Log H-491B

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: May 1, 1987

In reply refer to: H-87-13 through -16

State Directors of Pupil Transportation
(see attached list)

In 1977, a series of special Federal motor vehicle safety standards went into effect, mandating a higher level of safety for schoolbuses compared to other buses, but data on the crash performance of large schoolbuses built to Federal schoolbus standards have been lacking. Therefore, the Safety Board conducted a series of in-depth accident investigations from 1984 to 1986 on the crash performance of schoolbuses built to Federal schoolbus standards to determine how well the standards are working to protect passengers from injury and whether changes in the standards are needed. 1/

The crash investigation phase of this study, comprising 43 accidents, was conducted by headquarters staff and seven of the Safety Board's field offices located around the country. State and local school transportation officials, law enforcement officers, hospitals, and safety advocates were asked to notify Safety Board investigators when schoolbus accidents meeting the following criteria occurred.

The large schoolbus (weighing more than 10,000 pounds) was manufactured after April 1, 1977, was occupied by school age children, and

- the schoolbus was involved in a moderate speed collision that disabled the bus (occupant injuries need not have resulted); or
- the schoolbus overturned; or
- one or more of the schoolbus occupants was seriously injured or killed in the accident (the accident could be any type).

Obviously, given the Safety Board's limited workforce, it could not investigate every schoolbus accident which met these criteria. In addition, notification was sometimes not received or received too late for follow-through on accidents potentially of interest. Priority was given to the investigation of schoolbus accidents involving rollover or side impact, since injury data are particularly lacking in these types of accidents, and these types of accidents have generated the most occupant protection discussion.

1/ For more detailed information read Safety Study--"Crashworthiness of Large Poststandard Schoolbuses" (NTSB/SS-87/01).

During the 29 months this study was conducted, the Safety Board probably investigated every accident involving a large poststandard schoolbus which resulted in a schoolbus passenger fatality, most, if not all of the crashes which resulted in a serious or greater injury, and many of the crashes which produced moderate injuries. The Safety Board's study definitely was slanted towards the more serious rather than the minor schoolbus accidents, but this was precisely what the Safety Board intended. These are the crashes in which shortcomings in occupant protection will be more apt to be revealed. The Safety Board was not attempting to conduct a census of all schoolbus accidents in the United States, nor was it attempting to conduct a statistical sample of all injury-producing schoolbus accidents.

In each case, any damage to the exterior or interior of the schoolbus was carefully documented and medical information about each injured driver and passenger was obtained by interviewing the surviving occupants, parents, school officials, and medical personnel, and reviewing hospital records when available. The injury information was used to classify each injury according to the Abbreviated Injury Scale, a well recognized system for classifying the severity of physical injuries.

The Safety Board highway investigators also reconstructed the sequence of accident events for each schoolbus in the study, and attempted to determine when in the accident sequence schoolbus occupants were injured and the probable contact point(s) that produced their injuries. Using this information, the Safety Board also analyzed each schoolbus passenger's experience to determine the difference, if any, lap belt use would have made.

Because this study was undertaken solely to provide real-world data on how well modern schoolbuses protect occupants during a crash, it was not necessary to determine what caused the accident (the "probable cause"). Therefore, precrash factors (roadway condition, driver error or training and selection, discipline problems on the bus, improper passing by drivers of other vehicles, etc.) were not analyzed. Postcrash factors (evacuation and emergency medical care) also were not addressed except to distinguish between injuries sustained during the crash and those sustained during the evacuation. (Most injuries were sustained during the crash.) The study focused solely on events during the crash: how well did the bus perform; how did occupants sustain their injuries, if any; and how serious were the injuries.

Schoolbus passengers fared very well in the crashes investigated for the study, despite the fact that the accidents selected for investigation were slanted toward more serious schoolbus accidents. Ninety percent of the 1,119 unrestrained schoolbus passengers in the study sustained no injuries or only minor injuries as their most severe injury; 5.1 percent received moderate injuries as their most severe; and only 3.6 percent sustained more than moderate injuries. (Outcome for 1.3 percent of the occupants was unknown.) As a subset of the entire accident sample, those accidents involving a rollover had relatively similar passenger injury outcomes.

The Safety Board concluded that, overall, the schoolbus passengers in its cases would have received no net benefit from lap belt use. This finding of no overall benefit does not include the possibility of lap belted-induced injuries; if this possibility is counted, the introduction of lap belts would have had a negative effect on these passenger's safety.

