-	-
	11-HADDON TWP.	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	12-HADDONFIELD BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	13-LAUREL SPRINGS BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	14-LAWNSIDE BORO	-	1	1	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-
	15-MAGNOLIA BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	16-OAKLYN BORO	-	1	1	-	-	-	-	-	1	1	2	1	-	-	-	-	-	-	-	-
	17-PENNSAUKEN TWP.	-	7	-	-	-	-	1 (7 #)	-	1	2	3	-	-	-	-	1	-	-	-	-
	18-PINE HILL BORO	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	19-SOMERDALE BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	20-STRATFORD BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	21-VOORHEES TWP.	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	22-WATERFORD TWP.	-	2	-	1	-	-	-	-	1	3	4	1	-	-	-	-	-	-	-	-
	23-WINSLOW TWP.	-	11	4	-	-	-	1 (7 #)	-	5	3	8	2	3	-	-	-	-	-	-	-
T O T A L		-	31	10	2	1	-	2	-	15	48	63	8	3	1	-	2	-	-	1	-

LEGEND :-

SD ___ SAME DIRECTION
AN ___ ANGLE
HO ___ HEAD ON
SPV ___ STRUCK PARKED VEHICLE
SFO ___ STRUCK FIXED OBJECT
LT ___ LEFT TURN FROM OPPOSITE DIRECTION
PED ___ PEDESTRIAN
PC ___ PEDAL CYCLE
OT ___ OTHER

COUNTY	CITY	# FAT-AITY	# INJ-URY	# OF ACCI. INVOLVING INJURY #: 1	2	3	4	5 & ABOVE	# OF ACCIDENTS: FAT.	INJ.	PDO	TOTAL	COLLISION TYPE(INJ. & FATAL ACCI.): SD	AN	HO	SPV	SFO	LT	PED	PC	OT
5-CAPE MAY	1-LAWER TWP.	-	1	1	-	-	-	-	-	1	1	2	-	-	-	-	1	-	-	-	-
	2-MIDDLE TWP.	-	1	1	-	-	-	-	-	1	2	3	-	1	-	-	-	-	-	-	-
	3-OCEAN	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	4-UPPER TWP.	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
T O T A L		-	2	2	-	-	-	-	-	2	8	10	-	1	-	-	1	-	-	-	-

LEGEND :-

SD — SAME DIRECTION
AN — ANGLE
HO — HEAD ON
SPV — STRUCK PARKED VEHICLE
SFO — STRUCK FIXED OBJECT
LT — LEFT TURN FROM OPPOSITE DIRECTION
PED — PEDESTRIAN
PC — PEDAL CYCLE
OT — OTHER

COUNTY	CITY	# FAT-AITY	# INJ-URY	# OF ACCI. INVOLVING INJURY #: 1	2	3	4	5 & ABOVE	# OF ACCIDENTS: FAT.	INJ.	PDO	TOTAL	COLLISION TYPE(INJ. & FATAL ACCI.): SD	AN	HO	SPV	SFO	LT	PED	PC	OT
6-CUMBERLAND	1-BRIDGETON TWP.	-	2	-	1	-	-	-	-	1	-	1	-	1	-	-	-	-	-	-	-
	2-COMMERCIAL TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	3-MILLVILLE	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
	4-UPPER DEERFIELD TWP.	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	5-VINELAND	-	11	7	2	-	-	-	-	9	10	19	3	4	-	-	-	1	-	-	-
T O T A L		-	13	7	3	-	-	-	-	10	16	26	3	5	-	-	-	1	-	-	-

LEGEND :-

SD ___ SAME DIRECTION
AN ___ ANGLE
HO ___ HEAD ON
SPV ___ STRUCK PARKED VEHICLE
SFO ___ STRUCK FIXED OBJECT
LT ___ LEFT TURN FROM OPPOSITE DIRECTION
PED ___ PEDESTRIAN
PC ___ PEDAL CYCLE
OT ___ OTHER

COUNTY	CITY	# FAT-AITY	# INJ-URY	# OF ACCI. INVOLVING INJURY # 1	2	3	4	5 & ABOVE	# OF ACCIDENTS FAT.	INJ.	PDO	TOTAL	COLLISION TYPE(INJ. & FATAL ACCI.) SD	AN	HO	SPV	SFO	LT	PED	PC	OT
7-ESSEX	1-BELLIVILLE TOWN	1	5	1	-	-	1	-	1	2	1	4	2	-	-	-	-	1	-	-	-
	2-BLOOMFIELD TOWN	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	3-CALDWELL BORO	-	5	-	-	-	-	1	-	1	-	1	-	1	-	-	-	-	-	-	-
	4-EAST ORANGE CITY	-	9	-	2	-	-	1	-	3	1	4	1	1	-	1	-	-	-	-	-
	5-ESSEX FELLS BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	6-FAIRFIELD BORO	-	2	2	-	-	-	-	-	2	6	8	2	-	-	-	-	-	-	-	-
	7-GLEN RIDGE BORO	-	2	-	1	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-
	8-IRVINGTON TOWN	-	6	3	-	1	-	-	-	4	11	15	2	-	-	1	-	-	-	-	1
	9-LIVINGSTON TWP.	-	5	2	-	1	-	-	-	3	4	7	2	-	-	-	-	1	-	-	-
	10-MAPLEWOOD TWP.	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	11-MILLBURN TWP.	-	4	2	1	-	-	-	-	3	3	6	1	1	-	-	1	-	-	-	-
	12-MONTCLAIR TOWN	-	2	2	-	-	-	-	-	2	10	12	1	1	-	-	-	-	-	-	-
	13-NEWARK	-	34	2	3	2	-	3(6#+9#)	-	10	14	24	3	6	-	1	-	-	-	-	-
	14-NORTH CALDWELL BORO	-	1	1	-	-	-	-	-	1	1	2	-	-	1	-	-	-	-	-	-
	15-ORANGE	-	3	1	1	-	-	-	-	2	2	4	-	2	-	-	-	-	-	-	-
	16-SOUTH ORANGE VILLAGE	-	2	-	1	-	-	-	-	1	3	4	-	1	-	-	-	-	-	-	-
	17-VERONA BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	18-WEST CALDWELL BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	19-WEST ORANGE TOWN	-	46	2	1	1	-	1 (39#)	-	5	8	13	1	-	-	-	1	1	1	-	1
T O T A L		1	126	18	10	5	1	2	1	40	70	111	16	13	1	3	2	3	1	-	2

LEGEND :-

SD ___ SAME DIRECTION
AN ___ ANGLE
HO ___ HEAD ON
SPV ___ STRUCK PARKED VEHICLE
SFO ___ STRUCK FIXED OBJECT
LT ___ LEFT TURN FROM OPPOSITE DIRECTION
PED ___ PEDESTRIAN
PC ___ PEDAL CYCLE
OT ___ OTHER

COUNTY	CITY	# FAT-AITY	# INJ-URY	# OF ACCI. INVOLVING INJURY #: 1	2	3	4	5 & ABOVE	# OF ACCIDENTS: FATAL	INJ.	PDO	TOTAL	COLLISION TYPE(INJ. & FATAL ACCI.): SD	AN	HO	SPV	SFO	LT	PED	PC	OT
8-GLOUCESTER	1-DEPTFORD TWP.	-	2	2	-	-	-	-	-	2	5	7	1	-	1	-	-	-	-	-	[illegible]
	2-ELK TWP.	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	[illegible]
	3-FRANKLIN TWP.	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	[illegible]
	4-GLASSBORO BORO	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	[illegible]
	5-HARRISON TWP.	-	3	1	1	-	-	-	-	2	1	3	-	2	-	-	-	-	-	-	[illegible]
	6-MANTUA TWP.	-	5	-	-	-	-	1	-	1	1	2	-	1	-	-	-	-	-	-	[illegible]
	7-MONROE TWP.	-	-	-	-	-	-	-	-	-	9	9	-	-	-	-	-	-	-	-	[illegible]
	8-NATIONAL PARK BORO	-	2	-	1	-	-	-	-	1	-	1	-	1	-	-	-	-	-	-	[illegible]
	9-PITMAN BORO	-	1	1	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	[illegible]
	10-WASHINGTON TWP.	-	1	1	-	-	-	-	-	1	4	5	-	-	-	-	1	-	-	-	[illegible]
	11-WEST DEPTFORD TWP.	-	1	1	-	-	-	-	-	1	3	4	1	-	-	-	-	-	-	-	[illegible]
	12-WOODBURY	-	1	1	-	-	-	-	-	1	1	2	-	-	-	-	-	-	1	-	[illegible]
TOTAL		-	16	7	2	-	-	1	-	10	30	40	3	4	1	-	1	-	1	-	[illegible]

LEGEND :-

SD ___ SAME DIRECTION SPV ___ STRUCK PARKED VEHICLE PED ___ PEDESTRIAN NC ___ NON COLLISI[illegible]

AN ___ ANGLE SFO ___ STRUCK FIXED OBJECT PC ___ PEDAL CYCLE FAT. ___ FATAL

HO ___ HEAD ON LT ___ LEFT TURN FROM OPPOSITE DIRECTION OT ___ OTHER INJ. ___ INJURY

COUNTY	CITY	# FAT-AITY	# INJ-URY	# OF ACCI. INVOLVING INJURY # 1	2	3	4	5 & ABOVE	# OF ACCIDENTS FATAL	INJ.	PDO	TOTAL	COLLISION TYPE(INJ. & FATAL ACCI.) SD	AN	HO	SPV	SPO	LT	PED	PC	OT
9-HUDSON	1-BAYONNE CITY	-	3	3	-	-	-	-	-	3	1	4	-	-	-	1	-	-	-	1	1NC
	2-HARRISON TOWN	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	3-HOBOKEN CITY	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	4-JERSEY CITY	-	12	9	-	1	-	-	-	10	19	29	1	3	-	1	-	-	5	-	-
	5-KEARNY TOWN	-	-	-	-	-	-	-	-	-	5	5	-	-	-	-	-	-	-	-	-
	6-NORTH BERGEN TWP.	-	4	1	-	1	-	-	-	2	6	8	1	1	-	-	-	-	-	-	-
	7-SECAUCUS TOWN	-	3	-	-	1	-	-	-	1	3	4	1	-	-	-	-	-	-	-	-
	8-UNION CITY	-	3	3	-	-	-	-	-	3	8	11	-	1	-	-	-	-	-	-	2NC
	9-WEEHAWKEN TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	10-WEST NEW YORK TOWN	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	TOTAL	-	25	16	-	3	-	-	-	19	47	66	3	5	-	2	-	-	5	1	3

LEGEND :-

SD — SAME DIRECTION
AN — ANGLE
HO — HEAD ON
SPV — STRUCK PARKED VEHICLE
SPO — STRUCK FIXED OBJECT
LT — LEFT TURN FROM OPPOSITE DIRECTION
PED — PEDESTRIAN
PC — PEDAL CYCLE
OT — OTHER
NC — NON COLLISION
FAT. — FATAL
INJ. — INJURY

COUNTY	CITY	# FAT-AITY	# INJ-URY	# OF ACCI. INVOLVING INJURY #: 1	2	3	4	5 & ABOVE	# OF ACCIDENTS: FATAL	INJ.	PDO	TOTAL	COLLISION TYPE(INJ. & FATAL ACCI.): SD	AN	HO	SPV	SPO	LT	PED	PC	OT
10-HUNTERDON	1-BETHLEHEM TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	2-CLINTON TWP.	-	1	1	-	-	-	-	-	1	-	1	-	-	-	-	-	-	1	-	-
	3-DELAWARE TWP.	-	1	1	-	-	-	-	-	1	-	1	-	1	-	-	-	-	-	-	-
	4-EAST AMWELL TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	5-FLEMINGTON BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	6-FRANKLIN TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	7-HAMPTON BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	8-HIGH BRIDGE BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	9-KINGWOOD TWP.	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	10-LEBANON TWP.	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	11-RARITAN TWP.	-	14	1	-	-	-	1 (13)	-	1	2	3	1	-	-	-	1	-	-	-	-
	12-READINGTON TWP.	-	2	-	1	-	-	-	-	1	1	2	1	-	-	-	-	-	-	-	-
	13-WEST AMWELL TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
TOTAL		-	18	3	1	-	-	1	-	4	14	18	2	1	-	-	1	-	1	-	-

LEGEND :-

SD	SAME DIRECTION	SPV	STRUCK PARKED VEHICLE	PED	PEDESTRIAN	NC	NON COLLISION
AN	ANGLE	SPO	STRUCK FIXED OBJECT	PC	PEDAL CYCLE	FAT.	FATAL
HO	HEAD ON	LT	LEFT TURN FROM OPPOSITE DIRECTION	OT	OTHER	INJ.	INJURY

COUNTY	CITY	# FATALITY	# INJURY	# OF ACCI. INVOLVING INJURY #: 1	2	3	4	5 & ABOVE	# OF ACCIDENTS: FATAL	INJ.	PDO	TOTAL	COLLISION TYPE (INJ. & FATAL ACCI.): SD	AN	HO	SPV	SPO	LT	PED	PC	OT
1-MERCER	1-EAST WINDSOR TWP.	-	1	1	-	-	-	-	-	1	3	4	-	1	-	-	-	-	-	-	-
	2-EWING TWP.	-	9	4	1	1	-	-	-	6	7	13	-	4	-	-	1	-	-	1	-
	3-HAMILTON TWP.	-	12	2	1	-	2	-	-	5	5	10	2	3	-	-	-	-	-	-	-
	4-HIGHTSTOWN BORO	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
	5-HOPEWELL TWP.	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	6-LAWRENCE TWP.	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
	7-PENNINGTON TWP.	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	8-PRINCETON TWP.	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	9-TRENTON	1	12	3	3	1	-	-	1	7	9	17	1	6	-	-	-	-	1	-	-
	10-WEST WINDSOR TWP.	-	7	-	1	-	-	1	-	2	2	4	-	-	-	-	-	-	-	-	-
TOTAL		1	41	10	6	2	2	1	1	21	38	60	3	14	-	-	1	-	1	1	-

LEGEND :-

SD	SAME DIRECTION	SPV	STRUCK PARKED VEHICLE	PED	PEDESTRIAN	NC	NON COLLISION
AN	ANGLE	SPO	STRUCK FIXED OBJECT	PC	PEDAL CYCLE	FAT.	FATAL
HO	HEAD ON	LT	LEFT TURN FROM OPPOSITE DIRECTION	OT	OTHER	INJ.	INJURY

COUNTY	CITY	# FAT-ALITY	# INJ-URY	# OF ACCI. INVOLVING INJURY #: 1	2	3	4	5 & ABOVE	# OF ACCIDENTS: FATAL	INJ.	PDO	TOTAL	COLLISION TYPE(INJ. & FATAL ACCI.): SD	AN	HO	SPV	SFO	LT	PED	PC	OT
12-MIDDLESEX	1-CARTERET BORO	-	6	-	-	-	-	1 (6 #)	-	-	4	4	-	1	-	-	-	-	-	-	-
	2-CRANBURY TWP.	-	1	1	-	-	-	-	-	1	1	2	-	1	-	-	-	-	-	-	-
	3-EAST BRUNSWICK TWP.	-	1	1	-	-	-	-	-	1	11	12	1	-	-	-	-	-	-	-	-
	4-EDISON TWP.	-	7	3	-	-	1	-	-	4	14	18	2	1	-	-	-	1	-	-	-
	5-JAMESBURG BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	6-OLD BRIDGE TWP.	-	25	4	1	-	1	2(6#+9#)	-	6	16	22	3	3	2	-	-	-	-	-	-
	7-METUCHEN BORO	-	3	-	-	1	-	-	-	1	3	4	-	1	-	-	-	-	-	-	-
	8-MILLTOWN BORO	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	9-MONROE TWP.	-	1	1	-	-	-	-	-	1	-	1	-	-	1	-	-	-	-	-	-
	10-NEW BRUNSWICK	-	2	-	1	-	-	-	-	1	6	7	-	-	-	-	-	-	-	-	1NC
	11-NORTH BRUNSWICK TWP.	-	-	-	-	-	-	-	-	-	6	6	-	-	-	-	-	-	-	-	-
	12-PERTH AMBOY	-	1	1	-	-	-	-	-	1	-	1	-	-	-	1	-	-	-	-	-
	13-PISCATAWAY TWP.	-	24	-	-	-	-	1(24 #)	-	-	4	4	1	-	-	-	-	-	-	-	-
	14-SAYREVILL BORO	-	2	2	-	-	-	-	-	2	2	4	1	1	-	-	-	-	-	-	-
	15-SOUTH AMBOY	-	2	-	1	-	-	-	-	1	1	2	-	1	-	-	-	-	-	-	-
	16-SOUTH BRUNSWICK TWP.	-	4	1	-	1	-	-	-	2	-	2	1	-	-	-	1	-	-	-	-
	17-SOUTH PLAINFIELD BORO	-	3	3	-	-	-	-	-	3	1	4	1	1	-	1	-	-	-	-	-
	18-WOODBRIDGE TWP.	-	17	1	3	1	-	1 (7 #)	-	5	16	21	2	2	-	-	1	1	-	-	-
TOTAL		-	99	18	6	3	2	5	-	29	88	117	12	12	3	2	2	2	-	-	1