Driver lap belt installation and use is an entirely different matter. The driver of a schoolbus is seated in a considerably more vulnerable position than a schoolbus passenger.

The driver is surrounded by large, potentially dangerous areas of metal and glass, with the steering wheel, gearshift, and stairwell, in the immediate vicinity, while a passenger is in a more protected environment with padded seats in front and behind. In the past the Safety Board has issued safety recommendations that schoolbus drivers should be provided safety belts at their seating positions (such restraints were not always required for bus drivers) and has recommended that the schoolbus driver wear his or her safety belt whenever the vehicle is in motion.

Today lap belts now are routinely available for drivers of large schoolbuses, and Federal safety standards recommend that all schoolbus drivers be required to wear their seat belts whenever the bus is in motion. 2/

The recommendation that a schoolbus driver be restrained is based on more than the need to provide some form of occupant protection for the driver; proper lap belt use by the driver helps protect the schoolbus passengers as well. A driver must remain in his or her seat at all times and in control of the vehicle to be able to take evasive maneuvers if needed, and to minimize the consequences of the crash for all schoolbus occupants. A driver who has fallen from his or her seat due to a sudden swerve, impact, or rollover has relinquished control of the vehicle and is unable to influence the outcome of subsequent crash events.

Nevertheless, only slightly more than half of the schoolbus drivers in the study were wearing their available lap belts at the moment of the crash. Drivers were even unrestrained in buses which had restrained passengers.

Even more disturbing, many drivers who reported they were restrained probably were not wearing their lap belts properly, and thus were not afforded the full benefits of the restraint. In some cases in this study it is apparent that, although the schoolbus drivers were wearing their lap belts, the belts were improperly worn and thus allowed the drivers to slip off their seats, resulting in the loss of control of the bus.

The type of driver lap belt currently installed in most schoolbuses may favor such improper use. Most lap belts installed for schoolbus drivers are equipped with nonlocking retractors on each side of the belt to store belt webbing when the lap belt is not in use. When the belt is fastened around the driver, these storage retractors provide some tension or feeling of tightness to the belt. Unfortunately, drivers may assume these storage retractors are automatic or emergency locking retractors, i.e., that the retractors will stay locked in a crash so no additional belt can be played out. This is not the case; drivers must manually pull all the webbing out of both of the retractors and tighten both sides of the lap belt around them before the belt is properly "snugged up." If this is not done, all of the belt may play out in a crash, leaving the driver with a lap belt far too loose to provide proper restraint.

Indeed, an unadjusted belt can allow drivers to fall completely off their seat while still wearing the belt. Clearly, a belt worn so loosely will not provide any degree of restraint. Unfortunately, many drivers and school district personnel appear unaware of the hazards of wearing an unadjusted belt.

Improper lap belt wearing was involved in the Swink, Oklahoma, accident. In this accident, the driver lost control of her bus, the bus left the roadway, and rolled over. Twenty-seven passengers and the driver were injured. The schoolbus driver stated

2/ Federal Highway Safety Program Standard (HSPS) 17 — -Pupil Transportation Safety.

that she was wearing her lap belt but that it did not restrain her. Investigators found the lap belt was fully extended. It had played out completely during the crash because both sides had not been manually "snugged up" as this type of belt requires.

In a few cases, the lack of proper restraint for the driver clearly led to passenger injuries. For example, in the fatal schoolbus accident in Carmel, New York, the driver slipped from her seat when the bus went out of control and left the road. The bus eventually veered back onto the road and went off the other side of the road. Events which occurred in the second runoff subsequently resulted in the death of one of the passengers. The driver in this case may have had her belt partially on at the onset of the accident, or she may have been not wearing the belt at all, but it was clear she had fallen from her seat before the second runoff and thus could not control the bus. If the driver had remained in her seat, she might have regained control of the bus in time to prevent the second runoff and thus would have prevented the passenger's death and the other passengers' injuries (all injuries occurred during the second runoff).

Of course, lap belt use is recommended for schoolbus drivers for more than increased control of the vehicle. Restraint use hopefully increases the chances the driver will be conscious following the crash and able to direct evacuation efforts, thus sparing passengers from postcrash injuries. The most dramatic example is a schoolbus overturn near Caldwell, Texas. When the schoolbus struck a dirt embankment and overturned, it trapped a student's leg between the bus and ground. A fire broke out shortly following the crash. The schoolbus driver had been restrained during the rollover and was uninjured so she was able to direct rescue efforts. All passengers were safely evacuated from the bus; the trapped student was freed minutes before the fire reached her seat.