LEGEND :-

SD ___ SAME DIRECTION	SPV ___ STRUCK PARKED VEHICLE	PED ___ PEDESTRIAN	NC ___ NON COLLISIO
AN ___ ANGLE	SFO ___ STRUCK FIXED OBJECT	PC ___ PEDAL CYCLE	FAT. ___ FATAL
HO ___ HEAD ON	LT ___ LEFT TURN FROM OPPOSITE DIRECTION	OT ___ OTHER	INJ. ___ INJURY

COUNTY	CITY	# FAT-ALITY	# INJ-URY	# OF ACCI. INVOLVING INJURY #: 1	2	3	4	5 & ABOVE	# OF ACCIDENTS: FATAL	INJ.	PDO	TOTAL	COLLISION TYPE (INJ. & FATAL ACCI.): SD	AN	HO	SPV	SFO	LT	PED	PC	OT
13-MONMOUTH	1-ABERDEEN TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	2-ASBURY PARK	-	2	2	-	-	-	-	-	2	1	3	-	1	-	-	-	-	1	-	-
	3-COLTS NECK TWP.	-	2	-	1	-	-	-	-	1	2	3	-	-	1	-	-	-	-	-	-
	4-DEAL BORO	-	1	1	-	-	-	-	-	1	2	3	-	1	-	-	-	-	-	-	-
	5-EATONTOWN BORO	-	1	1	-	-	-	-	-	1	2	3	-	1	-	-	-	-	-	-	-
	6-FREEHOLD BORO	-	3	-	-	1	-	-	-	1	1	2	-	1	-	-	-	-	-	-	-
	7-FREEHOLD TWP.	-	-	-	-	-	-	-	-	-	9	9	-	-	-	-	-	-	-	-	-
	8-HIGHLANDS BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	9-HOLMDEL TWP.	-	-	-	-	-	-	-	-	-	4	4	-	-	-	-	-	-	-	-	-
	10-HOWELL TWP.	-	7	3	-	-	1	-	-	4	6	10	1	1	1	-	-	1	-	-	-
	11-KEYPORT BORO	-	1	1	-	-	-	-	-	1	-	1	-	-	1	-	-	-	-	-	-
	12-LOCH ARBOUR VILLAGE	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	13-LONG BRANCH	-	8	1	-	-	-	1 (7 #)	-	1	3	4	-	-	-	-	1	-	-	1	-
	14-MANALAPAN TWP.	-	-	-	-	-	-	-	-	-	7	7	-	-	-	-	-	-	-	-	-
	15-MARLBORO TWP.	-	6	2	-	-	1	-	-	3	4	7	2	-	-	-	-	-	-	-	-
	16-MIDDLETOWN TWP.	-	3	1	1	-	-	-	-	2	9	11	1	-	-	-	-	-	-	-	1
	17-MILLSTONE TWP.	-	1	1	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-
	18-NEPTUNE TWP.	-	4	1	-	1	-	-	-	2	5	7	-	1	-	1	-	-	-	-	-
	19-TINTON FALLS BORO	-	2	2	-	-	-	-	-	2	-	2	1	1	-	-	-	-	-	-	-
	20-OCEAN TWP.	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
	21-OCEAN PORT BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	22-HAZLET TWP.	-	2	-	1	-	-	-	-	1	-	1	-	-	1	-	-	-	-	-	-
	23-RED BANK BORO	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
	24-RUMSON BORO	-	2	-	1	-	-	-	-	1	-	1	-	1	-	-	-	-	-	-	-
	25-SPRING LAKE BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	26-UPPER FREEHOLD TWP.	-	5	-	1	1	-	-	-	2	-	2	1	-	1	-	-	-	-	-	-
	27-WALL TWP.	-	2	-	1	-	-	-	-	1	3	4	1	-	-	-	-	-	-	-	-
	28-WEST LONG BRANCH BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
TOTAL		-	52	16	6	3	2	1	-	27	70	97	8	8	5	1	1	1	1	1	1

LEGEND :-

SD — SAME DIRECTION	SPV — STRUCK PARKED VEHICLE	PED — PEDESTRIAN	NC — NON COLLISION
AN — ANGLE	SFO — STRUCK FIXED OBJECT	PC — PEDAL CYCLE	FAT. — FATAL
HO — HEAD ON	LT — LEFT TURN FROM OPPOSITE DIRECTION	OT — OTHER	INJ. — INJURY

COUNTY	CITY	# FAT-ALITY	# INJ-URY	# OF ACCI. INVOLVING INJURY #: 1	2	3	4	5 & ABOVE	# OF ACCIDENTS: FATAL	INJ.	PDO	TOTAL	COLLISION TYPE(INJ. & FATAL ACCI.): SD	AN	HO	SPV	SFO	LT	PED	PC	OT
14-MORRIS	1-BOONTON TOWN	-	1	1	-	-	-	-	-	1	1	2	-	1	-	-	-	-	-	-	-
	2-BUTLER BORO	-	2	-	1	-	-	-	-	1	2	3	-	1	-	-	-	-	-	-	-
	3-CHATHAM BORO	-	2	-	1	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-
	4-CHESTER TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	5-DENVILLE TWP.	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
	6-DOVER TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	7-EAST HANOVER TWP.	-	11	-	-	-	-	1 (11#)	-	-	1	1	-	-	-	-	-	-	-	-	1NC
	8-FLORHAM PARK BORO	-	-	-	-	-	-	-	-	-	4	4	-	-	-	-	-	-	-	-	-
	9-HANOVER TWP.	-	2	-	1	-	-	-	-	1	1	2	1	-	-	-	-	-	-	-	-
	10-HARDING TWP.	-	1	1	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-
	11-JEFFERSON TWP.	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
	12-KINNELON BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	13-LINCOLN PORK BORO	-	1	1	-	-	-	-	-	1	-	1	-	1	-	-	-	-	-	-	-
	14-MADISON BORO	-	2	2	-	-	-	-	-	2	1	3	2	-	-	-	-	-	-	-	-
	15-MINE HILL TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	16-MONTVILLE TWP.	-	-	-	-	-	-	-	-	-	6	6	-	-	-	-	-	-	-	-	-
	17-MORRIS TWP.	-	1	1	-	-	-	-	-	1	5	6	1	-	-	-	-	-	-	-	-
	18-MORRIS PLAINS BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	19-MORRISTOWN TOWN	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
	20-MOUNT OLIVE TWP.	-	1	1	-	-	-	-	-	1	2	3	1	-	-	-	-	-	-	-	-
	21-PARSIPPANY TROY-HILLS	-	2	2	-	-	-	-	-	2	7	9	2	-	-	-	-	-	-	-	-
	22-PEQUANNOCK TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	23-RANDOLPH TWP.	-	2	2	-	-	-	-	-	2	1	3	-	1	-	-	-	1	-	-	-
	24-ROCKAWAY BORO	-	8	-	-	1	-	1	-	2	1	3	-	1	1	-	-	-	-	-	-
	25-ROCKAWAY TWP.	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	26-ROXBURY TWP.	-	4	1	-	1	-	-	-	2	5	7	1	1	-	-	-	-	-	-	-
	27-WASHINGTON TWP.	-	2	2	-	-	-	-	-	2	2	4	1	-	1	-	-	-	-	-	-
	T O T A L	-	42	14	3	2	-	2	-	20	56	76	11	6	2	-	-	1	-	-	1

LEGEND :-

SD — SAME DIRECTION	SPV — STRUCK PARKED VEHICLE	PED — PEDESTRIAN	NC — NON COLLISION
AN — ANGLE	SFO — STRUCK FIXED OBJECT	PC — PEDAL CYCLE	FAT. — FATAL
HO — HEAD ON	LT — LEFT TURN FROM OPPOSITE DIRECTION	OT — OTHER	INJ. — INJURY

COUNTY	CITY	# FAT-AITY	# INJ-URY	# OF ACCI. INVOLVING INJURY # 1	2	3	4	5 & ABOVE	# OF ACCIDENTS FATAL	INJ.	PDO	TOTAL	COLLISION TYPE(INJ. & FATAL ACCI.) SD	AN	HO	SPV	SPO	LT	PED	PC	OT
15-OCEAN	1-BEACHWOOD BORO	-	7	-	1	-	-	1	-	2	-	2	-	2	-	-	-	-	-	-	-
	2-BERKELEY TWP.	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	3-BRICK TWP.	-	11	1	1	1	-	1	-	4	10	14	1	1	-	-	1	-	-	1	-
	4-DOVER TWP.	-	15	1	3	1	-	1	-	6	10	16	2	4	-	-	-	-	-	-	-
	5-JACKSON TWP.	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
	6-LACEY TWP.	-	1	1	-	-	-	-	-	1	1	2	-	-	-	-	-	1	-	-	-
	7-LAKEWOOD TWP.	-	5	-	1	1	-	-	-	2	2	4	2	-	-	-	-	-	-	-	-
	8-MANCHESTER TWP.	-	1	1	-	-	-	-	-	1	2	3	-	1	-	-	-	-	-	-	-
	9-SOUTH TOMS RIVER BORO	-	1	1	-	-	-	-	-	1	2	3	-	1	-	-	-	-	-	-	-
	10-STAFFORD TWP.	-	-	-	-	-	-	-	-	-	4	4	-	-	-	-	-	-	-	-	-
	11-TUCKERTON BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
TOTAL		-	41	5	6	3	-	3	-	17	37	54	5	9	-	-	1	1	-	1	-

LEGEND :-

SD __ SAME DIRECTION; AN __ ANGLE; HO __ HEAD ON

SPV __ STRUCK PARKED VEHICLE; SPO __ STRUCK FIXED OBJECT; LT __ LEFT TURN FROM OPPOSITE DIRECTION

PED __ PEDESTRIAN; PC __ PEDAL CYCLE; OT __ OTHER

NC __ NON COLLISION; FAT. __ FATAL; INJ. __ INJURY

COUNTY	CITY	# FAT-AITY	# INJ-URY	# OF ACCI. INVOLVING INJURY #: 1	2	3	4	5 & ABOVE	# OF ACCIDENTS: FAT.	INJ.	PDO	TOTAL	COLLISION TYPE(INJ. & FATAL ACCI.): SD	AN	HO	SPV	SFO	LT	PED	PC	OT
16-PASSAIC	1-CLIFTON	-	5	1	2	-	-	-	-	3	4	7	-	-	1	-	-	1	-	-	1
	2-HALEDON BORO	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
	3-HAWTHORNE BORO	-	1	1	-	-	-	-	-	1	1	2	-	-	-	-	-	-	1	-	-
	4-LITTLE FALLS TWP.	-	7	-	-	-	-	1 (7 #)	-	1	3	4	1	-	-	-	-	-	-	-	-
	5-PASSAIC	-	2	2	-	-	-	-	-	2	6	8	-	-	-	-	-	-	2	-	-
	6-PATERSON	-	12	2	1	-	-	1 (8 #)	-	4	6	10	1	1	-	2	-	-	-	-	-
	7-POMPTON LAKES BORO	-	2	-	1	-	-	-	-	1	-	1	-	1	-	-	-	-	-	-	-
	8-RINGWOOD BORO	-	2	-	1	-	-	-	-	1	-	1	-	-	1	-	-	-	-	-	-
	9-TOTOWA BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	10-WAYNE TWP.	-	9	3	-	2	-	-	-	5	7	12	1	2	1	1	-	-	-	-	-
	11-WEST MILFORD TWP.	-	-	-	-	-	-	-	-	-	5	5	-	-	-	-	-	-	-	-	-
	12-WEST PATERSON BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	TOTAL	-	40	9	5	2	-	2	-	18	37	55	3	4	3	3	-	1	3	-	1

LEGEND :-

SD ___ SAME DIRECTION
AN ___ ANGLE
HO ___ HEAD ON
SPV ___ STRUCK PARKED VEHICLE
SFO ___ STRUCK FIXED OBJECT.
LT ___ LEFT TURN FROM OPPOSITE DIRECTION
PED ___ PEDESTRIAN
PC ___ PEDAL CYCLE
OT ___ OTHER
NC ___ NON COLLISION
FAT. ___ FATAL
INJ. ___ INJURY

COUNTY	CITY	# FAT-AITY	# INJ-URY	# OF ACCI. INVOLVING INJURY # 1	2	3	4	5 & ABOVE	# OF ACCIDENTS FAT.	INJ.	PDO	TOTAL	COLLISION TYPE(INJ. & FATAL ACCI.) SD	AN	HO	SPV	SFO	LT	PED	PC	OT
17-SALEM	1-LOWER ALLOWAYS CR.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	2-OLDMANS TWP.	-	2	-	1	-	-	-	-	1	-	1	-	-	1	-	-	-	-	-	-
	3-PENNSVILLE TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	4-PILESGROVE TWP.	-	2	-	1	-	-	-	-	1	1	2	-	-	1	-	-	-	-	-	-
	5-PITTSGROVE TWP.	-	1	1	-	-	-	-	-	1	1	2	1	-	-	-	-	-	-	-	-
	6-UPPER PITTSGROVE TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	T O T A L	-	5	1	2	-	-	-	-	3	5	8	1	-	2	-	-	-	-	-	-

LEGEND :-

SD	SAME DIRECTION	SPV	STRUCK PARKED VEHICLE	PED	PEDESTRIAN	NC	NON COLLISION
AN	ANGLE	SFO	STRUCK FIXED OBJECT	PC	PEDAL CYCLE	FAT.	FATAL
HO	HEAD ON	LT	LEFT TURN FROM OPPOSITE DIRECTION	OT	OTHER	INJ.	INJURY

COUNTY	CITY	# FAT-AITY	# INJ-URY	# OF ACCI. INVOLVING INJURY #: 1	2	3	4	5 & ABOVE	# OF ACCIDENTS: FAT.	INJ.	PDO	TOTAL	COLLISION TYPE(INJ. & FATAL ACCI.): SD	AN	HO	SPV	SFO	LT	PED	PC	OT
18-SOMERSET	1-BERNARDS TWP.	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
	2-BERNARDSVILLE BORO	-	3	1	1	-	-	-	-	2	-	2	-	1	-	-	1	-	-	-	-
	3-BOUND BROOK BORO	-	1	1	-	-	-	-	-	1	1	2	-	1	-	-	-	-	-	-	-
	4-BRANCHBURG TWP.	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
	5-BRIDGEWATER TWP.	-	1	1	-	-	-	-	-	1	4	5	-	1	-	-	-	-	-	-	-
	6-FRANKLIN TWP.	-	9	-	1	-	-	1 (7 #)	-	2	3	5	-	1	1	-	-	-	-	-	-
	7-HILLSBOROUGH TWP.	-	10	1	-	-	-	1 (9 #)	-	2	2	4	-	-	1	-	1	-	-	-	-
	8-MONTGOMERY TWP.	-	1	1	-	-	-	-	-	1	-	1	-	-	1	-	-	-	-	-	-
	9-NORTH PLAINFIELD BORO	-	1	1	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-
	10-RARITAN BORO	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	11-SOUTH BOUND BROOK BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	12-WARREN TWP.	-	1	1	-	-	-	-	-	1	1	2	-	-	1	-	-	-	-	-	-
	13-WATCHUNG BORO	-	1	1	-	-	-	-	-	1	-	1	-	1	-	-	-	-	-	-	-
	T O T A L	-	28	8	2	-	-	2	-	12	20	32	1	5	4	-	2	-	-	-	-

LEGEND :-

SD ___ SAME DIRECTION
AN ___ ANGLE
HO ___ HEAD ON
SPV ___ STRUCK PARKED VEHICLE
SFO ___ STRUCK FIXED OBJECT
LT ___ LEFT TURN FROM OPPOSITE DIRECTION
PED ___ PEDESTRIAN
PC ___ PEDAL CYCLE
OT ___ OTHER
NC ___ NON COLLISION
FAT. ___ FATAL
INJ. ___ INJURY