In the Durango, Colorado, accident, the bus had rolled down a mountain embankment and had come to rest in an icy river. Passengers easily could have panicked. Although the restrained driver sustained two broken ribs and multiple contusions during the rollover, he was conscious and able to direct evacuation efforts.

In only one case in this study did a seat belt clearly fail. The driver in the Fort Myers, Florida, accident was released by her lap belt upon impact. This lap belt was removed by Safety Board investigators and tested in a laboratory, revealing that the buckle latch was faulty because a component was bent from its proper position. The Safety Board has since investigated a rollover case in Lincolnton, North Carolina, involving a latch plate failure by this make of belt, a Beam 300. The Beam 300 lap belt has a metal flap type latch plate similar to those found in airplanes.

There is some suggestion that these two accidents involving lap belt buckle failure are not isolated occurrences. The Safety Board has learned that in 1979, Canada recalled 710 Thomas Built buses manufactured from July 1, 1978, to June 11, 1979, because "the driver's seat belt buckle (Beam double adjust model) may only partially engage and may not adequately restrain the wearer in a vehicle crash" (Transport Canada recall #79205, issued December 4, 1979). Canadian files also contain a formal complaint filed in 1982 by a school board in Windsor, Nova Scotia, alleging that the Beam 300 buckle comes unfastened when the driver "moves his position on seat." The school board noted that the same Beam 300 seat belts were on all the 1976-1978 General Motors school buses in their fleet.

Prompted in part by the Safety Board's two cases of buckle failure, the National Highway Traffic Safety Administration's (NHTSA) Office of Defects Investigations has undertaken a preliminary evaluation of Beam 300 seat belts manufactured from 1978 through 1979. Latch disengagement was cited as the reason for the defects investigation.

The NHTSA has rulemaking underway to eliminate these flap type release latchplates now allowed in buses weighing over 10,000 pounds and to require push button release buckles similar to those required in passenger cars. This rule, if enacted, would eliminate the type of Beam 300 latchplate found in the Fort Myers accident bus and in the North Carolina accident.

The same rulemaking also contains a proposal that all lap belts for drivers of vehicles weighing over 10,000 pounds Gross Vehicle Weight Rating (GVWR) (including large schoolbuses) must be equipped with emergency locking retractors. The Safety Board understands that the NHTSA is now considering amending the proposal to also allow automatic locking retractors in driver lap belts. Such automatic locking retractors would have to be especially designed not to "rachet-up" because of vehicle motion. Otherwise, they could become quite uncomfortable for the driver.

Regardless of what type of locking retractors are required, the NHTSA proposal would go a long way toward eliminating the problem of unadjusted lap belts found in the Safety Board's study. It also would eliminate the latch plate problems observed. Rulemaking is in its final stages and a new rule is expected to be issued soon. Only new large schoolbuses, however, would be affected by the rule. The problems of poorly designed driver lap belts and improper belt use would remain on the older buses. Therefore, the Safety Board is issuing a recommendation that all large schoolbuses be retrofitted with safety belts which meet the new NHTSA requirements when enacted. This would ensure that drivers of old and new schoolbuses are afforded adequate restraints. The Safety Board also is issuing a recommendation that school districts instruct drivers on how to adjust properly the lap belts currently in the schoolbuses, because it may take time before all schoolbuses have improved lapbelts for drivers. On the average, schoolbuses are retired from the public school fleet after 10 to 12 years of service.

There is some question whether lap/shoulder belts should be considered for schoolbus drivers. Such belts clearly offer superior protection over lap belts for occupants of passenger cars; perhaps schoolbus drivers also would benefit from the upper torso restraint provided by lap/shoulder belts. However, analysis of the serious and worse injuries sustained by schoolbus drivers in this study does not support the need for lap/shoulder belt installation for schoolbus drivers. Intrusion was responsible for all the serious and above injuries, and no belt system can prevent injuries caused by intrusion. It is possible lap/shoulder belts might have prevented or mitigated some of the moderate injuries sustained by the schoolbus drivers, but the number of schoolbus drivers who sustained such injuries in the study is too small to support any conclusions. More study needs to be done before the safety benefits of lap/shoulder belts for schoolbus drivers can be evaluated.