COUNTY	CITY	# FAT-AITY	# INJ-URY	# OF ACCI. INVOLVING INJURY #: 1	2	3	4	5 & ABOVE	# OF ACCIDENTS: FAT.	INJ.	PDO	TOTAL	COLLISION TYPE(INJ. & FATAL ACCI.): SD	AN	HO	SPV	SFO	LT	PED	PC	OT
19-SUSSEX	1-ANDOVER TWP.	-	1	1	-	-	-	-	-	1	-	1	-	-	1	-	-	-	-	-	-
	2-BRANCHVILLE BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	3-BYRAM TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	4-FRANKFORD TWP.	-	7	-	-	-	-	1 (7 #)	-	1	1	2	-	-	1	-	-	-	-	-	-
	5-FRANKLIN BORO	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	6-FREDON TWP.	-	6	-	-	-	-	1 (6 #)	-	1	-	1	-	1	-	-	-	-	-	-	-
	7-GREEN TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	8-HAMBURG BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	9-HAMPTON TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	10-HARDYSTON TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	11-HOPATCONG BORO	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	12-LAFA YETTE TWP.	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	13-NEWTON TOWN	-	3	1	1	-	-	-	-	2	1	3	-	2	-	-	-	-	-	-	-
	14-SPARTA TWP.	-	2	-	1	-	-	-	-	1	4	5	1	-	-	-	-	-	-	-	-
	15-STANHOPE BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	16-VERNON TWP.	-	-	-	-	-	-	-	-	-	4	4	-	-	-	-	-	-	-	-	-
	17-WANTAGE TWP.	-	4	-	-	-	1	-	-	1	1	2	-	-	-	-	-	-	-	-	1
	T O T A L	-	23	2	2	-	1	2	-	7	24	31	1	3	2	-	-	-	-	-	1

LEGEND :-
SD ___ SAME DIRECTION; AN ___ ANGLE; HO ___ HEAD ON
SPV ___ STRUCK PARKED VEHICLE; SFO ___ STRUCK FIXED OBJECT; LT ___ LEFT TURN FROM OPPOSITE DIRECTION
PED ___ PEDESTRIAN; PC ___ PEDAL CYCLE; OT ___ OTHER
NC ___ NON COLLISIO; FAT. ___ FATAL; INJ. ___ INJURY

COUNTY	CITY	# FAT-AITY	# INJ-URY	# OF ACCI. INVOLVING INJURY #: 1	2	3	4	5 & ABOVE	# OF ACCIDENTS: FAT.	INJ.	PDO	TOTAL	COLLISION TYPE(INJ. & FATAL ACCI.): SD	AN	HO	SPV	SFO	LT	PED	PC	OT
20-UNION	1-BERKELEY HEIGHTS TWP.	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	2-CLARK TWP.	-	1	1	-	-	-	-	-	1	3	4	-	-	-	-	1	-	-	-	-
	3-ELIZABETH	-	-	-	-	-	-	-	-	-	6	6	-	-	-	-	-	-	-	-	-
	4-FANWOOD BORO	-	2	-	1	-	-	-	-	1	-	1	-	-	1	-	-	-	-	-	-
	5-GARWOOD BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	6-HILLSIDE TWP.	-	4	2	1	-	-	-	-	3	3	6	-	2	-	-	-	-	1	-	-
	7-LINDEN	-	5	3	1	-	-	-	-	4	6	10	1	1	-	-	-	1	-	-	1NC
	8-MOUNTAINSIDE BORO	-	13	-	-	1	-	1 (10 #)	-	2	-	2	1	1	-	-	-	-	-	-	-
	9-PLAINFIELD	-	3	3	-	-	-	-	-	3	7	10	-	1	-	1	1	-	-	-	-
	10-RAHWAY	-	2	-	1	-	-	-	-	1	2	3	-	1	-	-	-	-	-	-	-
	11-ROSELLE BORO	-	5	-	-	-	-	1	-	1	1	2	-	-	1	-	-	-	-	-	-
	12-SCOTCH PLAINS TWP.	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	13-SPRINGFIELD TWP.	-	1	1	-	-	-	-	-	1	4	5	-	-	-	-	1	-	-	-	-
	14-SUMMIT	-	1	1	-	-	-	-	-	1	1	2	-	-	-	1	-	-	-	-	-
	15-UNION TWP.	-	2	-	1	-	-	-	-	1	5	6	-	1	-	-	-	-	-	-	-
	16-WESTFIELD TOWN	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	T O T A L	-	39	11	5	1	-	2	-	19	45	64	2	7	2	2	3	1	1	-	1

LEGEND :-

SD ___ SAME DIRECTION	SPV ___ STRUCK PARKED VEHICLE	PED ___ PEDESTRIAN	NC ___ NON COLLISION
AN ___ ANGLE	SFO ___ STRUCK FIXED OBJECT	PC ___ PEDAL CYCLE	FAT. ___ FATAL
HO ___ HEAD ON	LT ___ LEFT TURN FROM OPPOSITE DIRECTION	OT ___ OTHER	INJ. ___ INJURY

COUNTY	CITY	# FATAITY	# INJURY	# OF ACCI. INVOLVING INJURY #: 1	2	3	4	5 & ABOVE	# OF ACCIDENTS: FAT.	INJ.	PDO	TOTAL	COLLISION TYPE(INJ. & FATAL ACCI.): SD	AN	HO	SPV	SFO	LT	PED	PC	OT
21-WARREN	1-BLAIRSTOWN TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	2-FRELINGHUYSEN TWP.	-	1	1	-	-	-	-	-	1	-	1	-	-	1	-	-	-	-	-	-
	3-HARMONY TWP.	-	7	-	-	-	-	1 (7 #)	-	1	-	1	-	-	-	-	1	-	-	-	-
	4-INDEPENDENCE TWP.	-	4	1	-	1	-	-	-	2	-	2	1	-	-	-	1	-	-	-	-
	5-LOPATCONG TWP.	-	3	-	-	1	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-
	6-MANSFIELD TWP.	-	1	1	-	-	-	-	-	1	1	2	-	-	1	-	-	-	-	-	-
	7-PHILLIPSBURG TOWN	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	8-POHATCONG TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	9-WASHINGTON BORO	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	10-WASHINGTON TWP.	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	TOTAL	-	16	3	-	2	-	1	-	6	6	12	2	-	2	-	2	-	-	-	-

LEGEND :-

SD — SAME DIRECTION
AN — ANGLE
HO — HEAD ON
SPV — STRUCK PARKED VEHICLE
SFO — STRUCK FIXED OBJECT
LT — LEFT TURN FROM OPPOSITE DIRECTION
PED — PEDESTRIAN
PC — PEDAL CYCLE
OT — OTHER
NC — NON COLLISION
FAT. — FATAL
INJ. — INJURY

APPENDIX C

SURVEY

OF

NEW JERSEY SCHOOL DISTRICT

TRANSPORTATION COORDINATORS

The purpose of this appendix is to present additional details about the survey of the school district transportation coordinators for the purpose of soliciting information about their experiences as well as views on the subject of seat belts on school buses. Most respondents (37) answered the last, open-ended question and their comments are presented here verbatim, with the exception of some minor grammatical editorial corrections that were made to improve the readability of some comments. The survey instrument itself is included after the comments as well as one of the sample, individualized cover letters that were sent to the transportaion coordinators with the questionnaires. This Appendix concludes with some detailed statistics compiled from the responses.

TRANSPORTATION COORDINATORS' COMMENTS

1. Type I school buses since 1977 have been built specifically to insure pupils will be protected in all but the most severe accidents, such as large truck, train or high speed head on collision. The above type vehicular accident could cause other types of internal or orthopedic injury.

2. Crash testing has proven the value of a type II seat belt system as described in FMVSS 208 & 209 respectively. Such a system should be mandated for proper usage. In the normal environment such a system is only good if the user does it properly. Anything less than proper usage can actually increase injury potential. I favor the availability of such a system in all school vehicles, but doubt the effectiveness in a non-handicap transportation environment due to usage factors.

3. Our district is all special education students, been transported by the sending districts, the type II vehicle have belts in them, the type I do not. Our buses are not equipped with belts, our type II buses have them. The problem with special education students may be that half need help putting the belts on and taking them off. We decrease the harm in certain cases. I personally would like to see more time and money put into drivers training. I believe a good defensive driver, one who has been trained in the hazards of the road is much more effective than seat belts.

4. It is our feeling that seat belts on type I buses could be more hazardous than safe in a serious accident or fire where a driver was unconscious, chances are fewer children would escape uninjured.

5. Seat belts on type I vehicle seem very unnecessary due to the high back seats and the fact that no child has ever been killed while on a type I bus in the State of New Jersey. Also as an active driver I know it will be impossible to find a belt that fits an 18 year old child as well as a five year old child equally well. Letting the children to buckle up will also be impossible unless monitors are hired for each vehicle. I vote a resounding no because they are not necessary.

6. Purchasing new 20 passenger vehicle with color coded seat belts. Have had no problems with seat belts in 16 passenger vehicle. I personally think they would provide better control of children in addition to providing safety in an accident. We are an elementary district. Pre-school children are required to wear seat belts. The habit should be continued by requiring their use on the school bus.

7. There have been so many studies that proved that seat belts in school buses are not good, that I don't understand why we are constantly bombarded with "another study". I know parents find it hard to believe that they are safer without seat belts and politicians like to bring it up for votes, but enough already. A study needs to be done for the most dangerous point in a school bus side - getting on (and waiting at bus stop) and especially upon leaving the bus.

8. It is hard to believe when you look at the statistics of school bus safety that the State does not put the money that it would cost to equip type I school buses with seat belts where it is most needed. Statistics tell us that most fatalities happen on the outside of the school bus. What we need is a State wide uniform strictly enforced ingress and egress procedure for students. Seat belts on type I school buses would only serve the special interest group, not the students.

9. In an emergency situation such as fire or a student evacuation, drivers will not have sufficient time to evacuate the bus due to the students being buckled in. In an emergency situation the process of evacuation would take a great deal of time if students were buckled. My major concern is in the loading and unloading of students where accidents happen, much training is needed in this area. A new driver becomes a school bus driver in about 3 weeks. They are then placed behind the wheel with students on board with no required training. Mandatory course should be given when this new employee is hired.

10. Seat belts in type II buses are a necessity, however seat belts in type I buses would be a hazard and a danger to students.

11. Personally I feel seat belts are unsafe for students. The higher seat backs, extra padding and good discipline from the driver are enough. I feel students are safer not buckled in. The drivers constant buckle/unbuckle and continually observe 54 students and keep a run time. Also please reread "Pemberton Loop School Bus Barxe" from 1985/1986 school year. Fatalities would have occurred if those students had been buckled.

12. i) Enforcement of students wearing belts is going to be impossible without a bus attendant walking up and down the isles and demanding students to belt up. Students in general will not wear them.

ii) Installation on existing buses is going to be a legal matter. All buses have different materials such as foam, wood etc. under the rubber flooring. How will the tie down be anchored.

iii) Improvement should be geared to the danger zones outside of the bus. This is where the real safety concerns are. Gloucester twp. had injuries on several buses due to wet and slippery floors. These are areas to be more concerned about.

13. Discussion concerning the seat belt controversy in full size school buses continues.

Those in favor of seat belts in school buses are legislators who are not knowledgeable about school bus transportation. They are reaching to the issue with emotions instead of common sense. These individuals are trying to equate seat belts in a school bus with seat belts in a car.

Individuals opposing seat belts are those who drive school buses and who are actually involved in student transportation. Also opposed are those preparing budgets who find additional funding would be necessary to provide seat belts.

The State of New Jersey has no record of ever having a fatality while being transported in a school bus. A student is fifty (50) times safer riding in a school bus than in a private car. School bus transportation is the safest mode of transportation.

I am employed in a school district that would require an additional $150,000 to our transportation budget to have seat belts installed. School buses can be utilized for twelve (12) years, seat belts would probably have to be replaced every three (3) years at a cost of $1,100.00 per bus.

The only way to make sure each student is wearing their seat belt properly is to have an additional adult on each bus.

We transport both high school and elementary level students with the same buses, so consequently, each change of students will require seat belt adjustments.

The statement that "you can't worry about cost if it saves one life", I agree with. I'm as safety conscious as anyone, but the seat belts may cause the first death. Also, in the event a bus catches fire, evacuation would be more difficult. Seating on a school bus is not designed for comfort, but for safety. Seats are positioned close together with padded high backs to distribute the impact over the whole body in the event of an accident. If lap belts are used, the body will jack-knife and only the head will strike the seat in front.

I'm concerned that due to emotional feelings involved, the State will again over legislate, add additional cost to the taxpayers, and possibly ruin an excellent safety record that school buses now possess.

14. We must put the seat belt issue to rest... The Canadian crash test and surveys have shown us that the seat belt will not improve safety to any major degree... We must concentrate on the "DANGER ZONE"... We would be reaching our goal for safer buses by mandating electronic sensors, driver training, student and parent education on bus safety instead of seat belts.

Stiffer fines must be imposed on drivers who pass stopped school buses. Law enforcement agencies have to realize the growing number of motorist who pass stopped school buses. The people who are crying for seat belts have to take off their blinders and look at the statistics.

15. Having to make sure 54 kids are buckled up, without a monitor on the bus disturbs me. I think is more hazardous to children trying to get off a school bus in an emergency.

16. After seeing the Canadian study on seat belts I would not like to see them on buses. The only seat belt I would go for is a shoulder and lap belt, both for buses and for van type vehicles. Until a safe seat belt is devised I would like to see them taken off the vans. With very young children they wind up around their ankles.

17. Seat belts of school buses other than special needs vehicle are not conducive to total bus safety. Compartmentalization serves as proper buffer and/or safety zone for the passengers. Our passengers are safer inside of a school bus unbuckled than inside of the average passenger car buckled up. When some one explains why are/or most fatal and severe injuries occur outside of the bus and not inside perhaps then will take another look.

18. i) Difficult to evacuate large number of younger students in case of accident and/or fire if belted in.

ii) Nearly impossible to release students from belts if vehicle is not in an upright position.

iii) Belts extremely hazardous if vehicle should be submerged in water. (on side or up-side-down)

Studies and films made by Canadian ministry of transportation are a must for any group considering installation of seat belts in Type I school buses.

19. Most students will not wear the seat belts. The students who would consider wearing them won't do so because of peer pressure. The seat belts would be cut or pulled out adding another expense to already high repair bills.

20. i) This study is a waste of State and Federal money since the resent studies have finally decided seat belts are not cost effective.

ii) This money would be better spent on driver and student training. That's where the accidents are happening.

21. It might be beneficial to all concerned to have a representative of your group attend a meeting of the school transportation supervisor's of New Jersey, a forum and question and answer session could be arranged easily.

22. We are a State agency and do not actually own or contract any buses. However, in my travels throughout the State of New Jersey and in conversation with transportation people, I sense that the transportation supervisors are not eager to have seat belts on large buses. The Federal Government has not set a standard for seat belts in large buses and many are afraid of the liability.

23. If you equip a bus with seat belts it will probably necessitate placing an aid on each vehicle to oversee changing belts from high school size individual to a small as a kindergarten child.

24. If seat belts are required in type I buses the size of the seats will be large in height which will not allow the driver to see the pupils as they sit in each seat.

25. I advocate the use of seat belts in autos. The fact remains as to school buses the seats are compartments, high backs cushioned for safety. So far in my opinion school buses are the safest vehicles on the road today. Most of the injuries involving school buses are usually outside the bus in the danger zones. This is the area students need training and instruction so they understand the safety aspects in this zone.

26. Belts have not been proven effective. I feel money would be better spent perfecting a system of restraint that could be driver operated at control panels (i.e.-such as seen on amusement park rides).

Driver, student, parent, safety training is also in need of upgrading statewide.

Parents in our district, are especially positive with student and driver training programs in operation - kindergarten orientation for both parents and students includes 1/2 hour for "bus safety training" with emphasis placed on danger zones. 24 hours of in-service safety and driver training programs are required for all drivers yearly. These programs include assertive discipline techniques, defensive driving course, local and state police programs, etc...

27. My personal opinion is that seats on buses with 6 straps (for seating 3 children) would take up too much time to organize and put same belts on and take off of the little ones.

We have had this problem with a 19 passenger bus used for kindergarten, the small children to be able to come out of the lap type belt, no matter how tightly they are adjusted.

We also have had instances where older children have fastened seat belts across the isle to hinder children in getting off the bus.

28. It is my personal opinion that seat belts on type I vehicle are not necessary. The children are required to remain seated at all times. Elementary students are sometimes mischievous and may use the belts as a "toy". The driver will have no way of determining 100% usage. In case of an emergency evacuation it would be difficult to exit quickly because the kindergartners and 1st grade may need help. A driver, also, has many other priority concerns and for a driver to monitor usage of 58 seat belted children during a 20 minute run may be counter productive with the other major concerns each driver has.