Installation of lap/shoulder belts for schoolbus drivers also poses problems. It is unclear where the upper anchor for the shoulder portion could be located. The seat would probably have to be redesigned to permit the anchor to be part of the frame. Furthermore, the driver is surrounded by windows without the "B" pillar type structure available in passenger cars for shoulder anchorage.

The Safety Board understands Thomas Built Buses has developed a prototype lap/shoulder belt assembly for drivers and is investigating the feasibility of installation. They are not prepared to offer driver lap/shoulder belts on their large buses yet.

Even if the restraint systems available to all schoolbus drivers are improved, no safety benefits will result if the belt is not worn. For this reason, as a result of the study findings, the Safety Board re-emphasizes the need for schoolbus driver restraint use to be mandated and enforced. The Safety Board previously has made recommendations relating to seat belt availability and use by schoolbus drivers. Early recommendations called for seat belts to be installed for schoolbus drivers (at one time they were not standard equipment) and urged that schoolbus drivers use the available restraints. The most recent Safety Recommendation, H-83-41, was issued in 1983 to all Governors:

> Review State laws and regulations, and take any necessary legislative action, to ensure that drivers of schoolbuses are required to wear their seatbelts whenever the vehicle is in motion, that all schoolbus drivers are made aware of this requirement, and that periodic monitoring of schoolbus driver seatbelt use is conducted.

This recommendation has been closed for 18 States but is open for the remainder of the States. A 1984 survey conducted by the National School Transportation Association found that 42 States had requirements that schoolbus drivers wear their belts. The Safety Board believes that most States probably now have such requirements. However, judging by the low restraint rates seen in the study, enforcement appears deficient. Hence, as a result of this study, the Safety Board is issuing a new recommendation, superseding H-83-41 and reiterating the concept that schoolbus drivers need to be restrained and emphasizing enforcement.

Another area of concern to the Safety Board was the deficiencies in seat cushion attachment observed in the study. Schoolbus seat design clearly has improved with the enactment of Federal schoolbus safety standards. Seats on poststandard schoolbuses do not have the low seat backs with exposed metal frames and insufficient padding that were typical of buses built before 1977 and were responsible for many serious head injuries. Schoolbus seats now have increased padding, increased seat back height, and are placed closer together. Furthermore, the seat backs are designed to "give" in a controlled way when impacted by a person in the seat behind. In this study, contact with the seat back was not a significant source of injury on poststandard schoolbuses. If injuries did result, they almost always were minor bruises or abrasions.

Nonetheless, the crashworthiness of schoolbus seats needs improvement. In 16 of the 44 accidents investigated for the study, seat cushions came loose during the crash. In four crashes, all of the passenger seat bottom cushions came loose; in the other 12 crashes, the number of bottom seat cushions unsecured following the accident varied between 2 and 15.

Cushions came loose in all types of schoolbuses in the study and in all types of accidents. Rollovers were particularly apt to result in unsecured cushions.

The problem of unsecured seat cushions is confined to the bottom cushion. The top cushions are permanently secured to the seat frame, whereas most of the bottom cushions can be flipped up or removed to facilitate bus cleaning and other types of maintenance.

The lack of a fail safe method of fastening bottom seat cushions is potentially dangerous for a variety of reasons. During an accident, particularly during a rollover, loose cushions can become missiles, tumbling about the bus and striking passengers. In addition, students can injure their backs and other parts of their bodies if they fall through the open seat frames or contact the exposed frame.

Loose seat cushions pose yet another potential danger when they fall into the aisle and hamper or block passenger escape routes or emergency exits. This occurred in two cases in this study. A blocked exit could spell disaster in a fire or in any other type of accident where passengers evacuate the bus quickly.

Finally, loose cushions pose a threat to preschool or elementary school passengers. If seat cushions come loose in a bus, it is conceivable that loose cushions could hide an unconscious small child from view and thus prevent emergency rescue personnel from locating and rescuing a small child quickly.

In some accidents, the seat cushions came free because the seat cushion clips had not been secured to the seat frames before the accident. In other cases, the bottom seat cushions came free probably because the clips at the rear of the cushion were loose and free to rotate and, therefore, did not secure the cushion to the rear of the seat frame. In still other cases, the clips may have been properly secured to the seat before the accident but rotated to the unsecured position during the impact or rollover. In the Bladensburg, Maryland, schoolbus accident, a non-swivelling clip "failed" because the bus seats had been reupholstered, covering some of the clips in the process, and the clips were not properly resecured. Passengers were injured in this accident by contact with loose seat cushions and exposed seat support rails.