Type II buses however, should have seat belts because more often than not these buses are used for transporting handicap children or other special needs and these buses are utilized with an aid.

29. Whatever decision is reached on seat belts in type I buses I would hope that some persons involved would spent at least one week riding school buses in as many districts as possible, and review the policies of those districts. If the requirements for assigned seating strict discipline and "good driving habit" are adhered to they result in the safe transportation of our students. If the supervisors and administrators "inspect" what they "expect" from their drivers throughout the school year, I think problems or hazards would be greatly reduced.

30. Any reasonable addition to school bus specifications that are certain to enhance safety would be welcomed by me. My concern with the lap belts methods, mandated by New York and being endorsed by the seat belt coalition, is that I have not seen conclusive proof that they enhance safety. Worse yet, I have exposed to test results and accident reports indicating that the lap belt may cause pelvic injuries due to direct pressure and impact of "whipping" of the head and neck. The liability my board would be exposed to and my "gut" fears of possible injury prevent me from specifying or installing lap belts.

31. I have been a strong supporter of safety belt use for more than twenty years, and have personally conducted programs to promote the use of seat belts. However, I do not feel seat belts should be installed in school buses for the following reasons.

i) The single purpose of a seat belt is to prevent the wearer from being ejected from a vehicle during the impact of an accident. A school bus does not have doors that may pop open on impact, nor are it's passengers likely to contact the windshield, due to compartmentalization of school bus seating.

ii) Our school district transports students whose weights range from 35 to 235 pounds on the same vehicles at different times of day. If all students used the belts, how can we assure that the belts are adjusted correctly for the wide range of student sizes.

iii) I feel seat belts on school buses would be horror show for our maintenance crew. Knotted and cut belts, jammed latches would take their time away from other safety related repairs.

32. After reading articles of seat belts I feel small elementary children would suffer from seat belts. Putting mandatory bus aides to help control children and co-operation with school administration will prevent accidents, driver safety

training courses and defensive driving courses would help more to produce better drivers. Radios on buses would help because of being able to reach out and get help with students who can't behave.

33. I believe the standards for bus seats are excellent and have saved many lives. Very few students die inside the bus. Why doesn't the subject of seat belts end and get to the real problem of students dying. That's outside the bus we run them over.

34. I feel the use of seat belts on type I vehicle would be misused rather than used. With the increased height of seats I see no need for belts.

35. Favor providing seat belts and or seat/lap/shoulder belts on all vehicles used to transport children. But to be used or not used by pupil as he/she is either trained or advised by parents. But definitely not a mandatory policy for each school district or school bus driver to enforce. The belt and buckle design must address the 'weapon' issue.

36. Big problem is who's going to buckle them up. For instance, in a bus full (40) of kindergarten students, the driver can't get out of the seat at each stop, shut off engine and hook the children up. What happens if a fire occurs who's going to unbuckle all these students. I myself have a hard time getting out of some seat belt and these are little children.

37. I believe that the installation of lap belts on school buses provides no additional margin of safety for children. I feel that belts may have the potential to harm children in the waist area in certain accidents. Compartmentalization at the bus interior seating areas protects school children far more effectively.

The installation of lap-shoulder belt combinations would at least alleviate the injury factor. However, current bus designs do not easily allow for such installations.

NEW JERSEY SCHOOL DISTRICT SURVEY ON SCHOOL BUS SEAT BELTS

It would be appreciated if you answer as many questions as possible. Feel free to make comments and qualify your answers. The last page contains space for general opinions and comments.

1. Does your district favor state legislation that will mandate the installation of seat-belts on Type I (standard 66 passenger) school buses?

   ☐ Yes ☐ No

2. If the State mandated seat-belts on Type I school buses would you prefer:

   ☐ Lap Belts ☐ Lap-Shoulder Belts

3. Do you allow standees on the school buses?

   ☐ Yes ☐ No

4. Please provide us with some information about your bus fleet.

	District Operated	Contractor Operated
Total number of Type I buses	_______	_______
Total number of Type II buses	_______	_______
Number of Post-1977 Type I buses	_______	_______
Number of Post-1977 Type II buses	_______	_______
Average age of Type I buses	_______	_______
Average age of Type II buses	_______	_______

5. What is the approximate number of pupils in your district in an average day? _______

   What is the approximate number of pupils transported by school bus in an average day? _______

6. Does your district provide transportation for pupils residing closer to the school than the minimum distance the state requires for funding?

   ☐ Yes ☐ No

7. Has your district adopted formal federal and state policies governing pupil transportation?

   ☐ Yes ☐ No

8. Are Type I school buses in your district equipped with seat belts now?

☐ Yes ☐ No

If all or some of your district's Type I buses are not equipped with seat belts, please answer the following Question No. 9.
If all Type I buses in your district are equipped with seat belts, please skip question No. 9 and go to question No. 10 to give us some information about your district's experience with seat belts.

9. School buses in your district are not equipped with seat belts because of the following reasons (Please check all that apply):

☐ It is not required by law.

☐ Belts will not improve safety

☐ Belts will cause more injuries than they are going to prevent

☐ Belts could be used as weapons by children

☐ Belts are not cost effective

☐ District is not able to bear the additional cost

☐ We are concerned with liability issues that the installation of belts may create.

☐ Other reasons. Please specify ____________

What is the attitude of parents towards seat belts on school buses?

☐ Supportive ☐ Indifferent ☐ Opposing Them

Please go to Question 11 on page 5, unless some of the Type I buses in your district are equipped with seat belts. In that case please answer the following Question No.10.

10. a) Have seat belts improved school bus safety in your district?

☐ Yes ☐ No ☐ I Don't Know

b) During the last school year were any students injured by a seat belt?

☐ No ☐ Yes How Many?____________

If Yes, Please indicate the general type of injury

i) ____________________________________

ii) ____________________________________

iii) ____________________________________

iv) ____________________________________

c) During the last school year were any students injured on a school bus in incidents that <u>did not</u> involve seat belts?

☐ No ☐ Yes How Many?__________

If Yes, Please indicate the general type of injury

i) ______________________________

ii) ______________________________

iii) ______________________________

iv) ______________________________

d) What is the attitude of parents towards seat belts on school buses?

☐ Supportive ☐ Indifferent ☐ Opposing Them

e) Insurance premiums for fully seat belt equipped buses versus non-equipped buses are:

☐ The same ☐ Lower ☐ I Don't Know

f) Does your district use monitors on school buses?

☐ No ☐ Yes

If monitors are used, please comment on their effectiveness in:

Enforcing seat belt use ______________________________

Enforcing general discipline ______________________________

Preventing accidents outside the bus ______________________________

The annual cost of monitors to the district is $__________

Please estimate the annual savings to the district from reduced damages to buses resulting from the presence of monitors $______

What percent of your buses have monitors on board in an average day?

☐ 1 to 25% ☐ 26 to 50%

☐ 51 to 75% ☐ 76 to 100%

g) According to your experience, does the use of seat belts on the school bus have a habit forming effect that carries over to student behavior and makes them "buckle-up" when they ride in private automobiles?

☐ Yes ☐ No ☐ I Don't Know

h) Which of the following problems, if any, has your district experienced with seat belts? (Please check all that apply)

☐ No Problems ☐ Cut Belt

☐ Removed Buckle ☐ Broken Buckle

☐ Improper Adjustment ☐ Belt Tied Together

☐ Belt Used as Weapon

☐ Other Problems. Please Specify ______________

i) On the basis of your district's experience, is money spent on seat belts justified?

☐ Yes ☐ No ☐ I Don't Know

j) Has your district ever faced any law suits resulting from the presence or absence of seat belts on school buses?

☐ Yes ☐ No ☐ I Don't Know

If Yes, please state briefly the case(s) and its disposition.

i) ______________________________

ii) ______________________________

iii) ______________________________

k) What percent of 20 passenger or larger buses of your own and/or contracted fleet are equipped with seat belts?

☐ 1 to 25% ☐ 26 to 50%

☐ 51 to 75% ☐ 76 to 100%

l) What percent of your students are using seat belts?

☐ 1 to 25% ☐ 26 to 50%

☐ 51 to 75% ☐ 76 to 100%

m) Please estimate the cost of repairing seat belts per vehicle per year

☐ $1 to $25 ☐ $26 to $50

☐ $51 to $75 ☐ $76 to $100

☐ $101 to $200 ☐ Over $200

n) Does your district have an educational campaign in effect for seat belts?

☐ Yes ☐ No

If Yes, Please describe briefly the type of campaign for:

Students: i) ______________________________

ii) ______________________________

iii) ______________________________

Drivers: i) ______________________________

ii) ______________________________

iii) ______________________________

Parents: i) ______________________________

ii) ______________________________

iii) ______________________________

11. Please feel free to make any comments on the subject of seat belts on school buses that you deem appropriate.

____

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Your answers to this survey are confidential. The forms will be seen only by the NJIT research team, and only summaries will be included in the final report. Individuals and districts will not be identified anywhere.

For our own information and in case we may have to contact you for some follow-up questions could you please provide us voluntarily with your:

Name: ________________________________

Telephone: ________________________________

District: ________________________________

Address: ________________________________

____

Thank you very much for the time you took to respond to our questions.

Please return the survey using the self addressed label that was enclosed, or address your own envelope to:

Athanassios K. Bladikas
New Jersey Institute of Technology
University Heights/ 502W
Newark, NJ 07102

New Jersey Institute of Technology

Center for Transportation Studies and Research

July 14, 1989

ist

Dear

As you may already know, the Center of Transportation Studies and Research of the New Jersey Institute of Technology is conducting for the Office of Highway Traffic Safety a State Legislature mandated study on whether seat belts should be required on all Type I school buses.

As a person who deals with the transportation of pupils on a daily basis you are knowledgeable about the issue and familiar with all arguments of the proponents as well as opponents of seat belts. In addition, the decision of the New Jersey State Legislature will have a direct impact on the way you discharge your responsibilities.

Your knowledge and position make your opinion and concerns invaluable to us, and we would appreciate it very much if you could take a few minutes to complete the enclosed survey. A return address label is enclosed for your convenience. If you prefer you may call me at (201) 596-3649 and provide us with your answers orally. The survey is completely confidential and you or your district will not be identified in our report. If you do not have an answer for some of our questions you may skip them, but please try to answer as many questions as possible. Please feel free to call if you have any additional questions or comments, and we will be glad to visit with you for a more extended discussion if you so desire.

Thank you in advance for your valuable contribution to our study.

Sincerely yours,

Athanassios K. Bladikas
Associate Director

Newark, New Jersey 07102
(201) 596-3355

SUMMARY OF NJ SCHOOL BUS DISTRICT SURVEY ON SCHOOL BUS SEAT BELTS

COUNTY	QUESTIONNAIRES SENT	NUMBER RECEIVED	PERCENTAGE RESPONSE
1-ATLANTIC	6	2	33%
2-BERGEN	7	1	14%
3-BURLINGTON	33	11	33%
4-CAMDEN	8	6	75%
5-CAPE MAY	4	2	50%
6-CUMBERLAND	5	0	0%
7-ESSEX	12	6	50%
8-GLOUCESTER	14	6	43%
9-HUDSON	1	1	100%
10-HUNTERDON	4	3	75%
11-MERCER	20	7	35%
12-MIDDLE SEX	16	3	19%
13-MONMOUTH	26	4	15%
14-MORRIS	16	7	44%
15-OCEAN	19	8	42%
16-PASSAIC	7	1	14%
17-SALEM	0	0	-
18-SOMERSET	7	2	29%
19-SUSSEX	7	1	14%
20-UNION	3	2	67%
21-WARREN	2	0	0%
NJ TOTAL	217	73	34%

SUMMARY OF NJ SCHOOL BUS DISTRICT SURVEY ON SCHOOL BUS SEAT BELTS

QUESTION NUMBER	NUMBER	PERCENTAGE
Q#_1		
_YES	8	11%
_NO	55	75%
_NO ANSWER	10	14%
Q#_2		
_LAP BELT	23	32%
_LAP-SHOULDER BELT	40	55%
_NO ANSWER	10	14%
Q#_3		
_YES	0	0%
_NO	71	97%
_NO ANSWER	2	3%
Q#_6		
_YES	64	88%
_NO	7	10%
_NO ANSWER	2	3%
Q#_7		
_YES	59	81%
_NO	9	12%
_NO ANSWER	5	7%
Q#_8		
_YES	5	7%
_NO	65	89%
_NO ANSWER	3	4%
Q#_9		
_a)	58	79%
_b)	39	53%
_c)	46	63%
_d)	44	60%
_e)	16	22%
_f)	10	14%
_g)	29	40%
_h)	13	18%
_SUPPORTIVE	12	16%
_INDIFFERENT	41	56%
_OPPOSING THEM	5	7%
_NO ANSWER	7	10%

	NUMBER	PERCENTAGE
Q#_10		
_a)		
_YES	5	
_NO	3	
_DON'T KNOW	6	
_b)		
_YES	1	
_NO	13	
_NO ANSWER		
_c)		
_YES	3	
_NO	15	
_NO ANSWER		
_d)		
_SUPPORTIVE	8	
_INDIFFERENT	11	
_OPPOSING THEM		
_e)		
_THE SAME	0	
_LOWER	1	
_DON'T KNOW	18	
_f)		
_YES	10	
_NO	11	
_NO ANSWER		
1--25%	4	
26--50%	1	
51--75%	2	
76--100%	2	
_g)		
_YES	4	
_NO	1	
_DON'T KNOW	12	

	NUMBER	PERCENTAGE
_h)		
1.	5	
2.	2	
3.	7	
4.	4	
5.	6	
6.	8	
7.	6	
8.	1	
_i)		
_YES	7	
_NO	2	
_DON'T KNOW	8	
_j)		
_YES	0	
_NO	15	
_DON'T KNOW	2	
_k)		
1--25%	6	
26--50%	3	
51--75%	0	
76--100%	4	
_l)		
1--25%	8	
26--50%	3	
51--75%	0	
76--100%	3	
_m)		
$1--$25%	4	
$26--$50%	1	
$51--$75%	0	
$76--$100%	1	
$100--$200%	2	
>$200%	2	
_n)		
_YES	8	
_NO	9	
_NO ANSWER		

Q# 4:

_MEAN; TYPE I (DISTRICT AND CONTRACTOR OPERATED) = 30
_S.D.; TYPE I (DISTRICT AND CONTRACTOR OPERATED) = 42

_MEAN; TYPE II(DISTRICT AND CONTRACTOR OPERATED) = 16
_S.D.; TYPE II(DISTRICT AND CONTRACTOR OPERATED) = 39

_% BUSES; TYPE I (DISTRICT & CONTRACTOR OPERATED)= 67%
_% BUSES; TYPE II(DISTRICT & CONTRACTOR OPERATED)= 33%

_PERCENT BUSES; TYPE I (DISTRICT OPERATED) = 55%
_PERCENT BUSES; TYPE I (CONTRACTOR OPERATED) = 45%

_PERCENT BUSES; TYPE II (DISTRICT OPERATED) = 66%
_PERCENT BUSES; TYPE II (CONTRACTOR OPERATED) = 34%

_% BUSES; TYPE I; POST-77 (D & C OPERATED) = 42%
_% BUSES; TYPE I; PRE-77 (D & C OPERATED) = 58%

_% BUSES; TYPE II; POST-77 (D & C OPERATED) = 56%
_% BUSES; TYPE II; PRE-77 (D & C OPERATED) = 44%

_MEAN AGE OF BUSES; TYPE I = 5 YEARS
_STANDARD DEVIATION OF AGE; TYPE I = 2 YEARS
_RANGE OF AGE; TYPE I = 1 MONTH -- 10 YEARS

_MEAN AGE OF BUSES; TYPE II = 5 YEARS
_STANDARD DEVIATION OF AGE; TYPE II= 2 YEARS
_RANGE OF AGE; TYPE II = 1 YEAR -- 10 YEARS

Q# 5:

_MEAN OF NUMBER OF PUPILS = 3777
_STANDARD DEVIATION OF # OF PUPILS = 5007
_RANGE OF NUMBER OF PUPILS = 65 -- 40,000

_MEAN OF # OF PUPILS TRANSPORTED = 2615
_S.D. OF # OF PUPILS TRANSPORTED = 2368
_RANGE OF # OF PUPILS TRANSPORTED = 65 -- 13200
_PERCENT OF PUPILS TRANSPORTED = 69%