Even when not secured to the seat frame, seat cushions did not necessarily come loose and tumble around the passenger compartment during the accidents investigated by the Safety Board. The type of accident determined whether they came free. For example, in an activity bus accident in Bloomfield Township, Ohio, a 1984 Carpenter schoolbus crashed head-on into the side of a passenger car which had gone out of control. After the collision, the bus ran off the road into a 5-foot drainage ditch and came to rest on its right side at a 45° angle.

Following the accident, the Safety Board found that the bottom seat cushions of all passenger seats on the bus were unsecured but still resting on the seat frame. The Safety Board investigator found that all rear clips on the seats had rotated approximately 90° from the locked position. This allows the seat cushion to flip up and possibly become unhinged from the seat. In this crash, the accident dynamics were such that no seat cushion came loose. If the rollover had been more extreme, they could have come free.

Consequences of failure to secure the seat cushions in a more extreme rollover accident is illustrated by an accident in Swink, Oklahoma. This accident involved a 1982 Wayne bus in which all of the seat cushion clips had been left unsecured in order to facilitate sweeping the bus floor. Seven of the seat bottom frame clips could never have been fastened because the stationary front clips had been bent backward. When this bus made a 360° revolution, every bottom seat cushion came loose and tumbled around the passenger compartment. Cushions struck three students and inflicted abrasions and lacerations. When the bus came to rest upright, the cushions littered the aisle and obstructed evacuation. Fortunately, no fire followed the crash and all students had time to climb over and around the seat cushions and evacuate the bus.

The Safety Board understands that most, but not all schoolbus manufacturers intend to manufacture buses with seats permanently affixed to the seat frames. The Safety Board believes that permanent attachment will circumvent poor maintenance practices and improve the crashworthiness of the seats.

Permanent attachment is proposed, however, for some new schoolbuses only. The Safety Board urges those schoolbus manufacturers who, at present, do not have firm plans to implement permanent attachment to formulate such plans as rapidly as possible. In the meantime, the Board believes that if a company plans to manufacture new buses without permanent seat attachment, the company must ensure that the method of attachment used provides a means for schoolbus drivers, in their pretrip inspection, to ascertain visually from a standing position that the seat cushions are indeed securely fastened.

The problem of ensuring that seat cushions remain attached during a crash will persist in large and small schoolbuses currently in use. For this reason and based on the findings of this study, the Safety Board is issuing new recommendations designed to address the problem of loose seat cushions in existing schoolbuses.

Therefore, the National Transportation Safety Board recommends that State Directors of Pupil Transportation:

> Require that all lap belts for drivers of large schoolbuses, regardless of the age of the bus, satisfy the requirements of the Federal rule affecting lap belts on vehicles weighing more than 10,000 pounds Gross Vehicle Weight Rating when that rule is made final. Initiate retrofit programs as needed. (Class II, Priority Action) (H-87-13)
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> Require that school districts incorporate, as a regular part of training for new schoolbus drivers and for inservice programs, explicit instructions on how to adjust the driver's lap belt properly. When applicable, emphasize that the belt must be manually adjusted on both sides. (Class II, Priority Action) (H-87-14)
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> Enforce and publicize the existing regulation that schoolbus drivers must wear their seat belts whenever the school vehicle is in motion. (Class II, Priority Action) (H-87-15)
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> Advise school districts under your jurisdiction to emphasize to maintenance personnel that seat cushions must be securely reattached after removal and to remind schoolbus drivers to include seat cushion attachment as part of the pretrip inspection. (Class II, Priority Action) (H-87-16)

Also as a result of its investigation, the National Transportation Safety Board issued Safety Recommendations H-87-11 to the National Highway Traffic Safety Administration and H-87-12 to schoolbus body manufacturers. The Safety Board also reiterated H-86-57 to Thomas Built Buses, L.P. and H-84-75 to the National Highway Traffic Safety Administration.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "...to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its

safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations H-87-13 through -16 in your reply.

BURNETT, Chairman, GOLDMAN, Vice Chairman, and LAUBER and NALL, Members, concurred in these recommendations.

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